โครงการก่อสร้างและตกแต่งภายในอาคารสำนักงาน กสทช. แห่งใหม่

(ปรับปรุงแก้ไขแบบครั้งที่ 2)

เจ้าของ

สำนักงานคณะกรรมการกิจการกระจายเสียง กิจการโทรทัศน์ และกิจการโทรคมนาคมแห่งชาติ



รายการคำนวณ

งานวิศวกรรมงานโยธาและงานโครงสร้างภายนอกอาคาร

รายการคำนวณโครงสร้างงานภายนอกเพิ่มเติม

1. ถนนทางเข้าหลัก
2. ถนนทางเข้า ที่จอดรถบัส และ ถนนทางออกฉุกเฉิน
3. ถนนทางเข้า หน้าอาคาร B
4. ทางเดิน เข้าอาคาร B
5. ทางเดินมีหลังคาคลุมบริเวณที่จอดรถบัส

ข้อกำหนดที่ใช้ในการออกแบบ (DESIGN CRITERIA)

งานโครงสร้างทางเข้าโครงการ

การออกแบบโดยวิธีกำลัง (Ultimate Strength design method) ACI 318-99 STANDARD

สัมประสิทธิ์น้ำหนักบรรทุก (Load factor)

น้ำหนักบรรทุคงที่ (Dead load : DL)	=	*1.40*
น้ำหนักบรรทุกจร (Live load : LL)	=	*1.70*

กำลังที่ต้องการเพื่อต้านน้ำหนักบรรทุก (U = Required strength to resist factored load)

U = 1.4DL + 1.7 (LL)

ตัวคูณลดกำลัง (Strength reduction factor)

สำหรับแรงดัด (Bending)	=	*0.90*
สำหรับแรงเฉือน (Shear)	=	*0.85*
สำหรับแรงอัด (Compression)	=	*0.70*

คอนกรีต (Concrete)

กำลังอัดประลัย (Ultimate Strength)	=	*320*	ksc	
แรงเฉือนแบบคาน Vc	=	*9.481*	ksc	(For Beam Shear)
แรงเฉือนทะลุ Vc	=	*18.962*	ksc	(For Punching Shear)

เหล็กเส้นกลม (Round Bar)

กำลังดึงสูงสุด (Yield Strength) Fy	=	*2400*	ksc	(SR 24)

เหล็กเส้นข้ออ้อย (Deformed Bar)

กำลังดึงสูงสุด (Yield Strength) Fy	=	*5000*	ksc	(SD 40)

เหล็กรูปพรรณ (Structural Steel)

Structural steel shape	GRADE	SS400
High strength bolt (HTB)	GRADE	F10T
Welding electrode	GRADE	E70
Anchor bolt	GRADE	SS400

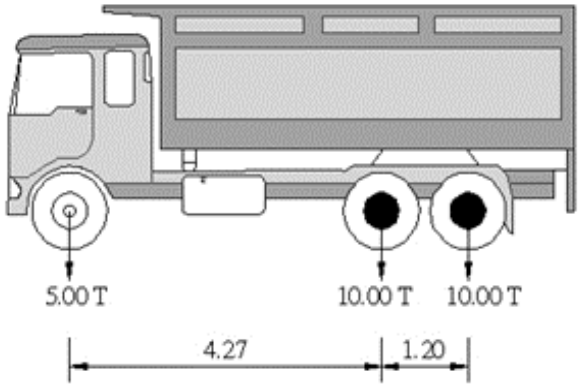
น้ำหนักบรรทุกคงที่ (Dead Load)

น้ำหนักคอนกรีต (DL. of Concrete)	=	2400	กก. ต่อ	ลบ.ม.	(kg/Cu.m.)
น้ำหนักอิฐมอญเต็มแผ่น (DL. of Brick Wall)	=	360	กก. ต่อ	ตร.ม.	(kg/Sq.m.)
น้ำหนักอิฐมอญครึ่งแผ่น (DL. of Half Brick Wall)	=	180	กก. ต่อ	ตร.ม.	(kg/Sq.m.)
น้ำหนักผนังก่ออิฐบล็อกหนา 9 ซ.ม.	=	160	กก. ต่อ	ตร.ม.	(kg/Sq.m.)

