

No 30 Read the following letter from W. C FURNIVALL, Esq, Under Secretary to the Government of India, Public Works Department (Railway), to Major-General G. W. WALKER, R E, Secretary to the Government of Madras, Public Works Department (Railway), dated Simla, 12th October 1875, No 2,545 R —

I AM directed to forward, for information, a book of tables for determining the scantlings of beams and joists of teak by Mr E H Stone, Civil Engineer, together with copy of a memorandum by the Consulting Engineer to the Government of India for State Railways on the subject

STATE RAILWAYS

Memorandum by the Consulting Engineer to the Government of India for State Railways on Mr Stone's Book of Formulae and Tables for Beams

THE book of tables and formulæ for teak beams by Mr Stone bears evidence of considerable ability and originality on the part of the author, and points out errors into which Engineers may, without reflection, fall

The only fault I have to find with the book is that it is too bulky and wants condensation, and the formulæ might be simplified

Mr Stone gives two formulæ, one involving the cube, and the other the 4th power—one for strength, and the other for stiffness his *modus operandi* is to calculate the weight by both of these, and then to select that which gives the lowest result It appears to me that this is unnecessary, as there is a point where the two formulæ balance with each other With the data adopted by Mr Stone, this point is where the depth of the beam is equal to $\frac{1}{16}$ th of the span, consequently on either side of this point, either one or the other may be neglected

Moreover, it is possible, by making all terms functions of the span, to simplify the formulæ and eliminate from them the cube and 4th power, thus I do by the construction of coefficients for the depth My formulæ for the construction of these coefficients is given on the accompanying diagrams Mr Stone's two formulæ—

$$W = \frac{a^3}{00937 L}, \text{ and}$$

$$W = \frac{d^4}{0075 L^3}, \text{ are by these}$$

means reduced to one very simple formula $W = S^3 K$

When S = clear span in feet,

K = coefficient varying with the depth,

W = safe load distributed in lbs.

If it be desired to find the depth, the converse formula,—

$K = \frac{W}{S^3}$ may be used instead of the two following formulæ given by Mr Stone

$$d = \sqrt[3]{00937 L w}, \text{ and}$$

$$d = \sqrt[4]{00752 L^3 w}$$

Having found the value of K by the formula $K = \frac{W}{S^3}$, the depth corresponding to it will be found in the table of values of K

The adoption of this simple formula enables a corresponding reduction in the diagrams

To illustrate the system suggested by Mr Stone, 25 diagrams will be required for spans from 6 to 30 feet, whilst, on the system I propose, only one is necessary to give the safe loads, and another to give the weights of the beams The diagrams are, moreover, of more simple

Proceedings of the Madras Government, Public Works Department,
2nd November 1875.

construction The table of the values of K may be worked out to any desired degree so as to obtain close results I have worked out coefficients for 11 different depths, which will, I believe, be more than will be required in practice In fact, except in special cases, it is not desirable to adopt depths smaller than $\frac{1}{4}$ th of span, as it is not an economical form, and in many cases the cost of large timber precludes the possibility of adopting beams of great depth

There is one other point in which I think Mr Stones's book fails, and that is in not providing for beams of other dimensions than those whose breadth is two-thirds of the depth

In some cases, it is found convenient to cut two beams out of a square balk, and then the dimension of the breadth = $\frac{1}{2}$ the depth is adopted in some cases, moreover, to save the joists, beams of these dimensions are used, and I think that to be perfect a book should have the weights of beams of both these classes

All that appears to me to be necessary are the diagrams A and B to guide the eye, the formula written on them for more close calculation, and a table C with the most useful spans worked out, in fact three pages of foolscap To these might be added two diagrams similar to A and B for beams whose breadth is half their depth

The diagrams and tables worked out by my formulæ are appended

26th July 1875

G L M

FORMULÆ

S = Span of beam in feet

D = Depth of beam in feet

d = Depth of beam in inches

W = Safe load distributed in lbs

$\frac{1}{n}$ = Proportion of depth to span = $\frac{D}{S}$

W = S³ K

$K = 80 \left(\frac{12}{n}\right)^3$ when $\frac{1}{n}$ exceeds $\frac{1}{4}$ th span
= $100 \left(\frac{12}{n}\right)^4$ when depth is less than $\frac{1}{4}$ th span

$K = 106723 \left(\frac{12}{n}\right)^3$ when depth exceeds $\frac{1}{4}$ th span
= $133333 \left(\frac{12}{n}\right)^4$ when depth is less than $\frac{1}{4}$ th span

w = Weight in lbs of unsupported length of beam

w = k S³

k = $\frac{225}{n^3}$ when breadth of beam = $\frac{1}{2}$ depth

k = $\frac{800}{n^3}$ when breadth of beam = $\frac{1}{4}$ depth.

