APPENDIX - III

CALCULATIONS FOR BENDING MOMENTS, DEFLECTIONS AND SHEAR FORCE FOR 60 cm. THICK CONCRETE DIAPHRAGM WALL.

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Calculations for Bending Moments, Deflections and Shear force for 60 cm. thick concrete diaphragm wall.

By beams on elastic foundation analysis for Both end hinged beams we have

Bending Moment

$$B.M. = \frac{W}{2\beta^2}\left[\frac{\text{Cos h}\beta x\,(\text{Sin h}\frac{\beta l}{2}.\ \text{Sin}\frac{\beta l}{2})\ \text{Cos}\ \beta x - \text{Sin h}\beta x\,(\text{Cos h}\frac{\beta l}{2}.\ \text{Cos}\frac{\beta l}{2})\ \text{Sin}\ \beta x}{\text{Cos h}\beta l + \text{Cos}\ \beta l}\right]$$

Deflection

$$Y = \frac{W}{k} - 2\frac{W}{k}\left[\frac{\text{Cosh}\beta x\,(\text{Cosh}\frac{\beta l}{2}.\ \text{cos}.\frac{\beta l}{2})\ \text{Cos}\ \beta x + \text{Sinh}\beta x(\text{Sinh}\frac{\beta l}{2}.\ \text{Sin}\frac{\beta l}{2})\ \text{Sin}\ \beta x}{\text{Cosh}\beta l + \text{Cos}\beta l.}\right]$$

Shear force

$$F = -\frac{W}{\beta}\left[\frac{\begin{array}{l}\text{SinhBx}\ (\text{Cosh}\frac{\beta l}{2}.\text{Cos}\ \frac{\beta l}{2} - \text{Sinh}\frac{\beta l}{2}.\text{Sin}\ \frac{\beta l}{2})\ \text{Cos}\ \beta x \\ + \text{CoshBx}(\text{Cosh}\frac{\beta l}{2}\ \text{Cos}\ \frac{\beta l}{2} + \text{Sinh}\frac{\beta l}{2}.\ \text{Sin}\ \frac{\beta l}{2})\ \text{Sin}\ \beta x\end{array}}{\text{Cosh}\beta l + \text{Cos}\ \beta l}\right]$$

(i) For depth -32M $\quad \beta = 0.36 \quad W = 58.34$ t/m

$\beta l/2 = 0.36 \quad \beta l/21 = 0.18$

$\text{Cosh}\frac{\beta l}{21} = \text{Cosh}\ 0.18 = 1.0162 \quad \text{Cos}\ 0.18 = 0.9838$

$\text{Sinh}\frac{\beta l}{21} = \text{Sinh}\ 0.18 = 0.1810 \quad \text{Sin}\ 0.18 = 0.1790$

$\text{Cosh}\frac{\beta l}{2} = \text{Cosh}\ 0.36 = 1.4333 \quad \text{Cos}\ 0.36 = 0.9287$

$\text{Cosh}\ 0.18 \times \text{Cos}\ 0.18 = 1.0162 \times 0.9838 = 0.9997$

$\text{Sinh}\ 0.18 \times \text{Sin}\ 0.18 = 0.1810 \times 0.1790 = 0.0323$

$\text{Cosh}\ 0.36 + \text{Cos}\ 0.36 = 1.4333 + 0.9287 = 2.3620$

(a) $\frac{\beta x_1}{2} = 0.0000$ (b) $\frac{\beta x_2}{2} = 0.045$ (c) $\frac{\beta x_3}{2} = 0.090$ (d) $\frac{\beta x_4}{2} = 0.135$

(e) $\frac{\beta x_5}{2} = 0.180.$

Where $x_1 = 0.00$ m., $x_2 = 4.0$ m, $x_3 = 8.0$ m, $x_4 = 12.0$ m $x_5 = 16.0$ m.

(a) $\frac{\beta x_1}{2} = 0.00$

Cosh 0 = 1.00 Cos 0 = 1.00

Sinh 0 = 0.00 Sin 0 = 0.00

$$Ma = \frac{W}{2\beta^2} \times \frac{\text{Sinh } \frac{\beta l}{2} \cdot \text{Sin } \frac{\beta l}{2}}{\text{Cosh } \beta l + \text{Cos } \beta l}$$

$$= \frac{58.34}{2x(.36)^2} X \quad \frac{0.0323}{2.362}$$

$$= +3.0608 \text{ t-m}$$

$$Ya = \frac{W}{K} - 2\frac{W}{K} \left[\frac{\text{Cos h } \frac{\beta l}{2} \cdot \text{Cos } \frac{\beta l}{2}}{\text{Cosh } \beta l \cdot \text{Cos } \beta l}\right]$$

$$= \frac{48.34}{200} \left[1 - 2 \times \frac{0.9997}{2.362}\right]$$

$$= \frac{48.34}{200} \left[1 - 0.8464\right]$$

$$= 0.0448 \text{ m.}$$

Fa = 0.00 t.

