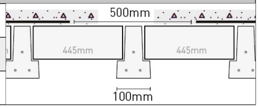
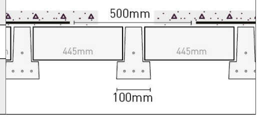
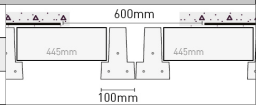
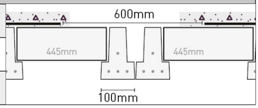
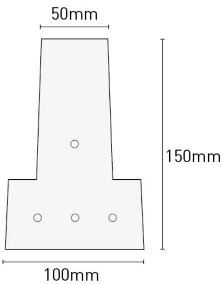
Load Span Tables

MATRIX
PRECAST CONCRETE

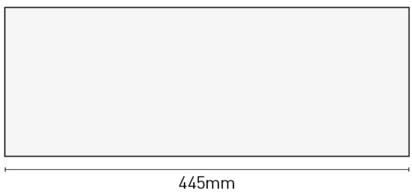
Load/Span Chart

for 150mm deep beams at varying centres

Blocks Density (kg/m^2)	Self Weight	Super Imposed Load (kN/m^2)						
		1.5	2.0	2.5	3.0	4.0	5.0	
S500 - 3 Wire								
660		4.240	3.955	3.720	3.521	3.201	2.954	
1350		3.948	3.714	3.516	3.346	3.067	2.847	
1900		3.748	3.545	3.371	3.220	2.969	2.767	
S500 - 4 Wire								
660		4.480	4.199	3.964	3.764	3.439	3.185	
1350		4.148	3.921	3.727	3.559	3.280	3.056	
1900		3.630	3.735	3.565	3.417	3.166	2.963	
D600 - 3 Wire								
660		5.226	4.907	4.638	4.402	4.036	3.742	
1350		4.943	4.669	4.436	4.227	3.899	3.632	
1900		4.746	4.502	4.291	4.101	3.799	3.550	
D600 - 4 Wire								
660		5.504	5.193	4.928	4.700	4.323	4.022	
1350		5.192	4.928	4.699	4.499	4.164	3.893	
1900		4.977	4.743	4.537	4.356	4.049	3.799	