งานโครงสร้างทางเข้าโครงการ

น้ำหนักบรรทุกจร (Live Load)

น้ำหนักบรรทุกรถบรรทุกมาตรฐาน กรมทางหลวง 25 ton



น้ำหนักบรรทุกจรถนน	=	2000	กก. ต่อ ตร.ม. (kg/Sq.m.)
น้ำหนักบรรทุกจรทางเท้า ทั่วไป	=	500	กก. ต่อ ตร.ม. (kg/Sq.m.)

RC. FLAT SLAB DESIGN

ถนนทางเข้าหลักและถนนหน้าอาคาร B

FLAT PLATE SLAB

1	**Material Properties**	LL	**2,000**	kg/sqm.	
	fc'	=	**320**	ksc	
	fs	=	**1,700**	ksc	
	k = 1/(1+fs/(n*fc))	=	0.347		
	j	=	0.884		
	R	=	18.43		
2	**Preliminary design fors slab thickess**				
	Short span length ,Ls	=	**2.00**	m	
	Long span length ,Lg	=	**2.00**	m	
	Slab Thickness ,t2(min) = 4 in	=	10.16	cm.	
	Slab Thickness ,t2(min) = Lg/36	=	5.6	cm.	
	t1(min) = 0.091L(1-2C/3L)*(141w'/fc')^0.5+2.54	=	8.1	cm.	
	t2(min) = 0.106L(1-2C/3L)*(141w'/fc')^0.5+3.81	=	10.3	cm.	
	Used slab thickness ,t2	=	**20**	cm.	
			OK		
	t2(max) = 1.5t1	=	30	cm.	
	covering , (d')	=	3	cm.	
	Effective Depth , (d2)	=	17	cm.	
	Drop Pannel width ,l1 ,0.30Ls < l1 < 0.40Ls	=	**0.80**	m	**0.22**
			OK		
	Drop Pannel length ,l2 ,0.30Lg < l2 < 0.40Lg	=	**0.80**	m	**0.22**
			OK		
	Drop pannel thickness ,t2	=	**12**	cm.	
			OK		
	Effective Depth at drop pannel, (d1)	=	9	cm.	
	Column width C1	=	**0.22**	m	
	Column length C2	=	**0.22**	m	
3	**LOAD**				
	DL ,Dead load	=	449	kg/sqm.	
	LL ,Live load	=	**2,000**	kg/sqm.	
	DL+LL ,Total load Uniform load ,w'	=	**2,449**	kg/sqm.	
	W_D	=	1,797	kg	
	W_L	=	8,000	kg	
	Total load on column ,W = W_D + W_L	=	9,797	kg	
	Load transfer to edge beam (B) = 0.4W	=	3,919	kg	
	Short span ,Ls	=	1959.424	kg/m.	
	Long span ,Lg	=	1959.424	kg/m.	

4 DESIGN

4.1	**Check beam shear strength of slab bo**		224	cm	
	Vp at C+d , (COLUMN)	=	2.5	ksc.	
	Vc =0.29*(fc')^0.5	=	5.2	ksc.	
			OK		
4.2	**Check puching shear strength of slab**				
	Vp at C+d/2 , (COLUMN)	=	3.6	ksc.	
	Vc =0.53*(fc')^0.5	=	9.5	ksc.	
			OK		
	Vp at l+d/2	=	1.1	ksc.	
	Vc =0.53*(fc')^0.5	=	9.5	ksc.	
			OK		
4.3	**Check Column Section Requirement**				
	F = 1.15-C/L	=	1.00	>= 1	1.04
	Mo =0.09FWLg(1-2C/3Lg)^2	=	1,514	kg-m	
	Mo =0.09FWLs(1-2C/3Ls)^2	=	1,514	kg-m	
	Case 1 Have Both uppper and Lower Column				
	Ic = 0.083t^3H/(0.5+W_D/W_L)	=	0	cm^4	>=42000
	Ic (ของโครงสร้างเสารูปสี่เหลี่ยม)	=	19,521	cm^4	
			OK		
	Case 2 Have Lower Column only				
	Ic = (2-2.3h/H)0.083t^3H/(0.5+W_D/W_L)	=	486,564	cm^4	>=42000
	H ,(Average Height of Upper and Lower Column)	=	**0**	cm	
	h ,(Top of slab to bottom of column capital)	=	**30**	cm	
	H ,(Lower Column)	=	**300**	cm	

