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MADRAS HIGHWAYS

THE JOURNAL

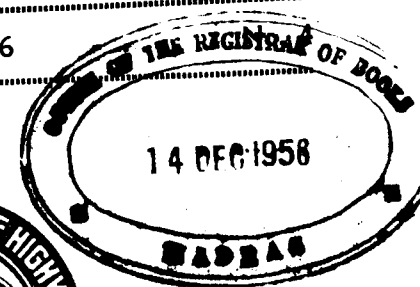
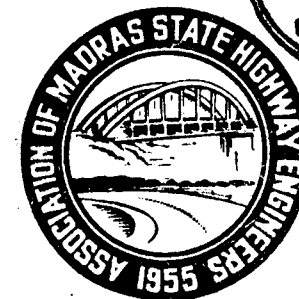
OF

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MADRAS STATE HIGHWAY ENGINEERS

Vol. I

October 1956

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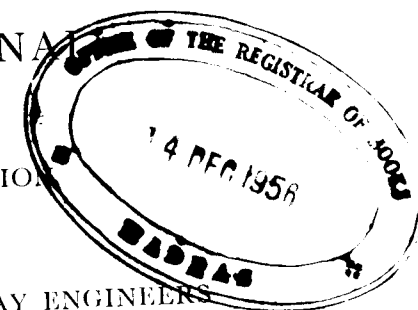
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from the
EDITOR



*The Views expressed by the authors of
the articles are purely their individual
Views and not those of association.*

It was just three years back that we parted from our brother engineers of Andhra State when that State came into existence in 1953. Again, now the new Mysore State and Kerala are formed and it is with feelings of sadness we are bidding farewell to some of our members belonging to West Coast districts of Malabar and South Kanara who are leaving us for service in the Mysore State and Kerala.

Engineers of this State had been brought up in a tradition of cosmopolitan outlook. Our department had been manned by engineers drawn by various linguistic groups and we had been able to work together like a happy family. We spoke different language at home but spoke only one language— the language of engineering when discharging our professional duties. Hence it is with deep regret we have to part from these colleagues. It is a matter of joy that still there will be a number of men in our department whose mother tongue is not Tamil thus keeping up our tradition. Though we will be missing these members at our annual sessions our consolation is we will have occasion to meet them at the national forum of Highway Engineers i.e. annual sessions of I. R. C. and learn their experiences in their new environments.

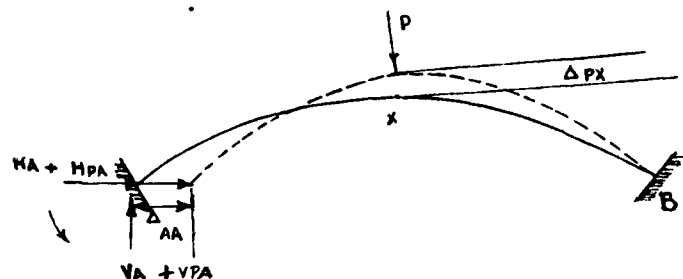


Fig. 1 (b)

The fig. 1-(a) shows a fixed arch subject to say forces H_A , V_A , and M_A , at the support A. Introduce a horizontal force H_A and move its point of application a horizontal distance of Δ_{AA} and in doing so there is no displacement in the direction of V_A and M_A . Hence the external work done by H_A on the frame is $\frac{1}{2} H_A \times \Delta_{AA}$. This must be equal to the internal work done (strain energy) by the stresses and strains (caused by H_A alone) throughout the arch.

$\therefore \frac{1}{2} H_A \times \Delta_{AA} = E_1$ (Internal work) — Follows from Castigliano's theorem.

Let Δ_{AX} be the displacement of any point X on the arch due to the displacement of Δ_{AA} .

Now apply an external load P on the arch at X. This load does external work equal to $P \times$ deflection at P (i.e.) Δ_{PX} . The application of load P causes reactions H_{PA} , V_{PA} and M_{PA} at the support and also internal stresses and strains. Since there is no displacement of H_P , V_{PA} and M_{PA} no work is done by these. Hence the internal work is equal to $\frac{1}{2} \times P \times \Delta_{PX}$.

$$(i.e.) \frac{1}{2} P \times \Delta_{PX} = E_2.$$

$$\therefore \text{Total internal work } E_1 + E_2 = \frac{1}{2} H_A \times \Delta_{AA} + \frac{1}{2} P \Delta_{PX} \dots (1)$$

By the principle of independence of forces the simultaneous application of H_A and P should result in the same internal work.

Hence,

$$E_1 + E_2 = \frac{1}{2} H_A \Delta_{AA} + \frac{1}{2} H_{PA} \times \Delta_{AA} + \frac{1}{2} P \times \Delta_{PX} - \frac{1}{2} P \times \Delta_{AX} \dots (2)$$

Equating (1) and (2)

$$H_{PA} \times \Delta_{AA} = P \times \Delta_{AX}$$

$$H_{PA} = \frac{\Delta_{AX} \times P}{\Delta_{AA}}$$

This is the fundamental equation upon which all mechanical analysis by means of deflections is based and may be stated thus:

“The load is to reaction as any arbitrary movement of the reaction point in the direction of the reaction is to the resulting movement of the load point in the direction of load”.

Make P equal to unity as required for influence lines, then,

$$H_{PA} = \frac{\Delta_{AX}}{\Delta_{AA}}$$

$$\text{If } P = 1$$

$$H_{1A} = \frac{\Delta_{AX}}{\Delta_{AA}}$$

(i.e.) The horizontal reaction at A due to a unit load at X is the ratio of the displacement at X to that of the given displacement at the support.

If Δ_{AA} is a known given quantity the Horizontal reaction is obtained by actual measuring the displacement at the load point.

BEGG'S DEFORMETER - GENERAL DESCRIPTION

This instrument, the most general in its application to structural analysis of any that have been developed to date is the invention of Prof. Geo E. Beggs of Princeton University and is recognised as standard apparatus for mechanical analysis.

A typical deformer consists in its three essentials (i) Model (ii) the gauge clamps and (iii) microscopes.

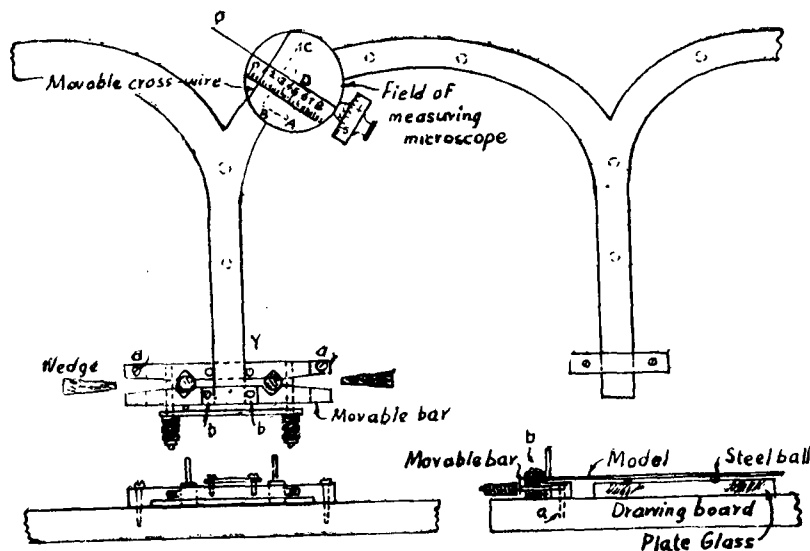


Fig. 2—Begg's Apparatus.

The model is usually cut from a thin sheet of Plastic material, celluloid being preferred on account of its permanence, strength and ease with which it may be worked although good results may be obtained with models of fiber and card board.

RELATIONSHIP BETWEEN MODEL AND PROTOTYPE

It is proved that,

$H_{1A} = \frac{\Delta_{AX}}{\Delta_{AA}}$ a relationship between actual deformations in the structure. But here we are measuring the deformations in the model and how these deflection ratios give the actual reaction is given below :

$$H_{1A} = \frac{\Delta_{AX}}{\Delta_{AA}}$$

But deflection at any point in a structure,

$$= \int \frac{M m d s}{E I} \quad \text{Where } M: \text{ Applied Moment.}$$

m : moment produced by auxiliary unit load.
 ds : an element of structure under consideration.

$$\therefore H_{1A} = \frac{\int M_A m \times ds / EI}{\int M_A m_A ds / EI} \dots (1) \quad \text{all forces and distances for the actual structure.}$$

Similarly in the model the reaction is

$$H_{1A}' = \frac{\int M_A' m_X ds' / E'I'}{\int M_A' m_A' ds' / E'I'} \dots (2)$$

The reduction factor for M_A , m_X and ds to get M_A' , m_X' and ds' are same for both the numerator and denominator of the two above equations (i.e.) linear.

Also E'/E is constant and hence If I'/I is constant the right hand side of both the equations are same and therefore, $H_{IA} = H_{IA}$.

Hence the depth of the various sections in the model should be proportional to the moment of inertia of the prototype.

DESCRIPTION OF THE INSTRUMENT

Gauges.—A gauge consists of two metal parallel bars each $4" \times \frac{1}{2}" \times \frac{1}{4}"$ shaped as shown in the figure:

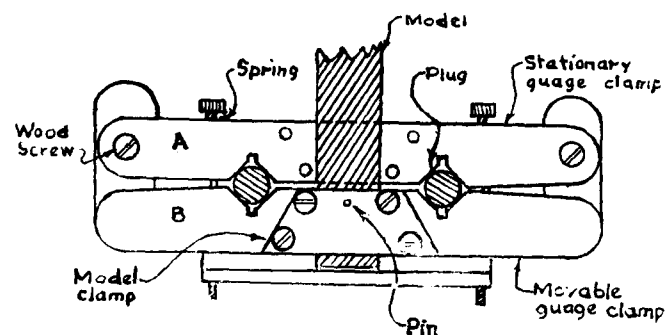


Fig. 3.

The bars are held together by two springs and the top bar has two holes in it so that when required it can be fixed to the drawing board and the movable bar has a hinge point near the inner edge in the middle. Both the arms are provided with clamping plates with four screws for each at the corners. The arms are grooved in V shape on each side of centre line. Usually six gauges are provided with each instrument.

Plugs.—In the V notches are inserted plugs. These are made of specially hard steel ground to a tolerance of $2/10,000"$. The tops of the plugs are

provided with coloured celluloid caps to distinguish between the various types. These are four types of plugs.

(a) **Normal Plugs.**—These have deep Yellow caps and they are all of equal diameter. They are called normal plugs as they are inserted in the opposing V-grooves of the metal arms when no deformation of the model is produced.

(b) **Thrust Plugs.**—These have red caps and they are of equal diameter but of bigger size than normal plugs. Similarly there are two plugs with white caps which are equal in diameter but lesser in size than the normal plugs. When the thrust plug is inserted the movable bar will be moved parallel to itself forward with red plugs and back with white plugs the movement will be about $1/40"$.

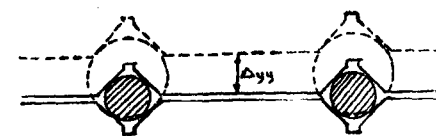


Fig. 3—Thrust.

(c) **Shear Plugs.**—These plugs have deep green caps. They are of equal diameter and equal size to the normal plugs but a portion of the circle is cut off so that the shape of the cross section of the plug is as shown in the figure. By introducing these plugs in place of the normal plugs the movable bar moves at right angles to itself *i.e.* it moves sideways. When the plugs are reversed so that the plane side of the plug comes in contact with the movable bar on the other side the movement of the bar takes place in a direction opposite to its first direction. The shear displacement is about $1/40"$.

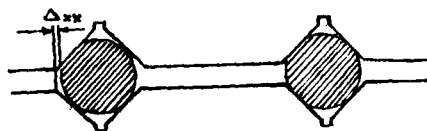


Fig. 4—Shear.

(d) **Moment Plugs.**—These are provided with black caps. The plugs are of unequal diameter, one being bigger than a normal plug by the same amount that another is smaller than the normal plug. The centre of the movable bar does not change its position but merely enables the movable bar to rotate round itself. By exchanging the bigger and smaller plugs, rotation in the opposite direction is obtained. The angle of rotation is about 0.28 of a degree.

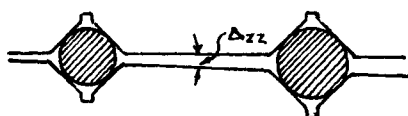


Fig. 5

(e) **Wedges.**—These are of ebonite and are in the form of a Cross. By driving in the wedges from the sides the two metal bars are separated a little so that the insertion or removal of plugs can be made with ease.

(f) **Filar Microscope.**—Filar microscopes provided with Beggs' apparatus have a few more facilities than the ordinary microscope. The eye piece rotates in the tube and can be placed in any desired direction. There is a scale attached inside the eye piece. There are two Cross hairs at right angles to each other which can be moved by manipulating the micrometer head. The eye piece is first turned round so that any of the cross wires may be in the desired direction and it is then clamped tightly by a screw provided for the purpose.

The cross hairs are then brought in line with the target mark made on the model. When the model is displaced the cross hairs are again moved to be in line with the target and the movement of the fork is measured on the micrometer head.

TECHNIQUE OF DEFORMATION OPERATION EXPLAINED

The object of the experiment was to check up the influence line diagram for reaction of a rigid frame (Noyyal Bridge) drawn by Moment Distribution Method.

