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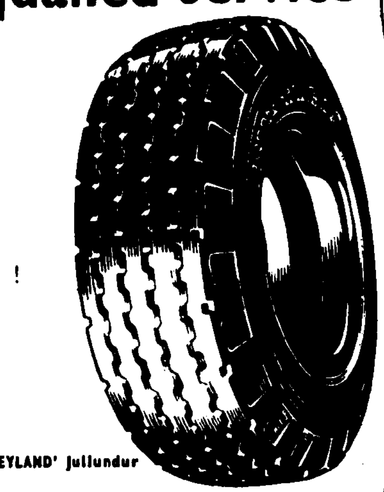

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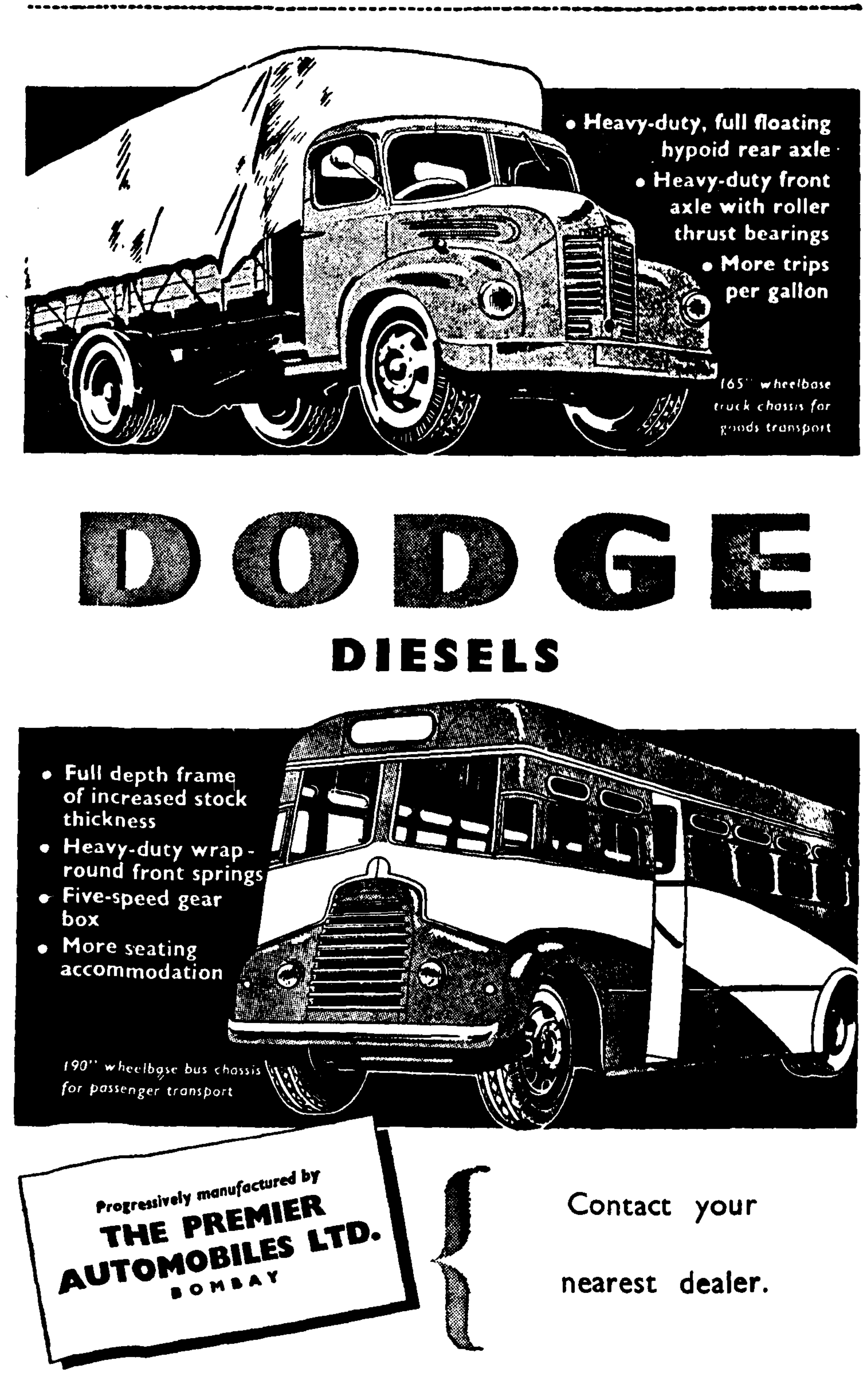

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

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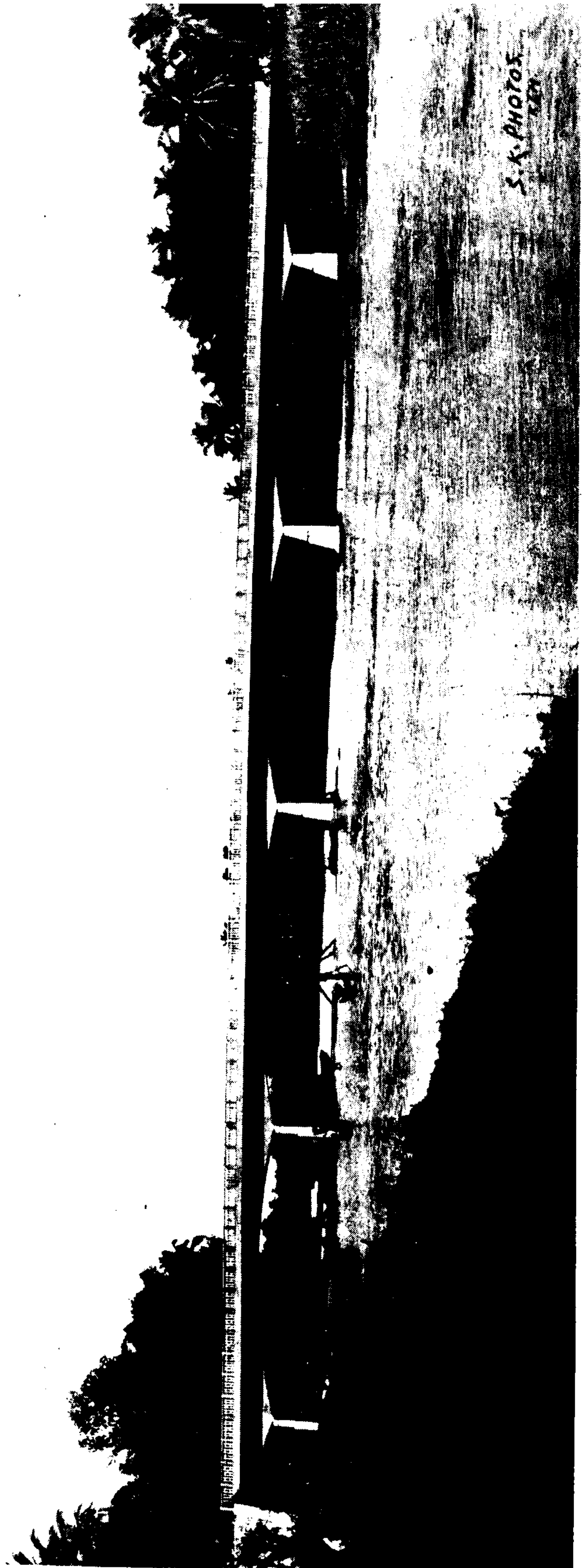


ARRATTUKADAVU BRIDGE

ACROSS THE ACHENCOIL RIVER AT MAVELIKARA IN MILE 1 1 OF MAVELIKARA-TIRUVELLA ROAD

(Kerala State)

TRANSPORT-COMMUNICATIONS MONTHLY REVIEW

A REVIEW OF
ROAD ENGINEERING, DEVELOPMENT & TRANSPORT

MARCH 1961

THE REQUIREMENTS OF AUTOMOBILES DURING THE THIRD FIVE-YEAR PLAN

By

SHRI B. V. VAGH*, B.E. (CIVIL) M.I.E. (IND.)

The production capacity of automobiles, other than motor cycles, scooters and three-wheelers, in the year 1960-61 was 20,000 cars, 5,500 jeeps and 28,000 commercial vehicles, making in all 53,500. This is proposed to be raised in the year 1965-66 to 30,000 cars, 10,000 jeeps and 60,000 commercial vehicles respectively making in all 1,00,000. Thus the capacity is proposed to be very nearly doubled during the Third Five-Year Plan.

Estimated Production and Number of Vehicles

During the Second Five-Year Plan about 63,000 cars, 22,000 jeeps and 91,000 commercial vehicles making in all 1,76,000 vehicles will be produced. The breakdown from year to year is as follows:

Year (Jan./Dec.)	Cars	Jeeps	Commercial vehicles	Total
1956	12,989	4,816	14,333	32,138
1957	11,601	4,679	15,649	31,929
1958	7,808	3,855	15,125	26,788
1959	11,769	4,731	19,820	36,320
1960 (Estd.)	18,438	4,628	25,888	48,954
	62,605	22,709	90,815	1,76,129
	85,314			

Stepping up production to the manufacturing capacity proposed to be provided in 1965-66, the estimated production during the Third Plan works out to about 1,27,000 cars, 39,000 jeeps and 2,32,000 commercial vehicles making in all 3,98,000 vehicles. Their estimated breakdown from year to year will be

*Executive Vice-President, The Indian Roads and Transport Development Association as follows :

Year	Cars	Jeeps	Commercial vehicles	Total
1961	20,800	5,600	32,800	59,200
1962	23,100	6,700	39,600	69,400
1963	25,400	7,800	46,400	79,600
1964	27,700	8,900	53,200	89,800
1965	30,000	10,000	60,000	1,00,000
	1,27,000	39,000	232,000	3,98,000
	1,66,000			

Thus, the number of vehicles likely to be produced during the Third Plan will be a little more than twice the number of vehicles produced during the Second Plan.

Based on the number of vehicles in the country at the end of the First Five-Year Plan, i.e., 1955-56 and allowing for replacements out of the production of vehicles during the Second and Third Plans at 20 per cent for cars and 25 per cent for commercial vehicles in each period of five years the estimated number of vehicles during those Plans works out as follows :

		Cars and jeeps	Commercial vehicles	
(i)	Number in 1955-56 in round figures	2,03,000	1,65,000	Item 1, page 116, Jha Committee's Report.
(ii)	Estimated production in Second Plan	85,000	91,000	
		2,88,000	2,56,000	
Less :				
(iii)	Replacements at 20% for cars and 25% for commercial vehicles in item (i)	41,000	41,000	
(iv)	Estimated number of vehicles in 1960-61	2,47,000	2,15,000	
(v)	Estimated production in Third Plan	1,66,000	2,32,000	
		4,13,000	4,47,000	
Less :				
(vi)	Replacements at 20% for cars and 25% for commercial vehicles in item (iv)	49,000	55,000	
(vii)	Estimated number of vehicles in 1965-66	3,64,000	3,92,000	

Note : These figures are inclusive of vehicles supplied to the Defence Services from 1956-57 onwards.

Thus, the actual number of vehicles likely to be on our roads at the end of the Third Five-Year Plan will be about 3.64 lakhs of cars and jeeps and 3.92 lakhs of commercial vehicles including vehicles supplied to defence services against 2.03 and 1.65 lakhs civilian vehicles respectively as at the end of the First Five-Year Plan. In other words, the number of vehicles during the ten years 1955-56 to 1965-66 will be about one and three-quarter times the number of cars and about two and one-third times the number of commercial vehicles in the country in 1955-56.

National Income

When the number of vehicles likely to be in the country is known it is necessary to find out :

(a) Whether the anticipated number is sufficient for our requirements, and

(b) Whether there is sufficient space for it on our roads, defective as they are.

In regard to (a), the main criteria should be an increase in the national income of the country from Plan to Plan. Based on it, the position will work out as follows :

	Second Plan			Third Plan		
Type	Number on the basis of N.I.	Number provided	Difference	Number on the basis of N.I.	Number provided	Difference.
1	2	3	4	5	6	7
Cars and jeeps	278,000	247,000	31,000	393,000	364,000	29,000
Commercial vehicles	260,000	215,000	45,000	430,000	392,000	38,000

Note : Figures in columns 2 and 5 are from page 117 of Jha Committee's Report.

It will be seen from this table that the deficiency on the basis of an increase in national income at the end of the Second Five-Year Plan will be about 30,000 cars and jeeps and 45,000 commercial vehicles and at the end of the Third Five-Year Plan will be about 30,000 cars and jeeps and 40,000 commercial vehicles. Excluding vehicles supplied to the defence services, the deficiency will be greater. Broadly, the estimated production of vehicles may be taken at about 30,000 cars and jeeps and 40,000 commercial vehicles short of the country's requirements on the basis of national income. Therefore, it is necessary to step up the production so as to make good this deficiency. It may be mentioned that in about the third year of the Second Five-Year Plan, there were complaints of shortage of vehicles and one of the items required to be investigated by the Jha Committee was this shortage. From this it will appear that unless this shortage is made good similar complaints may arise during the Third Five-Year Plan also.

Replacements

Another point is that the number of vehicles worked out in the above tables has been based on a conservative rate of replacements at 20 per cent for cars and 25 per cent for commercial vehicles during a period of five years. In practice this is not likely to be sufficient since according to a survey carried out by the Ministry of Transport in the year 1957 in and around Delhi, it was found that about 42 per cent of public carriers were more than 10 years old. This fact will make it necessary to step up the production still further. However, it would appear that even ignoring this point production for the year 1965-66 should be about 40,000 cars, 12,500 jeeps and 75,000 commercial vehicles against 30,000, 10,000 and 60,000 respectively provided for.

Utilisation of Roads

In regard to the utilisation of roads, the following table of the number of vehicles per mile on our surfaced roads from the year 1950-51 to the year 1965-66 will be found to be interesting:

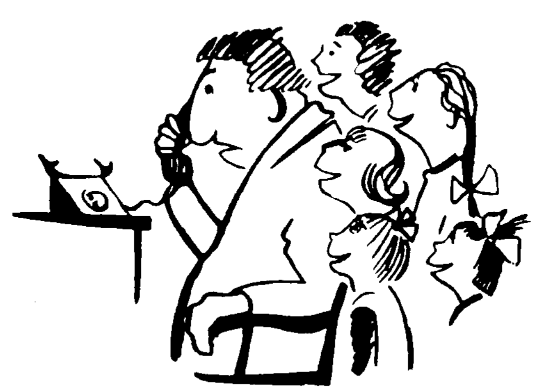
		1950-51	*1955-56*	*1960-61*	*1965-66* (Estd.)
1.	Milage of surfaced roads in round figures	97,500	121,600	144,000	164,000
2.	Number of cars in round figures	159,000	203,000	247,000	364,000
3.	Number of commercial vehicles including probable requirements of Defence Services	116,000	165,000	215,000	392,00
4.	Cars per mile	1.63	1.67	1.71	2.22
5.	Commercial vehicles per mile	1.19	1.36	1.49	2.39

Note: Figures for 1960-61 and 1965-66 are estimates based on Planning Commission's targets and will vary according to actual production.