C

TEAK BEAMS

Breadth two-thirds of the Depth

Span in Feet. S	Breadth of Beam in Inches b=533 S	Depth of Beam in Inches d=8 S	Safe load in lbs distributed W=546 S ³	Weight of the (unsupported length of) beam w=1333 S ³	Safe load in lbs deducting Weight of Beam W-w	Distance of Beams apart, with loads per superficial foot, including Weight of Floor		
						1 cwt	1½ cwt	2 cwt.
FEET	INCHES					FEET	FEET	FEET
10	533	8	5,466	133	5,333	47	31	23
12	640	96	7,862	230	7,632	56	37	28
14	746	112	10,702	366	10,336	65	43	32
16	853	128	13,978	546	13,432	74	49	37
18	960	144	17,690	777	16,913	83	56	41
20	1067	160	21,810	1,067	20,743	92	61	46
22	1173	176	26,426	1,420	25,006	101	67	50
24	1280	192	31,450	1,843	29,607	110	73	55
26	1386	208	36,910	2,343	34,567	118	79	59
28	1493	224	42,806	2,927	39,879	127	84	63
30	1600	240	49,140	3,600	45,540	135	90	67

Proceedings of the Madras Government, Public Works Department,
2nd November 1875.

TEAK BEAMS

Breadth half the Depth

Span in Feet S	Breadth of Beam in Inches b=48	Depth of Beam in Inches d=8 S	Safe load in lbs distributed W=41 S ³	Weight of the (unsupported length of) beam W=1 S ³	Safe load in lbs deducting weight of beam W-w	Distance of Beams apart from centre to centre per superficial feet.		
						1 cwt	1½ cwt.	2 cwt.
FEET	INCHES					FEET	FEET	FEET
10	48	80	4,100	100	4,000	35	23	17
12	48	96	5,904	173	5,731	42	28	21
14	56	112	8,036	274	7,762	49	32	24
16	64	128	10,496	410	10,086	56	37	28
18	72	144	13,284	583	12,701	63	42	31
20	80	160	16,400	800	15,600	69	46	34
22	88	176	19,844	1,065	18,779	76	50	38
24	96	192	23,616	1,382	22,234	82	55	41
26	104	208	27,716	1,758	25,958	88	59	44
28	112	224	32,144	2,195	29,949	95	63	47
30	120	240	36,900	2,700	34,200	101	67	50

No 31.

ORDER THEREON, 2nd November 1875, No 3,101.

RAILWAY, No 5

THE memorandum by the Consulting Engineer to the Government of India for State Railways will be

recorded and communicated to all officers of the department for information

(True Extract)

Major-General, R E,

Secretary to Government

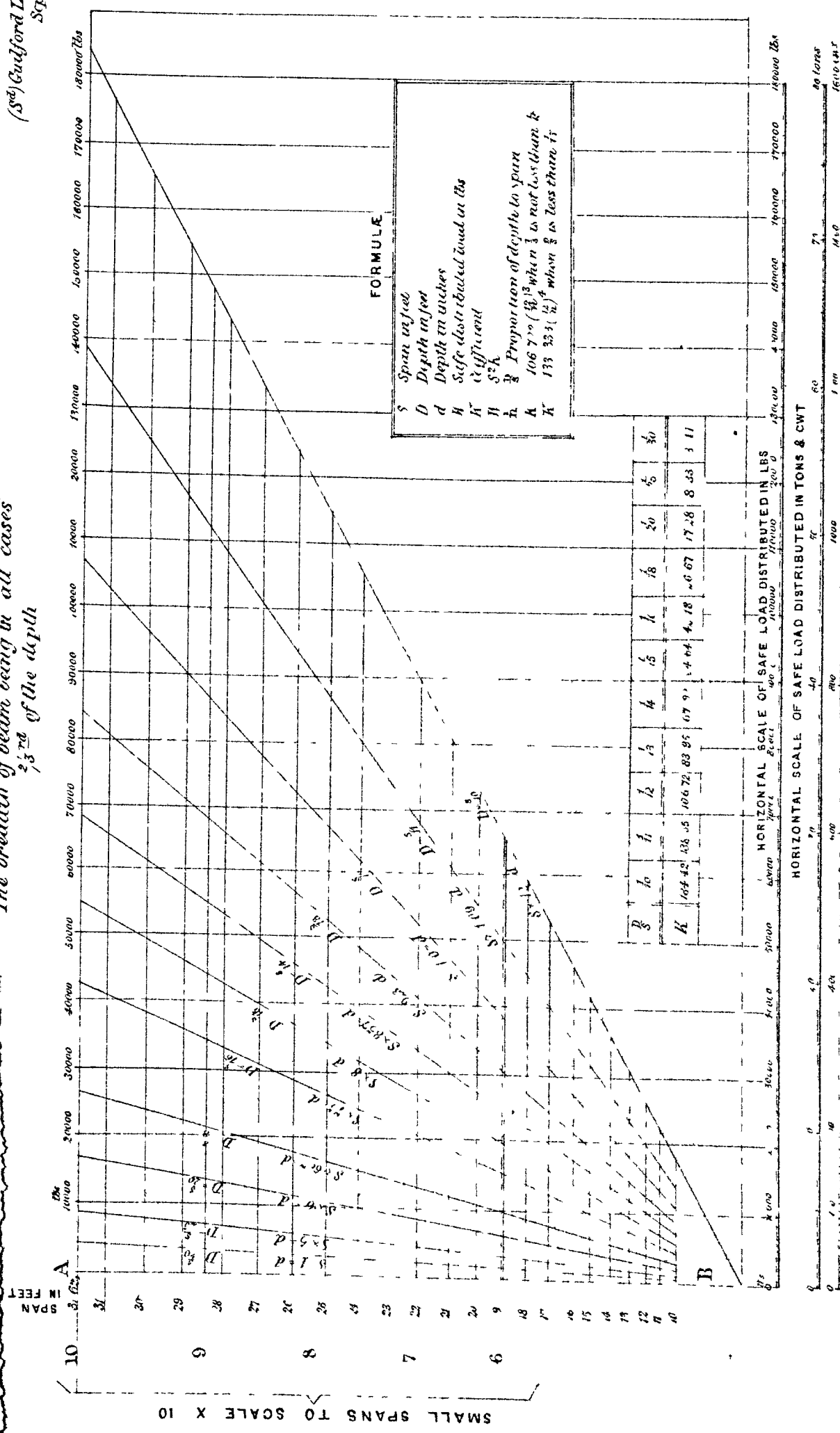
To the Chief Engineer for Irrigation
" Consulting Engineer for Railways
To all District Engineers
To the Executive Engineer, Wynad
" Consulting Architect