(i) **Preparation of the model.**—The rigid frame model was prepared with celluloid sheets about 3/16" thick and the model was made 1/96 of the prototype. The load points were marked with a needle. To ensure very good results it is best to mark these target points with a blade keeping the model under microscope so that the lines marked on the model may be as thin as possible. This is very important. The target marks may be filled with Indian ink so that they would be very clearly visible under the microscope.

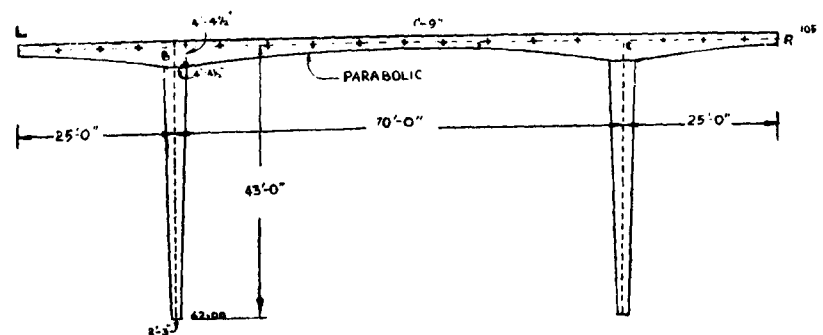


Fig. 6.

(ii) **Mounting the Model.**—A clean drawing paper is fixed on to the drawing board. A horizontal line is drawn and two vertical lines at the hinge points. The gauge clamps are taken out with the help of ebonite wedges and fixed on the drawing board over centre line marks, with the wooden screws keeping the normal plugs in the V notches. For the success of the analysis it is very important that these clamps are absolutely horizontal.

After fixing the clamps as mentioned above the model is fixed on to the clamp at its hinge points. The hole provided in the model must neither be too big or too small. It is better to make a small hole in the model at its hinge point and make it bigger by introducing the pins provided for this purpose in the apparatus. For good results the model must be firmly fixed at its hinge points to the clamp.

Errors will be greatly reduced by mounting the model in a way that will ensure frictionless movement. A very satisfactory support for the model consists of 3/8" steel balls such as used in bearings, placed directly under the celluloid and rolling over thin plate glass. The balls are held in place and the model is maintained in one plane by means of small weights placed directly just over the balls. On account of the tendency of the model to buckle, which changes the focus, both ball and weight should be placed close to the targets upon which readings are being taken.

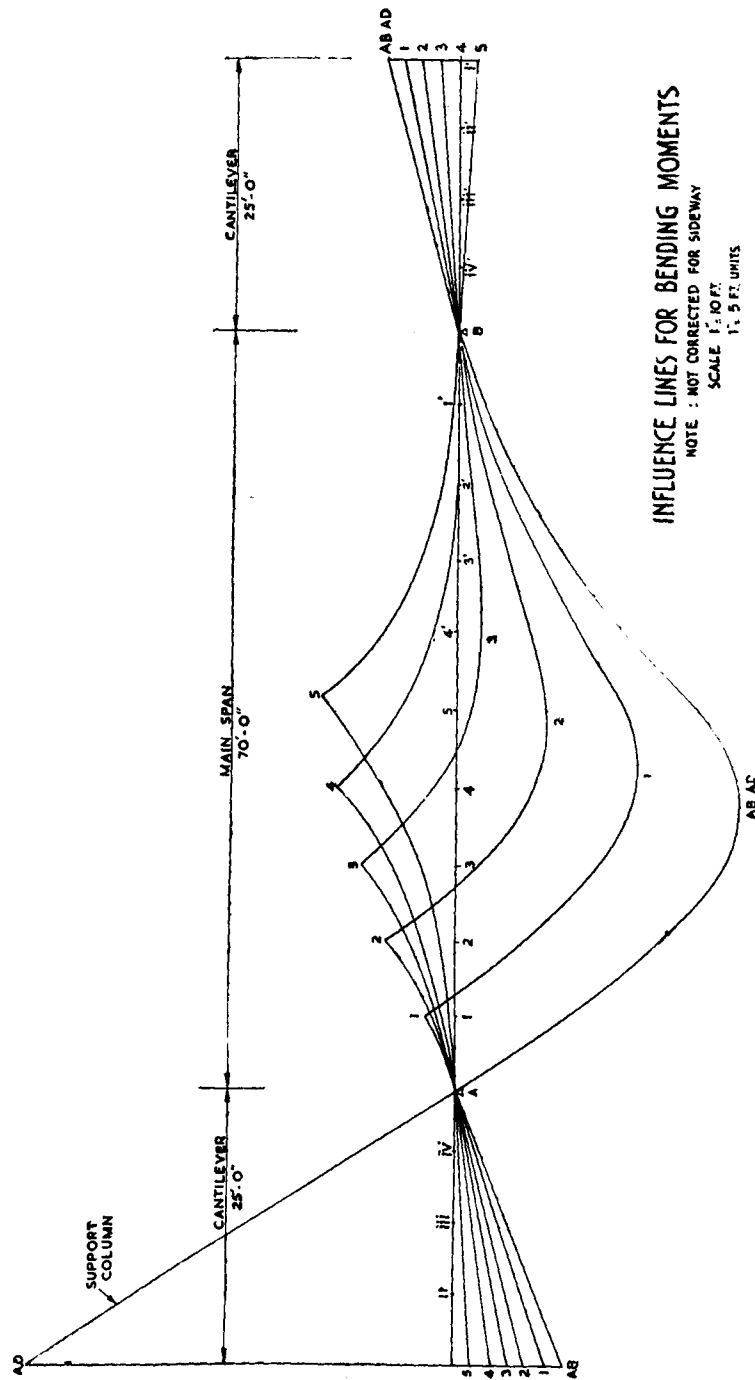
The principal things to be observed in the use of microscope are (a) accurate focus (b) avoidance of Parallax and (c) careful orientation of cross hairs.

Accurate focus can be obtained by moving the microscope tube up and down in its stand till the target is very clearly visible.

To avoid parallax the eye piece is taken out and a view is taken on a white sheet of paper. The milled head of the eye lens is slightly rotated so that the scale and cross hairs are clearly visible. The eye is moved forward and backward to see if the cross hair moves with the eye. When there is no movement good results are assured.

For orienting the cross hairs, first the target is brought into the field of view and then focussed as explained above. One of the cross hairs is made to coincide with the target mark by rotating the eye piece. By manipulating the drum of the eye piece the other cross hair is brought to the position.

(iii) **Calibration of plugs.**—A small ink dot is made at the edge of the movable bar of the gauge clamp. The normal plugs are introduced in the V-notches and the microscope is focussed on the ink dot. One of the cross hairs is made to come with the line of the edge AB. By Manipulating the drum vertical cross hair is made to bisect the ink dot and readings are taken (say b_1). The normal plugs are removed and shear plugs are introduced with its cut-face to the left. The vertical hair is now brought again in line with the target and readings are taken (say b_2). The value of the shear plug is the difference between the two readings multiplied by 2 i.e. $(b_1 - b_2) \times 2$.



(iv) **Readings.**—After knowing the value of shear plugs in micro-units the microscopes are focussed on the target marks at the load points. Three microscopes can be used at a time *i.e.* one at each load point. The horizontal cross hair is made to come in line with the horizontal line of the target mark, with normal plugs in the clamps. Readings are taken on both the micro-meter scale and drum scale. The normal plugs are removed and in the left clamp shear plugs are introduced with the cut faces left. The horizontal cross hair is again brought in line with the target mark and reading taken as before. Again the shear plugs are taken out and introduced in the notches with cut faces to the right and the readings are taken after bringing the cross hair in line with target mark.

Similarly vertical displacements in the direction of external loads are measured at all target points.

(v) **Calculations.**—First take the initial reading with the clamp at the initial point of its travel and then again take a second reading with the clamp at the end of its travel. Subtracting the second reading from the first gives the magnitude and sign of “reading difference”.

The influence line ordinate is obtained by dividing the reading difference by plug value (calibrated in micro-unit).

(vi) **Magnitude of Errors.**—Errors in the model analysis may be due to any one or combination of errors. The total error is sum of:

- (a) Inaccuracy in making the model : alignment and transverse dimensions.

- (b) Error in mounting.
- (c) Error in placing the target.
- (d) Errors in reading the deflections. Contributory causes being :
 - (1) Poorly defined targets.
 - (2) Parallax in microscopes.
 - (3) Inaccuracy of focus and orientation.
 - (4) Temperature variation.
 - (5) Eyesight and skill of the operator.

ACKNOWLEDGMENTS

The author wishes to express his sincere thanks to Sri P. V. Raj, Divisional Engineer (Designs) Andhra State for the valuable guidance received and to Sri K. Ramaswamy Reddy, Director, Highways Research Station and to the Chief Engineer (Highways) for the encouragement given while this paper was written.

REFERENCES

1. Elastic Arch Bridges—C. B. McCullough and Thayer, John Wiley & Sons, London.
2. Calculation, Design and Testing of R. C. by K. L. Rao, Pitman & Sons, London.

National Extension Service and Local Development Works

A NEW AVENUE OF ENGINEERING SERVICE

BY

SRI M. EDWIN RABINDRA B.A., B.E.,

Assistant Engineer (Highways).

I. GENERAL

It is an agreed principle now that India can be developed only if the conditions of life in the villages are improved. Ingenious schemes have been evolved to rejuvenate the village life, imparting a sense of importance to the villagers and making them feel that they have to play an important role in the development of their country. Community Project, National Extension Service and Local Development Schemes have been brought into existence towards this end. The general principle involved in these schemes is that our villagers should be made to feel that self-help is the best help. To encourage the villagers to achieve this, the Government goes half way to help them. The economic principle of private sector involving small savings also is brought into action, as the general rule is that Government will bear not more than 50% of the cost of the works undertaken, and that the villagers and Local Bodies should bear the rest. It is now the avowed policy of the Government to bring all the villages in India into the National Extension Service Scheme, during the 2nd Five Year-plan. The Scheme has

already come into existence in selected areas, and the Local Development Scheme caters to the needs of villagers outside the National Extension Service Blocks.

II. COMMUNITY DEVELOPMENT SCHEMES

(i) **National Extension Service.**—The National Extension Service Scheme is so designed as to bring officers into close contact with the villagers. A Block Development Officer of the cadre of Deputy Collector, Tahsildar or District Agricultural Officer etc., is put in-charge of a Block consisting of 2 or 3 Revenue Firkas. He is assisted by a Junior Engineer (Highways), an Agricultural Demonstrator, a Veterinary Assistant Surgeon, a Senior Co-operative Inspector, Social Education Organisers, and other Subordinate Grama Sevaks. The work of the various departmental Officers are co-ordinated by the Block Development Officer who attends to the needs of the villagers then and there without much of delay and red-tapism.

The district officers of the various departments also are responsible for the work of their subordinates, and as such they too come in contact with the villagers. Quarterly meetings of the officers and leading villagers are held in any of the villages of the Block presided over by the District Collector, when all the District Officers also are present, and the problems of the villagers are discussed and action taken immediately. Thus all the officers are made to feel the village life and offer all necessary help.

(ii) **Community Project.**—The Community Project Scheme also is run more or less on the same pattern as National Extension Service except for minor changes in heads of department, area covered and allotment.

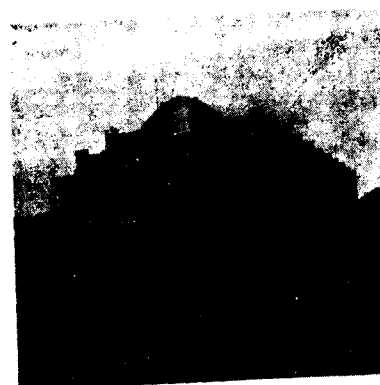
(iii) **Local Development.**—The Local Development Scheme is managed entirely by the District Collector with his revenue staff and technical personnel spared by our Highways Department. Most of our officers are well aware of the nature of works in this scheme. Some of our Engineers consider this scheme a flop; a high Revenue Official once remarked that it is a well-conceived but ill-planned Scheme. Whatever may be the pros and cons, it is a fact that thousands of miles of roads connecting innumerable villages have been formed in such a short while. The people who are anxious to have a road to their village, relinquish their rights over their lands, free of cost, for the formation of the road and enjoy the proud feeling that it is due to their sacrifice that they got their amenity. Hundreds of school buildings and numerous maternity centres have been constructed in a year or two, which would never have been possible under any other scheme. Our Engineers contend that the roads formed are unnecessary, and that these roads cannot be maintained by the Local Bodies. When the spirit of self help is inculcated in the villagers, it becomes an easy job for the villagers to maintain it by forming themselves by into a Committee in non-Panchayat areas. As the Government would be taking over all the Major District Roads under the District Board, there will be enough funds for maintenance by the Local Bodies too. Another ordinary complaint is that the buildings are not upto the Madras Detailed Standard Specifications. It is true that because the buildings are constructed by the villagers in a short time with the aid of local workmen without proper facilities for constant supervision by the Engineering staff, there may be some slipshod work, such as using of too much of mortar for

brick-masonry, a few faulty vertical joints, in stone masonry etc., but it is only out of ignorance and never intentional in 95% of the cases. Most of the buildings constructed are quite fine and strong enough to stand for the next fifty years atleast, if not more.