5 BENDING MOMENT FOR DESIGN COLUMN

Internal Column , M = (WL1-W_DL2)/40	=	400	kg-m	
External Column , M = (WL1)/30	=	327	kg-m	

8 Check Effective Depth due to Moment

Mg	=	757	kg-m	
dg = (Mg/R/(3/4*bs))^0.5 , (bs=Ls/2)	=	7.40	cm	OK
Ms	=	757	kg-m	
ds = (Ms/R/(3/4*bg))^0.5 , (bg=Lg/2)	=	7.40	cm	OK

6 Design Reinforcement for Long Span

Design for bending moment ,Mo	=	**1,514.32**	kg-m
d1 at column	=	**17.00**	cm
d2 at mid-span	=	**17.00**	cm
Strip width Ls/2	=	**1.000**	m

		Exterior Span			Interior Span	
		NEG. M	POS. M	NEG. M	POS. M	NEG. M
COL. Strip	coff.	**0.32**	**0.28**	**0.50**	**0.22**	**0.46**
	M(kg-m)	485	424	757	333	697
	As(cm^2)	3.58	1.66	5.60	1.30	5.15
	Reinf. (or)	DB12 0.32	0.68	0.20	0.87	0.22
	Reinf.	DB16 0.56	1.21	0.36	1.54	0.39
	USED					
MID. Strip	coff.	**0.20**	**0.20**	**0.18**	**0.16**	**0.21**
	M(kg-m)	303	303	273	242	315
	As(cm^2)	1.19	1.19	1.07	0.95	1.23
	Reinf. (or)	DB12 0.95	0.95	1.06	1.19	0.92
	Reinf.	DB16 1.70	1.70	1.88	2.12	1.63
	USED					

As(min) = **3.6** cm^2/m

Used = DB12 @ 0.314 m.

7 Design Reinforcement for Short Span

total load		**9,797.12**	kg
Design for bending moment ,Mo	=	**1,514.32**	kg-m
Strip width Lg/2	=	**1.000**	m

		Exterior Span			Interior Span	
		NEG. M	POS. M	NEG. M	POS. M	NEG. M
Col. Strip	coff.	**0.32**	**0.28**	**0.50**	**0.22**	**0.46**
	M(kg-m)	485	424	757	333	697
	As(cm^2)	3.58	1.66	5.60	1.30	5.15
	Reinf. (or)	RB9 0.18	0.38	0.11	0.49	0.12
	Reinf.	DB16 0.56	1.21	0.36	1.54	0.39
	USED					
MID. Strip	coff.	**0.20**	**0.20**	**0.18**	**0.16**	**0.21**
	M(kg-m)	303	303	273	242	315
	As(cm^2)	1.19	1.19	1.07	0.95	1.23
	Reinf. (or)	RB9 0.54	0.54	0.60	0.67	0.52
	Reinf.	DB16 1.70	1.70	1.88	2.12	1.63
	USED					

As(min) = **3.6** cm^2/m

Used = DB12 @ 0.314 m.

APPROACH (0.25)

SLAB case simple span L = 5.00

f_c'	=	320 ksc	t_{min}	=	0.250 m.	
Load factor		*DL*	=	1.40		
		LL	=	1.70		
DL	=	*1.4x* *600*	=	840	kg/m^2	
SDL+SCR	=	*1.4x* *120*	=	168	kg/m^2	
LL	=	*1.7x* *2000*	=	3400	kg/m^2	
w_u			=	**4408**	kg/m^2	
$P_{u,mid}$			=	0	kg	
$M^+_{L,w}$	=	*0.13* $w_u L^2$	=	13775	kg-m	
$M^+_{L,P}$	=	*0.25* $P_u L$	=	0	kg-m	
M^+_L			=	13775	kg-m	

As,B min = 4.00 Sq.cm.