(b) $\frac{\beta x_2}{1} = 0.045$

Cos h 0.045 = 1.0001 Cos 0.045 = 0.9992

Sin h 0.045 = 0.0450 Sin 0.045 = 0.4500

$$Mb = \frac{56.34}{2x(.36)^2} \times \frac{1.0001 \times .0323 \times 0.9992 - 0.0450 \times .9997 \times .045}{2.362}$$

$$= \frac{56.34}{2x(.36)^2} \times \frac{0.0323 - 0.00202}{2.362}$$

$$= \frac{56.34}{2x(.36)^2} \times 0.001282$$

$$= 2.7863 \text{ t.m}$$

$$yb = \frac{56.34}{200} \left[1-2 \left(\frac{1.0001 \times .9997 \times .9992 + .0450 \times .0323 \times .0450)}{2.362} \right)\right]$$

$$= \frac{56.34}{200} \left[1-.8458\right]$$

$$= .0434 \text{ m.}$$

$$Fb = - \frac{56.34}{(.36)} \times \frac{0.0450 \times (.9997-.0323) \times .9992 + 1.0001 \times (.9997+.0323) \times .045}{2.362}$$

$$= - \frac{56.34}{(.36)} \times \frac{.0450 \times .9674 \times .9992 + 1.001 \times 1.0320 \times .0450}{2.362}$$

$$= - \frac{56.34}{.36} \times \frac{.0434 + .0464}{2.362}$$

$$= - 5.9469 \text{ t.}$$

(C) $\frac{Bx_3}{1} = 0.09$

Cos h 0.09 = 1.0040 Cos 0.09 = 0.9959

Sin h 0.09 = 0.1000 Sin 0.09 = 0.0899

$$Mc = \frac{56.34}{2x(.36)^2} \times \frac{1.0004 \times .0323 \times .9959 - 0.1000 \times .9997 \times .0899}{2.362}$$

$$= \frac{56.34}{2x(.36)^2} \times \frac{.0322 - .008987}{2.362}$$

$$= 2.1294 \text{ t.m.}$$

$$Yc = \frac{56.34}{200}\left[1-2\left(\frac{1.0040 \times .9997 \times .9959 + 0.1000 \times .0323 \times .0899}{2.362}\right)\right]$$

$$= \frac{56.34}{200}\left[1-2\left(\frac{.9994 + .00029}{2.362}\right)\right]$$

$$= \frac{56.34}{200}\left[1-.8464\right]$$

$$= 0.04326 \text{ m.}$$

$$Fc = -\frac{56.34}{.36} \times \frac{0.1000 \times .9674 \times .9959 + 1.0040 \times 1.0320 \times .0899}{2.362}$$

$$= -\frac{56.34}{.36} \times \frac{.963 + .931}{2.362}$$

$$= . \ 12.5355 \text{ t.}$$

(d) $\frac{Bx_4}{l} = 0.135$

Cos h 0.135 = 1.0090 Cos .135 = 0.9910

Sin h 0.135 = 0.1350 Sin . 135 = 0.1300

$$Md = \frac{56.34}{2x(.36)^2} \times \frac{1.0090 \times .0323 \times .9910 - .1350 \times .9997 \times .1300}{2.362}$$

$$= \frac{56.34}{2x(.36)^2} \times \frac{.0323 - 0.0175}{2.362}$$

$$= 1.3472 \text{ t.m.}$$

$$Yd = \frac{56.34}{200}\left[1-2\left(\frac{1.0090 \times .9997 \times .9910 + .1350 \times .0323 \times .1300}{2.362}\right)\right]$$

$$= \frac{56.34}{200}\left[1-2\left(\frac{.9996 + .00056}{2.362}\right)\right]$$

$$= \frac{56.34}{200}\left[1 - .8469\right]$$

$$= .0431 \text{ m.}$$

$$Fd = -\frac{56.34}{.36} \times \frac{.1350 \times .9674 \times .9910 + 1.0090 \times 1.0320 \times .1300}{2.362}$$

$$= -\frac{56.34}{.36} \times \frac{.1294 + .1353}{2.362}$$

$$= -17.538 \text{ t}$$

(e) $\frac{Bx_5}{l} = 0.18$

Cos h 0.18 = 1.0162 Cos 0.18 = .9838

Sin h 0.18 = 0.1810 Sin 0.18 = .1790

Me = 0.00 t-m

ye = 0.00 m.

$$Fe = -\frac{56.34}{0.36} \times \frac{.1810 \times .9674 \times .9838 + 1.0162 \times 1.0320 \times .1790}{2.362}$$

$$= \frac{-56.34}{0.36} \times \frac{.1722 + .1877}{2.362}$$

$$= \frac{56.34}{.36} \times .1523$$

$$= -23.847 \text{ t.}$$

(ii) For depth -28 m $\beta = 0.36$ W = 52.09 t/m $\frac{Bl}{l} = 0.36$

Cos h 0.18 x Cos 0.18 = 0.9997 $\frac{Bl}{2l} = 0.18$

Sin h 0.18 x Sin 0.18 = 0.0323

Cos h 0.36 + Cos 0.36 = 2.3620

(a) $\frac{Bx_1}{l} = 0.00$ (b) $\frac{Bx_2}{l} = 0.0514$ (c) $\frac{Bx_3}{l} = 0.1028$

(d) $\frac{Bx_4}{l} = 0.1542$ (e) $\frac{Bx_5}{l} = 0.1800$

Where $x_1 = 0.0$ m, $x_2 = 4.0$ m, $x_3 = 8.0$ m, $x_4 = 12.0$ m $x_5 = 14.0$ m.