Against about 1.67 cars and about 1.36 commercial vehicles per mile of a surfaced road in our country in the year 1955-56, there were about 28 cars and about 9 commercial vehicles per mile of surfaced roads in Great Britain in that year. Taking the traffic capacity of our roads at half that in Great Britain on account of the known deficiencies in our road system, it would appear that on the basis of traffic in Great Britain there was room on our roads in that year for over eight times the number of cars (14.0 ÷ 1.67) and over three times the number of commercial vehicles (4.5 ÷ 1.36) on our roads. Against this, the estimated number per mile on our surfaced roads in 1965-66 will be about 1.33 times the 1956 number of our cars (2.22 ÷ 1.67) and about 1.75 times the 1956 number of our commercial vehicles (2.39 ÷ 1.36), against over 8 and 3 times respectively on the basis of half the traffic in Great Britain. This shows the extent to which we have still to make headway. The maximum utilisation of the traffic-carrying capacity of roads is an important point from the point of view of national development which should not be ignored since according to the findings of the National Council of Applied Economic Research, New Delhi, the employment potential of road transport as well as its contribution to the exchequer are much higher than those of the railways.

Thus even though the production of our automobiles is stepped up on the lines indicated above, there will be space on our roads for more cars and commercial vehicles than are likely to be produced by the year 1965-66. Finally, considered from all angles, namely, the requirements of vehicles on the basis of an increase in national income, the extent to which replacements of old vehicles will be necessary the traffic-carrying capacity of our roads and the gain in employment and contribution to the exchequer it is clear that the production targets for automobiles during the Third Five-Year Plan require to be reconsidered.

HUMOUR



"I beg you, do look once more, may be it is a boy after all!"

THE RAPID EVALUATION OF THE GEOMETRY OF HIGHWAY CURVES

By

P. O. MALONE, B.ENG., A.M.I.C.E., A.M.I. Struct. E.

Engineer, Rendel, Palmer & Tritton, Consulting Engineers

The determination of the alignment of a highway may be considered in two stages, the first stage being the investigation of a number of trial alignments, one of which is subsequently judged the best, and the second stage the more detailed investigation and development of the chosen alignment.

The first stage may be termed the "trial and error" stage, and at this juncture the engineer chooses tentative intersection points, radii of curves, etc., and requires a reasonably accurate assessment of the geometry of each of his trial alignments; for example, he will normally require to check that the radii chosen for consecutive curves are such that the curves do not overlap, also, he may require an estimate of the total length of each trial alignment, in which case he requires an estimate of the total length of each curve. Extreme accuracy at this stage is not, however, necessary, nor is it desirable or economical since for all alignments other than that adjudged the best, all the calculation, except in so far as it is necessary to establish the best line, is wasted.

To minimise the effort expended on routine calculation, nomographic charts may be usefully employed. The use of nomograms produces the required values with only a fraction of the effort required to produce the same values working from tables, and although the accuracy of the values derived from the nomograms is not of the same order as that from the calculations, working from tables, nevertheless the order of accuracy of the values from the charts is normally well within that required in the "trial and error" stage.

Apart from the obvious advantage of reducing the time spent by the engineer on purely routine arithmetical work, nomograms may be useful in other ways, for example:

(a) in the checking of accurately computed values to guard against gross errors in the latter, and

(b) as graphical representations of the relationship between the variables in a formula. In certain formulae, one variable may be expressed explicitly in terms of the others, but inversion to obtain the other variables is frequently extremely difficult; when such formulae are expressed in nomographic form, the values of all variables are obtained with equal facility. An example of this attribute of a nomogram is given below.

Examples of five types of nomogram relating to the geometric design of a highway will now be discussed. Four of these appear particularly suitable for application to the "trial and error" stage, whilst the fifth, that relating to the application of superelevation of a carriageway, appears to be accurate enough for use in the detail design stage.

The formulae used in the derivation of the nomograms for spiralled curves are those for the clothoid quoted in "Highway Spirals, Superelevation and Vertical Curves," by H. Criswell, using a centripetal acceleration of 1 ft./sec.^{3}. The calculation of the scale factors and the drawing of the nomograms follow standard practice, for which reference may be made to any standard mathematical text-book (e.g., "Practical Mathematics," Vol. II, by Toft and McKay). As a general rule it may be stated that an equation relating a single term on the left-hand side to a single term on the right-hand side is expressed nomographically by a series of parallel straight lines with logarithmic graduations, the necessity or otherwise for transfer axes being dictated by the total number of variables involved; an equation relating a single term on the left-hand side to the sum (or difference) of two terms on the right-hand side requires a somewhat more complicated nomogram, those in the examples below falling in this category requiring representation by two parallel straight lines with a curve for the third axis.

It may be noted that the length and breadth of a nomogram may be varied, independently, at will, and it is suggested that there is a case for drawing out these nomographic charts to a large scale (with a corresponding increase in accuracy) for general use in highway design offices.

The notation used is as follows:

- T total apex distance (equivalent to tangent distance in the case of a purely circular curve).
- R the radius of curvature at any point of a curve.
- $\triangle$ total deflection angle of a curve, in degrees.
- $\triangle_{ss}$ the angle consumed by the pair of spirals in a spiralled curve, in degrees.
- L_s the length of one spiral in a spiralled curve.
- L_c the length of the circular arc in a spiralled curve.
- L_{tot} the total length of curve (spirals plus circular arc) in a spiralled curve.
- L the length of arc in a purely circular curve.
- s the shift in a spiralled curve.
- c a symbol used in the formula for total apex distance for a spiralled curve, and equal, approximately, to $L_s/2$.
- D degree of curvature ($= 5729.6/R$).
- $f(\,)$ the usual mathematical notation for "function of", with subscripts to denote different functions.
- V design speed in miles per hour.

Nomogram for Total Apex Distance

The total apex distance (T) of a spiralled curve is given by the formula

$$T = (R + s).\tan\triangle/2 + c \text{..........(1)}$$

Although this formula has five variables, these are not all independent, and "s" and "c" may be expressed in terms of the radius "R" and the design speed "V". In addition, a slight simplification may usefully be made by taking "c" equal to half the length of the spiral; this means, in effect, that in the formula for "c", quoted by Criswell, the second term is neglected. This simplification does much to facilitate the working and has no appreciable effect on the accuracy of the values obtained from the nomogram.

Assuming a constant value for the design speed, equation (1), above, may be reduced to an expression containing three variables only, "T", "$\triangle$" and "R". In this example, an actual value of 61 m.p.h. has been used for "V"; the results from the nomogram are, therefore, directly comparable with those obtained from Criswell's A 60 Table, which, although for a nominal design speed of 60 m.p.h., has actually been calculated for a speed of 61 m.p.h.

Making the substitution for "s" and "c", and putting $V = 61$ in the resulting equation and re-arranging (1) becomes

$$\tan\triangle/2\left(R + \frac{21369.10^6}{R^3}\right) + \frac{358063}{R} - T = 0 \text{ ....(2)}$$

Expressed in functional notation, (2) may be written

$$f_1(\triangle).f_2(R) + f_3(R) + f_4(T) = 0 \text{......(3)}$$

This equation (3) is a standard form and readily transposes into a nomogram comprising two parallel straight lines and a curve. In this particular form of the expression, the straight line axes are those of "$\triangle$" and "T", whilst the curved axis represents radius (or degree) of curvature. The graduations on the T-axis are linear, those on the $\triangle$-axis are linear with respect to $\tan\triangle/2$, whilst the curved axis is calculated as the co-ordinates of a series of points, each one corresponding to a separate value of radius or degree of curvature; the expressions for these co-ordinates are functions of

(a) the functions in (2), above and

(b) the length and breadth of the nomogram.

It will be found that graduating both the "T" and "$\triangle$" axes in a positive sense

upwards results in the curved axis falling outside the pair of straight lines. Whilst this produces a perfectly correct nomogram, it is rather inconvenient to use, and it will be found that inverting of the graduations on one of the straight line axes (equivalent to a change of sign of the scale factor of that axis), brings the curved axis within the other two, and gives a more satisfactory and manageable diagram.

The resulting nomogram is shown in Fig. 1. The curved axis has been labelled "Degree of Curvature" and is marked in integral values and 12′ subdivisions thereof, although the calculations of the co-ordinates of the points on this axis have been made with the corresponding values of "R".

The value of the pictorial mode of expression can now be appreciated, and Fig. 1 presents a clearer picture of the relationship between the variables "T" "$\triangle$" and "R" than does equation (1) above. As an example of the utility of the nomogram, the problem of determining the radius of curvature of a curve to ensure a given total apex distance, may be quoted. It frequently happens that because of the nature of the terrain or possibly from aesthetic considerations, consecutive curves have a common terminal point, in which case once the radius of one of the curves (and therefore the total apex distance) has been chosen, the total apex distance of the other curve is automatically fixed. Equation (1) is explicit in terms of "T", but not so in terms of "R", and the normal method of tackling the problem of finding the value of "R" corresponding to the required value of "T" would be one of trial and error. In the nomogram, however, all the variables are, as it were, explicitly given in terms of the others, and in the case in point, it is merely necessary to lay a straight edge between the given values of "T" and "$\triangle$", whereupon the required value of radius or degree of curvature may be immediately read off on the middle axis.

It will be recalled that equation (2) was constructed on the basis of a constant value (61) for "V"; Fig. 1 therefore is a nomogram for this speed only. It is obvious that a series of such nomograms may be built up, one for each design speed, and either superimposed on the one chart, or kept distinct, each labelled for a separate design speed. The latter course is advocated since the charts are simple and easy to read; furthermore, the choice of a separate presentation for each design speed means that the range of values adopted for each of the variables may be varied, as necessary, from chart to chart.

Nomogram for Length of a Spiralled Curve

The length of the circular arc in a spiralled curve is given by the formula.

$$L_c = R.(\triangle - \triangle_{ss})\frac{\pi}{180} \text{................(4)}$$

$\triangle_{ss}$ is a function of "V" and "R" and substituting for $\triangle_{ss}$ and re-arranging, (4) becomes

$$\left(\triangle\cdot\frac{\pi}{180}\right).R\ \frac{3.155\,V^3}{R} - L_b = 0 \text{......(5)}$$

Now, turning to the total length of a spiralled curve, (L_{tot}.)

$$L_{tot} = L_c + 2\,L_s \text{ ....(6)}$$

L_s is a function of "V" and "R", so that substituting for L_c and L_s and re-arranging, (6) may be written

$$\left(\triangle\cdot\frac{\pi}{180}\right).R + \frac{3.155\,V^3}{R}\,L_{tot} - 0 \text{...(7)}$$

It will be observed that equation (7) is similar to equation (5) with the exception of the sign of the middle term. Furthermore, both equations (5) and (7) may be written in functional form

$$f_5(\triangle).\ f_6(R) + f_7(R) + f_8(L_c \text{ or } L_{tot}) = 0 \text{ ....(8)}$$

Equation (8) is similar in form to equation (3) and may, likewise, be expressed as a nomogram comprising two parallel straight lines and a curve. It would obviously be convenient to have a nomogram which would, for any given values of "$\triangle$" and "R", give directly, and simultaneously, the corresponding values for L_c and L_{tot}; this implies four axes, one for each variable so that with one setting of the straight edge, L_c and L_{tot} would be evaluated. It appears, however, that the mathematical form of the equations precludes this, and recourse has been made to a nomogram in which a single axis is provided for both L_c and L_{tot}, and two separate axes provided for curvature. An illustration, for a nominal design speed of 60 m.p.h., is shown in Fig. 2. This is, in effect, a pair of nomograms with a common axis for length of curve as shown in Fig. 2, a straight edge laid from any value of $\triangle$, through any given value of curvature, using the upper axis, therefor, will give, as an intercept on the R.H. axis, the corresponding value of L_c, whereas if the procedure is repeated using the lower curvature axis, the intercept on the R.H. axis is the corresponding value for L_{tot}. Due to the fact that the expressions for L_c and L_{tot} [equations (5) and (7)] differ only in the sign of one term, the calculation of the co-ordinates of the points on the two "curvature" axes is simplified in that the two points, one on each curve, corresponding to the same degree of curvature, have the same abscissa. As in the case of the nomogram for total apex distance, the straight line axes in Fig. 2 have been graduated in opposite directions.

Obviously for any given values of $\triangle$ and R, the difference between the values of L_c and L_{tot} represents twice the length of the spiral, L_s; thus L_s may be obtained, indirectly from a nomogram of the type of Fig. 2. However, since for any constant design speed, the value of L_s is inversely proportional to the radius, R, the chart could well be completed by a two-column table indicating, directly, corresponding values of curvature and length of spiral.

Thus, working to a fixed design speed, all the usual geometric information relating to a spiralled curve may be obtained directly from a pair of charts, similar to Figs. 1, and 2

Nomogram for Offset to Spiral

It is essential, at times, to have a knowledge of the value of the offset of a transition spiral from the line of the tangent, for various points along the length of the spiral; this knowledge is necessary when dealing with the encroachment of a transition spiral on a bridge, or wherever clearance in the area of the spiral is critical.

The general solution, embracing various design speeds and lengths of spiral may be expressed in nomographic form, and serves to illustrate the nomogram comprising parallel straight lines with logarithmic graduations.

The formula for the offset (y) of the spiral from the line of the tangent at the origin of the curve is given by

$$y = 0.291\, a\left(\frac{L_s}{100}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

where "a" is the degree of curvature at a point 100 ft from the origin of the curve. This formula is similar to that quoted by Criswell, with the exception that that the second term in the latter's formula has been omitted; the second term introduces a very small correction, and its omission does not materially affect the accuracy of the values derived from the nomogram. The variable "a" may be expressed in terms of the design speed, so that (9) may be written

$$y = 52{,}850\,\frac{L_s^3}{V^3} \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

or, in logarithmic form,

$\log y - (\log 52{,}850 + 3 \log L_s) + 3 \log V = 0$......(11) This is a standard form and transposes directly into a nomogram comprising three straight line axes, each with logarithmic graduations. The range of scale and the scale factor on any two of these axes may be chosen arbitrarily, but the third scale factor, and the ratio of the distances between the axes, cannot be so chosen, and, in fact, are functions of two scale factors chosen.

The resulting nomogram is shown in Fig. 3.

Nomograms for Circular Curves

The formulae for total apex distance (tangent distance), and for length of arc, for purely circular curves, are simpler than the corresponding ones relating to spiralled curves, and the transformation into nomographic form is easier.