$A_s{}^+_B$	=	0.00	cm^2	DB 12 mm. @	0.275 m
$A_s{}^+_L$	=	14.84	cm^2	DB 20 mm. @	0.2 m

Design CAP Beam

Beam No. CB1&CB2

Design load on beam

SPAN OF PILE	=	2.00	m
1.4 DL SLAB+BEAM	=	2184	[kg/m]
1.7 LL SLAB	=	6800	[kg/m]
	=		
uniform load (w1)	=	8984	[kg/m]

Beam size

b	=	**50**	[cm]
h	=	**50**	[cm]
d	=	**40**	[cm]
fc'	=	**320**	[kg/cm^2]
β	=	0.82	
fy DB	=	**5000**	[kg/cm^2]
fy stirrup	=	**2400**	[kg/cm^2]
M^+u	=	**1658**	[kg-m]
M-u	=	**4492**	[kg-m]
0.9Mn	=	55145	[kg-m]
R+u	=	2.30	[kg/cm^2]
R-u	=	6.24	[kg/cm^2]
ρ_b	=	0.0246	
0.75ρb	=	0.0184	
ρ +Req.	=	0.0005	
A_{s+}	=	0.93	[cm^2]

USED	4	DB	**16**	As = 8.0		[cm^2]
ρ_{min} =	0.0028		As_{min}	=	5.6	[cm^2]
As_{min}	=	**DB**	**16**	=	**3**	**Bars**

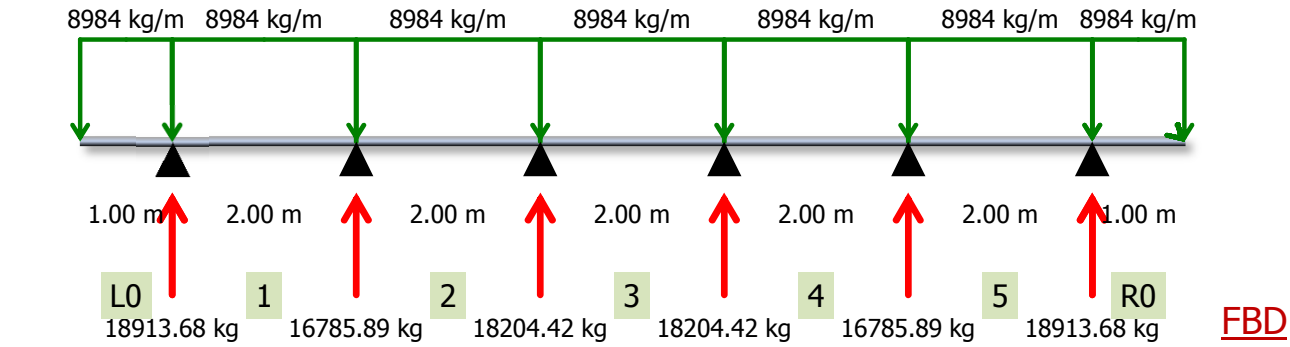
ρ –Req.	=	0.0013	
A_{s+}	=	2.52	[cm^2]

USED	4	DB	**16**	As = 8.0		[cm^2]
ρ_{min} =	0.0028		As_{min}	=	5.6	[cm^2]
As_{min}	=	**DB**	**16**	=	**3**	**Bars**