Exd E C Shunker

Spare Copies

The breadth of beam being in all cases $\frac{2}{3}$ of the depth

(Sd) Gulford L. Molenorth
Sept 17th 1875



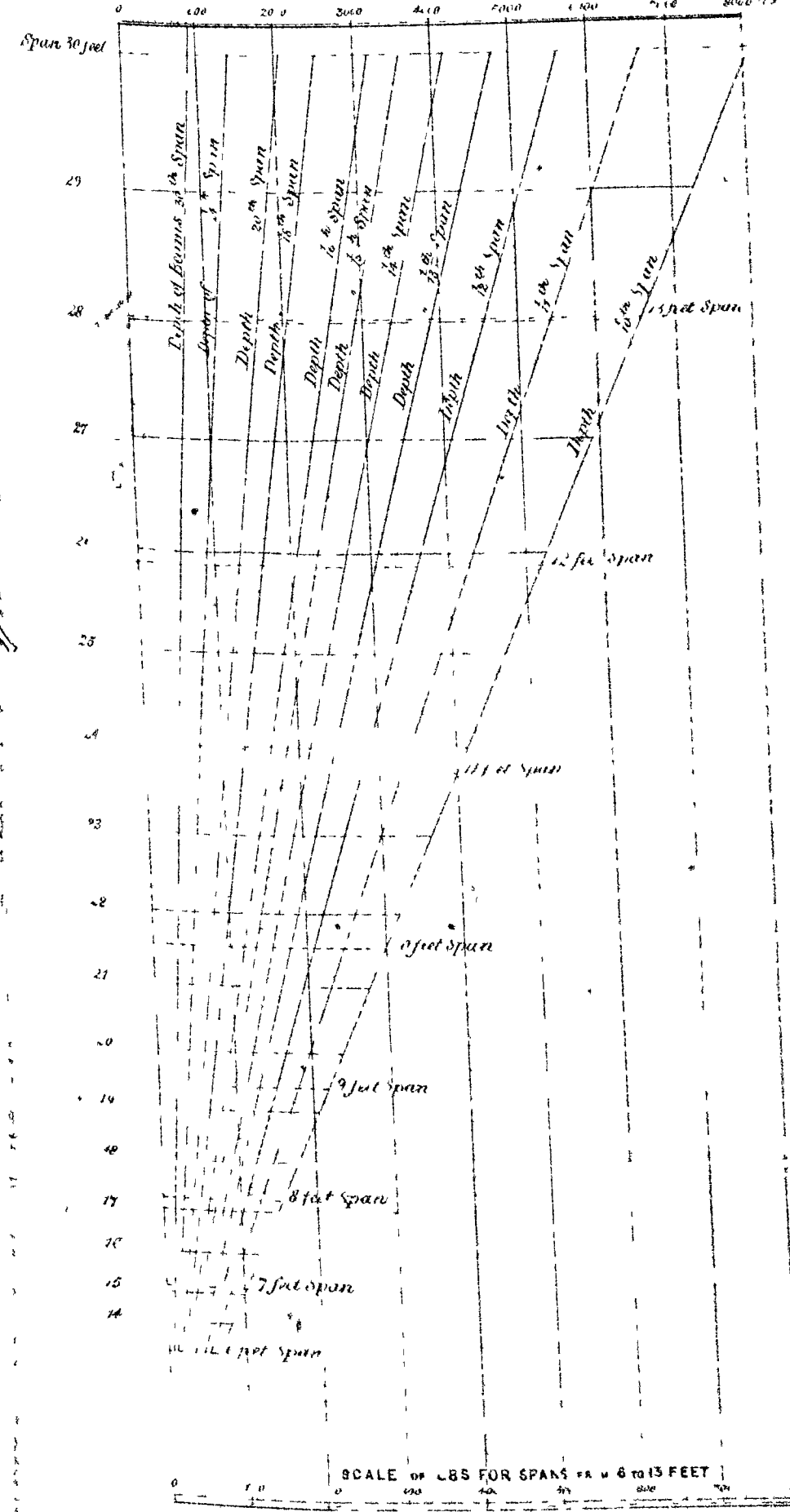
To use the diagram find the given load in the upper line and the point where the vertical line from it cuts the curve in span the diagram and the vertical line drawn from that point will show the safe load to be supported. The same argument for safe load in all cases to be noted has been used from the vertical line A B the entire section of the diagram of the proposed depth.