Total apex distance for the purely circular curve is given by the expression

$$T = R \tan \triangle/2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

or, in logarithmic form,

$$\log T - \log R - \log \tan \triangle/2 = 0 \ldots (12)$$

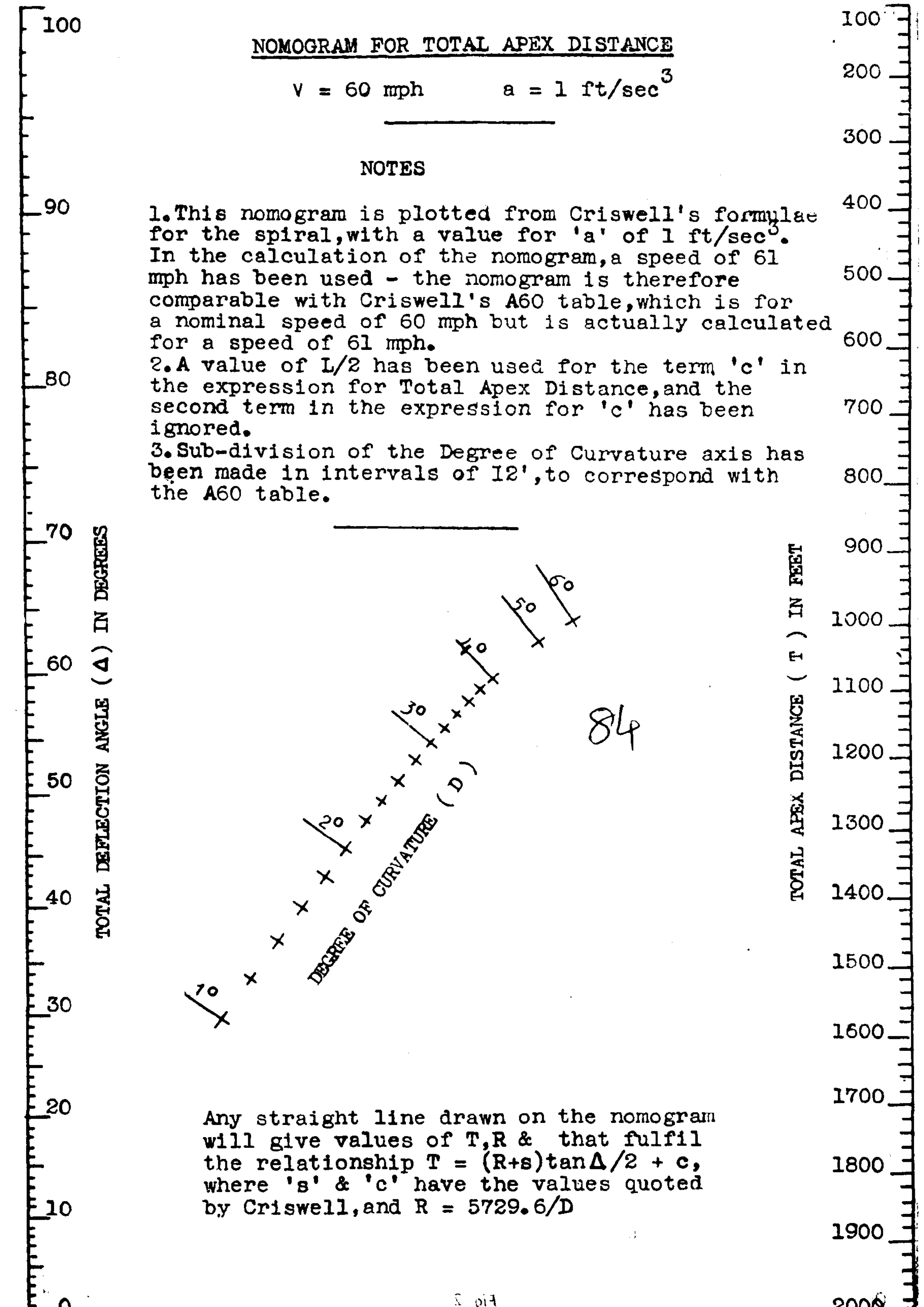
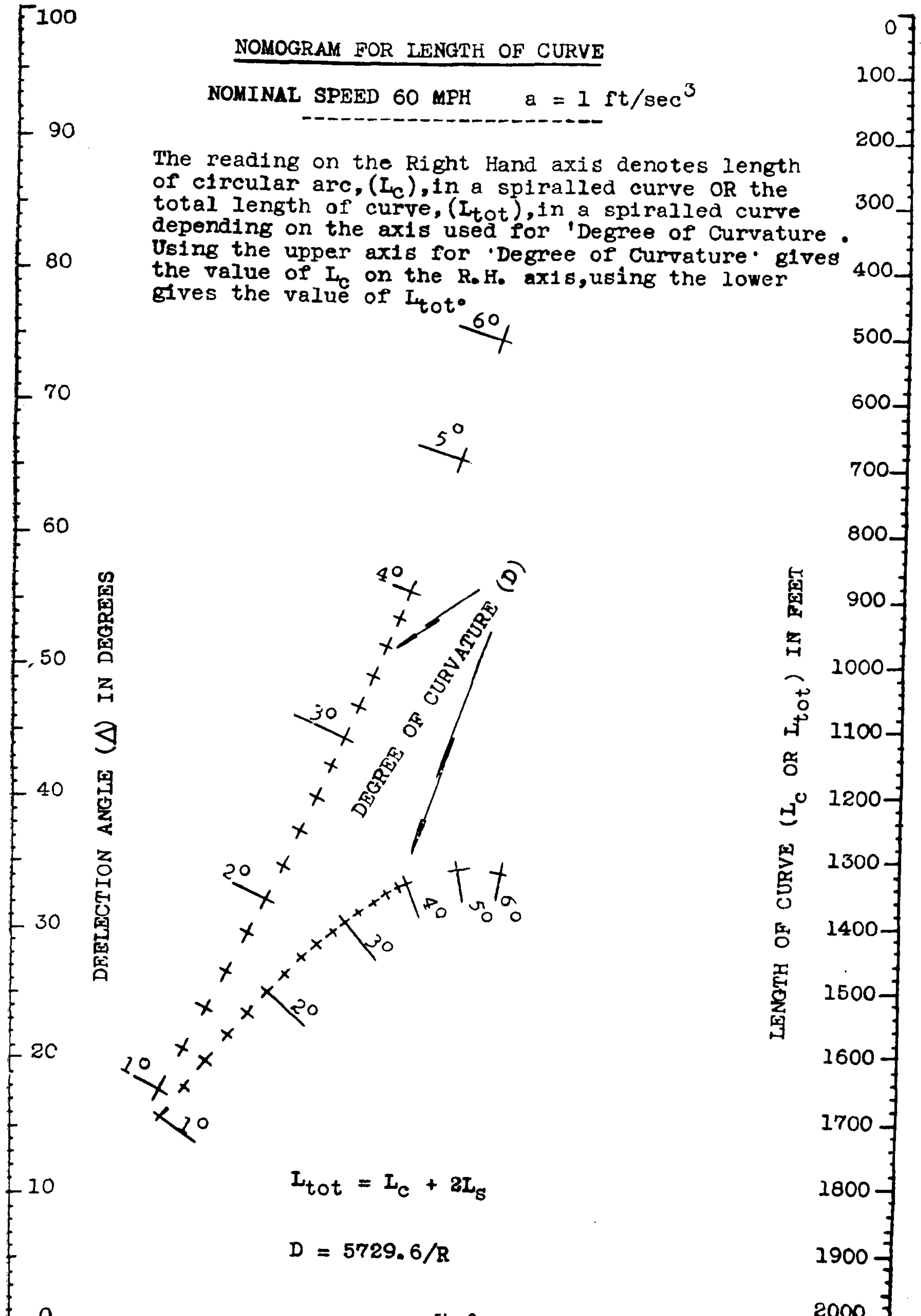


Fig. 1

NOMOGRAM FOR LENGTH OF CURVE

NOMINAL SPEED 60 MPH $a = 1$ ft/sec^3

The reading on the Right Hand axis denotes length of circular arc, (L_c), in a spiralled curve OR the total length of curve, (L_{tot}), in a spiralled curve depending on the axis used for 'Degree of Curvature'. Using the upper axis for 'Degree of Curvature' gives the value of L_c on the R.H. axis, using the lower gives the value of L_{tot}.



$$L_{tot} = L_c + 2L_s$$

$$D = 5729.6/R$$

Fig. 2

NOMOGRAM for OFFSET OF TRANSITION SPIRAL FROM LINE OF TANGENT

A straight line drawn from the graduation of any 'nominal design speed' through the graduation for any 'length of spiral' will give as the intercept on the R.H. axis the offset of the spiral from the line of the tangent at that distance along the spiral, and at the chosen nominal speed.

NOTE. The graduations on the L.H. axis have been calculated from the exact speed, as used by Criswell, and thereafter labelled with the nominal design speed. The nomogram therefore gives results comparable with those from Criswell's 'A' series of tables with 'a' = 1 ft/sec^3.

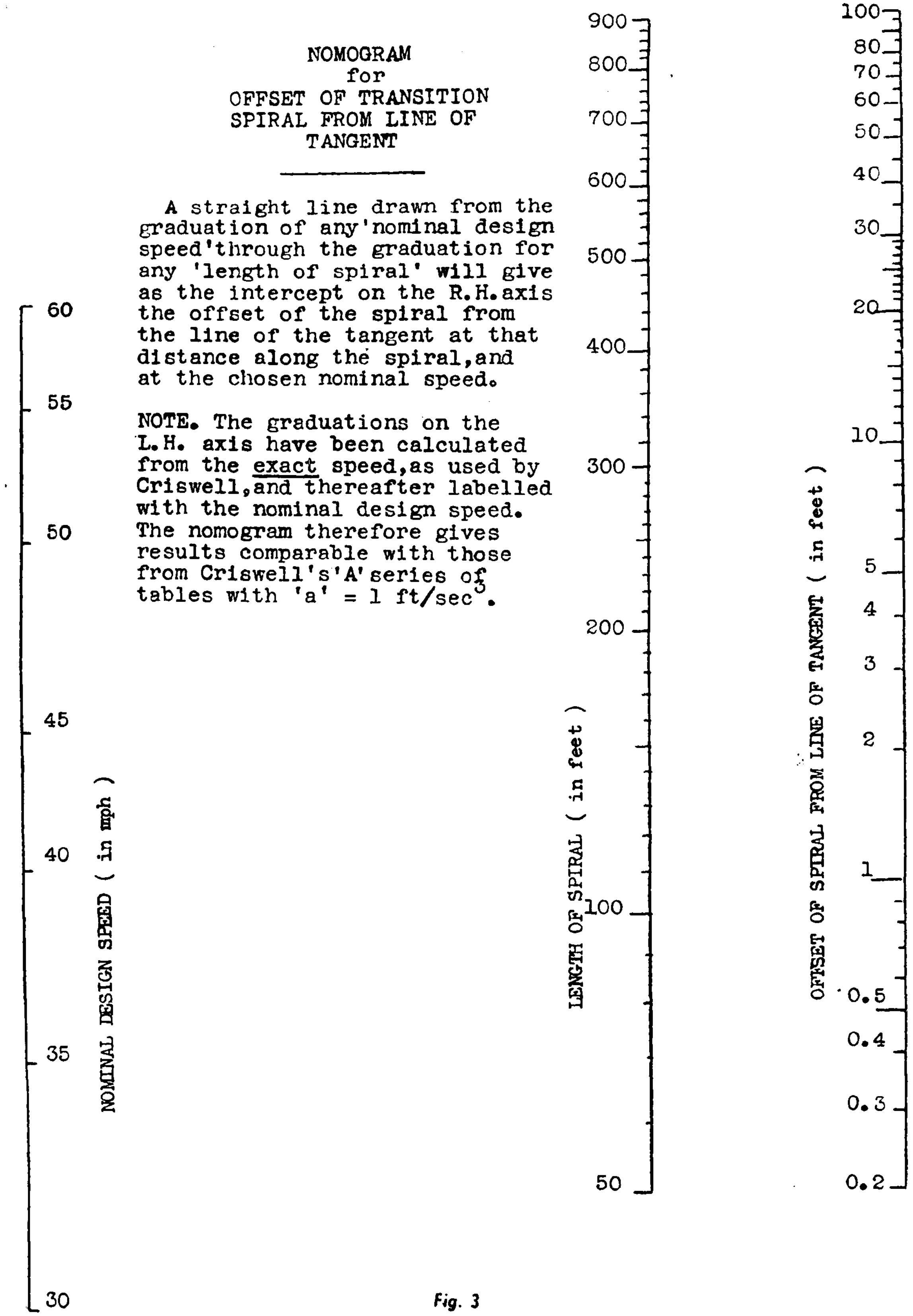
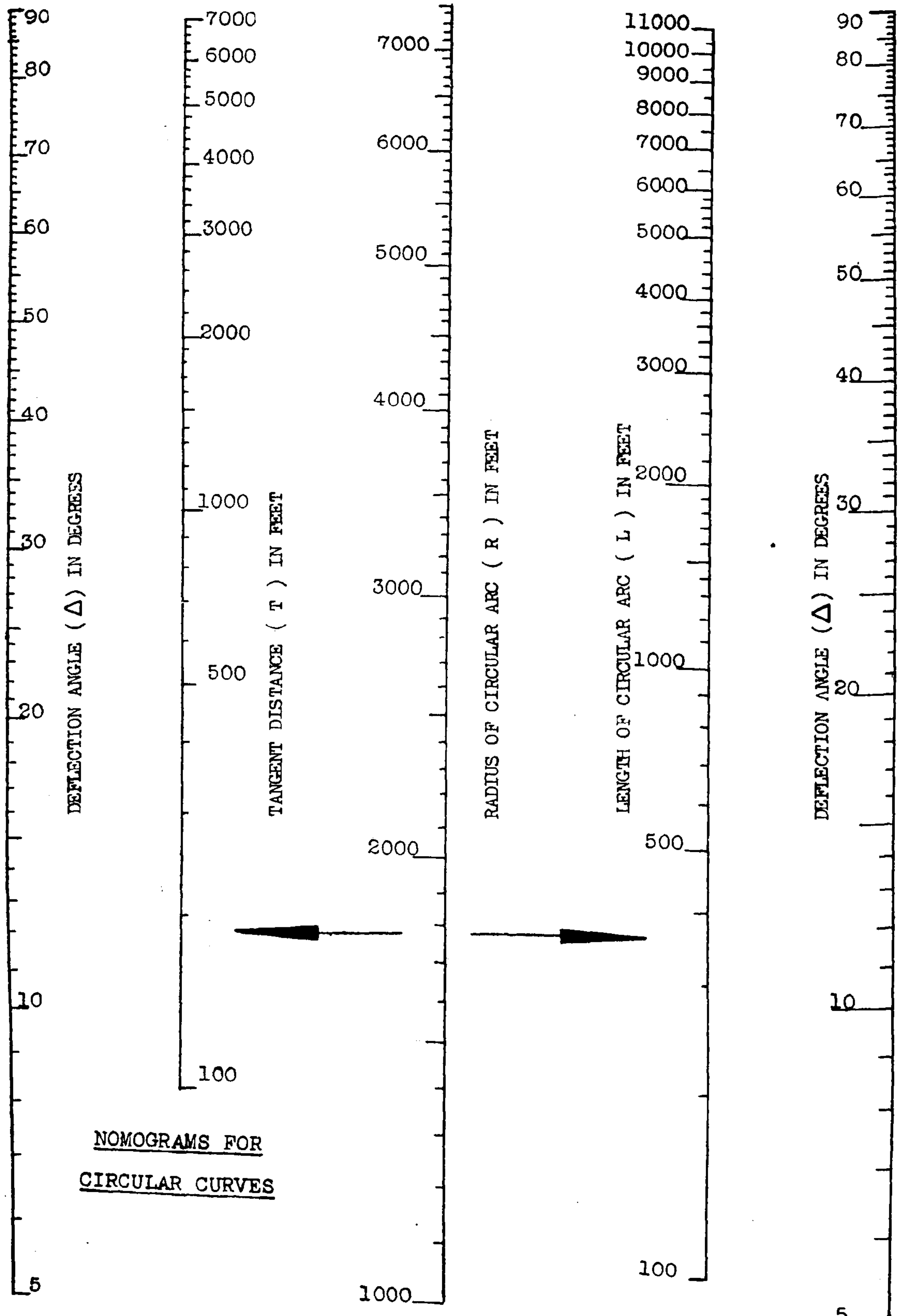
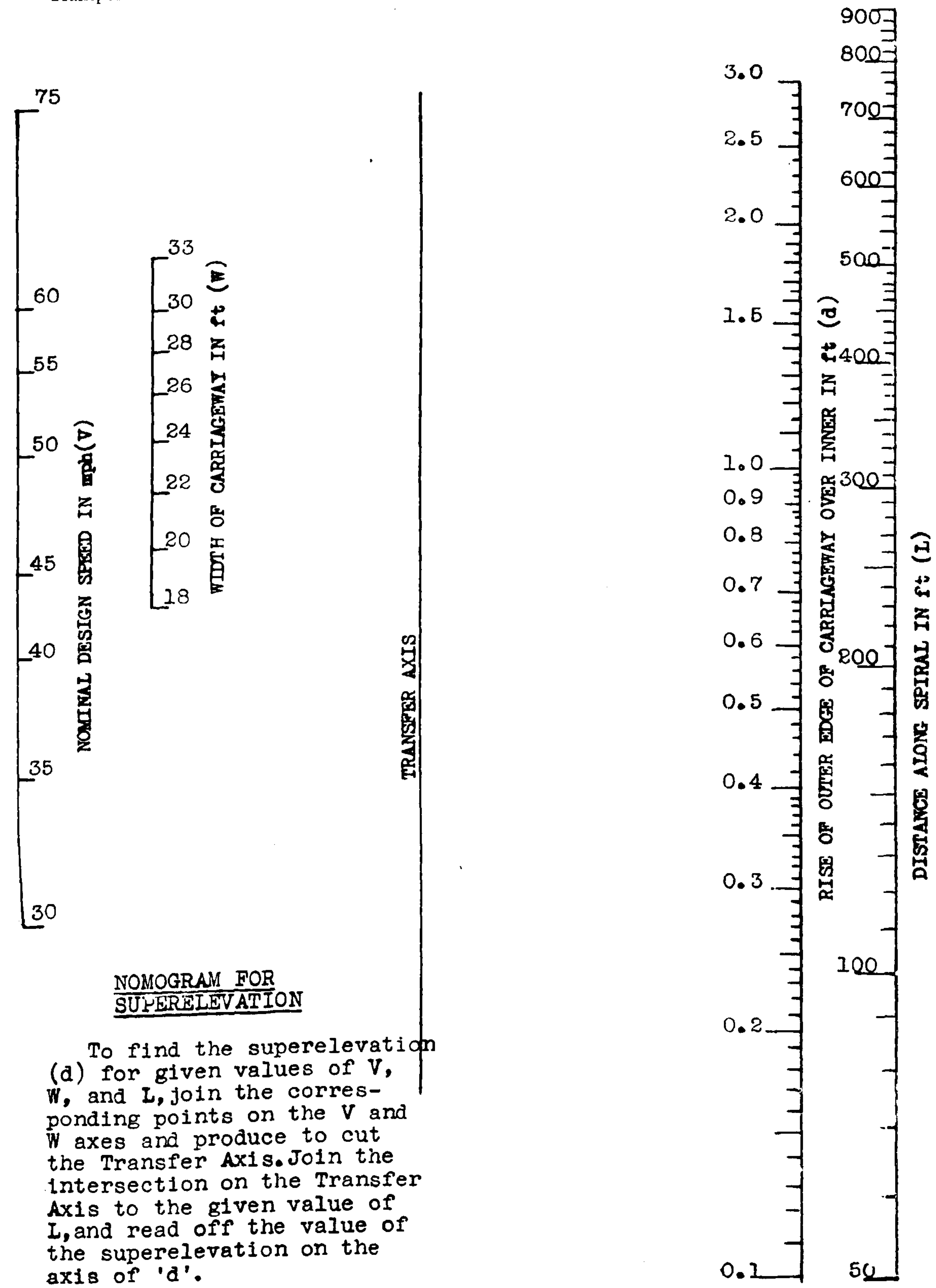