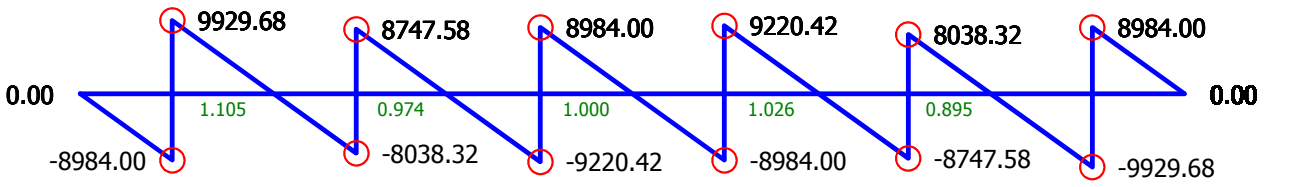
Design CAP Beam

Beam No. CB1&CB2

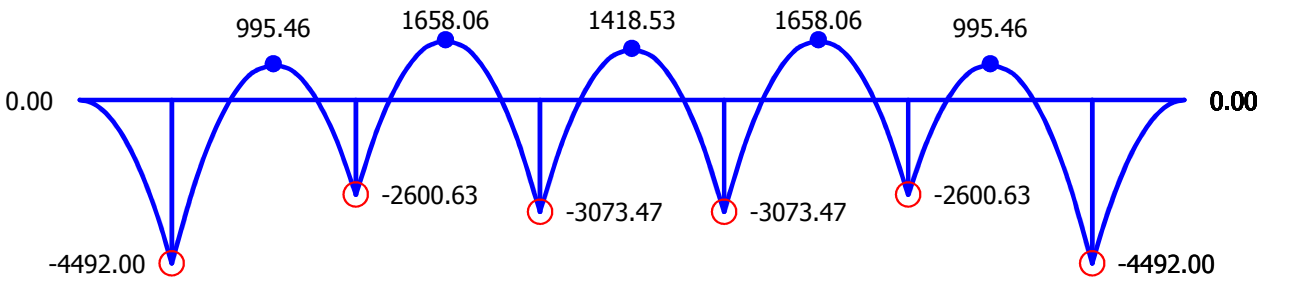
Design Stirrup	Wu	=	8984	[kg/m]
	Vu	=	9,930	[kg]
	ϕVc	=	16118	[kg]
	Vu@d	=	6336	[kg]
	Vu@d/ϕ – Vc	=	-11508	[kg]
RB	9	No of leg	=	2
	A_s	=	1.27	[cm^2]
Spacing	ϕ fy Av d/(Vu-ϕVc)	=	NA.	cm
	Av fy/3.5b	=	36.4	cm
	d/2	=	20.0	cm
	Use Spacing	=	15.0	cm



FBD



V (kg) SFD



M (kg-m) BMD

เกณฑ์กำหนดการออกแบบโครงสร้างถนนและลานจอดรถ

สำนักงาน กสทช. แห่งใหม่

ถ.รัตนาธิเบศร์ จ.นนทบุรี

ถนนทางออกฉุกเฉิน ถนนและทางเข้าที่จอดรถบัส

1) การออกแบบชนิดผิวถนนคอนกรีตเสริมเหล็ก จะใช้มาตรฐานออกแบบของกรมทางหลวง และปริมาณจราจรเทียบเท่าน้ำหนักล้อรถบรรทุกขนาดมาตรฐาน AASHTO HS20-44
2) กำหนดปริมาณการจราจรเฉลี่ย 1000 คัน/วัน
3) ออกแบบความหนาความหนาโครงสร้างถนนด้วยวิธี Road Research Laboratory Road Note 29
4) กำหนดระยะเวลาออกแบบใช้งาน 20 ปี
5) การออกแบบชนิดผิวถนนคอนกรีตเสริมเหล็ก ด้วยวิธี PCA
6) สมมติ อัตราการเพิ่มจราจร = 4 %
7) ใช้ค่า CBR ดินเดิม = 4%

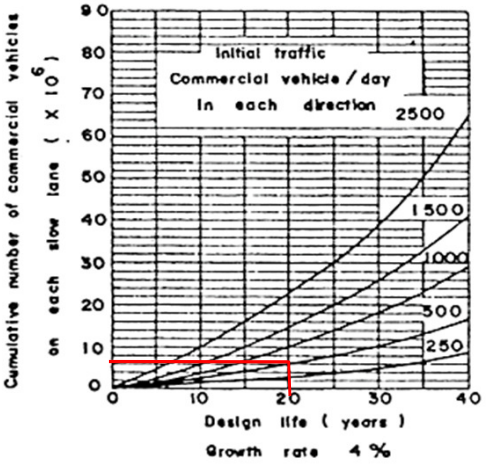
โครงสร้างชั้นทาง **ถนนทางเข้า และที่จอดรถบัส** **ถนนทางออกุกเฉิน**