(a) $\frac{Bx_1}{l} = 0.00$

Cos h 0.0 = 1 Cos 0.0 = 1

Sin h 0.0 = 0 Sin 0.0 = 0

$$Ma = \frac{52.09}{2 \times (0.36)^2} \times \frac{0.0323}{2.3620}$$

$$= + 2.7327 \quad t,m.$$

$$Ya = \frac{52.09}{200} \left[1 - 2 \times \frac{0.9997}{2.3620} \right]$$

$$= \frac{58.34}{200} \left[1 - 0.8464 \right]$$

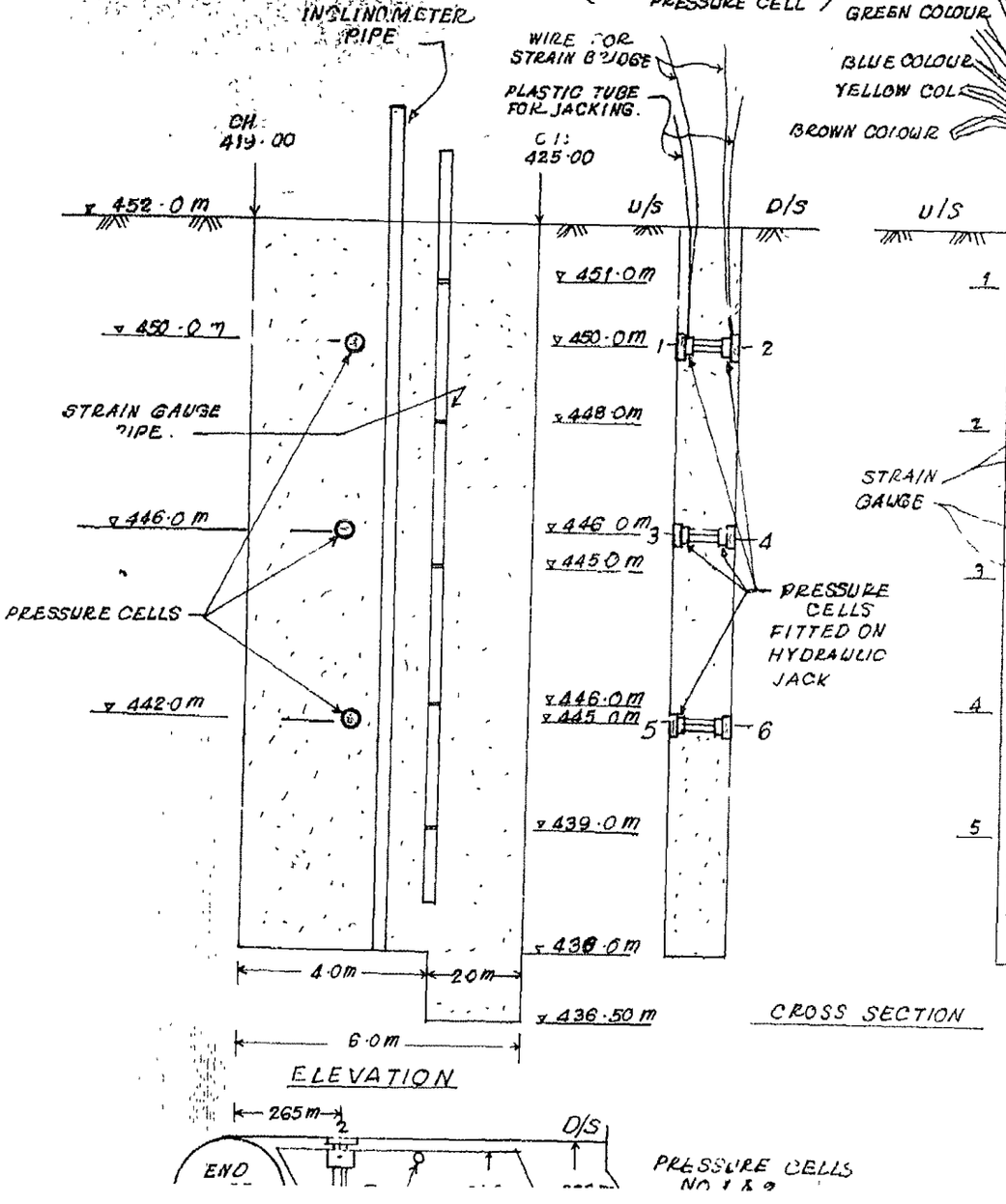
$$Fa = 0.00 \ t$$

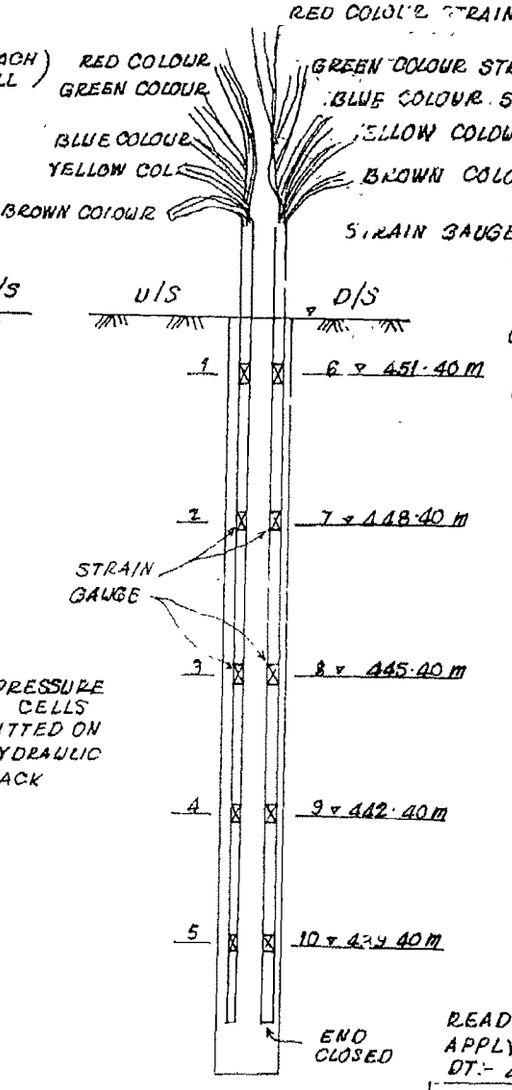
(b) $\frac{\beta x 2}{1} = 0.0514$