III. ENGINEERING STAFF

(i) **General Tempo.**—The Engineering staff allotted to the supervision of Local Development Works face a lot of difficulties. For proper implementation of the Local Development scheme in the true sense, the general outlook we have in the regular Highways Department has to be given up first. We have to attain a feeling that we are doing social work at village level. Once we give up our sense of false prestige and feel we are village uplift workers, we don't mind going to the villagers and contacting them for giving necessary instructions; we don't mind meeting the Tahsildar or other Revenue subordinates to help us in the alignment of the road through private lands; we don't mind imparting instructions to the villager-contractor any number of times; we don't lose our temper when we find a bad work done out of ignorance; we tolerate the crude behaviour of some of the villagers and their malicious and wrong views regarding us and our work, given out during their contact with the Revenue Officials; we sympathize with the villagers in their efforts to secure 25% or 50% of the estimated cost of the work in cash, kind or labour; we encourage the villagers to take up useful works without any feeling of diffidence.

(ii) **Practical Difficulties.**—During the course of execution of works, the practical difficulties encountered



Co-operative Society Godown
at Andipatti (Madurai Dt.)



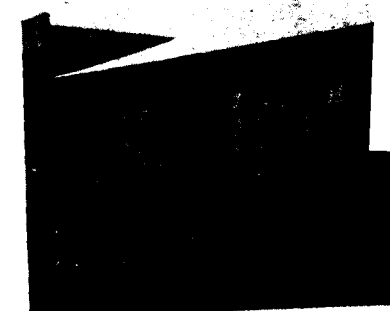
V. M. Bd. High School Building
at Periakulam (Madurai Dt.)



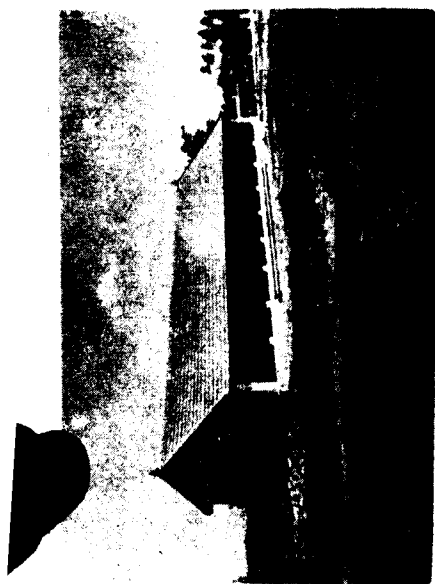
Maternity Ward at Vedsandur (Madurai Dt.)



V. M. High School Building
at Bodi (Madurai Dt.)



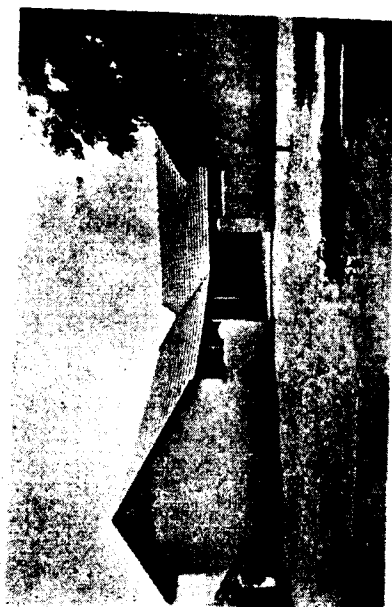
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School at Vambarpatti (Madurai Dt.)



School at Guziliamparai (Madurai Dt.)

National Extension Service & Local Development Works 21

by the Local Development staff are countless. The errors that would be committed by the villager-contractor have to be anticipated and instructions given in advance. Sometimes he mistakes our instructions and we come to know of it at a later stage only, when the work is beyond redemption. In certain cases, he feels he knows more than the Engineer forges ahead without our knowledge which devolves on us the painful necessity for forcing it to be rectified against his will. All these difficulties are more or less brought about by lack of staff, including Road Inspectors and lack of proper conveyance such as jeeps. Another problem is as regards our mingling with the revenue staff who have been trained in an entirely different outlook from ours. We have to bring to their attention by subtle means without any offence our difficulties in pushing through the works and make them understand our view point in the execution of works. It is seen that the Revenue staff become our friends in no time, when we contact them once or twice; and thereafter we mingle with them as comrades and not as officials. Factions arise among the villagers, which we have to handle deftly. When they feel diffident to take up useful works, we have to encourage them and talk to leading villagers to afford more financial help to the villager-contractor.

IV. WORKS

(i) **Buildings.**—The following hints may be useful to new entrants to this scheme. The common faults committed by the villagers are enumerated below for giving advance instructions to them. In building works etc., it will not be enough to intimate them to do concrete broken stone in Lime Mortar 1 : 2, as some

ignorant villagers may mean stone as quartz, field or laterite stone and may not adopt granite stones. The mason will put up a thick layer of mortar in between the bricks and will not take out the excess mortar on the sides. Our strict instructions to the beneficiary may not be of much use, as he thinks that he is spending more by putting more mortar and thereby is not doing any faulty work. If we should get the proper thickness of joints, we must contact the masons as well, as they deliberately use more mortar to quicken up their work. Before the parties cast bricks, we must acquaint them with the correct size of $8\frac{3}{4}" \times 4\frac{1}{4}" \times 2"$; otherwise there is always the chance of their making smaller-sized bricks. Then later on to make our required width of $1' - 1\frac{1}{2}"$ etc., they would use larger mortar joints or may even put small sized broken bricks in between the stretchers and headers. The brick kiln should be supervised, and under-burnt bricks should be rejected at the outset itself as it is very difficult to tackle the villagers, when the bad quality bricks are brought to site. Care has to be taken regarding lintels projecting a minimum of 9" on either side of the door and window edges, as otherwise the country bricks made by the villagers themselves may get crushed. The lintels should be so placed as not to touch the door and window top frames. To attain this the villagers would put a thick coat of lime mortar under the bricks below the lintels which may get crushed in course of time causing cracks in the plastering. Some times the inexperienced villager will produce bricks of very inferior quality, when we must calmly and assertively, but with encouraging words make him prepare another kiln of good bricks. As regards stone masonry, the ordinary method among villagers is to construct the edges with narrow stones of

less than 4" thickness and fill in the gaps at the centre with stone spalls and jelly with lot of mortar. We should scrupulously avoid this and give advance instructions to the masons regarding our specifications, and also educate the villagers who would crowd around us, so that the masons may be afraid to perpetuate such a bad work in our absence. We should inform the parties before hand the size of stones and number of bond stones they should bring from the quarry. The common error is made in laying vertical joints in a line extending for 2 or more courses. Regarding wood work it would ordinarily suffice to see that they do not buy unseasoned wood or wood with knots and that the joints in bressummers etc., occur over the supports. When we reach the tiling stage, the villagers will have so little money in their custody that they'd feel that wind ties over the tiles may not be a necessary item. But we must insist on this before finally closing the work. The parties should be made to understand the purpose of good watering for plastering and flooring. It would be good to thread line the flooring, as that would localise surface cracks. In window sills, cracks may be avoided by putting a single cut stone or cement concrete slab at the sill level. We must intimate the parties in advance regarding the colour of paint and wash to be used for the wood and the walls. The villagers are prone to use an assortment of gaudy red, blue and green colours and make us look helpless. It is our bounden duty that we construct a strong and safe building, but it will catch the eye of the lay public only if the finish is nice and as such, we should evince equal interest, if not more, in concentrating on good plastering work, pleasing colour washing and beautiful painting work. As the villagers would have exhausted all their resources by the time a building is

completed, unless we create a sense of enthusiasm, it would be difficult to get the site all round levelled up and saplings planted to present a neat appearance.

(ii) **Roads.**—As regards road work, we need the full co-operation of the Revenue Department, and the local villagers to get good alignment through valuable lands, gifted free of cost. The less we interfere in this matter and leave it to the good sense of the village leaders the more rewarding it would be. Proper instructions regarding easing of dips is essential. A second layer of earth work in filling the wheel track a month after laying the road gives good results. It will be advantageous to the villager as well as to the road if we suggest masonry culverts instead of Hume Pipe culverts. Though pipe culverts may be easy of execution, masonry culverts are preferable, as the poor villagers can defray a portion of the cost by “kind or labour”. As regards metalling we must insist on bed rolling for compaction before laying the metal to get uniform surface. The villagers should be educated on needs of superelevation and they should be informed of the certainty of considerable increase in pneumatic tyred traffic when once the road is metalled. They would form the road at the foot of the tank embankment close to it, cutting a portion of the bund itself to level up the road. This would endanger the tank and will be taken serious notice of, if maintained by the Public Works Department. In constructing culverts across Public Works Department channels and forming roads over Public Works Department Tank Bunds, we should contact the concerned Executive Engineer in person and get his approval, as correspondence would unnecessarily delay our work.

V. CONCLUSION

We are very much indebted to our Chief Engineer (Highways) who was responsible for steering our Department to play its role in this Nation Building Social Activity and thereby enhancing the prestige of our Department. We are given an opportunity in a new avenue to exhibit our ability to serve the public in the true sense of the word, and I am sure every one of us is striving his best to bring credit to our Department.

Highway Maintenance Practice

BY

Sri P. A. KRISHNASWAMI

(continued)

9. SURFACINGS

9. 1. Surface maintenance to a great extent depended on traffic volume and funds made available, and to some extent on the amount needed for other items than surface repairs such as earthwork, masonry repairs, etc. Mostly mileage grants were given for the roads, which had no relation to the high cost of surfacing materials prevailing in some cases. In the premotor days the surfacings for the roads were either waterbound macadam with granite, laterite, limestones or gravel or primary earth. It was only from about 1928 onwards that bitumen or cement concrete types came into use in the heavily trafficked sections, and their maintenance started thereafter. A large mileage was however of w. b. m. or lower types. A primary earth road was good only for light and slow traffic and lacked features essential for fast and heavy traffic. A gravelled road was somewhat better. Their maintenance was not much different from that of the waterbound macadam dealt with in the following paras. In the case of earth roads however there used to be very little money for thorough raising of the surface. Mainly filling up hollows and erosions was the only maintenance possible. Occasional levelling of ruts was done. Maintaining earth roads with log drags now will prove economical.

9. 2. Maintenance of w. b. m. surfacings was either by continuous patching, repairing long ruts and/or periodical renewals depending on the conditions prevailing. In the beginning, more of renewals and less of patch work used to be the practice. It was not unusual at times to find no patch metal in a furlong with bad pot holes while in the same mile quite a number of worn out furlongs had plenty of metal collected for renewals. This system seems to have been the outcome of misuse or wastage of patch metal in previous years, and did not matter much as long as there was no fast traffic. Gradually this had to give place to a combined system of both renewals and patch work by which very badly pitted and/or worn out furlongs were renewed, and pot holes or ruts in others in the mile were provided with patch materials. The cost of patch repairs, earthwork, and sundry, items of repairs was about 25 to 40 per cent of the allotment for the roads in later years while it used to be about 16 to 20 per cent previously, petty supervision and contingent items being about 5 per cent. In some districts Rs. 100 per mile for petty supervision and sundry works, drainage, earthwork, repairs to bridges and culverts was considered sufficient. The renewal of furlongs came in rotation once in 4 to 8 years, a chart of renewals being kept for the purpose. The allotment per mile of trunk roads was Rs. 500 per mile except for the first ten miles round Madras where Rs. 1,000 per mile was available. For the district, II Class and Marketing roads the amount varied from Rs. 200 to Rs. 600 a mile. For minor roads and village roads it was Rs. 200 to Rs. 25. These figures will show the poorness of the allotments when the cost of renewals is taken into account. In

course of time attempts were made to base the maintenance grants on the cost of materials and traffic. This is explained in later paras.

9. 3. A furlong was the normal unit length for renewal, which resulted, in course of time, in mile lengths in each of which good and indifferent stretches alternated. When motor speeds increased it was not possible to maintain the maximum legal speed. This created a general dissatisfaction amongst the motorists. Their demand for longer lengths of good road at a stretch with intervening indifferent reaches was met by making the mile or half-mile as the minimum unit length for renewals. The thickness of metal coating varied with the kind of material and was usually 2 to 3 inches. In a few cases even $1\frac{1}{2}$ inch renewal was adopted as a measure of economy. This was done in the case of hard metal surfacings which were introduced where traffic was heavy.

9. 4. On most roads with few exceptions there was no soling or foundation to distribute the weight and impact of motor traffic on the sub-base which became a serious problem. This had to be met and provided for if a satisfactory or even a passable surface was to be kept up. The rotation of renewals (mentioned in the last para) was found to be insufficient. The only course left open was to increase the metal crust thickness by additional metal coatings out of special grants. In this way the necessary crust thickness was secured after systematic work over a number of years. This was possible on main roads, but on minor and village roads this could not be done. Naturally they were in indifferent or poor condition, coming in for much

criticism. As a makeshift arrangement, in order to allow light motor traffic to use the roads, the earth roads were gravelled and the gravelled ones metalled with the local available materials, the work being spread over a number of years, as and when funds were available. As the lorries and buses formerly were provided with single high pressure tyres on the rear axles, their pressure intensity used to be felt more than that of the present twin low pressure tyres. In practice it was seen that at least 8 inches depth of hard metal crust was necessary on roads carrying this type of traffic. Except the trunk roads most others did not have this crust depth which had therefore to be gradually built up, by frequent 3 inch renewals every second or third year. These occasions were availed of to introduce hard granite metal. In spite of the lack of funds this had to be done. During this transition period the lorry and bus traffic on roads had to be restricted. Even with this increased depth of crust, the w. b. m. surfaces were subjected to considerable damage by the combined action of motor vehicles and carts, the action of one being supplementary to the other. The cart traffic developed longitudinal ruts and the fast vehicles dislodged the protruding metal at the edges of the ruts, which were in turn crushed to powder by iron tyred traffic. Low spots developed into innumerable small pot holes under the impact of motors; and the iron tyred wheels with their side thrust and wobbling action deepened these, by crushing the metal at the edges. The motor wheels started churning them in wet weather (if not immediately patched up) converting them into large deep holes thus completely ruining the surface. The practice was therefore, as far as possible, to do the patch work immediately on the

appearance of the small holes prior to the rainy season with the gang coolies, wherever they were employed.