Fig. 3



NOMOGRAMS FOR CIRCULAR CURVES



NOMOGRAM FOR SUPERELEVATION

To find the superelevation (d) for given values of V, W, and L, join the corresponding points on the V and W axes and produce to cut the Transfer Axis. Join the intersection on the Transfer Axis to the given value of L, and read off the value of the superelevation on the axis of 'd'.

Length of arc for a purely circular curve is given by the expression

$$L = R\,\frac{\Delta\pi}{180} \quad \ldots\ldots(13)$$

or, in logarithmic form

$$\log L - \log R - \log \frac{\Delta\pi}{180} = 0 \quad \ldots\ldots(14)$$

Each of equations (12) and (14) contain only three variables so that each may be represented by a nomogram of three parallel straight lines, as in the previous example. In this instance, the two nomograms may be conveniently combined in one chart, as in Fig. 4, with the R-axis placed centrally and common to both nomograms. As drawn, a straight edge laid from any value of R to any value of Δ on the $L.H.$ axis gives, as an intercept on the T-axis, the total apex distance of the curve, whereas the straight edge laid between the same two values on the $R.H.$ portion of the chart gives, as an intercept on the L-axis, the total length of arc.

The calculations for the graduation on the T- and L-axes are somewhat tedious, and the work may be minimised by noting that when $\Delta = 90°$, $T = R$, and that when $\Delta = 57.3°$ (1 radian), $L = R$. Thus in the $L.H.$ portion of the chart, any straight line drawn through $\Delta = 90°$ has numerically equal intercepts on the T and R-axes, and in $R.H.$ portion of the chart, any straight line drawn through $\Delta = 57.3°$, has numerically equal intercepts on the L- and R-axes. It is therefore only necessary to carry out the calculation for the graduation on the R-axis and the Δ-axes, and to complete the graduations on the T- and L-axes by straight edge, as described above.

Nomogram for Superelevation

The amount of superelevation applied at various points on a transition spiral is frequently taken as proportional to a fraction of the centrifugal ratio, and it is possible to construct a nomogram expressing the relationship between the superelevation to be applied and the design speed, width of carriageway and distance along the spiral. The formula for the superelevation involves four variables and serves as an example of the use of a transfer axis in a nomogram.

Following the practice adopted in Criswell's Tables, a superelevation equal, numerically, to one-third of the centrifugal ratio, will be adopted so that the theoretical superelevation, "d" across a carriageway of width "W" is expressed as

$$d = \tfrac{1}{3}\cdot\frac{V^2}{15.R}\cdot W \quad \ldots\ldots(15)$$

Expressing "R" in terms of "L" and "V", (15) may be written

$$d = \frac{W.L_s}{142.V} \quad \ldots\ldots(16)$$

or in logarithmic form

$$\log d - \log W - \log L_s + \log k = O \quad \ldots(17)$$

where $k = 142.V$

Equation (17) has four variables whereas the standard forms dealt with in the previous examples had only three, and this is overcome by the introduction of a further variable, "z", and re-writing equation (17) as a pair of equations, each containing only three variables, thus,

$$\log k - \log W + z = 0 \quad \ldots\ldots(18)$$

$$\log d - \log L_s - z = 0 \quad \ldots\ldots(19)$$

Each of these equations, (18) and (19) may be expressed independently as a nomogram of three parallel straight lines, and the z-axis is, in fact, the link between the two. It is necessary to ensure therefore that the scale factor adopted for this common axis is the same in both cases. The z-axis acts therefore as the transfer axis, and the form of the nomogarm is illustrated in Fig. 5.

It may be noted that the grouping of the four variables in equation (17) into two pairs, for the contruction of equations (18) and (19), is arbitrary, but that once chosen, the variables must be read together in the same pairing in the nomogram. Thus in the example in Fig. 5, the variables W and V have been grouped ("k" being proportional to V), as have L_s and d, so that in using the nomogram, the values of V and W are first combined to produce an intercept on the transfer axis, and this intercept then used in conjunction with the L_s- and d-axes. This grouping of the variables was adopted since the values of V and W would normally be constant in any given case, and would give rise therefore to a fixed point on the transfer axis.

(Continued on page 27)

THE DESIGN AND CONSTRUCTION OF THE FORSTER-TUNCURRY BRIDGE

By

R. Milton Johnson, B.C.E., S. M. (Havard) & G. P. Cook, B.C.E.

Associate Member *Associate Member*

(Continued from November 1960 T.C M.R.)

3. Piling

3.1. *Pile Arrangement.*—The concrete piers for the bridge were proportioned according to the Department of Main Roads original design. It was only necessary to redesign the piling to suit the revised pier spacing and type of pile chosen by the contractor. In order to achieve an economical piling arrangement, close attention was paid to the method of calculating the forces in the pile groups.

All the piers in shallow water up to 10 ft deep are supported on vertical 12 in. x 12 in. prestressed concrete piles; however, when the depth exceeds this figure batter piles are used to cater for the horizontal forces from wind and stream flow. The arrangement chosen consists of 8 piles in line, 4 plumb and 4 on a batter.

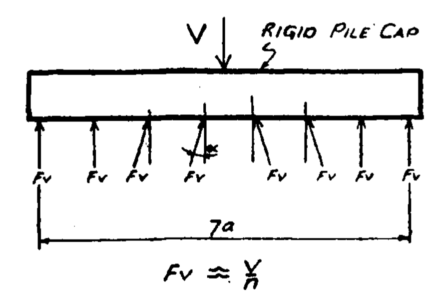


Fig. 8.—Analysis of Vertical Loads.

3.2. *Analysis.*—The arrangement of the supporting piles is shown in Fig. 9. In the analysis for this case several assumptions were made as follows:

(i) The vertical load on the pile cap produces equal axial loads in all piles, both vertical and battered. This is approximately true since the maximum batter used was 1-6 producing an angle of 9.5°, the cos α equal to 0.986 (see Fig. 8).

(ii) The horizontal loads are resisted by the 4 inside batter piles, the force being equal to $\pm \frac{H}{\sin\alpha}$(see Fig. 9.)

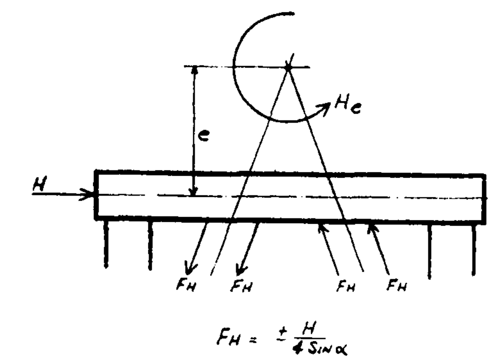


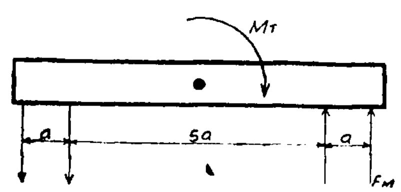
Fig. 9.—*Analysis of Horizontal Loads.*

(iii) All moments on the pile cap are resisted by the outside vertical piles only and have no effect on the internal batter piles. This is conservative for the outside piles. The moments to be considered consist of 2 parts, (1) the moments due to all external loads about the centre of the pile cap and (2) the moment due to the horizontal force being displaced from the centre for lateral resistance of the internal batter piles. These moments are of opposite sign and it is possible to regulate the total moment so that it can be small. The moment in the outside vertical pile is therefore:

$$\frac{Mt}{10.6a} \text{ (see Fig. 10).}$$

The above technique is very simple to use in a design office and gives a result which is sufficiently accurate for practical purposes. By a suitable selection of the batter for the internal piles it can be arranged that all piles receive an equal share of the load. The common procedure has been to place batter piles on the outside of the pile cap and the vertical ones on the inside. This results in the outer piles receiving loads due to both shear and moments and complicates the stress analysis. It is believed that the vertical piles should be placed on the outside since in this position they can best resist any moments applied to the pier.

$$M_T = M - He$$



$$F_M = \pm \frac{M_T}{10.6a}$$

Fig. 10.—*Analysis of Moments.*

3.3. *Type of Pile*: The type of pile chosen for the special piers in deep water is a 14-in. octagon of prestressed concrete. This pile is now finding favour in New South Wales since its introduction on this project. The pile has the following advantages :

(*a*) The octagonal shape prevents the initiation of cracks under hard driving conditions due to its flat changes in contour.

(*b*) The prestress reduces the tensile stresses in the concrete caused by the impact of the hammer.

(*c*) The high tensile strand used enables better compaction of the concrete than for single high tensile wires : this is because there is a reduction in the number of tendon positions, thereby creating more space for the placing and vibration of concrete. The tendons are more economical to place in the mould due to reduction in the number of anchorages.

In the selection of size and reinforcement of such a pile the following factors need consideration :

(1) Strength under axial loads as a short column.

(2) Strength under axial load as a long column.

(3) Moment capacity during handling.

(4) Moment capacity combined with a compression as occurs in service.

It should be noted that in the elastic theory the moment capacity, when combined with a direct load, is increased with the magnitude of that direct load. In the ultimate theory the moment capacity is reduced by the presence of an axial load. One must, therefore, calculate the situation with due regard to the maximum permissible stresses and a factor of safety of two should exist against failure due to applied bending moments.

(5) The axial load applied to the pile is limited according to the soil conditions. In this case borings indicated sand to a considerable depth merging to a soft sandstone. Test piles were driven which indicated adequate bearing capacity with a penetration of 30 ft. The levels were fixed with due regard to possible reductions in bed level. The maximum axial load was fixed at 45 tons after considerable investigation. The properties of the pile used are as follows :

A concrete area of 162 sq. in., H.T. steel area of 0.96 sq. in. The 12⅜-in. dia. strands give a prestress of 760 lb per/sq. in., the effective prestress per strand being 10.2 Kip (see Fig. 11).

4. Construction

4.1. *Supervision and Control.*—Overall supervision of the project was the responsibility of an experienced qualified engineer who remained on the project throughout. Prior to the commencement of site works he was responsible for the preparation of the detailed constructional plan from which comprehensive materials and plant lists were prepared.

During the project the site engineer was responsible for the efficient site operation,

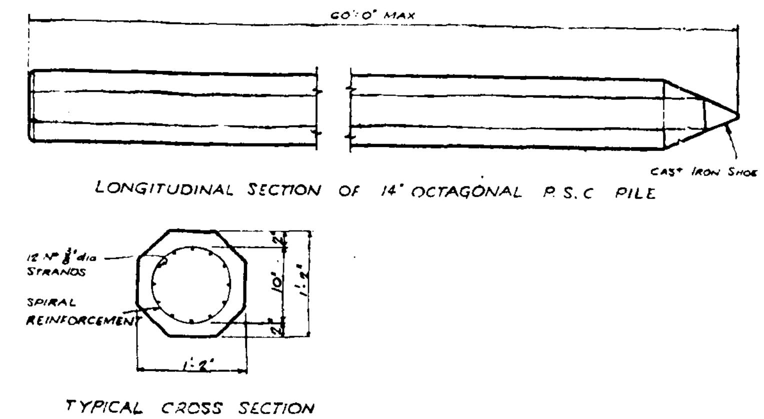


Fig. 11.

the solution of all technical problems, the placing and following up of all orders and the quality and accuracy of the workmanship. He was assisted in this role by a project foreman who directly controlled all labour and plant.

One of the most important aspects of supervision was the maintenance of good relations with the local towns people and the Supervising Authority, who had a resident Clerk of Works on the site. With their wide experience in this class of work, the Department was of the greatest possible assistance to the contractors, providing solutions to many of the minor constructional problems.

In all, a maximum labour force of 50 men was employed on the project, and of these all but eight key personnel were recruited locally. They were split up into teams of from five to ten men, each under the control of a leading hand and kept where possible continuously on the same task.

4.2. *Site Plan.*—The construction plan arrived at and maintained throughout was—

The piles of pretensioned concrete would be manufactured at Sydney, transported to the site and stored. From there they would be transported to position by large or light railway and driven by conventional methods. The beams would be cast on site, handled into position by the same method as the piles and lifted into position by a crane rolling out on the already completed portion of the bridge. All reinforced concrete work would be by standard methods (see Fig. 12).

4.3. *Beam Casting.*—The site available for the casting of the beams consisted of hydraulic fill placed during the normal operation of the ferry dredge. This was levelled, graded and set as shown in Fig. 12. A five-ton derrick crane was erected covering the casting slab, a barge loading dock and ample storage space for all the types of units.