ปริมาณการจราจรต่อวันเฉลี่ย

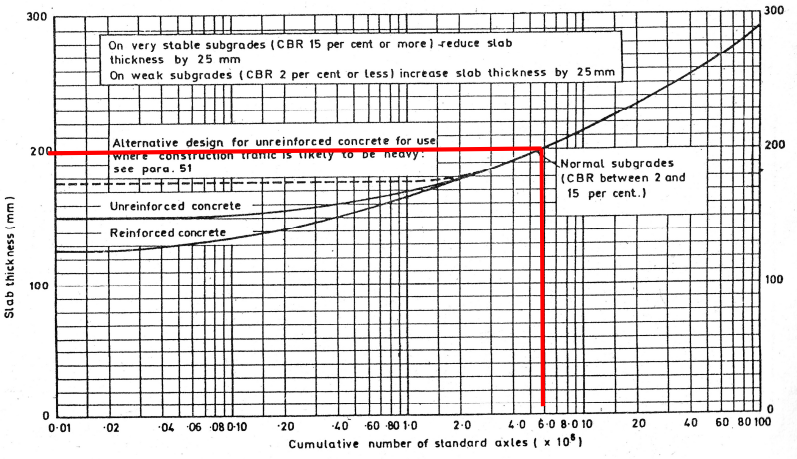
AVERAGE DAILY TRAFFIC (ADT) =	1000	คัน/วัน
ประเภทช่องจราจร	1	ทิศทาง
ปริมาณการจราจรในปัจจุบัน =	1000	คัน/ทิศทาง
ออกแบบอายุการใช้งาน	20	ปี
อัตราการเพิ่มจราจร	4%	
จากรูป 9.12 ปริมาณการจราจรรถบรรทุกในช่องแล่นช้า	6,000,000	คัน

ประเภทถนน	จำนวนเพลามาตรฐานต่อรถบรรทุก 1 คัน (A)	จำนวนเพลามาตรฐานต่อจำนวนเพลารถบรรทุก (B)	จำนวนเพลามาตรฐานต่อรถบรรทุก 1 คัน (AxB)
ทางด่วน ทางหลวงจังหวัด ปริมาณการจราจรรถบรรทุก >1000 คัน/วัน/ทิศทาง	2.7	0.4	1.08
ทางหลวงระหว่างเมือง ปริมาณการจราจรรถบรรทุก 250-1000 คัน/วัน/ทิศทาง	2.4	0.3	0.72
ถนนประเภทอื่น ปริมาณการจราจรรถบรรทุก < 250 คัน/วัน/ทิศทาง	2.25	0.2	0.45

จากรูป 9.12 จำนวนเพลามาตรฐาน (AxB) ถนนประเภทอื่น			0.72	
ปริมาณการจราจรรถบรรทุกในช่องแล่นช้า			4,320,000	คัน
ดินคันทาง		**USE CBR SUBGRADE =**	4	%
รองพื้นทาง	=	15 + 8 =	23	ซม.
จากรูป 9.13 ความหนาคอนกรีต		=	20	ซม.



ภาพที่ 9.12 แสดงความสัมพันธ์ระหว่างผลรวมของจำนวนรถบรรทุกในแต่ละทิศทางเกณฑ์องจราจรที่อยู่ติดกับช่องจราจรแล่นช้า และอายุการใช้งาน มีอัตราการเพิ่มของการจราจร 4% ในบริเวณที่พักอาศัยและพื้นที่ใกล้เคียง



ภาพที่ 9.13 ใช้กำหนดความหนาของผิวทางคอนกรีตตามวิธีของ Road Note 29

คำนวณออกแบบเหล็กเสริม ถนน คสล.ด้วยวิธี PCA

วัสดุ

f_c' = 280 ksc

ROUND BAR SR24				*COLD DRAWN STEEL WIRE TIS747*				
fy	=	2400	ksc	*fy*	=	5500	ksc	
f_S	=	1200	ksc	f_S	=	2500	ksc	WIREMESH
u	=	24	ksc					

ก) ถนนผิวทาง คสล.หนา 20 ซม.

1) คำนวณออกแบบเหล็กเสริม ตามขวาง

ความกว้างแผ่น L = 3.5 ม.

l = 3.50 m

h = 8.0 in

μ = 1.50

ROUND BAR SR24			*COLD DRAWN STEEL WIRE TIS747*			
A_s	=	$w_o \mu l / f_s$	A_s	=	$w_o \mu l / f_s$	
		1.05 cm^2/m		=	0.50	cm^2/m
RB-	6	@ 0.26	MESH	ϕ	4.6	@ 0.32

2) คำนวณออกแบบเหล็กเสริม ตามยาว

ความกว้างแผ่น L = 10 ม.