9. 5. The bullock carts had a tendency to follow in a trail on roads, and this accounted for the formation of the longitudinal ruts (or tracks) referred to in the last para. This started just after a renewal. Efforts were made to prevent this by obliterating the track marks with blindage materials, gravel, or fine metal chips screenings while the renewed surface was fresh, and by periodical blinding thereafter. This had only a temporary effect. In course of time the blindage will be carried away by winds after being sucked and lifted up by the pneumatic tyres of fast vehicles, or washed away by rains, leaving the surface rough and the metal exposed. If the lost blindage was not restored the exposed metal used to ravel and get scattered on the road. So periodical blinding of the surface was necessitated, and played an important part in maintaining the water bound macadam. A good binding material was the best blindage. On important roads good gravel or other similar material was collected for this work, and the surface wetted and blinding done. Work done without this wetting will not last long.

9. 6. This practice resulted in a very dusty surface, and, in built up areas, was a nuisance likely to affect the health of the people. Roads in such areas therefore came to be dressed with bituminous compounds or cement concreted out of special half grants sanctioned by government. Wherever the combined traffic was heavy and maintenance extremely costly, improved types of surfacing had to replace the water bound macadam for economical maintenance. For example in the case of a trunk road near Madras, the average of 5 years (1923-'28) maintenance cost for water

bound macadam was Rs. 2-10-9 per 100 s. ft., and after the introduction of bituminous macadam it was Rs. 2-1-6 per 100 s. ft. inclusive of interest at $3\frac{1}{2}\%$ on the cost of improvement. Besides this saving, a better riding surface was obtained. Similarly in another reach on the same trunk road these figures were Rs. 2-6-0 and Rs. 1-7-6 per 100 s. ft. respectively. The traffic on the former was 595, 680 tons iron tyred and 1,460,000 tons pneumatic tyred per annum; and on the latter 396,456 tons I.T. and 1,223,592 tons P.T. per annum. With this kind of traffic, maintenance of w.b.m. was not only costly but also difficult and unsatisfactory. As a result of this experience, the upgrading of w.b.m. surfaces carrying very heavy traffic (about 2000 tons per day) was taken up. Gradually this was extended over a larger mileage. Originally such upgrading was considered under the account rules as an original work requiring separate sanction and could not be carried out under maintenance. In course of time, however, the surface dressing works were brought under the head of "Repairs" and this made possible the conversion of a large mileage of w.b.m. into black-top surfaces mostly out of maintenance saving accruing from previously upgraded mileage.

9. 7. The black-top surfaces had to be patched up and sealed with bitumen periodically. Patch work was needed mostly in the slow traffic lanes or areas subjected to intense bandy traffic. In the fast lanes renewal of seal coats had to be done in time, as soon as wear had come upto a stage when the surface presented a pock-marked appearance. Failure resulted in formation of potholes in these lanes also. For patch work, emulsions or cut backs were found more useful,

especially in the absence of heating and mixing out-fits. Where facility existed hot binder or mix was used for patching. For seal coats, the writer's experience was that the use of emulsions with coarse sand or fine chippings gave quite satisfactory results, and work could be got done easily and quickly, and it did not produce "bleeding" so common with the use of hot bitumen. This is due to the larger area that can be treated with a gallon of cold emulsion than hot bitumen. A correct grade with a high percentage of bitumen had to be used. Usually 'Colas' or 'Socony Emulsion' was used. The resulting surface was good and even, without appreciable rise in the level of the road surface. This was particularly advantageous beside c.c. road strips and other similar hard non-wearing surface types, beside man-hole covers and situations where surface wear was very little. Where holes had developed it was the practice to cut the edges roughly to form squares or rectangles and patch up with pre-coated chips of size suitable for the depth. Sometimes shallow ruts and depressions were surface painted and suitable sized chips spread to conform to the original surface and tamped or rolled. This type of work needed care in execution and further consolidation on the following day. Emulsions and cut-back bitumen were used for patch work. Premixing was done in cut asphalt drums or on lids of drums or on old metal sheets, since premixing plant was not available. As the mileage of black-top roads was not extensive, these methods were found quite suitable. Surface dressing for sealing extensive areas of black top roads with hot bitumen was done with a spraying boiler. Pressure sprayers for emulsions were got on loan from Firms. Prior to 1938 the cost of this type of maintenance work

ranged between 9 as. and Re. 1/- per 100 s. ft. of the total area of black top surface, depending on the cost of sand, fine aggregate and asphalt cement. Bituminous concrete and macadam types of surfaces developed ruts and holes in the cart traffic lanes. The edges of the long ruts were picked vertically for at least an inch depth and the surface cleaned and painted with bituminous cement. In the case of bituminous macadam, the rut was filled with suitable sized chips of broken metal to suit the camber and profile, hand-packed, and tamped or rolled. This was then grouted with asphalt cement and gritted with fine chippings and rolled or tamped until well set. In the case of asphaltic concrete, premixed chips were filled into the cleaned and painted rut or hole and consolidated. Wherever seal was necessary it was applied as already described above.

9. 8. After the long continuous ruts in the slow traffic lanes were repaired it was observed that the carts started to move along a different set of tracks (see figure 6). After these were repaired it was seen that they took to the original tracks again. This showed that the animals naturally preferred a smooth surface. So in a length of about a furlong, instead of the usual method of repairs, $4\frac{1}{2}$ inches thick cement concrete tracks 2 ft. wide spaced 4 ft. centre to centre

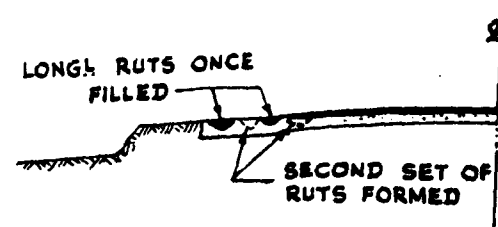


Fig. 6.

were laid along these ruts at a cost of Rs 1,366. This had the effect of concentrating the bandy traffic on these two tracks (creteways). The traffic proved too much for this and the tracks started pitting after being worn out in places. These defective areas had to be filled with C. Concrete or bituminous premix. After about 13 years of maintenance in this way, it was seen that the black-top surface in the slow lanes had become wavy and presented the appearance of corrugated roofing sheets laid longitudinally (see fig. 7) In the rains surface drainage was defective. It was then decided to lay cement concrete roadway for the slow traffic lanes retaining the black-top between the two c. c. lanes. This was the beginning of the conphalt surface on this reach.

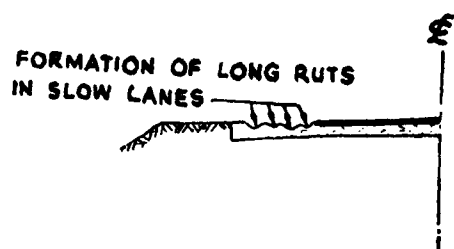


Fig. 7.

9. 9. The cement concrete surfacings required very little maintenance. The joints had to be examined and the lost filler material replaced. Exposed edges had to be given protection by remetalling where this had been cut up by traffic. There was no wear on the surface noticeable anywhere. The average cost of surface maintenance used to be about 9 pies per 100 s. ft. of the concrete road area. This type was the least expensive for maintenance and afforded the most

satisfactory surface. But careful inspection and timely filling of joints were called for. The metalled shoulders and earth berms had to be kept in good condition.

9. 10. For all types of surfacings mostly local materials alone could be used in view of the economy in first cost. This in some cases, especially with water bound macadam, proved unsuitable for heavy traffic. Upto 1922 there was no facility for testing rocks with regard to their suitability for road work. It was only in October 1921 that a start was made by the Superintendent of Government Test House, Calcutta to obtain equipment for the purpose and provide for Attrition, Abrasion, Impact and Cementation tests. Compression tests could be however made at the Madras Engineering College, where in recent years abrasion and attrition tests are also carried out. These tests are also perhaps possible in the Madras Highways Laboratory. The importance of these tests was realised after getting the results for most materials in use, which revealed that some of the stones in use were really not good to stand attrition and abrasion. The use of really good broken stone was found economical in the long run. There was a large range of rocks in use in the State (then Province) chiefly Laterite, Lime, Kunkar, Quartz, Black Trap, Gneiss, and Syenite. The total length of water bound macadam under maintenance, as could be ascertained from 19 District Boards was about 15,617 miles in 1932, for maintaining which 72 power rollers were reported to be available. Only 6 district boards had one water lorry each, and one board had a water tank trailer attached to a steam roller. This would indicate that power roller consolidation could not have been extensive since the mileage per roller was as much

as 217. This naturally reflected itself in the standard of maintenance that could be achieved. As it was inevitable to have a large mileage of w. b. m. roads for a long time to come, steps were taken in course of time to acquire a large number of power rollers. It was only at the end of last war and after the formation of the Highways Department in 1946 that orders could be placed on State or Presidency basis for the required number of rollers which were also obtained. The position at present must therefore be quite satisfactory, which it is expected must show itself in better maintenance standards.

9. 11. The importance of using good materials and adoption of proper technique is being recognised to a larger extent these days as is seen reflected in the existing specifications in "The Madras Highway Manual". At first the only specifications available were those in each district which formed part of contract documents. These were mostly suited to local materials and practices. After Government took over responsibility for maintenance of trunk roads the Madras Detailed Standard Specifications of P.W.D. came to apply to works first on trunk roads and then on other classes of roads gradually. Standards for construction and maintenance are being issued by the Indian Roads Congress also and are coming into vogue. These tend to co-ordination and the adoption of uniform standards all over India. These are the outcome of the best practices, past and present, and based on careful observation of methods of work and of the results. This points to the importance of inspection, staying on works and keenly observing all the operations involved, and watching the results and maintaining a truthful record

of these for future reference. By this means only, will it be possible to advance the maintenance technique with the advance of time and change of traffic and other conditions. Therefore specifications by their very nature cover general cases under certain conditions and may have to be varied. Blind adherence to standards and specifications may not always yield satisfactory results. In exceptional cases the man on the spot with good experience is a better guide under such circumstances. Suggestions for change in technique should deserve the most careful and impartial consideration irrespective of its source of emanation.

10. TOOLS AND PLANT, MACHINERY

10. 1. Minor tools and plant like spades, crow bars, rammers, jumpers, sledge and hand hammers for road metal quarrying, pick-axes, pruning knives were all kept in stock under each section officer for use whenever departmental work was undertaken or in times of emergency like famine works, flood damages etc. or for issue to gang coolies. They could also be issued to contractors after collecting their book values as deposit, subject to payment of rent under the Local Boards Manual. Besides these, other equipments like metal and gravel and sand screens, stone rollers with frames to suit, and ropes for dragging them were also kept. Different sized rollers were made, the diameters varying between $2\frac{1}{2}$ and 4 feet to suit different classes of road metal or gravel to be consolidated. Maintaining these in serviceable condition was part of road maintenance. But, for account purposes this was separately estimated for upto about 2% of road maintenance allotment, and expenditure charged thereto. Heavy Tools and Plant like the power rollers, and mixers used

to be maintained under a separate estimate sanctioned for the purpose, and their working and hire charges (based on original cost and depreciation) recovered from concerned works on which they were employed. In framing these estimates and in fixing the hire charges, a certain amount of experience and personal knowledge of the condition of the machinery and its working was necessary. An annual inspection of these was made and the repairs needed assessed and action taken.