The casting bed was 100 ft long, 30 ft wide and 5 in. thick, laid accurately to level and graded where required to suitable drainage channels. Bolted to the slab were five steel soffits each 90 ft long and capable of handling a day's production of two beams. These beams were given a slight reverse curvature to offset partly the hogging effect when the beams were stressed.

The beam moulds were of pressed steel construction and were provided with lifting eyes so that they could be handled by the crane. Although light enough to be manhandled, the use of the crane considerably minimised damage to the forms and no maintenance was required on them throughout the project. A special feature was their almost complete lack of bolts and nuts and dependence on pins and wedges.

The reinforcing was assembled by tack-welding into three separate cages which were placed into the forms and welded together. This ensured rapidity of placement and reduced the possibility of movement during the concreting operation. One and a quarter inch holes for prestressing wires were formed by inflatable rubber tube formers which were held in place by ⅜-in. dia. pins passing through the mould at 30-in. centres. These pins were removed within an hour of completion of casting and the holes filled by ramming with an flange and enclosing the whole beam in a continuous envelope of thin polythene material. This proved most efficient, providing a continuously wet surface on the beam during the hottest days. After 7 days the beams were lifted at their 1/5th points and stacked ready for stressing. When the concrete had reached a strength of 5,000 lb. per sq. in., the 12-wire cables were threaded through and stressed, using

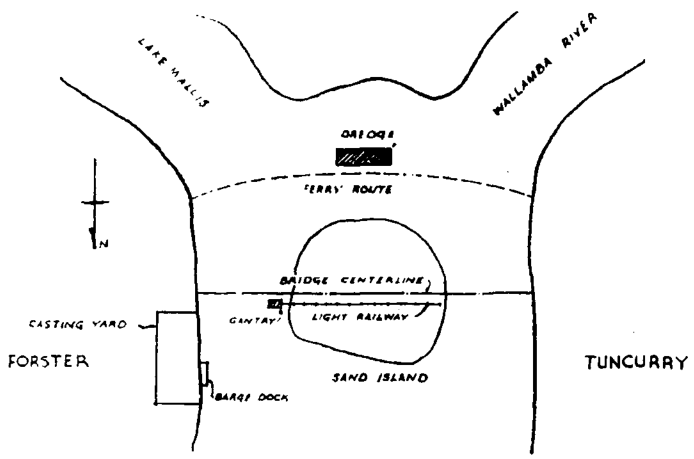


Fig. 12.

earth dry mortar. The aggregate used consisted of a crusher run ⅜-in. to ¾-in. irregular river gravel and sand from the Manning River at Taree. This sand, being deficient in fines, was given a suitable grading by the addition of a small quantity of washed dune sand. An almost pure water was obtained from a spear point sunk at the casting yard site less than 200 ft from the shore and to a point 20 ft below sea level.

Batching of the aggregates was by a swing weight batcher which fed into a half-yard paddle mixer. The mixed concrete was hoisted into position by a half-yard Kipple bucket on the hook of the derrick crane. Once in the mould the concrete was vibrated into position by 60-mm and 33-mm pneumatic immersion vibrators. This proved most efficient and despite the thin web, no honeycomb patches occurred.

The beams were cured for seven days by covering them with hessian, running a perforated hose down the full length of the top automatic dewedger jacks, proceeding from the upper cable downward. Measurement was by extension of the cables only and was calculated from the stress-strain data on each coil of wire used.

After stressing, the cable ducts were grouted, using neat cement with an 0.40 water/cement ratio, which was pumped through to a final pressure of 150 lb per sq. in. After grouting, the wires were cut with an oxy torch and bent back. The recesses were patched and the end of each beam given two coats of bituminous paint (see Fig. 13).

4.4 *Pile casting*:

(*a*) 12-*in Square Pretensioned Piles*.— These pretensioned piles were cast in Sydney on a pretensioning bed 320 ft long and accommodating an average of six piles. Twentyeight 0.2-in. dia. wires were used to apply the prestress and were tensioned singly by means of a 10-ton electrically operated jack capable of applying final extension of 30 in. Fabricated steel side and soffit moulds were used with a production

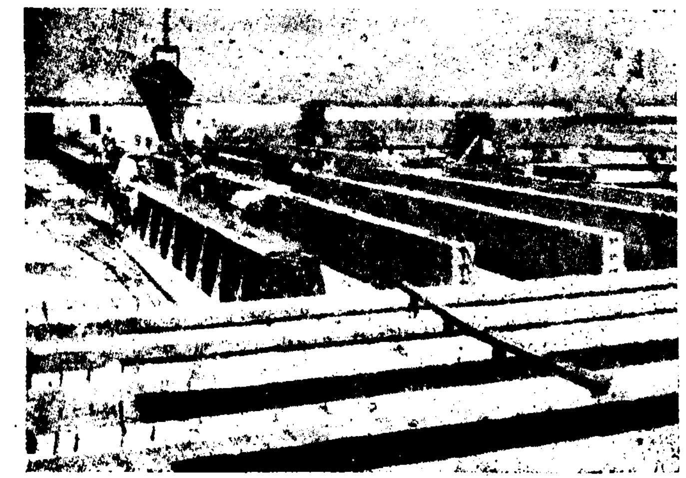


Fig. 13.—**General view of beam casting yard**

of three piles per day and a turnover of a stressing line every two days.

In order to achieve this it was necessary to use steam curing, which was carried out overnight for a period of eight hours. At 24 hours after casting the concrete strength was of the order of 4,200 lb. per/sq. in., which was considerably in excess of the 3,300 lb. per/sq. in. required for release. Release at this time was carried out by oxycutting of wires, which resulted in a virtual shock release of the first pile. Pull-in of the wires was measured and on the first pile averaged $\frac{3}{16}$ in. with values as high as ⅜ in. For other piles the pull-in was of the order of $\frac{1}{16}$ in. to ⅛ in.

The bow in two perpendicular directions was measured on every pile and any piles with large bows were selected for bending tests with the bow placed downward. Loading was carried out at the quarter points of a span one half the length of the pile. The load was designed to produce a tension of 250 lb. per sq. in. on the underside. Although 5 per cent of the piles were tested in this manner all piles passed without the sign of a crack.

(*b*) 14-*in. Octagonal Pretensioned Piles*.—These pretensioned piles were cast in Sydney on pretensioning beds 180 ft long and contained 12 No. ⅜-in. dia. strand. Three steel moulds were used, giving a casting rate of three piles per day. One advantage of the octagonal shape was that no holes or inserts were required for handling devices as shaped grabs could be used to fit around the section. General details of the manufacture were the same as for the 12-in. piles except for the method of testing. This was arranged so that two points of support gave a self-weight cantilever bending moment, inducing a stress of 250 lb. per sq. in. tension.

4.5. *Pile Driving*.— On arrival at the site the piles were lifted by the yard crane, examined, sorted into lengths and stacked. On demand the piles were loaded on to a 40-ft × 20 ft plywood barge and towed either directly to the pile frame or to a simple gantry on the sand island where they were affloaded on to bogies on a 30-in. railway track and winched into position.

Driving of the 12-in. piles was carried out by a 45-ft timber frame with a two-ton winch and monkey mounted on a skid base. When working as a floating unit, this frame was mounted on a 3 × 12 N.L.E. steel pontoon barge 22 ft wide and 73 ft long, which could be allowed to settle on the river bottom without fear of damage. The position of the barge was controlled by six five-ton winches connected to suitable anchors

Generally the driving conditions were hard and a typical pile driving record is shown in Fig. 14. If a larger pile section had been used it would have been extremely difficult to reach the required penetration due to the increase in frictional area and resistance of the pile. One 16 in. × 16 in. experimental reinforced concrete pile was in fact driven and the driving record of this pile is also shown in the same diagram. These piles were both driven in the Tuncurry Abutment where ground conditions were uniform.

Driving of the 14-in. piles was carried out by a 55-ft steel frame set on rollers on falsework previously driven by the light frame. This frame carried a three-ton hammer and a five-ton winch. The driving of these piles proved to be extremely difficult, and constant driving of 20–30/15 ft ton blows

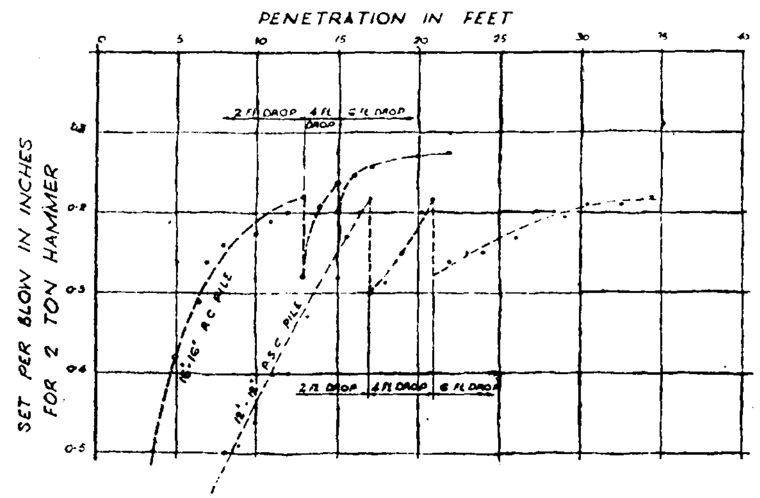


Fig. 14

was required to reach the required penetration. By applying the Hiley formula these piles can be shown to have an ultimate load of approximately 160 tons against the 87.5 tons required by design considerations.

In view of this excessively hard driving, an extensive under-water examination was carried out with a diver, but no sign of any cracking or damage to the piles could be found.

4.6 *The Bridge Piers.*—The piers were cast in normal reinforced concrete to the Department's design. The formwork was supported by yokes off the piles, which also carried the ends of the braces from the side forms and so controlled vertical line. The concrete was poured by setting up small batching plants on the abutments and feeding a hoist tower at the pier by a monorail running along a light catwalk. This catwalk was constructed for the access of men and materials and to enable the project to be accurately set out. The aggregate for the batching plant on the sand island was supplied by the construction of a temporary ferry landing.

As the pedestals were up to 20 ft in height, 30 ft wide and supported on a single row of piles often in over 20 ft of water, they were not stable if unsupported in windy conditions. To overcome this it was necessary to brace the top of each pedestal to the underside of the crossheads on either side of it by 1-in. dia. tie bars and to continue this bracing back to a suitable anchor pier.

4.7. *Beam Placing.*—The beams were lifted into position by a five-ton derrick crane which was progressively rolled forward on a railway track on the last span launched. In the launching position the king post rested on the outside two beams four feet from their end, and the rear leg carrying eight tons of counterweight was bolted to the same two beams six feet from the other end. As the crane was moved forward over the beams before the deck had been cast, it was necessary to place temporary lateral bracing in the centre of the span to prevent lateral buckling of the compression flange as the derrick crane rolled over the span. This was done by bolting 6 in. × 3 in. channels transversely across the

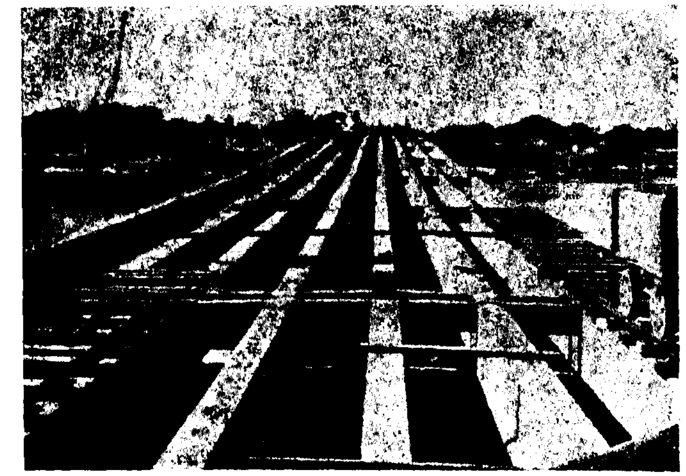


Fig. 15

View along undecked section of bridge

Fig. 16

View showing beam launching and transverse stressing technique

Fig. 17

View of Completed bridge

centre of the span on both the top and bottom flanges and fixing it tightly against the beams by a series of wedges and cleats.

Once positioned the beams were held in place by wooden braces until the precast transverse stiffener blocks were placed and stressed. These blocks were accurately aligned using timber wedges, grouted into position using an earth dry mortar and the following day stressed. The crane was then moved over ready to launch the next span (see Figs. 15 and 16).

4.8. *Bridge Deck.*—The bridge deck was cast on a plywood soffit supported on simple wooden trestles wedged off the bottom flange of the I-beams. A small gap was left between the forms and the edge of the beams to allow for manufacture and assembly tolerances. This was filled with 12 : 1 sand-cement mortar which was easily scraped off when the forms were stripped seven days later.

The deck concrete was mixed up to seven spans to the rear of that being poured and brought into position by a monorail. It was vibrated using immersion vibrators and finished with wooden floats to give a non-skid surface. Curing was carried out by the use of building paper covered by 2 in. of sand kept moist by a perforated hose. This was maintained for a full seven days.

The kerbs were not cast integrally with the deck but were cast separately some days later, as it was found possible by this method to obtain a straighter line. The handrail was bolted directly to the kerbs and consisted of 5 in. × 4 in. × ½ in. angle iron posts with 3½ in. × 3½ in. × ⅜ in. angle rails. These rails were all drilled, cut and fitted on site to obtain accurate horizontal line and the smooth vertical curve required. The surface protection consisted of metal spraying followed by two coats of approved paint. The spraying consisted of a coat of 0.002 in. of pure zinc to a sand blasted surface, followed by a second coat of 0.004 in. of pure aluminium. The thickness was rigidly checked by a gauge.

The steelwork for the lift span was placed in an identical manner to the other spans and bolted together using high tensile bolts. All such bolted joints were sand-blasted, sprayed and painted after erection.

Conclusions

1. Multi-span prestressed concrete structures can compete more than favourably with steel, particularly in a corrosive or marine atmosphere where the cost of the initial surface treatment and maintenance of steel is high.

2. Co-operation between the design and construction elements during the initial conception and construction is essential for maximum economy.

3. Limitation in the number of components in such a structure leads to simplicity in techinque and rapidity of erection.

4. Provided skilled technical supervision is employed, the production of prestressed concrete units can be efficiently carried out by relatively unskilled labour.

(*Concluded*)

The future has a way of repaying those who are patient with it.
—*The Rev. Arthur Pringle.*

99632

NEW PILING METHODS USED IN BRITAIN

A NEW pile developed by a Swiss company, Dicht, A. G., has been introduced into the United Kingdom and Eire by a recently-formed company in the Holloway group of construction firms, London.

The London organization, H.D. Foundations, undertakes all kinds of piling and foundation work, but as sole licensee in the United Kingdom and Eire of the new pile it is initially concerned with the development of this system.

A demonstration pile which has been dug out after driving. This shows completed shank with bulb at base (unreinforced pile).

The new pile is known as the "Delta". It is a driven cast-*insitu* pile, normally unreinforced though longitudinal reinforcement can be introduced should conditions require it.

The drive can be either vertical or at a batter of 1 : 4. There are advantages not shared by all other forms of *insitu* pile, it is claimed. Since it is a driven pile the bearing capacity can be calculated by one or another of the standing piling formulas. Concreting takes place in the dry, in a water-tight tube. The base of the pile is normally enlarged to increase bearing capacity and the bulbs so formed can be increased in size in special circumstances or extra bulbs can be driven out at higher levels.