cos h 0.0514 = 1.001 Cos 0.0514 = 0.9985

sin h 0.0514 = 0.0500 Sin 0.0514 = 0.0500

DATE OF INSTALLATION OF ALL THESE INSTRUMENTS - 4-4-77.





NOTES :-

(1) ON U/S SIDE IN STRAIN GAUGE NO.2 OUT OF TWO STRAIN GAUGES ONE IS FOUND DAMAGED DURING INSTALLATION.

(2) ON D/S SIDE IN STRAIN GAUGE NO.3. OUT OF TWO STRAIN GAUGES ONE IS FOUND DAMAGED.

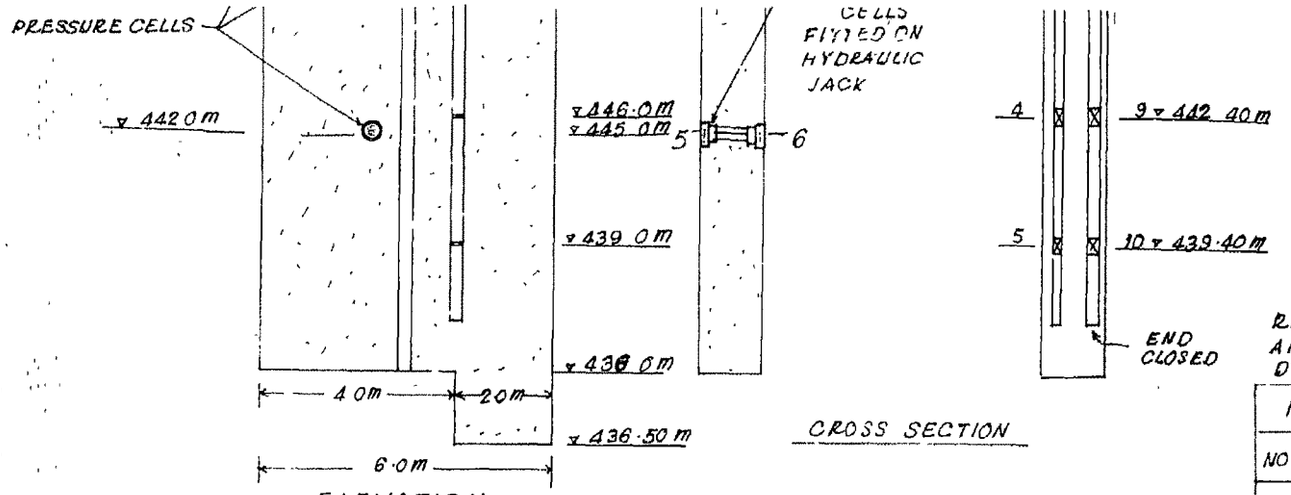
(3) PLASTIC TUBING ARE PROVIDED FOR INCLINOMETER PIPE