10. 2. In the case of heavy machinery, renewal of parts subjected to constant wear was important and necessitated the stocking of such spare parts to avoid a break-down in the working season. The running gears of power rollers, rims of roller wheels and the bearings and bushes needed careful examination and maintenance. It was seen that roller rims, when worn out to about 1 inch thickness, were susceptible to breakage without notice and had to be replaced before the working season. Good water had to be used for the boilers to avoid corrosion of boiler tubes. Replacement of boiler tubes used to be necessary also inspite of the use of good water in the case of old rollers. To prevent incrustation inside the boiler a compound, known as 'Boilerine', was mixed with water, and the boiler wash-out was regularly got done once a week. During the off-season the outside of the boiler tubes used to be got painted with special paint to prevent corrosion. In spite of all this care the tubes used to leak at their junctions with the face plates inside the boiler, and had to be expanded with a 'Tube-Expander' or replaced in worst cases. A stock of spare boiler tubes had to be

kept for the purpose. The injector parts also needed careful attention in the steam rollers. Occasionally the gratings of the fire box used to need attention. On account of constant high heat they got bent at times and allowed coal to drop out resulting in waste. They had to be straightened or re-placed. Asbestos packings for the inspection man-holes, spare water gauge glasses and rubber rings for their end connections and the like had to be kept in sufficient number with the drivers to meet sudden demands. In the case of motor rollers, besides the rolls it was found essential to keep spare platinum points for the magneto to replace worn out ones. Owing to their heavy going, the platinum points got pitted very soon and needed frequent rubbing down with emery to ensure smooth, even and perfect contact and good sparking. Another important point to be observed was that there was no play in the fixture between the fork of the front rolls and the undercarriage to which it was connected. A play in this mean an oscillatory movement of the wheel resulting in uneven consolidation and initial waviness in the rolled surface. The engines of the motor rollers and lorries required periodical decarbonising, grinding of valves and adjustment of tappets, and replacement of rings. Getting these done through firms proved to be very costly. They were got done by experienced drivers under careful supervision instead of sending them to firms as a measure of economy. Periodical cleaning up and painting and burnishing exposed metal parts had to be done. Heating and spraying boilers were cleaned daily of all residual materials, and the attached pumping equipment, hose and nozzle were also similarly kept clean, and ready for use. Concrete mixing drums and the blades required similar attention, to keep them

trim and clean. The hoisting wire rope needed special care and greasing. The engines of these had to be kept in good order just as in the case of motor roller or lorry.

10. 3. Since rural water supply in charge of Local Bodies had to be attended to by the engineering staff, stock of pumps, and pump parts and pipes were also held along with the other tools and plant. Boring sets were also kept. These came in handy for bridge investigation and construction, and sometimes for road works. "Myers Pumps" with filter points were also held for use during fairs and festivals and sometimes at road sides for highway works, in situations where water scarcity existed. All these had to be given maintenance attention.

10. 4. As the mileage of improved types of surfacing increased in course of time the number of these machines increased; and with the formation of the Highways Department the care and maintenance of these had to be entrusted to a separate division (Transport & Machinery). This centralisation of work was necessary for uniformity of work and bulk purchases resulting in economy, and quick repairs and easy replacements, and greater efficiency. With the establishment of the T. & M. Division, at present officers in charge of highway maintenance are saved all this additional work and to that extent they are free to devote their undivided and exclusive attention to road maintenance with a corresponding additional benefit to the road users. Early attempts to have a co-operative system of storing Tools and Plant at a central stores and

distributing to Local Bodies for use on works when required* did not materialise. It was however left to the Highways Department to achieve this.

10. 5. Daily work sheets and logs were maintained for the rollers and lorries showing the hours of work, consumption of fuel and other articles required for their working, out-turn, repairs and replacements carried out etc. This was helpful in arriving at an average data of maintenance costs of these machinery. On a rough average the cost of lorry maintenance came to about 2½ to 3 as. per ton mile (including depreciation), and for rollers about Re. 1-5 per 100 s. ft. of rolling on w. b. m. The hire charges for these, when lent to contractors or for recovery from works by adjustment, were based on these maintenance costs. Although the actuals for each type of roller or lorry varied a flat rate was fixed, one for rollers and one for lorries. Actual cost in each case depended on the volume of work that offered, variation being in the inverse ratio of volume of work done, due to the overheads. This emphasized the necessity to keep the machinery working without idle days if real economy was to be obtained.

11. TRAFFIC DATA

11. 1. The importance of traffic data came to be recognised as and when traffic developed. In the beginning this was confined to areas subjected to heavy traffic, where the need arose to improve the existing surface. It was only after 1935 that traffic data on Presidency basis came to be collected by traffic counts (taken half-yearly) with the creation of the post of

*Vide L. & M. Engineers' Journal, August 1921, p. 17

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Road Development Engineer in the Local Administration Department of government. On Trunk II Class and Marketing Roads, and other important roads counts of all vehicular traffic were taken for 7 days and nights continuously and the average per day taken as the daily traffic for that half year. These figures were published by Government yearly and formed a useful statistics in aiding to plan for improvements and maintenance.

11. 2. The importance of traffic data is coming to be recognised more and more now-a-days with increase of motor traffic. Safety construction and maintenance of a road free from danger involved a knowledge of the traffic which can be had only by collecting and maintaining these statistics. "The Times of India" so early as 17th January 1936 mentioned about vehicles driven by 'robot' and 'wide accident-proof roads'. Although this stage has not been reached, the existing trends indicate that such a day may not be far off at least on some of the main roads. Present traffic at any rate on these roads demands, in maintenance, the adoption of principles of traffic control and regulation; and the extent of such demands can be known only from the traffic data. The compilation of the same is therefore an important part of maintenance work.

11. 3. Formerly restrictions were imposed on speed, load, and the number of buses and lorries that could be allowed to ply on roads. This no doubt caused vexation to the fleet owners, and denied convenience to the public. The present trend is to alter the geometric lay out of roads, and to strengthen the road surface to permit this type of traffic to the extent of affording necessary convenience to the public, without causing undue strain on the road finances.

12. ROAD APPURTENANCES

12. 1. It was mentioned in para 3. 1. that road appurtenances also need maintenance. Although this was always given a low priority, yet their importance and usefulness could not be ignored. The mile, furlong and boundary stones, direction signs, warning signals and other miscellaneous erections like guard stones at culvert parapets and in curves, retaining walls in high banks and the road avenues came under this category.

12. 2. The mile and furlong stones, though expected to conform to schedule of rates of the district in regard to their sizes, mode of lettering and fixing, were not uniform in adjacent districts or even in the same district on different roads. They were of granite stone generally. The figures were carved and tarred, and faced the road generally. In some districts the figuring was on both the broad faces which faced the travellers, the mileage figures being continuous and representing the distances to and from the terminal cities. In the case of trunk roads alone, the mileage was continued from district to district. As a large number of stones got broken by bullock carts shying at motor vehicles, they had to be replaced by R. C. stones. At the end of rainy season and official year it was usual to get all the stones neatly whitewashed, and the figures tarred. Besides improving their visibility this added to the tidiness of the roads. At the time of providing R. C. stones the replaced granite ones were got redressed and figured and used on new roads under formation. The granite ones were merely fixed in earth while the R.C. ones were fixed in concrete. A neat earthen platform was formed round these and turfed and maintained neatly. The Indian Roads Congress has now issued standards for adoption on roads of national importance.

12. 3. The road boundary stones consisted of demarcation stones fixed by the Revenue Department for purposes of verification of land records. The survey and demarcation of road land as such came to be done after the issue of Revenue G. O. No. 1713 dated 8th October 1926 as amended by G.O. No. 54 dated 11th January 1927. The limit of one chain (66 ft.) fixed in the G. O's was not absolute, but was subject to the condition that the actual width was always retained. The width included drains, avenue trees, space for stocking road materials and a 'reasonable road margin'. Maintaining the boundry stones in a conspicuous manner was necessary to easily detect encroachments on road. This was rather difficult in the beginning since survey plans of all road land were not available. These had to be subsequently bought and the stones whitewashed along with mile and furlong stones. Eviction of encroachments on road land by getting notices issued under the L. B. Act was part of the work of the engineering department. Prevention and eviction became more important with the advent and increase of motor traffic, because of the necessity to maintain greater width of carriageway. In view of the increase in speed and volume of motor traffic, minimum standards have been now fixed by the I.R.C. for road land widths for the several classes of roads.

12. 4. The direction posts and boards needed painting to keep them bright and visible. The old direction signs consisted of square or circular wooden posts with long rectangular wooden boards for arms fixed all at the same level. (see fig. 8) These indicated only the next important city or town or village and was not of much use to a new long distance traveller. In

course of time it was found that the boards were at too great a height to be easily read by the motorist. Further, as all the boards were at one level they were not all

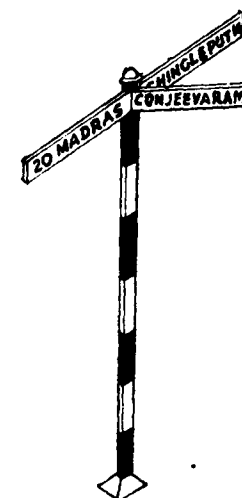


FIG. 8
OLD TYPE SIGN POST
& BOARDS

visible together, with the result that where the branch road leads to could not be easily read from one and the same position. So the boards came to be fixed at different levels. The height of the post itself was reduced to $7\frac{1}{2}$ ft. above road. Originally the post was painted fully white or black, and the boards white and the letters black. This was not conducive to good visibility. The post was painted alternately white and black. The non-motorable roads were indicated by red-painted boards. The old wooden direction signs in a district were replaced by cast iron posts and boards with letters (see fig. 9). These were maintained by painting with good enamel

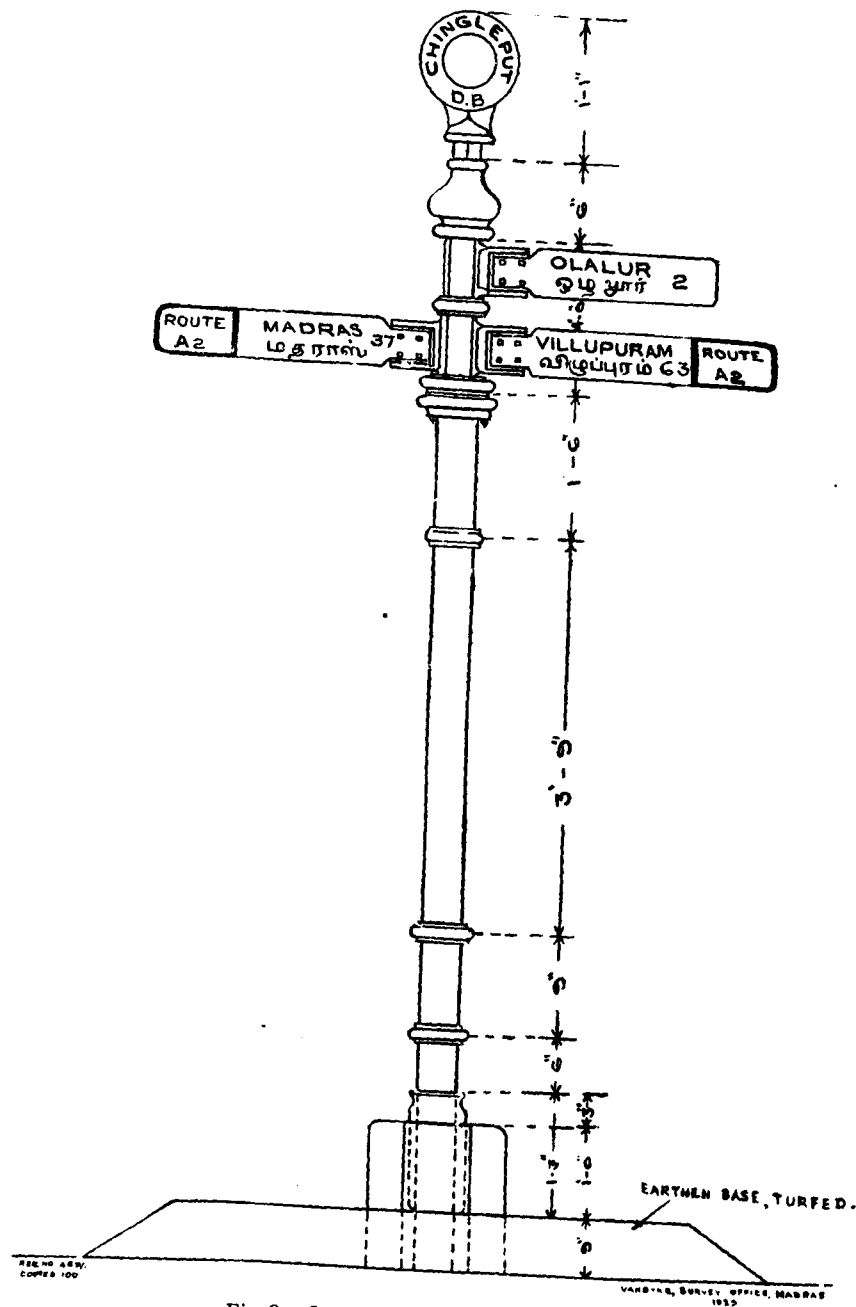


Fig 9.—Later Type Sign Post & Boards.

every year, the letters of the board being black on white back-ground. The posts were alternately white and black painted. A circular or square mound of earth (platform) was formed around these at the base and turfed and maintained. Where a certain amount of protection against traffic was required the earthen platforms were provided with masonry kerbs, which were 'zebra' painted. It is seen that these are being replaced by wedge shaped masonry constructions with necessary inscriptions. With the advance of motor traffic warning signs became necessary. They were erected by the road authority, except those indicating speed limit which were provided by the police department. The posts were of angle or Tee irons and the boards of sheet iron or casting, depending on the type of warning. The conventional triangle at top was also of iron with reflectors. In course of time the reflectors got damaged by mischievous boys and were not replaced. These posts also were fixed in concrete and 'zebra' painted. Periodical painting once a year was got done. In heavily trafficked built up areas where traffic control points existed, the direction sign post and traffic umbrella were combined and erected in R. C. (*Vide* figure 10, photo). These added to the appearance of the road.

12. 5. The outer edges of roads in curves on high banks were provided with guard stones or railings with granite posts and steel hand railings as some steel sections were available. This provided a certain amount of security for traffic against accidents. In some instances R. C. railings fixed into R. C. Posts were provided in later constructions. The guard stones and posts were kept white-washed or 'zebra' painted.