The six stages in the construction of an unreinforced "Delta" pile (shown in accompanying diagram) are :

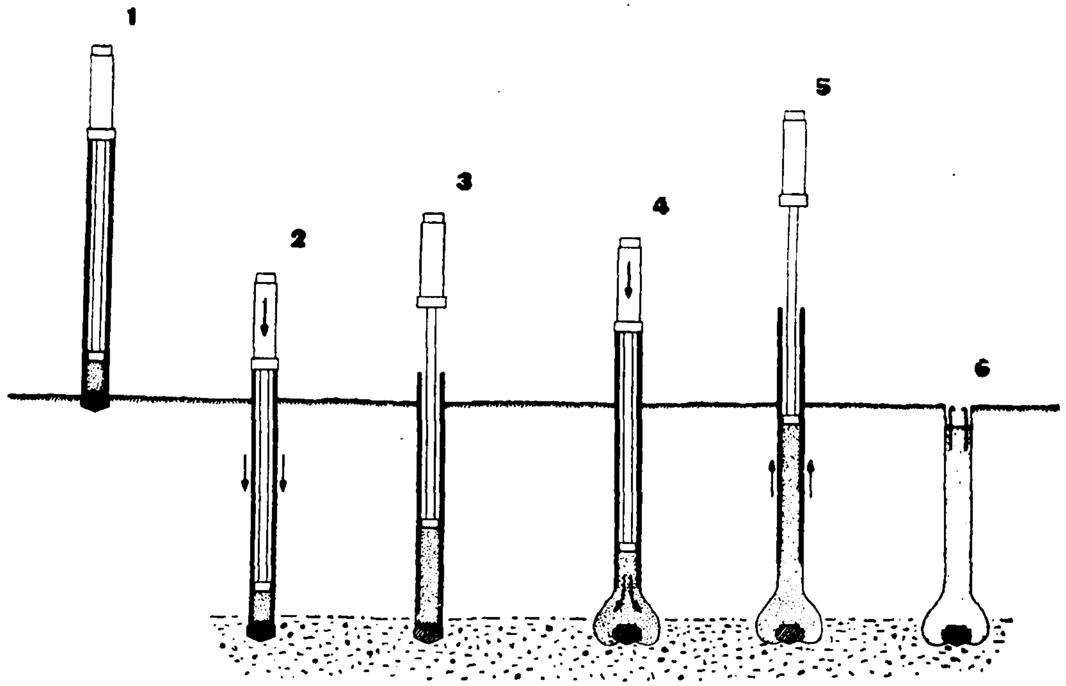
1. Pitch driving tube on reinforced concrete pile shoe, with a small amount of concrete between mandril and the shoe.

2. Drive to required level and set.

3. Insert sufficient concrete in tube to form bulb.

4. Using hammer and mandril ram concrete while withdrawing the tube slightly, thus driving out a bulb.

5. Fill or part fill tube with concrete and with a hammer and mandril resting on concrete withdraw tube.



Stages in pile formation

Concrete in the bulbs is thoroughly consolidated by ramming with the piling hammer. While the tube is being withdrawn the concrete is under considerable load from the weight of the mandril and hammer so that necking and voids are obviated; and as the tube is driven and not bored there are no spoil disposal problems and the site is left clean.

6. Insert starter bars if required.

Operation 5 may be carried out in one stage for the whole of the pile or for longer piles in several stages.

To reinforce the pile, the method is basically the same, but four reinforcing bars are attached to the mandril between operations 3 and 4. The reinforcement is attached to the mandril with binding wire which breaks when ramming of the bulb begins.

To take advantage of good intermediate bearing strata extra bulbs can be made on the shank of the pile by interrupting step 5 at the required depth and repeating 3 and 4. In the event of the final bearing strata being poor oversized bulbs can be produced by introducing extra concrete in step 3 and withdrawing the tube correspondingly further in step 4. For driving longer piles both the driving tube and the mandril can be extended: as the tube is withdrawn from the base and not the top, a simple and quick connection can be made.

Technical data of the "Delta" pile are as follows: piling hammer, Delmag D12; tube external diameter $16\frac{1}{2}$ in.; thickness, $\frac{3}{4}$ in.; length, 39 ft or 42 ft; length of extension, 26 ft or $32\frac{1}{2}$ ft; length of extended tube, 65 ft or 75 ft (tubes of different length and diameters can also be used); pile point diameter, 19 in.; diameter of pile (normal) $16\frac{1}{2}$ in. (actual diameter is usually larger; diameter of standard bulb, minimum, 3 ft).

(*From* : '*World Construction*', *September, 1960*)

(*Continued from page 16*)

Summary

Much of the calculation involved in the formulation of the alignment of a higway is routine arithmetical work, and it is obviously highly desirable that such work is reduced to a minimum. The representation, in nomographic form, of the formulae connected with the geometric design of a highway removes the necessity for such routine calculation and gives results, which, whilst not generally to the degree of accuracy of those computed from table are, nevertheless, of a degree of accuracy sufficient for the purpose, particularly in the trial alignment stage. Five examples of such nomogram are given, together with notes on the manipulation of the formulae and the construction of the nomograms, and with suggestions for alternative forms. It is considered that these charts, or variations or extensions of them, could well be drawn out to a large scale for general use in a highway design office.

It is not suggested that the use of these charts should supplant the accurate determination, from tables, of the geometry of the final aligment, once the latter has been established—accurately determined values are obviously required for design purposes and for setting out. It is suggested, however, that at all stages of the investigation up to the detailed calculation of the final alignment, the use of these nomograms will ensure an order of accuracy well within that required and will lead to real economy of effort.

(*From* : "*Roads and Road Construction*", *October, 1960*)

REDUCING SKIDDING FATALITIES TO NIL IN HAMPSHIRE

By

H. N. JENNER, ESQ., M.B.E., COUNTY SURVEYOR

ABOUT a sixth of all accidents are skidding accidents and even omitting realignment and superelevation which may be necessary these accidents can be reduced by 70 per cent to 90 per cent by the use of a better stone either in the surfacing or as surface dressing. From the results obtained in Hampshire it seems to be a moral obligation on Highway Engineers and Highway Authorities to treat skidding accident sites and test road surfaces at potential skidding sites and sites where there may be emergency braking as at the approaches to round-abouts, pedestrian crossings, traffic lights, etc.

By this means wet skidding accidents at tested sites in Hampshire have been reduced during the past 2½ years from 270 to 36 (including 10 fatalities reduced to 0).

The method of application of the new test in Hampshire has been to ask stone suppliers to state in their tenders the polished stone value of their stone when tendering. This has been checked in the County Laboratory on the method set out in the New British Standard 812. This value has been taken into account with the other properties of the stone and indeed also the price, and stones have been selected in Hampshire which are .60 or slightly under for most skidding sites, but for difficult sites (sharp curvature, steep gradients and hard braking) stones with values above ·60 have been chosen.

From my experience as Chairman of the British Standards Specification Committee concerned with this specification and in Hampshire, and with regard to the availability of stone and the test in practice I would not advise that the minimum polished stone value should be called for in a specification for the simple reason that to quote precise value of, say, .63 might rule out stones of, say, .61 or .62 which the results do not justify.

(*From: "Highways and Bridges and Engineering Works", November 16th, 1960*).

A woman looks at a prospective husband as she looks at an old house. She doesn't see it the way it is now, but the way it's going to be when she gets it remodelled.

HERE AND THERE

1. WORLD CENSUS OF AUTOMOBILES

as on 1-1-1960

AMERICA (EXCL. U.S.A. & CANADA)	... 42,69,200	ITALY	... 20,70,300
AUSTRALIA	... 26,55,600	INDIA	... 4,56,600
AFRICA	... 24,98,200	IRELAND	... 2,08,200
AFGHANISTAN	... 5,000	INDONESIA	... 1,38,800
BRITAIN	... 62,34,700	JAPAN	... 14,98,200
BURMA	... 36,900	MALAYA	... 1,18,700
CANADA	... 49,41,000	PAKISTAN	... 66,400
CHINA	... 2,07,500	SINGAPORE	... 75,500
CEYLON	... 1,03,000	THAILAND	... 80,600
FRANCE	... 56,75,000	U.S.A.	... 7,02,34,300
GERMANY (WEST)	... 43,10,800	U.S.S.R.	... 37,60,000
GERMANY (EAST)	... 27,400	**WORLD TOTAL:**	**10,96,72,100**

2. AUTOMOBILE PRODUCTION IN INDIA

YEAR	Cars, Jeeps & Station Wagons, etc.				Commercial Vehicles						Grand Total
					Trucks			Passenger Buses			
	Cars	Jeeps & L. Rovers	Station Wagons Utilities, etc.	Total	Petrol	Diesel	Total	Petrol	Diesel	Total	
1953	4,936	—	—	4,936	—	—	8,990	—	—	—	13,926
1954	5,435	—	—	5,435	—	—	9,027	—	—	—	14,462
1955	9,528	3,294	769	13,591	4,432	2,024	6,456	441	2,596	3,037	23,084
1956	12,989	4,139	677	17,805	4,158	6,762	10,919	242	3,172	3,414	32,138
1957	11,601	4,069	610	16,218	3,108	8,790	11,898	68	3,683	3,751	31,929
1958	7,808	3,550	305	16,663	2,866	8,162	11,028	104	3,983	4,097	26,788
1959	11,769	4,655	76	16,500	4,238	10,723	14,961	9	4,850	4,859	36,320
Jan. 1960	1,501	157	Nil	1,658	429	1,262	1,691	Nil	435	435	3,784
Feb. 1960	1,505	498	Nil	2,003	283	1,326	1,609	Nil	533	533	4,145
Mar. 1960	1,924	576	Nil	2,500	369	1,174	1,543	Nil	564	564	4,607
Apr. 1960	1,334	400	Nil	1,734	273	1,478	1,655	Nil	317	317	3,706
Total up to Apr. 1960	5,264	1,631	Nil	7,895	1,318	5,240	6,498	Nil	1,849	1,849	16,242

3. BETTER ROADS WANTED

Public Give Views on Accidents

● IN a recent Gallup Poll in Great Britain, people were asked what things would, in their view, be most likely to reduce road accidents. The following are their first choices for the list they were shown (figures in percentages):

	Total	Motorists	Non-Motorists
Better designed roads ...	38	50	33
Heavier penalities for offending motorists ...	18	12	20
Reduce speed limit in built-up areas ...	16	11	18
Stricter driving tests ...	12	11	12
More road safety education ...	8	8	8
Stricter test of cars and lorries ...	5	4	6
Heavier penalties for offending pedestrians ...	2	3	2
Heavier penalties for offending cyclists ...	1	1	1
Don't know ...	0	0	0

The above is published by arrangement with the *News Chronicle*.

(From: " B.R.F. Bulletin No. 281," July 1959)

4. GRACEFUL NORTH NORWAY BRIDGE IS DEDICATED

● NORWAY'S LONGEST all-portland-cement-concrete bridge was officially dedicated July 3. The Troms ϕ Bridge, connecting the North Norway town of Troms ϕ with the mainland, has a cantilever centre span of 3,400 ft. The dedication ceremonies were held in conjunction with the opening of the Arctic Fair and Travel Exposition, which was held at the new Troms ϕ Museum building with open-air exhibits in the People's Park.

The 1,862,000 dollars bridge was opened to traffic early in May. Construction work began in 1957. It is constructed on slim concrete pillars spaced across the turbulent Troms ϕ Sound that separates the island of Troms ϕ from the mainland. The clearance of more than 131 ft under the main span at high tide permits even the largest of today's merchant ships to pass under it.

The bridge has two 10-ft lanes for motor vehicles, flanked on each side by a 3-ft pedestrian lane. Before the bridge was opened two ferries plied Troms ϕ Sound, carrying about 130,000 cars and trucks and approximately 50,000 bicycles each year. Only 45 miles from the mainland bridge approach is State Highway 50, which, in turn, is linked with the continental highway network.

Financing of the bridge was started by a group of bridge boosters who chipped in 6,300 dollars to form an association. Funds were obtained from banks, insurance companies, the Norwegian Government and the North Norway Fund. Toll fees have been fixed at 98 C. for automobiles, 1.26 dollars for trucks, and 1.68 dollars for buses.

It is expected that during the first year of operation, toll revenue will be approximately 140,000 dollars a year. It is hoped that its bank and insurance loans, totalling approximately 1,040,000 dollars, can be amortized during the first 12 years of

operation. From then on, steadily increasing traffic in the area should assure adequate highway toll receipts.

Prime Minister Einar Gerhardsen officiated at the official dedication of the Troms ϕ Bridge.

(From: " Better Roads ", Volume 30, No. 10, October, 1960).

5. QUALITIES OF A GOOD MANAGER OR BOSS

● THE HIGHLY successful manager of Minute Maid Corporation told Sales Executives Club members of New York what he thought the qualities of a good manager were. He admits that no one man probably possesses all qualities in full, but successful managers have a good share of the following:

(1) *Creative ability* — a manager should be a man who thinks. Ideas are the vital spark in successful management.

(2) *Judgment*—a manager should be a man who can make sound and wise decisions. Brilliant ideas can be downright dangerous unless tempered with good judgment.

(3) *Administrative skill*—a manager should be a man who can plan ahead—forecast needs for men—money, materials and machines, then translate those plans into a practical effective program of operation.

(4) *Positive attitudes*— a manager should be a man who functions constructively and with enthusiasm. Business needs leaders

who can inspire their people. A worried looking boss can touch off a wave of fear rolling through the organization.

(5) *Faith*—a manager should be a man who has faith in people and himself.

(6) *Courage*—a manager should be a man of courage, willing to take calculated risks. In nearly every business decision, one person must have the courage to take positive action without having at hand all the facts necessary to make a risk-free decision. Lack of courage has caused many managers to play into the hands of more courageous competitors.

(7) *Character*—a manager should be a man of high integrity. On this, there can be no compromise. There is no room at the top for the man lacking in character.

Note by Editor: "For How to be an Unsuccessful Executive," read page 32 of TCMR for December 1960.

6. ROAD PROGRAMME FOR NEPAL

● A 20-year programme has been drawn up for building 4,000 miles of road in Nepal, disclosed Gen. Subarna Shamsher, Deputy Prime Minister of Nepal, in his inaugural address at the ECAFE Highways conference held at Kathmandu recently.

At present, it is understood, Nepal has a total of 300 miles of road to serve the country of 54,000 sq. miles. The new programme is directed at providing a mile of road for every 14-sq. mile area of the kingdom.

The week-long conference was attended by about 50 delegates and observers from 17 countries and problems of international highways were discussed.

(*From: "Automobile News", Vol. XIV, No. 12, December, 1960*)

7. CHECK YOUR WAISTLINE

● MANAGEMEMT, throughout the world, is now taking more interest in the personal weight of their executives and employees. Metropolitan Life Insurance Co. of New York, which has done a great deal of research on this subject, explains why this subject is of special concern.

If you are 20 pounds overweight, the death rate is 10% higher.

If you are 25 pounds overweight, the death rate is 25% higher.

If you are 50 pounds overweight, the death rate is 60% higher.

This is based upon a study of several million case histories in the life insurance field.

Once it was thought that your weight should naturally increase as you grow older. Now, the experts say that what you weighed in your 20's is a good weight at any age.

Overweight is closely tied in with arteriosclerosis, hypertension and diabetes—which together are responsible for a large proportion of chronic illness, and about half the death-rate. High blood pressure is also found in combination with overweight.

Many companies are now organizing health maintenance programs to battle obesity. Standard Oil Co., whose employees receive free physical examinations at regular intervals, now give detailed dietary instructions and personalized guidance to overweight employers.

What can you do about the overweight problem in your sugar organization?