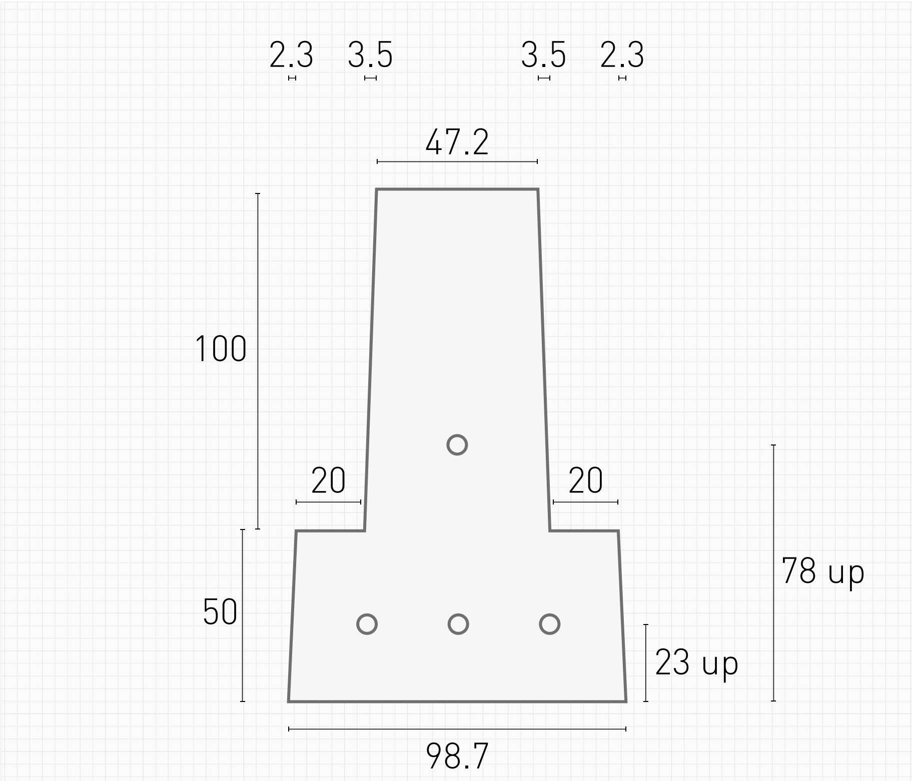


weight = 24kg/m



weight = 24kg/m

150x100 T-Beam
Dimension & Properties



Weight of unit = $\frac{24 \times 9895}{10^6}$ = **0.237 kN/m** Approximately 24kg/m

3 wires:	MRserv	= **4.484 kN/m**
	MRult	= **6.390 kN/m**
	√co	= **13.715 kN**
4 wires:	MRserv	= **4.804 kN/m**
	MRult	= **8.616 kN/m**
	√co	= **14.727 kN**

Note
1. Based upon: BS8110-1:1997 Structural use of concrete
2. 50mm screed

Properties of Section

Area

	No. off	b (mm)	d (mm)	Total Area (mm^2)	'y' (mm)
A =	1	47.2	100.0	4720	100.00
B =	1	94.2	50.0	4710	25.00
C =	2	3.5	100.0	350	116.67
D =	2	2.3	50.0	115	33.33
Total Area = 9.895					

1st moment about Base = Area × 'y'

A =	4720	×	100.00	=	472000
B =	4710	×	25.00	=	117750
C =	350	×	116.67	=	40835
D =	115	×	33.33	=	3833
First Moment about Base				=	634, 417 mm^3

Position of Neutral Axis from Base:

NA_b = 634,417 ÷ 9,895 = 64.115mm

1st Moment about Base × Neutral Axis from Base
= 634, 417 × 64.115 = 40,675,644 mm^4

Moment of Inertia about Base:

A = 1 ((b × d^3 / 12) + (Area × y^2))	=	51133333
B = 1 ((b × d^3 / 12) + (Area × y^2))	=	3925000
C = 2 ((b × d^3 / 36) + (Area × y^2))	=	4958606
D = 2 ((b × d^3 / 36) + (Area × y^2))	=	143724
I_{base}		60,160,663 mm^4

Moment of Inertia about Neutral Axis:

I_{na} = 60,160, 663 mm^4 – 40,675,644 mm^4 = 19,485,019 mm^4
= 19,485,019 mm^4 = <u>19.485019</u> × 10^6 mm^4

3 Wire Beam Dimensions & Properties

CONCRETE

Depth = 150.00 mm;
Effective Shear width = bv = 47.20 mm;
Area = A = 9,895 mm^2;
Structural Width = b = 54.20 mm;
Depth of Top = hf = 127.00 mm

Moment of Inertia = I = 19.485019 × 10^6 mm^4;
NAb = 64.115 mm;
Bearing Length = 100mm
Concrete Grade = fcu = 60 kN/mm²;
Concrete Strength at transfer= fci = 40 N/mm^2;

Shrinkage = Esh (from Part 2, Fig 7.2) = 300 Youngs Modulus for Concrete Grade = Ew = 36 kN/mm^2 ;
Youngs Modulus for Concrete at transfer = Et = 28 kN/mm^2;
Flexural Tensile Stress in Concrete(pretensioned) to be based on Class3 Crack Width 0.1mm
4.3.4.3 Flexural Tensile Stresses in Pretensioned Concrete for Grade 50 or more:
Class3 Crack Width 0.1mm = 4.8 × Depth factor (Table 4.3) = 4.8 × 1.1 = 5.3 N/mm^2
Section Modulus, Zt = I / Depth - Nab = 0.226873 × 10^6 mm^3
Section Modulus, Zb = I / Nab = 0.303907 × 10^6 mm^3