l = 10.00 m

h = 8.0 in

μ = 1.50

A_s	=	$w_o \mu l / f_s$				
		3.00 cm^2/m		=	1.44	cm^2/m
RB-	9	@ 0.21	MESH	ϕ	5.6	@ 0.17

ϕ 5.6x4.6mm @ 0.15 x 0.30

ตารางเหล็กสำหรับงานถนน คสล.ที่ใช้ในหน่วยงานราชการ

ขนาดถนน (กว้าง x ยาว) (m.)	ความหนาคอนกรีต (cm.)	ขนาดของตะแกรงเหล็ก
3.00 x 6.00	15	Dia 4.0 x 4.0 mm.@ 15 x 30 cm.
	20	Dia 4.0 x 4.0 mm.@ 15 x 30 cm.
3.00 x 7.50	15	Dia 4.0 x 4.0 mm.@ 15 x 30 cm.
	20	Dia 4.6 x 4.0 mm.@ 15 x 30 cm.
3.00 x 10.00	20	Dia 5.3 x 4.0 mm.@ 15 x 30 cm.
	25	Dia 5.6 x 4.6 mm.@ 15 x 30 cm.
3.50 x 10.00	15	Dia 4.6 x 4.0 mm.@ 15 x 30 cm.
	20	Dia 5.6 x 4.6 mm.@ 15 x 30 cm.
	25	Dia 5.6 x 4.6 mm.@ 15 x 28.50 cm.
4.00 x 10.00	25	Dia 5.6 x 4.6 mm.@ 15 x 25 cm.
4.50 x 10.00	25	Dia 5.6 x 4.6 mm.@ 15 x 22.50 cm.

ตารางที่ ก.1 ขนาด ความยาว และระยะห่างของ DOWEL BAR (PCA)

ความหนาแผ่นคอนกรีต มม.	รอยต่อเพื่อการขยายตัว		รอยต่อเผื่อการหดตัว	
	ϕ มม.	ยาว มม.	ϕ มม.	ยาว มม.
150	20	400	20	400
175	25	450	25	450
200	25	450	25	450
225	32	450	25	450
250	32	450	25	450
275	32	450	25	450

หมายเหตุระยะห่าง DOWEL BAR ทุก 30 ซม.

ตารางที่ ก.2 ขนาด ความยาว และระยะห่างของ TIE BAR (ROAD NOTE 29)

ความหนาแผ่นคอนกรีต มม.	ϕ มม.	ยาว มม.	ระยะห่าง มม.
150 - 180	12	700	750
190 - 230	12	700	750
> 240	16	900	750

ข้อกำหนดที่ใช้ในการออกแบบ (DESIGN CRITERIA)

โครงการ : กสทช

ทางเดินเชื่อมจุดจอดรถบัส

การออกแบบโดยวิธีกำลัง (Ultimate Strength design method)

สัมประสิทธิ์น้ำหนักบรรทุก (Load factor)

น้ำหนักบรรทุกคงที่ (Dead load : DL)	=	*1.40*
น้ำหนักบรรทุกจร (Live load : LL)	=	*1.70*
แรงลม (Wind load : WL)	=	*1.70*
แรงแผ่นดินไหว (Earthquake load : EL)	=	*1.87*

กำลังที่ต้องการเพื่อต้านน้ำหนักบรรทุก (U = Required strength to resist factored load)

U = 1.4DL + 1.7 LL

U = 0.75 (1.4DL + 1.7LL + 1.7WL) หรือ 0.9DL + 1.3WL

U = 0.75(1.4DL + 1.7LL + 1.87EL) หรือ 0.9DL + 1.43EL

ตัวคูณลดกำลัง (Strength reduction factor)

สำหรับแรงดัด (Bending)	=	*0.90*
สำหรับแแรงเฉือน (Shear)	=	*0.85*
สำหรับแรงเฉือน (Compression)	=	*0.70*

คอนกรีต (Concrete)

กำลังอัดประลัย (Ultimate Strength) Fc'	=	*320*	ksc
แรงเฉือนแบบคาน Vc	=	*9.481*	ksc (For Beam Shear)
แรงเฉือนทะลุ Vc	=	*18.962*	ksc (For Punching Shear)

เหล็กเส้นกลม (Round Bar)