Retaining walls with parapets for embankments where existing had to be carefully inspected and maintained to see that the weep holes were functioning and that no plants or weeds were growing in them. The



Fig. 10—Combined Traffic Umbrella and Sign Post

parapets used to be painted alternate white and black. Occasionally pointing or plastering or rebuilding damaged portions was necessary.

12. 6. Most of the highways had (and are still perhaps having) very good avenues, the benefits of which are enjoyed by all road users. The existence of these for a very long period, inspite of the ravages of nature and human beings, speaks of the vision and foresight of those who planted and reared them up, and the care exercised by those who maintained them.

But yet one is left with a feeling that there is not the amount of co-operation from the public which will encourage road avenue maintenance at its best. The most difficult part of avenue maintenance had always been, and will be, to fight against vandalism and mischief. Once the avenues had grown upto their full stature, maintenance consisted, apart from numbering them and maintaining their list or register, in occasional lopping of branches that interfered with traffic flow or lighting or overhead service lines, and protecting the roots with earthwork against scours due to rains. In curves it was usual, after fast traffic developed, to whitewash the trunks above the roots to a height of 4 to 4½ ft. The most serious problem was to prevent wholesale removal of leaves to be used as green manure during the cultivation season, and stealthy lopping of branches and removal of barks for fuel by the anti-social elements of the village. Those caught red-handed were then and there charged before the magistrates for mischief and got summarily punished. But most of the crimes went undetected inspite of personal interest taken by those in charge. Unless summary powers are given to the maintenance authority or punitive measures taken against the village, this crime may not abate, and avenue maintenance will continue to be a very serious problem. More than this, the aesthetic beauty of the roads is likely to be lost in course of time.

13. INSPECTIONS

13. 1. As everyone knows, inspections are necessary to safeguard road and public interests and to collect data for estimating repairs to be provided for, to see that the sanctioned repairs are carried out in

time and according to specifications; and so are quite essential for proper maintenance work. These had to be methodical and arranged to suit conditions and seasons. Inspections, to be effective, had to be so timed that important parts of the work in execution were supervised to obviate the possibility of any defective execution creeping in. On the effectiveness of this kind of supervision depended the efficiency of the resulting work. A rough programme of inspections used to be chalked out in advance for each month and adhered to scrupulously as far as practicable. Such adherence to programme tended to produce similar reactions in the agency executing the works and the subordinates in charge. The benefits of timely execution, though immeasurable, always enhanced the prestige of the department in addition to that of the individual. It was always beneficial to take the officers, maistry, and contractors together for these inspections

13. 2. During the first quarter of the year, attention used to be bestowed upon the collection of materials at quarries and roadsides (after verifying the stock at site) by visiting the quarries and by road inspection with a view to ensure that correct size and quality of road materials were quarried from suitable pits in the quarry before carting. This made considerably easy the work of the department and the contractors, and resulted in the avoidance of materials brought on the road having to be rejected or made to be rebroken and sieved much to the annoyance of all concerned. It also tended to educate the labour working at the quarry and made them improve upon their work. All preliminaries required in connection with the works to be done in the ensuing spreading and

rainy season were got done including repairs to Tools & Plant. This part of the year was also the season for getting the building and well works of Local Bodies executed which had to be done by the District Board Engineer and his Assistants. In this way, although this quarter of the year was considered slack season from road-works point of view, the officers had sufficient work to keep them busy. This was also the period when the avenues could be checked and the road avenue usufructs auctions conducted. It was also necessary during inspections at this period to see whether the provisions of the sanctioned estimates were sufficient. If not, special sanction for the additional work had to be obtained. A diligent inspection and collection of complete information would be necessary. After the introduction of black-top and cement concrete surfacings, repairs to these had to be got done during this period. During the months of July to December execution of water-bound macadam surface repairs had to be done besides drainage attention January to March was the final closing season for works.

13. 3. To facilitate inspection and accumulation of data above referred to, and for assessing the next seasons repairs (*i.e.*, its estimating and budgeting which used to be done between October and November) an inspection note-book of the size of a field book, showing the name of road at the top of each page with columns for road mileage, repairs done and proposed, and the present condition of each furlong on the date of inspection, and other remarks, was maintained. (See fig. 11). This was in addition to the Road Renewal Charts. The entries made in this showed, as indicated in the figure, the condition of the surface,

DISTRICT RANGE
NAME OF ROAD

MILE & FURLONG	RENEWALS OR PATCH			ROAD CONDITION		REMARKS
	1936-37	1937-38	1938-39	2-5-38		
7 1	12' x 2"		200	e		
2	2' x 2"		12' x 2"	31		GRANITE METAL QUARRY L: OM-2F
3		12' x 2"	25			2 VENTS 3' x 3' G. SLAB
4		12' x 2"	25			
5		12' x 2"	25			
6	12' x 2"		150	C		GRAVEL QUARRY R: 1M-1F
7			200	C		
8	12' x 2"		2' x 2"	n		

FIG. 11. POCKET INSPECTION NOTE BOOK

besides the positions of cluverts, and bridges in the reach, positions of quarries, water sources and other useful information. The renewals done in the previous two years and proposed in the year would be shown in it, and also the patch metal quantities in the non-renewal furlongs. This would be always carried by the officers on duty, although there was another statutorily prescribed for notes of inspection made in it. (L. F. Form No. 81). The chart note-book was a very useful record for reference at the time of preparation of estimates. Proposals for the year would be shown in red and of the previous year in blue and of the year previous to that in black. The patch work quantities of the year would be shown in c. ft. Record of notes of inspection would be by symbols entered in the columns as explained below:

Cupped holes	...	c	Rutted	...	r
V. Badly cupped holes	...	c	Badly rutted	...	r
Worn out	...	w	Eroded berms	...	e
Badly worn out	...	w	Long Ruts	...	lr

Any combination of more than one defect would be entered one below the other in the column. These symbols are conventional, and might be made more exhaustive, if necessary. Conditions of berms would be also noted in the remarks column for clarity, sometimes. Bends in road would also be shown in the remarks column by appropriate sign. Each overseer maintained a book for his range, and each Assistant Engineer for each overseer's charge under him. The District Board Engineer maintained books for the whole district. Entries were made during inspections. Any change in the condition of a furlong noticed since last inspection would be entered in the 2nd and 3rd

columns. Three inspections were provided for in the note-book. This enabled notes to be recorded quickly while moving fast in vehicles. A complete record of inspection was thus available always.

13. 4. Opportunity was availed of during inspection to educate the coolies and maistries in the correct methods of carrying out works. This bore fruit once they found the good effects of following the instructions. In the case of works to be done by the gang coolies a fortnightly programme was drawn up in advance and approved by the Assistant Engineer. This was made to be followed, being entered in an order book. This will be left with the gang coolies concerned whenever the maistry had to be away on other works. Inspecting officers could always check this to see if the programme was being followed. Deviations from the programme could be ordered in writing by the inspecting officer if necessary. The effective supervision by maistries was difficult to achieve in view of their lack of training and appreciation of the fundamental principles and their application on the field. It was considered, at one time, to give a year's training* to a few selected young men (with working knowledge of english) in each district. This did not materialise. As they are the weakest link in the chain of supervisory staff their training in proper methods had been important and could only be secured by personal contact, without leaving them alone.

13. 5. All the roads would be inspected by the Dt. Board Engineer at least once during the collection season and once during the spreading season, more frequent visits being made where necessary and laxity

* Please see L. & M. Engineers' Journal for 1920.

existed. The assistant engineers toured all the roads in their charge at least once in two months if not every month. Inspection jointly by all officers would clear up several matters which would have otherwise taken up considerable time in correspondence. Frank talks over several disputed points following inspections usually led to a satisfactory solution and final settlement. In such matters very broad views had to be taken without the prestige of office entering into the question. It should be more with a view to help the juniors out of their difficulty and give them a good lead in all matters. Sympathy and forbearance are better tonics than punishments without mercy.

14. ADMINISTRATION AND FINANCE

14. 1. The administration of roads (other than P. W. D. and Cantonments) was in charge of Local Bodies (Dt. Boards and Taluk Boards). These bodies consisted of elected representatives of the people and nominated members. Until about 1918 the District Collectors were the presidents of Dt. Boards and Dy. Collectors, presidents of Taluk Boards. After this year the members elected one amongst themselves as president. The boards met at least once a month to transact business. The streets in municipalities and unions (at present panchayats) were in their charge. The works on the latter would be attended to by the district board engineering staff when so requested and permitted by the board or an executive order of the president, district board. The district board engineer were under the control of the district boards till 1924, although creation of posts carrying a maximum monthly salary of Rs. 300/- required sanction of government. The executive staff, except maistries, could be appointed by the president.

Maistry could be appointed only by the engineer. The executive staff including the engineer was paid by the Dt. Board. After the creation of Provincial cadre of D. B. Engineers they drew their salary from Govt. treasuries direct; and Govt. adjusted the cost of this establishment towards the district board funds. They were also liable to be transferred from one district to another.

14. 2. Approval of budget and sanction of estimates were by boards. In the case of urgent works, the district board engineers could start them in anticipation of Board's sanction after obtaining the executive orders of the president subject to ratification by the Board at its next meeting. The works were got done by the engineering staff consisting of the district engineer, assistant engineers and overseers (or supervisors) mostly through contractors or contracting agencies to whom works were entrusted on tender.

14. 3. The system of administering works by elected bodies naturally had its own defects. Every time a fresh election to these bodies took place there was naturally a change in their constitution and a new president was elected. It was not therefore unusual at times to find want of continuity in the policy which had its repercussions on execution of works with uncertainty of funds for some works. Further, the Dt. Board engineering staff was not on a par with the corresponding P.W.D. staff in the matter of pay and emoluments, and had also no bright prospects of promotion to higher grades, being confined to one district. This was not quite encouraging. In spite of this they continued their work as satisfactorily as possible under

the conditions. The "Indian Engineering" of 4th June 1921 expressed itself as follows :

"Of the works carried out by the district boards, perhaps the major part is carried out by the District Engineer, and the Engineering staff under him; and comprises such works as road, buildings, wells, and various other works. * *

"Regarding qualifications and training, the Government expects the same high standard as is required of men recruited for the P.W.D. Then naturally the question is asked why this disparity between the pays of the engineers of two services. * * * *

"In the case of the D. B. Engineers, they being under the Local Boards, the only one to appreciate their work is the poorest of the tax payers to Government; and with very scanty emoluments and grants, what the District Boards can offer or contribute towards their public works is, when all is said and done, very meagre in the extreme. Yet whether the contributions are meagre or otherwise, the District Engineer carries out the work allotted to him with all the zeal and determination which produce results which any engineer would be proud of. But unfortunately for the District Board Engineers there is no cadre. * * *

14. 4. After 1924 it was possible for D. B. Engineers to be promoted to higher grades in the newly formed cadre of Dt. Board Engineers, though not on a par with the P. W. D. scales of pay. Again about the year 1938 the scale of pay was revised and the starting

pay was even reduced for the new entrants. In spite of this, the efficiency of the works did not suffer, which stands to the credit of the service. After the formation of the Communications Department in 1940, during the war years a P. W. D. circle for works on roads of strategic importance was created which provided scope for absorbing engineers from the district board service. They had the benefit of the P. W. D. scales of pay and allowances. This paved the way for all the D. B. engineering service personnel being absorbed in the newly formed Highway Department in 1946 with pay and allowances similar to the P. W. D. scales. This put an end to the disparity in the pay scales of the two services.

14. 5. The finance needed for road works of the Boards was mainly derived from the road cess on land revenue collections. The only additional sources were, in the beginning, grants from Government and toll revenue. Land revenue collections were varying from year to year, depending on the vagaries of nature; and the amount credited to the boards on this account therefore varied. An optional land cess could also be levied by the boards, and some of them levied this also. The toll income was however a growing one, as will be seen from the following figures:

Year		Toll Income in Rs. Lakhs
1913-'14	...	13.00
1918-'19	...	25.00
1923-'24	...	30.00
1928-'29	...	39.00

With the abolition of tolls, tax on petrol replaced toll revenue though not to the same extent. The expenditure

on road works upto 1928-'29 was approximately Re. one crore; and thereafter it gradually went up to Rs. 1½ crores, in spite of fall in the income of Local Bodies due to abolition of tolls. This fall in income was to some extent compensated by the income from license fees from motor buses and lorries, which enabled them to spend more on maintenance. Even this slight increase in expenditure was beneficial though not sufficient. It prevented complete shattering of the road surface by the increasing traffic. As the funds were insufficient even for main roads, very little could be spent on village roads, which needed improvement badly if real progress and prosperity were to be had.

14. 6. To aid in the development of village communications, the Village Development Fund was constituted in 1930 by making the levy of optional land cess compulsory; and ear-marking a portion of it for village road development. The total cess after the creation of this fund, viz., eighteen pies per rupee of land cess, was distributed at six pies to Dt. Boards, six pies to Tk. Boards, three pies to Panchayats, and three pies to the Village Development Fund. In 1928-'29, Dt. Boards got about 44.5 lakhs from land cess, and thereafter it fell to Rs. 35.3 lakhs. With these levies and grants from Government, road maintenance increased to Rs. 1½ crores. In spite of this increase and the creation of V.D.F. the increase in the mileage of village roads was very little mainly due to difficulty in their subsequent maintenance which was not adequately provided for.