STEEL

Characteristic strength of steel = **1,770 N/mm**^{2}.
Coefficient for transmission length = Kt = 600.
Youngs Modulus for Steel = Es = 200 kN/mm^2
Nominal Tendon Diameter = **5.00 mm**

No. of Tendons	Area of each tendon (mm^2)	Distance from base (mm)	Aps = No. x area (mm^2)	Aps x Distance from base (mm^3)	Pk = Aps x Char. strength / 10^3 (kN)
2	19.64	23.00	39.28	903.44	69.526
1	19.64	78.00	19.64	1,531.92	34.763
3			58.92	2,435.36	104.288
Tendons in TENSION ZONE ONLY, i.e. distance from base is less than NAb:			39.28	903.44	65.526

Centroid (a1) = (Aps × Distance) / Aps = 41.333 mm
Eccentricity (e) = NAb - a1 = 22 .78 mm
Centroid of tendons in TENSION ZONE ONLY (a2) = (Aps × Distance) / Aps = 23.000 mm

RELEASE STRESSES

Initial P/S force (P1) = 70% × Pk = 70% × 104.288 kN = 73.002 kN
Relaxation losses = P1 × 1.2 × 0.025 = 2.190 kN
P/S force (P2) = P1 - (50% × Relaxation losses) = 73.002 kN - 1.095 kN = 71.907 kN
fpt (on release) = ((P2 × 10^3) / Area) - ((P2 × e × 10^3) / Zt)
= ((71.907 × 10^3) / 9,895.00) - ((71.907 × 22.78 × 10^3) / 0.226873 × 10^6)
= 0.046 N/mm^2
fpb (on release) = ((P2 × 10^3) / Area) + {{P2 × e × 10^3) / Zb)
= ((71.907 × 10^3) / 9,895.00) + ((71.907 × 22.78 × 10^3) / 0.303907 × 10^6)
= 12.657 N/mm^2

fc (on release) = (((Depth - a1) / Depth) × (fpb [on release] - fpt(on release))) + fpt(on release)
= (((150.00 - 41.333) / 150.00) × (12.657 - 0.046)) + 0.046 N/mm^2
= 9.182 N/mm^2

Elastic deformation losses

loss 1 = ((P2 / A) + (P2 × e^2 / I × 10^6)) × (Aps × Es / Et)
= ((71.907 / 9,895.00) + (71.907 × 22.78^2 / 19.485019 × 10^6)) × (58.92 × 200.00 / 28.00)
= 3.864 kN

P3 after loss 1 loss 2 = P2 - loss 1 = 71.907 - 3.864 kN = 68 .042 kN
= ((P3 after loss 1 / A) + (P3 after loss 1 × e^2 / I × 10^6)) × (Aps × Es / Et)
= ((68.042 / 9,895.00) + (68.042 × 22.78^2 / 19.485019 × 10^6)) × (58.92 × 200.00 / 28.00)
= 3.657 kN

P3 after loss 2 loss 3 = P2 - loss 2 = 71.907 - 3.657 kN = 68.250 kN
= ((P3 after loss 2 / A) + (P3 after loss 2 × e^2 / I × 10^6)) × (Aps × Es / Et)
= ((68.250 / 9,895.00) + (68. 250 × 22.78^2 / 19.485019 × 10^6)) × (58.92 × 200.00 / 28.00)
= 3.668 kN

P3 after loss 3 loss 4 = P2 - loss 3= 71.907 - 3.668 kN = 68 .239 kN
= ((P3 after loss 3 / A) + (P3 after loss 3 × e^2 / I × 10^6)) × (Aps × Es / Et)
= ((68.239 / 9,895.00) + (68.239 × 22.78^2 / 19.485019 × 10^6}) × (58.92 × 200.00 / 28.00)
= 3.667 kN