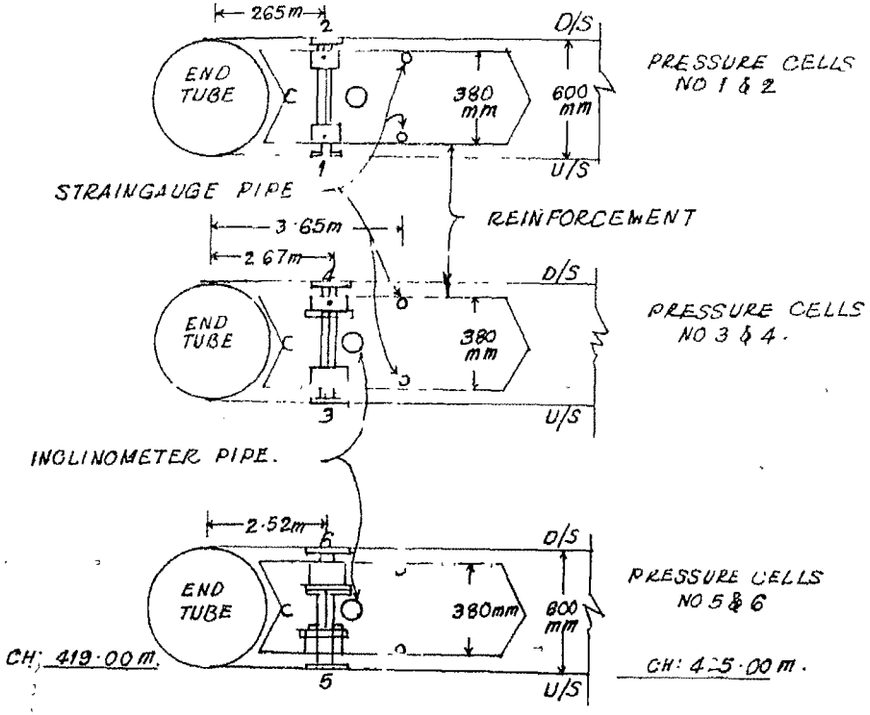
PRESSURE GAUGE READINGS ON HYDRAULIC JACK OF EARTH PRESSURE CELLS DT:- 4.4.77 & 5.4.77.

CELL NO	lb/in²	Kg/Cm²
1	125.0	10.0
2	125.0	10.0
3	0.0	0.0
4	7.0	0.0
5	0.0	0.0
6	125.0	10.0

READINGS ON STRAIN BRIDGE ON APPLYING JACKING PRESSURE DT:- 4.4.77.

PRESSURE CELL	μ STRAIN	Kg/Cm² STRESS
NO 1 SPC-F 30 K-77021	100	0.81
NO.2. SPC. F 30 K 77026	80	0.75
NO.3. — DO — 77024	100	0.81
NO 4. — DO — 77023	100	0.81





2	125.0	10.0
3	0.0	0.0
4	7.0	0.0
5	0.0	0.0
6	125.0	10.0

READINGS ON STRAIN BRIDGE ON APPLYING JACKING PRESSURE
DT:- 4.4.77.

PRESSURE CELL	μ STRAIN	Kg/Cm² STRESS
NO 1 SPC F 30 K 77021	100	0.81
NO 2 SPC F 30 K 77026	80	0.75
NO 3 — DO — 77024	100	0.81
NO 4 — DO — 77023	100	0.81
NO 5 — DO — 77025	10.0	0.81
NO 6 — DO — 77019	100	0.81

FIG 5.1

$$Mb = \frac{52.09}{2 \times (.36)^2} \times \frac{1.0010 \times 0.0323 \times .9985 - 0.0500 \times .9997 \times .0550}{2.3620}$$

$$= \frac{52.09}{2 \times (.36)^2} \times \frac{0.03228 - 0.0027}{2.3620}$$

$$= 2.5113 \text{ t-m}$$

$$yb = \frac{52.09}{200} - 2 \times \frac{52.09}{200} \quad \frac{1.001 \times .9997 \times .9985 + 0.0500 \times 0.0323 \times .0550}{2.3620}$$

$$= \frac{52.09}{200} \left[1 - 2 \times \frac{.9992 + .00012}{2.3620}\right]$$

$$= 0.400 \text{ m.}$$

$$Fb = -\frac{52.09}{.36} \times \frac{0.0500 \ (.9997 - .0323) \times .9985 + 1.001 \ (.9997 + .0323) \times .550}{2.3620}$$