14. 7. In order to aid local bodies in developing and maintaining the roads, a Central Road Fund was created by the Central Government, the source being

taxes on motor vehicles spare parts, tyres etc. and tax on petrol. This fund could however be used only on new works or improvements. To the extent this could be used for improvements, relief was afforded to road maintenance. A planned co-ordinated programme was drawn up, for all new works and improvements, in 1934 by a special officer appointed by Government which was published in the form of a report, known as "Vipan's Report". This gave priority to feeder roads to Rlys. from markets, and village to market roads. This formed the basis for all road development programmes in the Province (now State), since then. As these schemes developed, mileage of roads and the number of culverts and bridges increased without any additional source of income for their maintenance. This caused a financial crisis in road maintenance. At this period it was considered at one of the L. & M. Engineers' meetings* whether any rational method of fixing or arriving at a formula for mileage maintenance grant could be derived, and a formula was suggested by a member. It was not pursued because it was beyond the means of most local bodies. Further, during the last war years, the roads subjected to heavy military traffic were allotted special grants by Government to compensate for the additional damage caused. In 1941 this question of minimum maintenance amounts for roads was examined by the Communications Department formed in Oct. 1940. The average of five years' actual amounts spent on maintenance of each road was examined and fixed as minimum for those roads. Unless this minimum amount was spent by the boards on roads they were not eligible for this additional government grant for damages caused by military traffic. This ensured during war years necessary allotment of

*See L. & M. Engineers' Journal for March 1934.

funds for road maintenance by the boards, without curtailment, or diversion of funds to other heads of account. Even this did not materially help in solving the maintenance problem. It was therefore decided by government in 1946 to take over a large mileage of roads from local bodies and maintain them as government roads. This afforded relief to local bodies who are perhaps now in a better position to provide more for the limited mileage of roads left with them and for village road works. Social service organisations, the N. C. C., and the N. E. Schemes are supplementing the efforts of road administrations to form and maintain village roads. The formation and maintenance of all-weather earth roads to the villages has come to be recognised as quite essential for the economic development of the country and social welfare of the village community. Motorable earth roads will aid considerably in establishing better health and medical services and adoption of modern methods of cultivation to step up production. More opportunities therefore exist for present young engineers in Highway Service to work for the community than in the days of their predecessors.

15. CONCLUSION

15. 1. The brief account of highway work done in the past will show that very little advance had been made when compared with what still remains to be done. Conditions at present are very congenial for development. A road research station has also been started in Madras, with the object of aiding road development, especially the formation of roads "connecting villages to the nearest main road" and to develop "the most economical materials for bases and surfacings". During the foundation laying ceremony of the Research Station, H. E. the Governor expressed

the hope that the Madras Engineers would continue the good work they had been doing, and that they would value public money more than their own, and exercise economy in the execution of works. It would have been noticed that at all times in the past it was want of adequate finance that was responsible for not making sufficient headway in highway work. The same factor will continue for all times since funds are needed for all other developments also. So it must be the endeavour of officers to see that the rupee is made to go a long way and that as much of a rupee's worth is got on the road as possible. This is the conclusion of the writer; and he wishes the young officers in the department will make conclusion and objective their own also.

15. 2. Before closing this the writer thanks the Association and its Office Bearers for having given him this opportunity to write a paper. If it is not considered impertinent, the writer would advice the young readers to remember that if work is done with earnest interest it will not be taxing; and if they forget even their food at the proper hour owing to demands of work, it will not affect them so long as they do not think about the matter. And another is, that whatever position may be occupied, the duties attached to it must be performed without restraint and conscientiously. It is written by a Sanskrit Poet as follows; the translation is given:

“ Their shade is for others,
While they themselves stand in sun;
Even their fruits are for others' use;
In this respect trees are like ‘*Satpurusha*’ ”.

To remember and follow this way of doing things will lighten one's tasks considerably.

(i) STRENGTHENING A REINFORCED CONCRETE SLAB

During the construction of a four-story reinforced concrete framed building in Egypt serious cracking occurred in the slabs adjacent to the beams. This was found to be due to lack of reinforcement in the tops of the slabs over the beams and insufficient reinforcement in the bottoms of the slabs at midspan to resist the bending moments on the slabs.

Before deciding upon a method of strengthening the slabs, tests were made to measure their elastic and plastic deflections in the cracked condition. To measure the deflection, holes were made through the centres of slabs and $\frac{3}{4}$ in. dia. tubes passed through and fixed to the slabs. A $\frac{3}{8}$ in. dia. rod was passed through the tube and its lower end supported on a timber frame carried on the floor below. A dial gauge was supported on the slab, the plunger of the gauge bearing on the upper end of the $\frac{3}{8}$ in. rod; consequently any movement of the slab was recorded on the gauge. The elastic and plastic deformation immediately after loading was 0.4 in. and increased to 0.5 in. after 24 hours. The residual deflection was 0.185 in.

The method of strengthening consisted in casting a 2 in. reinforced slab about 7 ft. wide over the beams. To anchor the reinforcement to the existing slab, holes, 8 in. by 2 ft. on plan, were cut at intervals of 2 ft. 4 in.

on each side of the beams (Fig. 3). The reinforcement consists of groups of two $\frac{3}{4}$ in. diameter bars at 2 ft. 4 in. centres with their ends bent down into the holes through the existing slab, smaller bars being provided between these bars as shown in Fig. 1. Before casting the 2 in. slabs the floors were propped to prevent deflection due to their own weight; the props were left in position for seven days after concreting. Further tests were made after the strengthening had been carried out. The same load was used as in the first tests, and a comparison of the deflections before and after strengthening is shown in Fig. 2, from which it is seen that plastic deformations have been considerably reduced. The addition of the 2 in. slab does not interfere with the levels of the finished floor which was previously covered with wood or cement tiles.

The investigation and the strengthening of the floor were carried out under the direction of Professor H. F. El. Baroudy, Ph. D., A.M.I.C.E., Faculty of Engineering, Alexandria University Egypt.

—(Extracted from "Concrete and Constructional Engineering" December '55, Vol. L, No. 12).

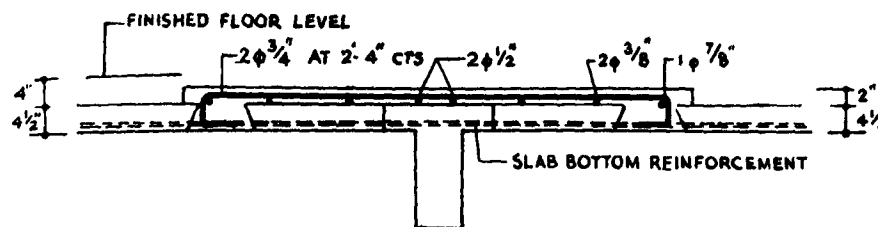


Fig. 1.—The Additional Reinforcement.

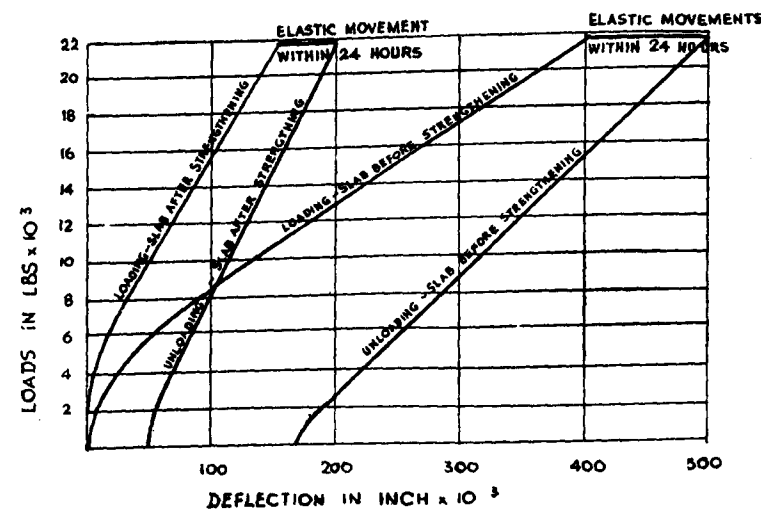


Fig. 2.—Comparison of the Deflections before and after Strengthening the Slab.

(ii) ROAD ROLLERS:

Road Rollers come very high in the list of items important to India's present and future prosperity. It is opportune, therefore, to consider a few of the features relating to the preparation of modern roads in India.

It must be admitted first of all that the employment of different road-making techniques and changing fashions in road surfacing materials make machine designs, which meet the needs of one country when employing one material, nevertheless inadequate in other countries where a different surfacing material is used.

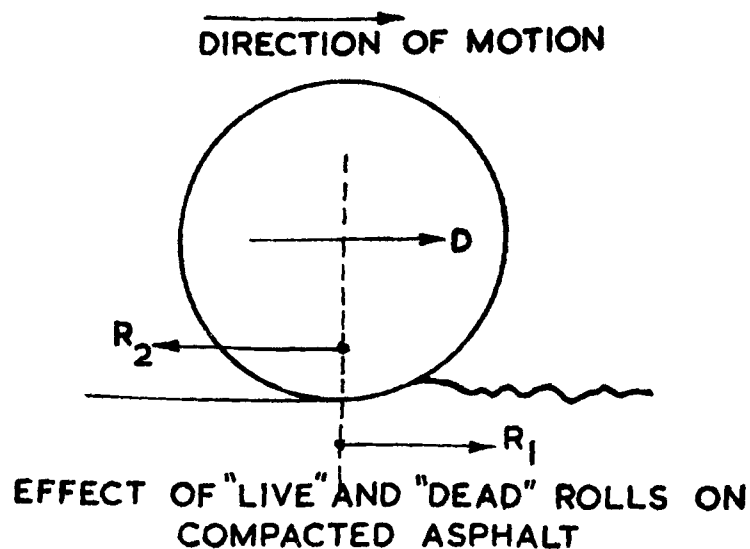
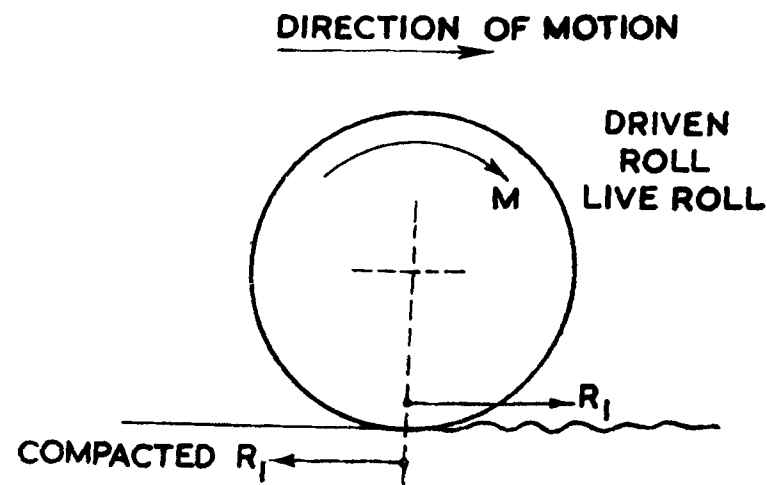
The three-wheeled Roller is an excellent tool in the construction of macadam type highways. In this country where mechanical spreaders are used today

with a tramacadam and bituminous macadam laid comparatively cold, the material is so 'unplastic' at the moment of laying that there is practically no tendency for it to move laterally under any type of Roller.

It has been the prevalence of this type of topping in Germany, France and the United Kingdom over the past 20 years which caused the Tandem Roller to decline in popularity in favour of the three-wheeled roller with its higher specific pressure and, therefore, better compacting qualities. Add to this fact that on the macadam type of road the pitching of large hand laid stones which form the base of the road, required a heavy robust type of Roller with a high leneal pressure and you will see that for this type of roads the three-wheeled Roller was the ideal dual purpose machine. In an attempt to retain this dual purpose quality with a machine which would yet give a more even pressure for surface rolling with more modern plastic carpets, certain manufacturers introduced after the war the sliding ballast weight and the principle of pressure equalisation. With these Rollers good results were still obtained with comparatively low temperature mixes which might be described as "warm" rather than "hot". We know that such Rollers have also been used and given satisfactory results on the very hot, fine sand and filled asphaltic carpets, but we recognise that more skill is required on the part of the driver to avoid marking, and it is imperative that the Roller runs with its large wheels, that is the driven wheels, nearest to the Finisher so that it is these "Live" wheels which first come on the carpet while it is still in the partly compacted state as left by the Finisher.

It is obvious that with these hot asphaltic concretes, the degree of compaction demanded of the roller is nothing like so high as with the cold macadam type of carpet. Finishers, particularly of the Baber-Greene type with its highspeed tamping bar do in fact compact these hot mixes to a very high degree, and all that is required of the Roller in such cases is an 'ironing' of the surface to close it, render it waterproof, and smooth out the joints, between the various stripes. For such purposes the Tandem Roller with its low specific pressure and its unbroken rolling surface is ideal. Nevertheless, the same rule that the driven roll must be the first to approach the newly laid material holds good. It will be seen that certain designers deliberately place the driver with his back to the guide or steering roll and with the controls in such a position that he finds it most natural to drive the machine power roll first. Perusal of the diagram attached will show the reasons for this. In the first sketch which illustrates a driven roll approaching uncompacted material. It will be seen that the tendency for the roll to surmount the small inclined formed due to the difference in level between the uncompacted and the compacted material. Note that with a pre-compacting Paver this difference will probably be extremely small. Nevertheless, the fact that the roll is driven allows is to surmount any such difference in level without the tendency to push the material ahead of it evident with a deal roll. With the driven roll in this diagram, it will be noted that the reaction on the asphalt surface is toward the rear, that is the thrust is against material which has already been compacted and knit to the base.