P3 after loss 4 Fina l Force (P3) = P2 - loss 4 = 71.907 - 3.667 kN = 68.240 kN
= 68.240 kN

fpt [at transfer] = ((P3 × 10^3) / Area) - ((P3 × e × 10^3) / Zt)
= ((68.240 × 10^3) / 9,895.00) - ((68.240 × 22.78 × 10^3) / 0.226873 × 10^6)
= 0.044 N/mm^2

fpb [at transfer] = ((P3 × 10^3) / Area) + ((P3 × e × 10^3) / Zb)
= ((68.240 × 10^3) / 9,895.00) + ((68.240 × 22.78 × 10^3) / 0.303907 × 10^6)
= 12.012 N/mm^2

fc [at transfer] = (((Depth - a1) / Depth) × (fpb [at transfer] - fpt [at transfer])) + fpt [at transfer]
= (((150.00 - 41.333) / 150.00) × (12.012 - 0.044)) + 0.044 N/mm^2
= 8.714 N/mm^2

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Remaining Losses

Relaxation = (50% × Relaxation Losses) = (0.5 × 2.190) = 1.095 kN
Shrinkage = (Esh × Es × Aps) / 10^6 = (300 × 200.00 × 58.92) / 10^6 = 3.535
Creep = ((1.8 / (Et × 10^3)) × Es × fc [at transfer] × Aps = ((1.8 / (28.00 × 10^3)) × 200.00 × 8.714 × 58.92 = 6.601 kN

Final P/S force(P4) = P3 - Remaining Losses = 68.240 - (1.095 + 3.535 + 6.601) = 57.008 kN

Final Stresses

fpt [final] = ((P4 × 10^3) / A) - ((P4 × e × 10^3) / Zt)
= ((57.008 × 10^3) / 9,895.00) - ((57,008 × 22.78 × 10^3) / 0.226873 × 10^6)
= 0.037 N/mm^2

fpb [final] = ((P4 × 10^3) / A) + ((P4 × e × 10^3) / Zb)
= ((57.008 × 10^3) / 9,895.00) + ((57.008 × 22.78 × 10^3) / 0.303907 × 10^6)
= 10.035 N/mm^2

fc [final] = (((Depth - a1) / Depth) × (fpb [final] - fpt [final])) + fpt [final]
= (((150.00 - 41.333) / 150.00) × (10.035 - 0.037)) + 0.037 N/mm^2
= 7.280 N/mm^2

Service Moment = MR

MRt = (((0.33 × fcu) - fpt [final]) × Zt) / 10^6 = (((0.33 × 60) - 0.037) × 0.226873 × 10^6) / 10^6 = 4.484 kNm
MRb = ((fpb [final] + Flex.Tensile Stress) × Zb) / 10^6 = ((10.035 + 5.3) × 0.303907 × 10^6) / 10^6 = 4.654 kNm
MR = **4.484 kNm**

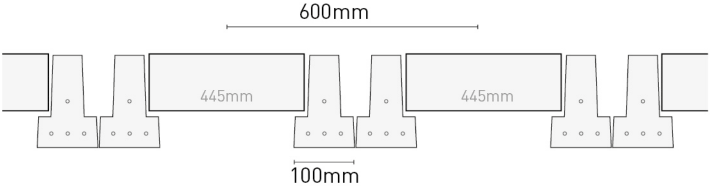
Ultimate Moment = Mu

Mu is determined by using tendons in the TENSION ZONE ONLY = a2
a3 = Depth - a2 = 150.00 - 23.000 = 127.000 mm
Pu = 0.87 × Pk(tension) = 0.87 × 69.526 = 60.487 kN
acl = (Pu × 10^3) / (0.45 × fcu × bv) = (60.487 × 10^3) I (0.45 × 60 × 47.20) = 47.463 mm
Mu = (Pu × (a3 - (acl × 0.45))) / 10^3 = (60.487 × (127.000 - (47.463 × 0.45)) / 10^3
= **6.390 kNm**