$$= - 6.4241$$

(C) $\frac{\beta x_3}{1} = 0.1028$

Cos h 0.1028 = 1.0052 Cos 0.1028 = 0.9940

Sin h 0.1028 = 0.1042 Sin 0.1028 = 0.1050

$$Mc = \frac{52.09}{2 \times (.36)^2} \times \frac{0.3227 - 0.01093}{2.3620}$$

$$= \frac{52.09}{2 \times (.36)^2} \times \frac{0.3227 - 0.01093}{2.3620}$$

$$= 1.8149 \text{ t-m}$$

$$Yc = \frac{52.09}{200} - 2 \times \frac{52.09}{200} \quad \frac{1.0052 \times .9997 \times .9940 + .1042 \times .9997 \times .1050}{2.3620}$$

$$= \frac{52.09}{200} \left[1 - 2 \left(\frac{.9989 + 0.00035}{2.3620}\right)\right]$$

$$= 0.04008 \text{ m.}$$

$$Fc = - \frac{52.09}{0.36} \times \frac{.1042 \times .9674 \times .9940 + 1.0052 \times 1.0320 \times .1050}{2.3620}$$

$$= \frac{52.09}{0.36} \quad \frac{0.1002 + 0.1089}{2.362}$$

$$= -12.8106 \text{ t.}$$

(d) $\frac{\beta x_4}{l} = 0.1542$

Cos h 0.1542 = 1.0150 Cos 0.1542 = 0.9800

Sin h 0.1542 = 0.1550 Sin 0.1542 = 0.1700

$$Md = \frac{52.09}{2x(.36)^2} = \frac{1.0150 \times .0323 \times .9800 - .1550 \times .9997 \times .1700}{2.3620}$$

$$= \frac{52.09}{2x(.36)^2} \quad \frac{0.03213 - .02634}{2.3620}$$

$$= + 0.4924$$

$$yd = \frac{52.09}{200} - 2 \times \frac{52.09}{200} \quad \frac{1.0150 \times .9997 \times .9800 + .1550 \times .0323 \times .1700}{2.362}$$

$$= .0410 \text{ m.}$$

$$Fd = -\frac{52.09}{.36} \times \frac{0.1550 \times .9674 \times .9800 + 1.0150 \times 1.0320 \times .70}{2.3620}$$

$$= -\frac{52.09}{.36} \times \frac{.1469 + .1842}{2.362}$$

$$= -20.27 \text{ t-m.}$$

(e) $\frac{\beta x_5}{l} = 0.18$

Cosh 0.18 = 1.0162 Cos 0.18 = 0.9838

Sinh 0.18 = 0.1810 Sin 0.18 = 0.1790

Me = 0.00 t-m

Ye = 0.00 m.

$$Y_c = \frac{43.12}{200} - 2 \times \frac{43.12}{200} \quad \frac{1.0100 \times .9997 \times .9900 + .1440 \times .0323 \times .1400}{2.3620}$$

$$= \frac{43.12}{200} \quad 1 - 2 \times \frac{.9995 + .0026}{2.362}$$

$$= \frac{43.12}{200} \quad 1 - .8468$$

$$= 0.0330 \text{ m.}$$

$$F_c = -\frac{43.12}{0.36} \times \frac{.1440 \times .9674 \times .9900 + 1.0100 \times 1.0320 \times .1400}{2.3620}$$

$$= -\frac{43.12}{0.36} \quad \frac{.1379 + .1459}{2.362}$$

$$= - 14.3852 \text{ t.}$$

(d) $\frac{\beta x_4}{1} = 0.18$

Cos h 0.18 = 1.0162 Cos 0.18 = 0.9838

Sin h 0.18 = 0.1810 Sin 0.18 = 0.1790

Md = 0.00 t-m

Yd = 0.00 m.

$$F_d = \frac{43.12}{0.36} \times \frac{.1810 \times .9674 \times .9838 + 1.0162 \times 1.0320 \times .1790}{2.3620}$$

$$= -\frac{43.12}{0.36} \times 0.1521$$

$$= -18.2180 \text{ t.}$$

For $l = 15.5$ m $\quad \beta = 0.36$ $\quad w = 38.86$ t/m

$\frac{\beta l}{l} = 0.36 \qquad \frac{\beta l}{2l} = 0.18$

Cos h 0.18 x Cos 0.18 = 0.9997

Sin h 0.18 x Sin 0.18 = 0.0323

Cos h 0.36 x Cos 0.36 = 2.3620

(a) $\frac{\beta x_1}{l} = 0.00$ (b) $\frac{\beta x_2}{l} = 0.093$ (c) $\frac{\beta x_3}{l} = 0.18$

where $x_1 = 0.00$ m, $x_2 = 4.00$ m, $x_3 = 7.75$ m.

(a) $\frac{\beta x_1}{l} = 0.00$

Cos h 0.00 = 1.00 Cos 0.00 = 1.00

Sin h 0.00 = 0.00 Sin 0.00 = 0.00

$$Ma = \frac{38.86}{2(0.36)2} \times \frac{0.0323}{2.362}$$

$= 2.0383$ t.m.

$$Ya = \frac{38.86}{200} \quad 1 - 2 \left(\frac{0.9997}{2.362} \right)$$

$$= \frac{38.86}{200} \quad 1 - .8464$$

$= 0.0298$ m.