For one thing, set a good example yourself. Beware of the first 10 pounds of overweight. According to a University of Southern California Professer of Physical Education, the average adult can keep himself in condition with only 20 minutes of exercise per week—providing this is done in two 10-minute sessions and he exercises the right muscles. Recommended is a vigorous warm up exercise, such as running in place, followed by neck stretching exercises; abdominal exercises (raise legs) while laying flat on the floor, and arm and shoulder exercises (pushups). He says bending over and touching the toes—a very popular exercise—does more harm than good. It stretches back muscles already over-stretched from sitting down.

If you don't know what your weight should be, look over the following chart which has recently been developed by Metropolitan Life Insurance Co.:

RECOMMENDED WEIGHTS FOR MEN—AGE 25 AND ABOVE

Height	*Small Frame*	*Medium Frame*	*Large Frame*
5'4"	118-126	124-136	132-148
5'5"	121-129	127-139	135-152
5'6"	124-133	130-143	138-156
5'7"	128-137	134-147	142-161
5'8"	132-141	138-152	147-166
5'9"	136-145	142-156	151-170
5'10"	141-150	146-160	155-174
5'11"	144-154	150-165	159-179
6'	148-158	154-170	164-184
6'1"	152-162	158-175	168-189
6'2"	156-167	162-180	173-194
6'3"	160-171	167-185	178-199
6'4"	164-175	172-190	182-204

(*From: "Sugar Azucar", November, 1960*)

WHAT CAN A MAN DO?

"If a man's after money, he's moneymad; if he keeps it, he's a capitalist; if he spends it, he's playboy; if he doesn't get it, he's a ne'er-do-well; if he doesn't try to get it, he lacks ambition. If he gets it without working for it, he's a parasite; and if he accumulates it after a lifetime of hard work, people call him a fool who never got anything out of life.

CURRENT LITERATURE

ABSTRACTS

NIGHT VISIBILITY: Bulletin 255, 1960. Highway Research Board, 2101 Constitution, Washington, D.C.

THIS Bulletin contains the following Papers:

"Traffic Operations as Related to Highway Illumination and Delineation," by A. Taragin and Burton M. Rudy.

"Influence of Tinted Windshield Glass on Five Visual Functions," by Ernst Wolf, Ross A. McFarland, and Michael Zigler.

"Dark Adaptation as a Function of Age and Tinted Windshield Glass," by Ross A. McFarland, Richard G. Domey, A. Bertrand Warren, and David C. Ward.

"The Association Between Retinal Sensitivity and the Glare Problem," by Robert H. Peckham and William M. Hart.

"Some Factors Affecting Driver Efficiency at Night," by T. W. Forbes.

"An Experimental Low-Cost Lighting System for Important Highways in Rural Areas," by A. W. Christie.

"Effectiveness of Holland Tunnel Transitional Lighting During the Winter Months," by Alan T. Gonseth.

"Some Results of Cooperative Vehicle Lighting Research," by Thomas R. Kilgour.

"Visual Comfort Evaluations of Roadway Lighting," by Charles H. Rex and J. S. Franklin.

"Illumination Requirements for Roadway Visual Tasks," by H. Richard Blackwell, B. S. Pritchard, and Richard N. Schwal.

"Driver Performance Related to Interchange Marking and Night-time Visibility Conditions," by J. E. P. Darrell and Marvin D. Dunnette.

"Unified Reflective Sign, Pavement and Delineation Treatments for Night Traffic Guidance," by Joseph T. Fitzpatrial.

"Visual Characteristics of Flashing Roadway Hazard Warning Devices," by Jerry Howard and Dan M. Finch.

"Advancement in Roadway Lighting," by Charles H. Rex.

"Vision at Levels of Night Road Illumination. V. Literature 1959," by Oscar W. Richards.

NOTES ON THE SHEARING RESISTANCE OF SOFT CLAYS. Highway Research Abstracts, Volume 30, Sept. 1960.

By order of the Government, the Swedish Geotechnical Institute has to carry out investigations in the valley of the river Gota Alv in south-western Sweden, where several landslides have occurred and which will no doubt be subject to further slides, the soil conditions being under perpetual altering processes.

Mainly in connection with investigations of the risk of further landslides in a river valley, it proved necessary to make additional research on the strength of soft clays. Some preliminary results are reported to encourage discussion on the subject.

The results indicate, among other things, the value of common quick testing and the cohesion method, and the difficulties in establishing a unique relation between strength and effective stresses because of the secondary settlements and creep.

Moreover, some objections to the common way of using the Coulomb formula and of treating triaxial test results are raised, and modified values of the apparent angle of friction are plotted against the plasticity index.

THE DEVELOPMENT OF ASPHALT SURFACINGS FOR STEEL BRIDGE DECKING: J.J. Trott, B.Sc., A. Inst. P. & D. S. Wilson, Road Research Laboratory, Department of Scientific and Industrial Research, U.K.

AT the request of the Joint Consulting Engineers for the proposed new bridges over the rivers Forth and Severn, the British Ministry of Transport and Civil Aviation asked the Road Research Laboratory to make tests to help to decide on the choice of a surfacing that would be sufficiently impervious to protect the steel decking from rust and corrosion, and that would be durable, non-skid and of a thickness not exceeding 2 in. It was desirable, to test the possible surfacings on the full-scale and steel panels 9 ft long by 7 ft wide of a construction similar to that of the then proposed decking were placed in the carriageway of the Colnbrook By-pass on Trunk Road A. 4. This road carries more than 40,000 tons of traffic per day and some of the test panels were subjected to this traffic for periods of up to six years.

The tests began in 1949 and continued until the end of 1957. Preliminary experiments indicated that 1½ in. layer of stone-filled mastic asphalt was sufficient, but that special care was necessary to prevent entry of water at the boundaries. Experiments were then made to devise methods of keeping the water out. The dynamic strains generated in the steel plate by heavy moving vehicles showed that the proposed surfacing made a significant contribution to the rigidity of the steel plate under winter conditions, but its contribution was negligible at summer temperatures. From the observations made during the experiments the following conclusions were arrived at 1 to 7:

1. A 1-in. thickness of stone-filled mastic asphalt would be too thin for use on the deck of the proposed bridge. Cracks would probably form over the longitudinal stiffeners and permit water to penetrate through to the steel plate.

2. A 1½-in. thickness of stone-filled mastic asphalt behaved satisfactorily for 5 years under heavy traffic. Cracks formed in it but did not penetrate through to the steel. These tests were made with a steel plate ½ in. thick: thus it is reasonable to expect that a 1½-in. surfacing would behave well on the plate proposed for the bridge.

3. Special construction is necessary to keep water out of the edge joints. Angle-iron at the edges of the deck plates, filled with rubber/bitumen sealing compound together with a surfacing of 1½ in. of stone-filled mastic asphalt gave a joint that withstood heavy traffic for at least 6 years.

4. When angle-iron was used with a two-course surfacing consisting of stone-filled mastic asphalt overlying 3/8 in. of damp-course mastic, the resistance to the ingress of water at the edges was not so good as that given by 3.

5. It was found advantageous to sand-blast the steel plate, spray it with metallic-zinc, and to prime it with bituminous paint to minimise rusting and corrosion and to improve the bond between the surfacing and the plate.

6. Strain measurements made on the steel decking plates under heavy moving vehicles showed that the asphalt surfacing 1½ in. thick made a significant contribution to the overall rigidity of the decking in winter, but under summer temperatures it contributed practically nothing to the rigidity.

7. The tensile strains generated in the steel appeared to be independent of the speed within the range of 2 to 20 miles per hour at which the heavy vehicle travelled across the surface.

THE FIRE-RESISTANCE OF PRE-STRESSED CONCRETE BEAMS: Leslie Alan Ashton, B.Sc. (Eng.), Chief Experimental Officer, Joint Fire Research Organization and Stephen Charles Clavell Bate, Ph.D., B.Sc. (Eng.), A.M. I.C. Principal Scientific Officer, Building Research Station, Proceedings September 1960, Volume 17, The Institution of Civil Engineers, London.

THE Paper presents the results of an investigation of the fire-resistance of prestressed concrete beams with posttensioned cables, which was carried out by the Joint Fire Research Organization with the co-operation of the Building Research Station.

The main object of the investigation was to obtain information on the design of beams for buildings of high fire risk, such as large warehouses, where a fire-resistance of 4 hours would be required for structural elements.

It is shown that, for normal forms of composite prestressed concrete beams used in floor construction, resistance is governed by the protection given to the prestressing steel. For hard-drawn steel wire, a cover to the cable of 1-1/2 in. of concrete is sufficient to give a resistance of 1 hour; for longer priods of fire resistance, secondary reinforcement is necessary to hold the concrete cover in place, and a cover of 4 in. gives a fire-resistance of 4 hours. By further increasing the concrete cover, fire-resistances of upto 6 hours may be obtained.

The results of subsidiary tests to determine the effects of load, end-restraint, additional insulation, and form of section are presented and discussed, and the effects of partial damage in fire are also considered.

Conclusions

The investigation described in this Paper has shown that, as with other forms of construction, adequate fire-resistance can be attained with prestressed concrete beams when proper attention is given to design. The results obtained have led to the following conclusions, which are primarily applicable to simply supported composite prestressed concrete beams with post-tensioned cables of hard-drawn steel wire:

(i) Failure of a beam carrying its design load will occur when the mean temperature of the prestressing steel reaches about 400°C.

(ii) Fire-resistance depends on the protection given to the steel. A fire-resistance of 1 hour is obtained when the cover of concrete to the prestressing steel is $1\frac{1}{2}$ in. Periods of 2 & 4 hours are obtained with covers of $2\frac{1}{2}$ and 4 in. respectively, provided that the cover is retained in position with secondary reinforcement.

(iii) A substantial increase in the fire-resistance of a beam is obtained by the application of some form of insulation to its exposed surfaces, provided that the adhesion of the insulation to the concrete is ensured for the whole of the fire period. Precast slabs of lightly reinforced vermiculite concrete used as a mould lining when casting the beam are equivalent in insulating value to about twice their thickness of concrete. Evidence from other fire tests suggests that smaller thicknesses of vermiculite gypsum plaster or sprayed asbestos, in each case applied direct to the surface of the beam, should provide similar insulation to that obtained with vermiculite concrete in the tests, being equivalent to a maximum of three times their thickness of concrete.

(iv) The failure of prestressed concrete beams with secondary reinforcement is gradual, and is accompanied by large deflexions which give ample warning of collapse.

(v) If the temperature of the steel in a prestressed concrete beam exposed to fire has exceeded about 180°C, the reduction in the stiffness of the beam is likely to be severe and will normally necessitate replacement of the structural member.

ROAD RESEARCH REPORT FOR 1959: Road Research Laboratoy, Harmondsworth, Her Majesty's Stationery Office, U.K.

TRAFFIC increased at an average rate of seven per cent between 1951 and 1958. Last year it went up by twelve per cent and, if this trend continues, the national estimates of future traffic will need drastic upward revision. This is the view expressed by the Road Research Board in their Report for 1959, published today, which states: "The problem of coping with existing traffic and providing for its future increase, therefore, threatens to become even more urgent than we foresaw in 1954".

The Board welcomes the important research the Laboratory has carried out in its observations of the M. 1 motorway. The results obtained are expected to provide a valuable guide in the planning of a national programme; problems recommended for study include the effect of lighting on accident rates and trials of anti-dazzle fences.

The Board's report continues: "There are obvious difficulties to be faced in urban areas, but the contribution possible from motorways deserves serious study in relation to the traffic for which provision has to be made now and in the future".

Among the arrangements made between the Laboratory and the Ministry of Transport, the Board are pleased to record plans for two further groups of experimental sections on the Great North Road.

In the report of the Director of Road Research (Sir William Glanville, C.B., C.B.E., F.R.S.) details are given of the research carried out at the Laboratory during 1959. The subject studied include:

TRAFFIC AND SAFETY

London Traffic

A study of London traffic has revealed that the rate of traffic growth in the London area is greater at night than during the day. From 1953 to 1958 traffic between 9 a.m. and 5 p.m. rose by 28 per cent but traffic between 1 a.m. and 6 a.m. increased by 100 per cent.

The eighth London traffic survey, covering about forty miles in Central London, was made in the autumn of 1958. It shows that the number of commercial vehicles is still increasing slowly; that buses and taxis have maintained their downward trend; and that private vehicles have increased more rapidly, until in 1958 they represented the largest single class of traffic. The average journey time, under peak-hour conditions, was 7.3 minutes per mile of which 3.3 (or 45 per cent) was spent waiting or queueing at controlled intersections.

An analysis of data collected in a survey of travel in Greater London, shows that in a normal week 60 per cent of road travel was in buses, 22 per cent in private cars, 10 per cent by bicycle and the remaining 8 per cent by coach, taxi or motorcycle. Fifty per cent of travel on week days took place between 7 and 9 a.m. or between 5 and 7 p.m.

Parking Meters and 'no waiting' signs

Parking meters in Mayfair helped to increase average traffic speed by 9 per cent but in the surrounding West End zones it decreased by between 7 and 13 per cent.

Another study, in Glasgow, has shown that the introduction of 'no waiting' signs in the central area, despite an increase of 5 per cent in traffic flow, has raised the average journey speed by 12 per cent. The greatest effect was at intersections, delays being reduced by 23 per cent.

Motorway Speeds

An investigation into vehicle speeds and driver behaviour was made on Britain's first motorway the Preston-By-pass in May 1959. There was a marked similarity between car speeds on the By-pass and on the Continental motorways. Lorry speeds were roughly equal to those on the Belgian and French roads but slightly lower than those in the Netherlands and Germany.

Skidding

The Laboratory's portable skid-resistance tester is now being made by three firms.

Casualty Rates

An examination of accident statistics has shown a considerable variation in road casualty rates per head of population from one part of the country to another. The biggest factor in this variation is probably the volume of traffic, but its type, the character of towns, the condition of the roads and differing human response may also have some effect.

Of particular interest is the variation in child-casualty rates. Pedestrian casualties per thousand children (under 15) living in towns varied from 3.2 in Wales to 2.2 in Greater London, Hertfordshire and Surrey. There was considerable variation amongst the regions in the severity of casualties to children. This was matched by a similar variation for adults.

'Chain-collisions'

One type of accident—'chain' collisions —in which successive vehicles run into the back of one another—is of considerable importance on motorways and other high-speed roads. An investigation was made to see whether the recommended separation distance of one car length (15 feet) for each 10 miles of speed was adequate: larger separations are recommended on wet roads.

An examination of 216 accidents that occurred in two months of 1958 on zebra crossings in the Metropolitan Police District showed that in 81 of these the following events occurred (not necessarily in this order):

(1) a vehicle (or line of vehicles) stops at a crossing;

(2) one or more pedestrians move into the carriageway;

(3) at least one of the pedestrians is hit by another vehicle.

MATERIALS AND METHODS OF CONSTRUCTION

Pavement Design

Investigations to design the structure of a road with regard both to the sub-soil and the traffic continue to occupy an important place in the research programme and the solutions of many of the problems involved are being sought largely through full-scale experiments on heavily-trafficked roads.

Soil Moisture

Apparatus has been developed for studying the moisture suction properties of soils using the pressure-membrane technique, a technique first developed by agricultural scientists. The apparatus covers the range of suctions likely to arise in civil engineering problems in the United Kingdom.

Stone Temperature

In the manufacture of coated materials for bituminous surfacings it is essential to control the temperature of the aggregate as it leaves the dryer, so that the material can be laid satisfactorily. A device has therefore been developed which traps a portion of free-flowing aggregate for a few moments so that it collects in a small heap round a sensitive thermometer and is then released.

Riding Quality of Concrete Roads

Experimental work to improve the riding quality of concrete roads has continued. Finishing machines, modified so that the finishing screed was supported between two bogies instead of resting directly on the forms or rails as at present, were used on a number of sites during the year. They were found to produce more uniform road surfaces and, the Laboratory states it is important that they should be generally employed for major concrete constructions.