Ultimate Shear Resistance = Vco

ft = 0.24 × Sqrt(fcu) = 0.24 × Sqrt(60 = 1.859 N/mm^2
fcp = (((Depth - NAb) / Depth) × (fpb(final) - fpt [final])) + fpt [final]
= (((150.00 - 64.115) / 150.00) × (10.035 - 0.037)) + 0.037 = 5.762 N/mm^2
lt = Transmission length = Kt × Nominal tendon dia. / Sqrt(fci) = 600 × 5.00 / Sqrt(40) = 474.342 mm
fcpx = (((Bearing length + NAb) / lt) × (2 - (Bearing length + NAb) / lt)) × fcp
= (((100 + 64.115) / 474.342) × (2 - (100 + 64.115) / 474.342)) × 5.762 = 3.297 N/mm^2
Vco = (0.67 × bv × Depth) × (Sqrt((ft^2) + (0.8 × fcpx × ft))) / 10^3
= (0.67 × 47.20 × 150.00) × (Sqrt((1.859^2) + (0.8 × 3.297 × 1.859))) / 10^3
= **13.715 kN**

Double 600



	(Service)		(Ultimate)
Load:	2/Joists	0.474	× 1.4 = 0.664 kN/m
	Grout	0.115	× 1.4 = 0.161 kN/m
	Block	0.286	× 1.4 = 0.400 kN/m
	Finishes	0.682	× 1.4 = 0.955 kN/m
	SIL	0.890	× 1.6 = 1.424 kN/m
		2.447 kN/m	3.604 kN/m

$M = \frac{wl^2}{8} \quad \therefore \sqrt{\frac{8 \times M}{w}}$

where l = effective span
Clear span = effective span - 100mm

3 wire

Clear Span - Service loading = $(8 \times 2 \times 4.484 / 2.447)^{0.5}$ - 0.100 = 5.314m
Clear Span - Ultimate loading = $(8 \times 2 \times 6.390 / 3.604)^{0.5}$ - 0.100 = 5.226m
Hence 5.226 maximum allowable - MR Ult critical

3 Wire	Clear Soans - MR Serv = 2 x 4.484 / MR Ult = 2 x 6.390					
	SIL - kN/m2					
Block Density	1.5	2.0	2.5	3.0	4.0	5.0
660	5.226	4.907	4.638	4.402	4.036	3.742
1350	4.943	4.669	4.436	4.227	3.899	3.632
1900	4.746	4.502	4.291	4.101	3.799	3.550

4 wire

Clear Span Serv = $(8 \times 2 \times 4.804 / 2.447)^{0.5}$ - 0.100 = 5.504
Clear Span Ult = $(8 \times 2 \times 8.616 / 3.604)^{0.5}$ - 0.100 = 6.084
Hence 5.504 maximum allowable - MR Serv critical

4 Wire	Clear Soans - MR Serv = 2 x 4.804 / MR Ult = 2 x 8.616					
	SIL - kN/m2					
Block Density	1.5	2.0	2.5	3.0	4.0	5.0
660	5.504	5.193	4.928	4.700	4.323	4.022
1350	5.192	4.928	4.699	4.499	4.164	3.893
1900	4.977	4.743	4.537	4.356	4.049	3.799

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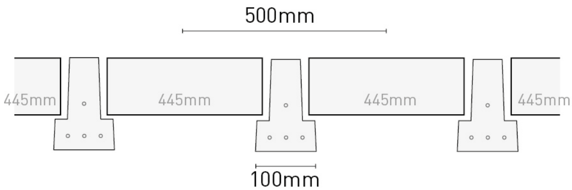
Single 500