Fa $= 0.00$ t.

(b) $\frac{\beta x_2}{l} = 0.093$

Cos h 0.093 = 1.0045 Cos 0.093 = 0.9955

Sin h 0.093 = 0.0950 Sin 0.093 = 0.0920

$$Mb = \frac{38.86}{2x(.36)^2} X \frac{1.0045 \times .0323 \times .9955 - .0950 \times 1.0045 \times .0920}{2.3620}$$

$$= \frac{38.86}{2x(.36)^2} X \frac{0.0323 - 0.0087}{2.3620}$$

$$= 1.4932 \text{ t.m.}$$

$$Yb = \frac{36.86}{200} - 2 \times \frac{38.86}{200} \frac{1.0045 \times .9997 \times .9955 + .0950 \times .0323 \times .0920}{2.3620}$$

$$= \frac{38.86}{200} \left[1 - 2 \times \left(\frac{.9997 + .0003}{2.3620}\right)\right]$$

$$= \frac{38.86}{200} \left[1. - 0.8467\right]$$

$$= 0.0298 \text{ m.}$$

$$Fb = - \frac{38.86}{.36} \times \frac{0.09500 \times .9674 \times .9955 + 1.0045 \times 1.0320 \times .0920}{2.3620}$$

$$= - \frac{38.86}{.36} \times \frac{0.0915 + 0.0954}{2.3620}$$

$$= -8.5384 \text{ t.}$$

(c) $\frac{Mx_3}{1} = 0.18$

Cos h 0.18 = 1.0162 Cos 0.18 = 0.9838

Sin h 0.18 = 0.1810 Sin 0.18 = 0.1790

Mc = 0.00 t.m.

Yc = 0.00 m.

$$Fc = - \frac{38.86}{0.36} \times \frac{.1810 \times .9674 \times .9838 + 1.0162 \times 1.0320 \times .1790}{2.3620}$$

$$= - \frac{38.86}{0.36} \text{ X } 0.1521$$

$$= - 16.4180 \text{ t}$$

$$Fe = -\frac{52.09}{.36} \times \frac{.1810 \times .9674 \times .9838 + 1.0162 \times 1.0320 \times .1790}{2.3620}$$

$$= -\frac{52.09}{.36} \times \frac{0.1717 + .1877}{2.362}$$

$$= -22.0077 \text{ t.}$$

(iii) For l = 24 m. $\beta l = 0.36$ W = 47.86 t/m

$$\frac{\beta l}{l} = 0.36 \qquad \frac{\beta l}{ll} = 0.18$$

Cos h 0.18 x Cos 0.18 = 0.9997

Sin h 0.18 x Sin 0.18 = 0.0323

Cos h 0.36 x Cos 0.36 = 2.3620

(a) $\frac{\beta x_1}{l} = 0.0000$ (b) $\frac{\beta x_2}{l} = 0.060$ (c) $\frac{\beta x_3}{l} = 0.120$

(d) $\frac{\beta x_4}{l} = 0.180$

Where $x_1 = 0.0$ m, $x_2 = 4.0$ m, $x_3 = 8.0$ m, $x_4 = 12.0$ m

(a) $\frac{\beta x_1}{l} = 0.00$

Cos h 0.00 = 1.00 Cos 0.00 = 1.00

Sin h 0.00 = 0.00 Sin 0.00 = 0.00

$$Ma = \frac{47.86}{2.(36)^2} \times \frac{.0323}{2.3620}$$

$$= 2.5105 \text{ t.m.}$$

$$Ya = \frac{47.86}{200} \quad 1 - 2 \times \frac{.9997}{2.3620}$$

$$= \frac{47.86}{200} \quad 1 - .8464$$

$$= 0.0367 \text{ m.}$$

(b) $\frac{\beta x_2}{l} = 0.060$

cos h.0.07 = 1.0018 Cos 0.06 = 0.9982

sin h 0.06 = 0.0600 sin 0.06 = 0.0600

$$Mb = \frac{47.86}{2 \times (.36)^2} \times \frac{1.0018 \times .0323 \times .9982 - 0.060 \times .9997 \times .0600}{2.3620}$$

$$= \frac{47.86}{2 \times (.36)^2} \times \frac{.0322 - .0035}{2.3620}$$

$$= 2.2336 \text{ t.m.}$$

$$Yb = \frac{47.86}{200} - 2 \times \frac{47.86}{200} \times \frac{1.0018 \times .9997 \times .9982 + .0600 \times .0323 \times .0600}{2.3620}$$

$$= \frac{47.86}{200} \left[1 - .8464\right]$$

$$= 0.0367 \text{ m.}$$

$$F_b = -\frac{47.86}{0.36} \times \frac{.0600 \times .9674 \times .9982 + 1.0018 \times 1.0320 \times .0600}{2.3620}$$