As will be seen from the second sketch with an ideal or non-driven roll, forward motion is due to



the push of the chassis on the axle pin at the centre of the roll and the roll itself turns because of the reaction between its circumference and the road surface. In such a case the direction of thrust on the road surface is forward and where such a roll comes up against uncompacted material, particularly where this is hot and plastic as is the case, with sand filled bituminous concrete, there is a distinct tendency to push the material ahead of the roll until the resistance of the accumulating material overcomes the frictional resistance on the roll which then surmounts the heap of accumulated bituminous material leaving it as a wave.

The supplementary question of roll diameter also has its effect on surface finish, since even with the smoothest system of reverse clutches, there is a small instant of dwell when a machine reverses and during this short instant, particularly with a hot plastic mix, there is a tendency for the machine to sink slightly into the surface leaving a slight indentation. To reduce such marking to a minimum, the Roller must have as nearly instantaneous as possible a reverse, with smooth take-up and should have the greater practicable wheel diameter.

Possibly the above points are not considered by the layman, when he sees a Road Roller working but a little reflection will soon bring to mind tremendous strides that have taken place in Road Roller design so that the modern Streamlined and efficient Road Roller has as much resemblance to its forebears as a brand new Buick has to a Model T Ford.

—(Extracted from "Auto Spark",
Vol. VIII, No. 2, February '56).

1. The Freyssinet system, the oldest in the field of prestressing, has been developed in France. Its first bridge was built in Germany in 1938, and after the war it played an important part in the reconstruction of a great number of road bridges in France. Since then, it has been introduced in all the continents of the world. In 1949, its first bridge was built in India.

—(Extract from "Journal of the Builders Association of India", June 1956, Vol. 4, No. 6).

2. In 1836 the steam excavator was patented by twenty-year-old William Smith Otis, but many years were to elapse before it was developed into the successful power shovel that we know to-day. The steam roller was patented in 1863 and was first used in Calcutta, strangely enough, in that year. In 1867 the first English steam roller was made (Prior to that date road crusts had been compacted by horsedrawn rollers, some water ballasted).

The engine was of 12 H. P. and the driving rollers were 7 ft. in diameter and 2 ft. wide. The steering roll, made in two sections, was 5 ft. diameter and the total weight was in the region of 30 tons. The first English machine made was sold to the City of Liverpool, to whom should be accorded the credit of being the first Highway Authority in the United Kingdom to own a steam roller.

In 1869 two road rollers were exported to the United States and in that year the Commissioners of Central Park, New York, reported that "in one day's steam rolling at a cost of 10 dollars as much work was accomplished as in two days with a 7 ton roller drawn by eight horses at a cost of 20 dollars a day".

In 1871 a steam roller incorporating rear wheel drive and front wheel steering appeared.

The majority of these early developments in roller design were due to the inventive genius and energy of Thomas Aveling, of Rochester (1824-1881). His last invention, introduced in 1880, incorporated parallel front rolls instead of conical and a steering from which spanned the rolls and carried the vertical pivot in.

—"Extract from the Journal of the Institution of Highway Engineers Vol. III, No. 1, Jan. 1954".

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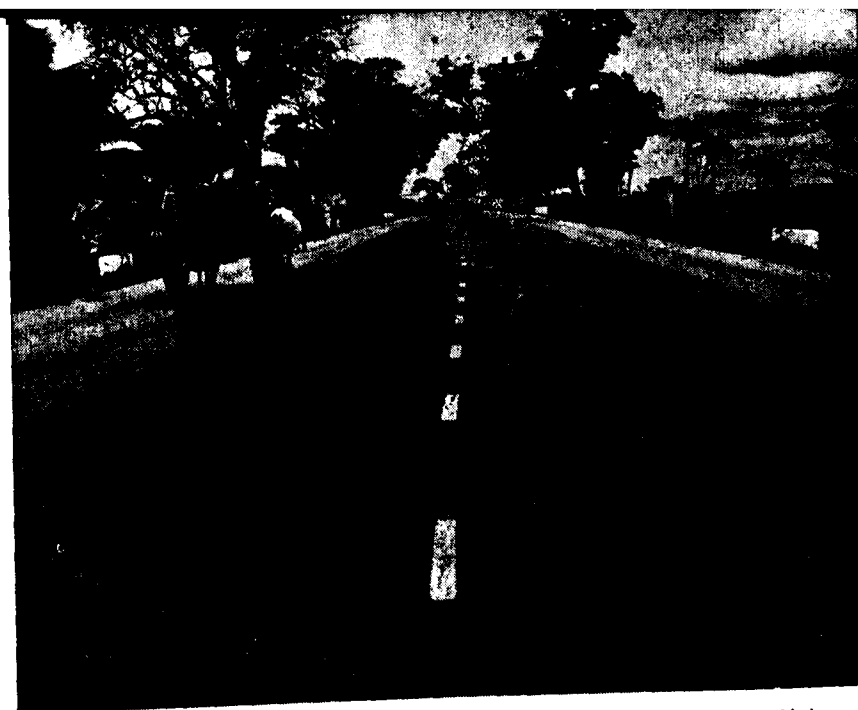
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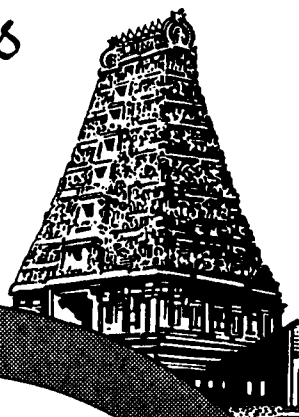


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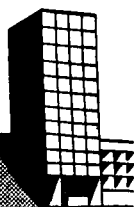
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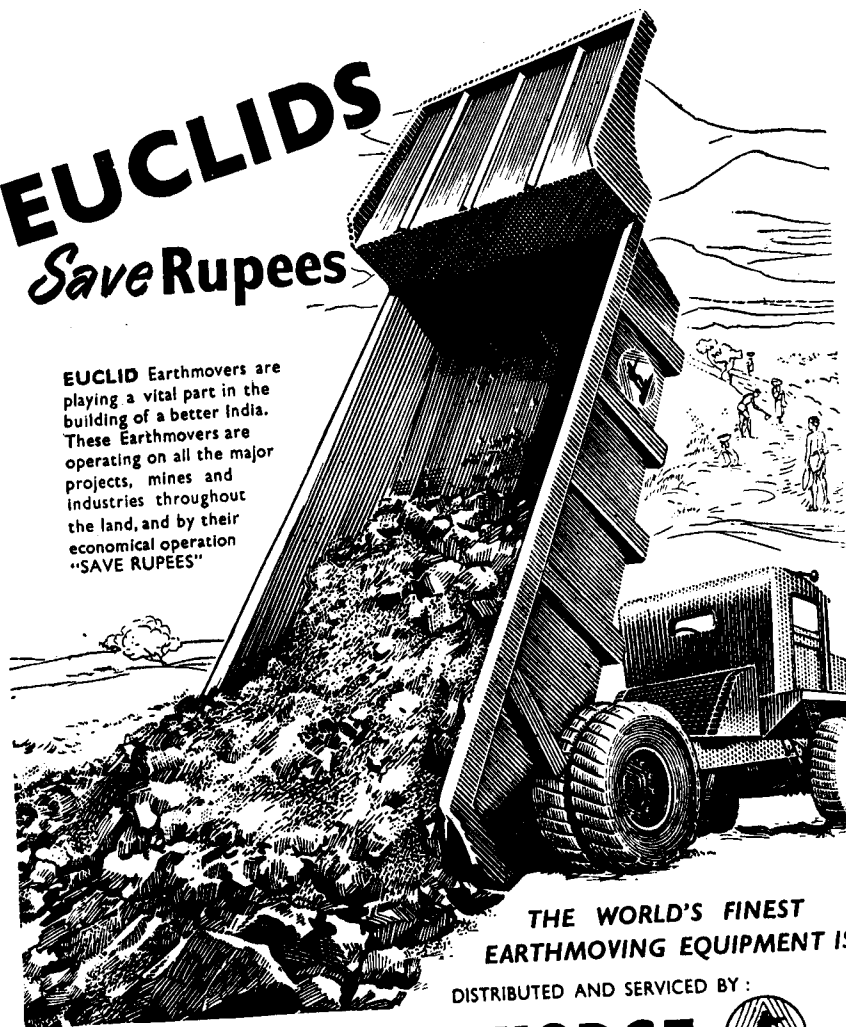
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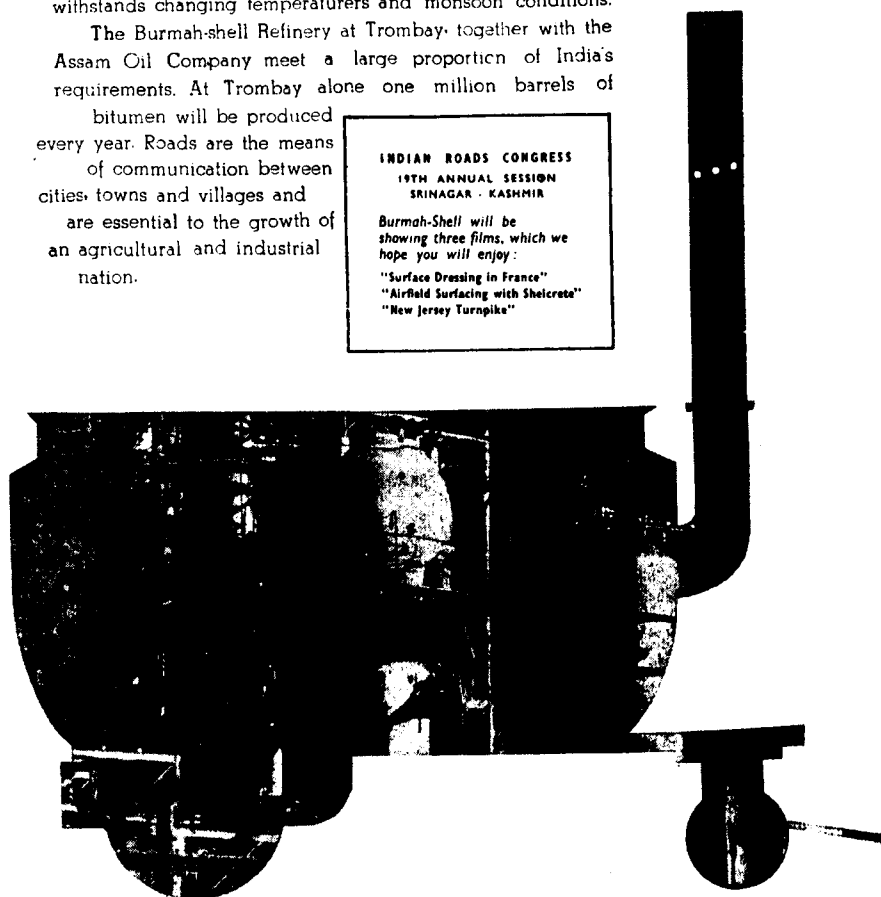
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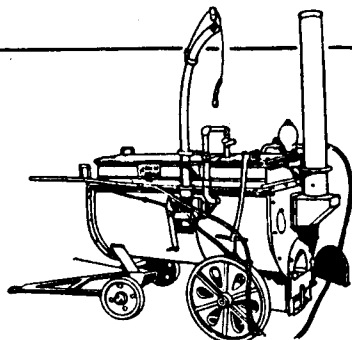
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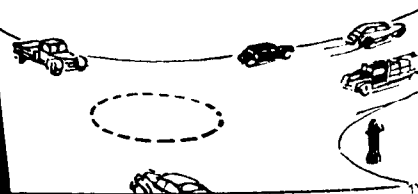
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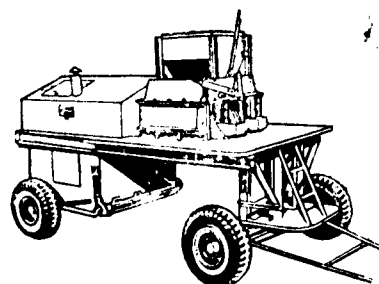
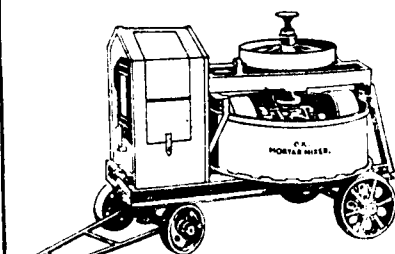
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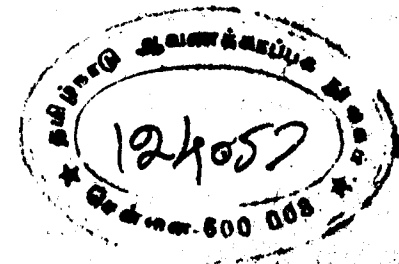
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—Sardar K. M. PANNIKAR.



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