	(Service)		(Ultimate)
Load:	Joist	0.237	× 1.4 = 0.332 kN/m
	Block	0.286	× 1.4 = 0.400 kN/m
	Finishes	0.568	× 1.4 = 0.795 kN/m
	SIL	0.741	× 1.6 = 1.186 kN/m
		1.832 kN/m	2.713 kN/m

$$M = \frac{wl^2}{8} \quad \therefore \sqrt{\frac{8 \times M}{w}}$$

where l = effective span
Clear span = effective span - 100mm

3 wire

Clear Span - Service loading = $(8 \times 4.484 / 1.832)^{0.5}$ - 0.100 = 4.325m
Clear Span - Ultimate loading = $(8 \times 6.390 / 2.713)^{0.5}$ - 0.100 = 4.240m
Hence 5.687 maximum allowable - MR Ult critical

3 Wire	Clear Spans - MR Serv = 4.484m/ MR Ult = 6.390					
	SIL - kN/m^2					
Block Density	1.5	2.0	2.5	3.0	4.0	5.0
660	4.240	3.955	3.720	3.521	3.201	2.954
1350	3.948	3.714	3.516	3.346	3.067	2.847
1900	3.748	3.545	3.371	3.220	2.969	2.767

4 wire

Clear Span Serv = $(8 \times 4.804 / 1.832)^{0.5}$ - 0.100 = 4.480m
Clear Span Ult = (8 × 8.616 / 2.713)0.5 - 0.100 = 4.940m
Hence 4.480 maximum allowable - MR Serv critical

4 Wire	Clear Spans - MR Serv = 4.804 / MR Ult = 8.616					
	SIL - kN/m^2					
Block Density	1.5	2.0	2.5	3.0	4.0	5.0
660	4.480	4.199	3.964	3.764	3.439	3.185
1350	4.148	3.921	3.727	3.559	3.280	3.056
1900	3.630	3.735	3.565	3.417	3.166	2.963

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4 Wire Beam
Dimensions & Properties

CONCRETE

Depth = 150.00 mm;
Effective Shear width = bv = 47.20 mm:
Area = A = 9,895 mm^2;
Structural Width = b = 54.20 mm;
Depth of Top = hf = 127.00 mm

Moment of Inertia = I= 19.485019 × 10^6 mm^4;
NAb = 64.115 mm;
Bearing Length = 100 mm
Concrete Grade = fcu = **60 N/mm²**;
Concrete Strength at transfer = fci = 40 N/mm^2
Shrinkage = Esh (from Part 2, Fig 7.2) = 300
Youngs Modulus for Concrete Grade = Ew = 36 kN/mm^2;
Youngs Modulus for Concrete at transfer = Et = 28 kN/mm^2;
Flexural Tensile Stress in Concrete(pretensioned) to be based on Class3 Crack Width 0.1mm
4.3.4.3 Flexural Tensile Stresses in Pretensioned Concrete for Grade 50 or more:
Class3 Crack Width 0.1mm = 4.8 × Depth factor (Table 4.3) = 4.8 × 1.1 = 5.3 N/mm^2
Section Modulus, Zt = I / Depth - Nab = 0.226873 × 10^6 mm^3
Section Modulus. Zb = I / Nab = 0.303907 × 10^6 mm^3

STEEL

Characteristic strength of steel = **1,770 N/mm²**.
Coefficient for transmission length = Kt = 600.
Youngs Modulus for Steel = Es = 200 kN/mm^2
Nominal Tendon Diameter = **5.00 mm**

No. of Tendons	Area of each tendon (mm^2)	Distance from base (mm)	Aps = No. x area (mm^2)	Aps x Distance from base (mm^3)	Pk = Aps x Char. strength / 10^3 (kN)
3	19.64	23.00	58.92	1,355.16	104.288
1	19.64	78.00	19.64	1,531.92	34.763
4			78.56	2,887.08	139.051
Tendons in TENSION ZONE ONLY, i.e. distance from base is less than NAb:			58.92	1,355.16	104.288

Centroid (a1) = (Aps × Distance) / Aps = 36.750 mm
Eccentricity (e) = NAb - a1 = 27.36 mm
Centroid of tendons in TENSION ZONE ONLY (a2) = (Aps × Distance) / Aps = 23.000 mm