DIAGRAM OF
WEIGHT OF THE UNSUPPORTED LENGTH OF STEAK BEAMS,
whose breadth is $\frac{1}{3}$ the depth

By General I. M. S. ...
1871

SCALE OF CWT. FOR SPANS ABOVE 13 FEET

SCALE OF LBS FOR SPANS EXCEEDING 13 FEET



FORMULAE

S = Clear span in feet
 k = coefficient for depth of beam
 $\frac{1}{h}$ = Proportion of depth to span
 D = Depth of beam in feet
 w = Weight of the unsupported length of beam in lbs
 $u = \frac{8}{h^2} k$
 $h = \frac{1}{\sqrt{\frac{8}{k} u}}$

VALUES - K

$\frac{1}{h}$	K
$\frac{1}{10}$	3
$\frac{1}{11}$	248
$\frac{1}{12}$	283
$\frac{1}{13}$	377
$\frac{1}{14}$	456
$\frac{1}{15}$	533
$\frac{1}{16}$	619
$\frac{1}{18}$	692
$\frac{1}{20}$	770
$\frac{1}{24}$	1333
$\frac{1}{30}$	2021

SCALE OF LBS FOR SPANS FROM 6 TO 13 FEET

No. 2345/12.

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

Howay

To,

The Secretary to the Govt. of Madras,
Public Works Department.
(Railway).

Santa 12th October 1875.

Sir,

I am directed to forward, for information, a book of tables for determining the scantlings of beams and joists of oak, by Mr. E. H. Stone, Civil Engineer, together with a copy of a memorandum by the Consulting Engineer to the Government of India for State Railways on the subject.

I have the honor to be,

Sir,

Your most obedient servant,

M. F. M. M.
Under Secretary.

All communications
will be addressed to
Secretary

11/10/75

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1-12-75
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Im

W. 1895 Sep.

from

No. 6859

The Gov. of India

Oct 12 Oct 25 1895.

27 No. 2545 R.

Forwarding herewith
drawn by the Comptroller
to the Gov. of India for
Black Rep. on the Board
Book of the Board and
Tables for her use.

W. 1895

No. 3101 of the Memorandum by the Comptroller
Engineer to the Gov. of India for the Railways will
be recorded and communicated to all Offices
of the Dept. for information
Sept 12 1895
Sept 12 1895

Sept 12 1895
Sept 12 1895
Sept 12 1895

75

Memo

Enclosure to Genl. J. Duran
I. W. D. letter No 2545R
dated 12th October
1875 - Diagrams A & B
referred to in Mr.
Holesworth's Note
on Mr. Stone's Book
of Formulae and
Tables for Beams

I. W. Dept - Ry BK
Calcutta No 2545R
1875.

C. No. 6857.

1875

of 1875

Madras:

PUBLIC WORKS.

Ch. Engr. for Bridge

2nd Nov 1875, No 30/4

Nov. 30 - 31

Price Formulas & Tables
in brand Floris of text
from Fort of India for
warding Memorandum by
to Fort of India for State
on - Recorded and
communicated to all officers
kept -