$$= -\frac{47.86}{0.36} \times \frac{0.0578 + 0.0620}{2.3620}$$

$$= -6.7402 \text{ t.}$$

(c) $\frac{Bx_3}{l} = 0.12$

Cos h 0.12 = 1.0072 Cos 0.12 = 0.9928

Sin h 0.12 = .1203 Sin 0.12 = 0.1197

$$Mc = \frac{47.86}{2x(.36)^2} \times \frac{1.0072 \times .0323 \times .9928 - .1230 \times .9997 \times .1197}{2.3620}$$

$$= \frac{47.86}{2 \times (.36)^2} \times \frac{.0322 - .0147}{2.362}$$

$$= 1.3655 \text{ t-m}$$

$$Yc = \frac{47.86}{200} - 2 \times \frac{47.86}{200} \times \frac{1.0072 \times .9997 \times .9928 + .1203 \times .0323 \times .1197}{2.3620}$$

$$= 0.0367 \text{ m.}$$

$$Fc = -\frac{47.86}{0.36} \times \frac{.1203 \times .9674 \times .9928 + 1.0072 \times 1.0820 \times .1197}{2.3620}$$

$$= -\frac{47.86}{.36} \times \frac{.1154 + .1244}{2.3620}$$

$$= -16.1923 \text{ t}$$

(d) $\frac{Bx_4}{l} = 0.18$

Cos h 0.18 = 1.0162 Cos 0.18 = 0.9838

Sin h 0.18 = 0.1810 Sin 0.18 = 0.1790

Md = 0.00

Yd = 0.00

$$Fd = -\frac{47.86}{.36}\ \frac{.1810 \times .9674 \times .9838 + 1.0162 \times 1.0320 \times .1790}{2.3620}$$

$$= -\frac{47.86}{.36} \times .1521$$

$$= -22.2208 \text{ t}$$

(iv) For l = 20m, β = 0.36, W = 43.12 t/m

$$\frac{\beta l}{1} = 0.36 \quad \frac{\beta l}{2l} = 0.18$$

Cos h 0.18 x Cos 0.18 = 0.9997

Sin h 0.18 x Sin 0.18 = 0.0323

Cos h 0.36 x Cos 0.36 = 2.3620

(a) $\frac{\beta x_1}{1} = 0.00$ (b) $\frac{\beta x_2}{1} = 0.072$ (c) $\frac{\beta x_3}{1} = 0.144$

(d) $\frac{\beta x_4}{1} = 0.180$

Where x_1 = 0.00 m, x_2 = 4.00 m, x_3 = 8.00 m, x_4 = 10.00 m

(a) $\frac{\beta x_1}{1} = 0.00$

Cos h 0.00 = 1.0000 Cos 0.00 = 1.0000

Sin h 0.00 = 0.0000 Sin 0.00 = 0.0000

$$\text{Mx Ma} = \frac{43.12}{2 \times (.36)^2}\ \frac{.0323}{2.362}$$

$$= 2.2622 \text{ t-m}$$

$$Ya = \frac{43.12}{200}\ 1 - 2 \times \frac{0.9997}{2.3620}$$

$$= \frac{43.12}{200}\ 1 - .8484$$

$$= 0.0331 \text{ m.}$$

Fa = 0.00

(b) $\frac{Bx_2}{l} = 0.072$

Cos h 0.072 = 1.0025 Cos 0.072 = 0.9970

Sin h 0.072 = 0.0750 Sin 0.072 = 0.0720

$$Mb = \frac{43.12}{2(.36)^2} \times \frac{1.0025 \times .0323 \times .997 - .075 \times .9997 \times .072}{2.3620}$$

$$= \frac{43.12}{2.(.36)^2} \times \frac{1.0026 \times .0323 \times .997 - .075 \times .9997 \times .072}{2.3620}$$

$$= \frac{43.12}{2x(.36)^2} \times \frac{0.0322 - .0053}{2.3620}$$

= 1.8794 t-m.

$$Yb = \frac{43.12}{200} - 2 \times \frac{43.12}{200} \frac{1.0025 \times .9997 \times .9970 + .1440 \times .0323 \times .0720}{2.3620}$$

$$= \frac{43.12}{200} \left[1 - 2 \frac{0.9990 + .0001}{2.3620}\right]$$

$$= \frac{43.12}{200} \left[1 - .8458\right]$$

= 0.0332 m.

$$Fb = - \frac{43.12}{0.36} \times \frac{.0722 + .0744}{2.3620}$$

= - 7.4261 t

(c) $\frac{Bx_3}{l} = 0.144$

Cos h 0.144 = 1.0100 Cos 0.144 = 0.9900

Sin h 0.144 = 0.1440 Sin 0.144 = 0.1400

$$Mc = \frac{43.12}{2x\ (.36)^2} = \frac{1.0100 \times .0323 \times .9900 - 0.1440 \times .9997 \times .1400}{2.3620}$$

$$= \frac{43.12}{2\ x(.36)^2} \times \frac{0.0322 - .0201}{2.3620}$$

= 0.8477 t-m.