RELEASE STRESSES

Initial P/S force (P1) = 70% × Pk = 70% × 139.051 kN = 97.336 kN
Relaxation losses = P1 × 1.2 × 0.025 = 2.920 kN
PIS force (P2) = P1 - (50% x Relaxation losses) = 97.336 kN - 1.460 kN = 95.876 kN
fpt (on release) = ((P2 x 10^3) / Area) - ((P2 × e × 10^3) / Zt)
= ((95.876 × 10^3) / 9,895.00) - ((95.876 × 27.36 × 10^3) / 0.226873 × 10^6)
= -1.875 N/mm^2

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fpb (on release) = ((P2 × 10^3) / Area) + ((P2 × e × 10^3) / Zb)
= ((95.876 × 10^3) / 9,895.00) + ((95.876 × 27.36 × 10^3) / 0.303907 × 10^6)
= 18.322 N/mm^2
fc (on release) = (((Depth - a1) / Depth) × (fpb (on release) - fpt (on release))) + fpt (on release)
= (((150.00 - 36.750) / 150.00) × (18.322 - -1.875)) + -1.875 N/mm^2
= 13.374 N/mm^2

Elastic deformation losses

loss 1 = ((P2 / A) + (P2 x e^2 / I × 10^6)) × (Aps × Es / Et)
= ((95.876 / 9,895.00) + (95.876 × 27.36^2 / 19.485019 × 10^6)) × (78.56 × 200.00 / 28.00)
= 7.505 kN
P3 after loss 1 loss 2 = P2 - loss 1 = 95.876 - 7.505 kN = 88.371 kN
= ((P3 after loss 1 / A) + (P3 after loss 1 x e^2 / I × 10^6)) × (Aps × Es / Et)
= ((88.371 / 9,895.00) + (88.371 × 27.36^2 / 19.485019 X 10^6)) × (78.56 × 200.00 / 28.00)
= 6.917 kN
P3 after loss 2 loss 3 = P2 - loss 2 = 95.876 - 6.917 kN = 88.959 kN
= ((P3 after loss 2 / A) + (P3 after loss 2 x e^2 / I × 10^6)) × (Aps × Es / Et)
= ((88.959 / 9,895.00) + (88.959 × 27.362 / 19.485019 × 10^6)) × (78.56 × 200.00 / 28.00)
= 6.963 kN
P3 after loss 3 loss 4 = P2 - loss 3 = 95.876 - 6.963kN = 88.913 kN
= ((P3 after loss 3 / A) + (P3 after loss 3 x e^2 / I × 10^6)) × (Aps × Es / Et)
= ((88.913 / 9,895.00) + (88.913 × 27.36^2 / 19.485019 × 10^6)) × (78.56 × 200.00 / 28.00)
= 6.960kN
P3 after loss 4 loss 5 = P2 - loss 4 = 95.876 - 6.960 kN = 88.916 kN
= ((P3 after loss 4 / A) + (P3 after loss 4 x e^2 / I × 10^6)) × (Aps × Es / Et)
= ((88.916 / 9,895.00) + (88.916 × 27.36^2 / 19.485019 × 10^6)) × (78.56 × 200.00 / 28.00)
= 6.960 kN
P3 after loss 5 Final Force (P3) = P2 - loss 5 = 95.876 - 6.960 kN = 88.916 kN
= 88.916 kN

fpt [at transfer] = ((P3 x 10^3) / Area) - ((P3 × e × 10^3) / Zt)
= ((88.916 × 10^3) / 9,895.00) - ((88.916 × 27.36 × 10^3 / 0.226873 × 10^6)
= -1.739 N/mm^2
fpb [at transfer] = ((P3 x 10^3) / Area) + ((P3 × e × 10^3) / Zb)
= ((88.916 × 10^3 / 9,895.00) + ((88.916 × 27.36 × 10^3 / 0.303907 × 10^6)
= 16.992 N/mm^2
fc [at transfer] = (((Depth - a1) / Depth) × (fpb [at transfer] - fpt [at transfer])) + fpt [at transfer]
= (((150.00 - 36.750) / 150.00) × (16.992 - -1.739)) + -1.739 N/mm^2
= 12.403 N/mm^2