Snow Ploughs

Tests with models have been carried out with two types of snow plough, the Vee plough and the single-blade plough, to improve methods of dealing with snow and ice. With the Vee plough, tests have been made to determine the best shape of blade for ploughing snow up to 6 in. deep on motorways at speeds up to 30 mile/h. Tests are continuing. With the single-blade plough, the performance is considerably improved if the angle it makes with the direction of travel is reduced from about 60 degrees to 45 degrees while adjusting its length to clear the same width of track.

Road Heating

Investigations into methods of electrical heating on roads to prevent the formation of ice and frost have led to some interesting developments. A full-scale experimental road-heating system, 750 yards long, has been built into the nearside lanes of the A. 412 at Uxbridge Road, Slough. The heating grids comprise insulated heating cable of six different types supplied at 240 volts and the investigation is to determine which cables gives the best results. The output is 9 watts per square foot, except over bridges where it has been slightly raised to offset losses from the underside.

A similar system has been devised along the Mound in Edinburgh and on the ramp leading to the roof of the new Retail Market in Coventry. These investigations are continuing, but at Coventry satisfactory results have already been obtained, although the rate of snow-melting was rather low because the power output was lower than expected.

CENTRAL ROAD RESEARCH INSTITUTE, NEW DELHI, ANNUAL REPORT FOR 1959-60 CENTRAL ROAD RESEARCH INSTITUTE, P.O.C.R.R.I., NEW DELHI-20.

The foreword to this report written by **Prof.** S. R. Mehra, Director, Central Road Research Institute, is reproduced below:

This report describes briefly the results of research work carried out at the Central Road Research Institute during 1959-60. The scientific exploitation of local materials has continued to receive pointed attention.

Pilot projects for popularization of all-weather stabilized soil roads made fairly satisfactory progress, in the background of existing circumstances, and proposals for further development have been received already from two States.

Use of scientifically compacted soil, as a cheap substitute for hard materials, in the lowest layers of the designed pavement, has not yet caught the fancy of the higway engineers, allegedly due to shortage of compaction equipment. This is feasible method of making the new roads strong enough for the heavier traffic which is now coming on them, without appreciably increasing the unit cost of the pavement, and as such should receive urgent consideration.

On each mile of road constructed without such treatment, the country will have to spend a disproportionate amount of money on strengthening in the very near future, not to speak of the inconvenience to traffic caused by the detrimental deformation of the road surface, emanating from inadequate thickness of pavement. It therefore argues, that, soil compaction should be made obligatory, even if it means longer working hours for available compaction equipment, and a little slowing down of the construction programme.

The use of lime-molasses mixtures in soil stabilization, has given very encouraging results, and the idea is exploitable for construction of special purpose low cost all-weather roads in concentrated sugarcane areas, for transport of cane to the sugar factories, which can supply molasses cheaply for use on their own roads.

A reference was made in the previous report, to the usefulness of lime in stabilization of road bases. Further work has shown that dolomite lime is even more effective than ordinary commercial lime for this purpose. As there are large unused deposits of dolomite in Rajasthan, Bihar, Gujarat and other parts of India, the idea of the possibility of production of commercial dolomite lime from such deposits is being pursued.

The actual application of the results of research remains generally very slow, although, judging from the increasing number of inquiries being received, it appears that the interest is gradually building up. The process could be considerably accelerated if sufficient funds could be earmarked for development of research results, thus underwriting any small risks of failure which are inherent in such undertakings, and thereby making it possible for the engineering staff to utilize research in the bold manner that is called for at present, if substantial dividends are to be readily earned from the large investments being made on research.

BUDGETS AND ADMINISTRATION REPORTS

MADRAS STATE BUDGET FOR 1960-61 (A BRIEF REVIEW WITH REFERENCE TO CIVIL WORKS).

THE budget estimate of revenue receipts for the year 1960-61 is Rs 8,087.23 lakhs and the expenditure on revenue account is estimated at Rs 8,120.88 lakhs with a consequent deficit of Rs 33.65 lakhs.

The revised estimate of the revenue for the year 1959-60 is Rs 7,829.71 lakhs and of expenditure is Rs 7,771.84 lakhs leading to a surplus of Rs 57.87 lakhs. The actuals for 1958-59, revealed revenue receipts of Rs 6,995.07 lakhs and expenditure of Rs 6835.37 lakhs resulting in a surplus of Rs 159.70 lakhs. The Budget Estimate of Revenue Expenditure on Civil Works for the year 1960-61 is Rs 1,063.21 lakhs which is 13.1 per cent of the total State Revenue. The expenditure on Civil Works for the year 1959-60 (revised estimate) for the year 1958-59 (actuals) is Rs 1,157.66 lakhs and Rs 625.45 lakhs respectively, giving a percentage of 14.8 per cent and 8.9 per cent respectively with respect to the corresponding figures of total State Revenue for the years 1959-60 and 1958-59 respectively.

The expenditure on Communications alone (original works and repairs combined) works out to Rs 288.87 lakhs for 1960-61 which is 3.6 per cent of the total State Revenue. The expenditure on Communications is Rs 277.91 lakhs (revised estimate) in 1959-60 and Rs 292.39 lakhs (actuals) in 1958-59, which amounted to 3.5 per cent and 4.2 per cent respectively of the corresponding figures of total State Revenue for the years 1959-60 and 1958-59.

The Capital Outlay on Civil Works outside the Revenue Account is estimated at Rs 395.38 lakhs for the year 1960-61. The revised estimate and the actual estimate for the same for the years 1959-60 and 1958-59 are Rs 378.49 lakhs and Rs 281.69 lakhs respectively.

LIST OF APPROVED WORKS ON NATIONAL HIGHWAYS

S. No.	Job No.	Name of the work	Amount (Rs in lakhs)
		ANDHRA PRADESH	
1.	2534-AH-50	North approach road to regulator-*cum* road bridge across Krishna near Vijayawada—Shifting of Beat Yard at Seethawgarain National Highway No. 5.	1.13
		DELHI	
2.	2536-DLH-8	Providing 1″ dense carpet on Delhi-Gurgaon Road from mile 6/0 to mile 7/2 to mile 7/2—National Highway No. 8.	0.44
		GUJERAT	
3.	2513-GR-8A	Construction of a bridge over the Machhu river at Malika on N.H. No. 8A section—Bamanbore to Wankaner.	6.20
4.	2514-GR-8A	Construction of a bridge over the Bhagao river on N.H. No. 8A.	35.09
5.		Two works each costing less than 2 lakhs ...	2.30
		KERALA	
6.	2524-KR-47	National Highway No. 47—Improvements to Quilon-Alleppey Road, miles 22/6½ to 25/0—Deviation in Kayamkulam town.	5.18
		MADRAS	
7.	2510-MD-7	Widening the black top surface to 22′ and formation to 38′ in mile 278/2 to 288/0 (Dindigul Division)—N.H. No. 7.	2.56
8.	2515-MD-45	Widening the B. T. to 22′ width and formation to 38′ in miles 150 to 214 of N. H. No. 45.	7.94
9.	2516-MD-45	Widening the B. T. to 22′ width in miles 122 to 150 of N. H. No. 45.	7.31
		MADHYA PRADESH	
10.	2523-MP-43	Resectioning and black-topping, miles 66/4 to 198/2 of N. H. No. 43 in Dandakaranya area.	35.28
11.		Three works each costing less than 2 lakhs ...	3.73
		MAHARASHTRA	
12.		Two works each costing less than 2 lakhs ...	3.28

Note: Works estimated to cost less than Rs one lakh are not included in the above list.

S. No.	Job No.	Name of the work	Amount (Rs in lakhs)
		ORISSA	
13.	2511-RS-6	Upgrading N.H. No. 6—section III: from Deogarh to Barkote.	4.33
		PUNJAB	
14.	2512-PB-IA	Widening and raising of N.H. No. IA from miles 22 to 45 except miles 27, 28, 30 and 31.	10.71
		RAJASTHAN	
15.		Three works each costing less than 2 lakhs.	1.66
		UTTAR PRADESH	
16.	2518-UP-2	Widening of two-lane traffic (Kanpur to Barah), miles 51-70 of N.H. No. 2 in the Kanpur District.	8.86
17.	2525-UP-28	Improvements to miles 200-217 (excluding miles 204-205) of Gorakhpur-Kasia-Tamkohi.	16.14
		WEST BENGAL	
18.	2517-BG-6	Land acquisition for the construction of road from Durgapur to Khasida (Kharagpur division of N.H. No. 6) in the district of Midnapur.	10.41

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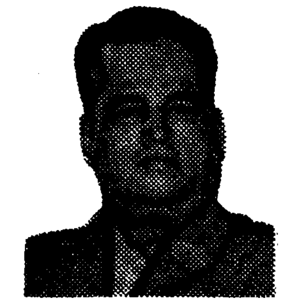

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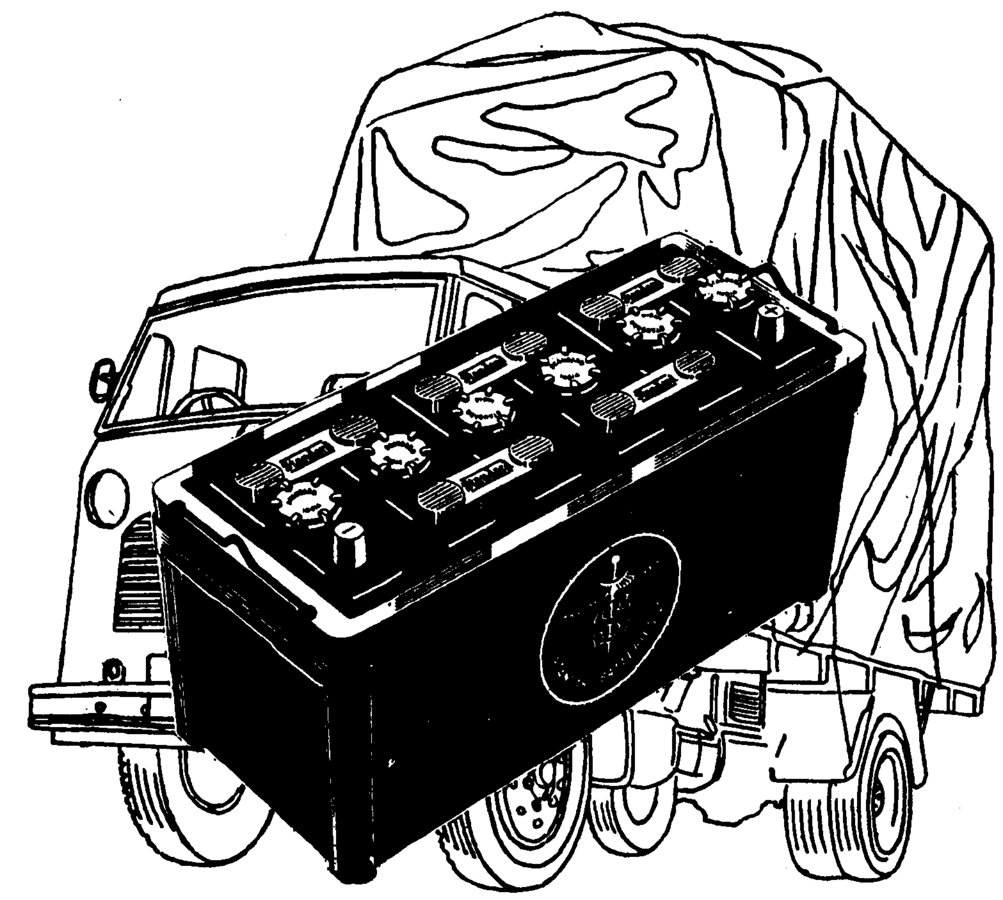

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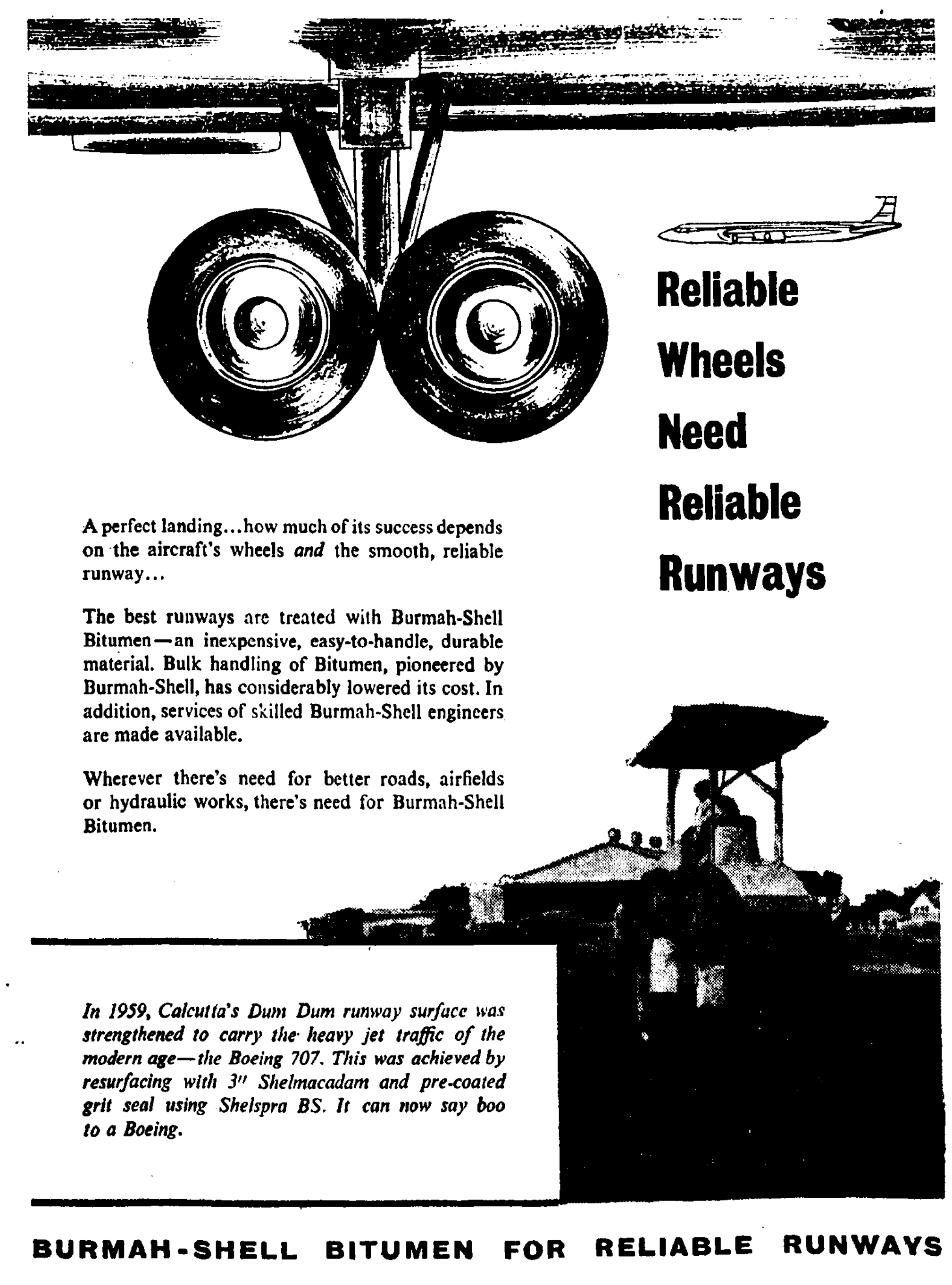

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