Remaining Losses
Relaxation = (50% × Relaxation Losses) = (0.5 × 2.920) = 1.460 kN
Shrinkage = (Esh × Es × Aps) / 10^6 = (300 × 200.00 × 78.56) / 10^6 = 4.714
Creep = ((1.8 / (Et × 10^3)) × Es × fc [at transfer] × Aps = ((1.8 / (28.00 × 10^3)) × 200.00 × 12.403 × 78.56 = 12.528 kN

Final PIS force (P4) = P3 - Remaining Losses = 88.916 - (1.460 + 4.714 + 12.528) = 70.214 kN

Final Stresses
fpt [final] = ((P4 × 10^3) / A) - ((P4 × e × 10^3) / Zt)
= ((70.214 × 10^3) / 9,895.00) - ((70.214 × 27.36 × 10^3) / 0.226873 × 10^6)
= -1.373 N/mm^2

fpb[final] = ((P4 × 10³) / A) + ((P4 × e × 10³) / Zb)
= ((70.214 × 10³) / 9,895.00) + ((70.214 × 27.36 × 10³) / 0.303907 × 10⁶)
= 13.418 N/mm²

fc[final] = (((Depth - a1) / Depth) × (fpb [final] - fpt [final])) + fpt [final]
= (((150.00 - 36.750) / 150.00) × (13.418 - -1.373)) + -1.373 N/mm²
= 9.794 N/mm²

Service Moment = MR

MRt = (((0.33 × fcu) - fpt [final]) × Zt) / 10⁶ = (((0.33 × 60) - -1.373) × 0.226873 × 10⁶) / 10⁶ = 4.804 kNm

MRb = ((fpb [final] + Flex.Tensile Stress) × Zb) / 10⁶ = ((13.418 + 5.3) × 0.303907 × 10⁶) / 10⁶
= 5.682 kNm

MR = 4.804 kNm

Ultimate Moment = Mu

Mu is determined by using tendons in the TENSION ZONE ONLY = a2

a3 = Depth - a2 = 150.00 - 23.000 = 127.000 mm

Pu = 0.87 × Pk[tension] = 0.87 × 104.288 = 90.731 kN

acl = (Pu × 10³) / (0.45 × fcu × bv) = (90.731 × 10³) / (0.45 × 60 × 47.20) = 71.195 mm

Mu = (Pu × (a3 - (acl × 0.45))) / 10³ = (90.731 × (127.000 - (71.195 × 0.45)) / 10³
= 8.616 kNm

Ultimate Shear Resistance = Vco

ft = 0.24 × Sqrt(fcu) = 0.24 × Sqrt(60) = 1.859 N/mm²

fcp = (((Depth - NAb) / Depth) × (fpb [final] - fpt (final])) + fpt [final]
= (((150.00 - 64.115) / 150.00) × (13.418 - -1.373)) + -1.373 = 7.096 N/mm²

lt = Transmission length = Kt × Nominal tendon dia. / Sqrt(fci) = 600 × 5.00 / Sqrt(40) = 474.342 mm

fcpx = (((Bearing length + NAb) / lt) × (2 - (Bearing length + NAb) / lt)) × fcp
= (((100 + 64.115) / 474.342) × (2 - (100 + 64.115) / 474.342)) × 7.096 = 4.061 N/mm²

Vco = (0.67 × bv × Depth) × (Sqrt((ft²) + (0.8 × fcpx × ft))) / 10³
= (0.67 × 47.20 × 150.00) × (Sqrt((1.859²) + (0.8 × 4.061 × 1.859))) / 10³
= 14.617 kN

MATRIX PRECAST CONCRETE

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