กำลังดึงสูงสุด (Yield Strength)	Fy	=	*2400*	ksc	(SR 24)

เหล็กเส้นข้ออ้อย (Deformed Bar)

กำลังดึงสูงสุด (Yield Strength)	Fy	=	*4000*	ksc	(SD 40)
กำลังดึงสูงสุด (Yield Strength)	Fy	=	*5000*	ksc	(SD 50)

เหล็กรูปพรรณ (Structural Steel)

Structural steel shape	GRADE	SS400
High strength bolt (HTB)	GRADE	F10T
Welding electrode	GRADE	E70
Anchor bolt	GRADE	SS400

น้ำหนักบรรทุกคงที่ (Dead Load)

น้ำหนักคอนกรีต (DL. of Concrete)	=	2400	กก. ต่อ ลบ.ม.	(kg/Cu.m.)
น้ำหนักอิฐมอญเต็มแผ่น (DL. of Brick Wall)	=	360	กก. ต่อ ตร.ม.	(kg/Sq.m.)
น้ำหนักอิฐมอญครึ่งแผ่น (DL. of Half Brick Wall)	=	180	กก. ต่อ ตร.ม.	(kg/Sq.m.)
น้ำหนักผนังก่ออิฐบล็อกหนา 9 ซ.ม.	=	160	กก. ต่อ ตร.ม.	(kg/Sq.m.)
น้ำหนักผนังกระจก	=	120	กก. ต่อ ตร.ม.	(kg/Sq.m.)

น้ำหนักบรรทุกจร (Live Load)

น้ำหนักบรรทุกจรหลังคา ทางเดินเชื่อม	=	50	กก. ต่อ ตร.ม.	(kg/Sq.m.)
น้ำหนักบรรทุกจรทางเดินเชื่อม	=	500	กก. ต่อ ตร.ม.	(kg/Sq.m.)

S1 **(0.15)**

case simple span

L = 2.00

f_c'	=	320	ksc	t_{min} =	0.100 m.	
Load factor			*DL*	=	1.40	
			LL	=	1.70	
DL	=	*1.4x*	*360*	=	504	kg/m^2
SDL+SCR	=	*1.4x*	*120*	=	168	kg/m^2
LL	=	*1.7x*	*500*	=	850	kg/m^2
w_u				=	**1522**	kg/m^2
$P_{u,mid}$				=	0	kg
$M^+_{L,w}$	=	*0.13*	$w_u L^2$	=	761	kg-m
$M^+_{L,P}$	=	*0.25*	$P_u L$	=	0	kg-m
M^+_L				=	761	kg-m

As,B min = 3.75 Sq.cm.
As min = 3.75 Sq.cm.

$A_s{}^+_B$	=	0.00	cm^2	RB 9 mm. @	0.15 m
$A_s{}^+_L$	=	3.25	cm^2	RB 9 mm. @	0.15 m

NBTC Cover walkway B1(0.2x0.5),B1(0.2x0.5),B1(0.2x0.5)

| | | |

NBTC Cover walkway B2(0.2x0.4)

Load factor	DL =	1.40				**B2**						
	LL =	1.70		CANT L			SPAN 1			CANT R		
Span length	(m)			0.00			2.00			0.00		
Slab thickness	(m)			0.01			0.15			0.15		
Strip width	(m)			3.00			1.25			1.25		
Beam width	(m)			0.20			0.20			0.20		
Beam depth	(m)			0.40			0.40			0.40		
SDL	(kg/m)	120	360			150			150			
$DL_{, slab}$	(kg/m)	24	72			450			450			
$DL_{, girder}$	(kg/m)		192			192			192			
$DL_{, total}$	(kg/m)		624			792			792			
L.L.	(kg/m)	500	1500	1.00		625	1.00		625	1.00		
Service load	(kg/m)		2124			1417			1417			
Ultimate load	(kg/m)		3424			2171			2171			
Concentrate Load (kg)		Service load	Factor load	x (m)		Service load	Factor load	x (m)	Service load	Factor load	x (m)	
Concentrate DL	1.40	0	0	0.00		0	0	1.00	0	0	0.00	
		0	0	0.00		0	0	1.00	0	0	0.00	
		0	0	0.00		0	0	1.00	0	0	0.00	
Concentrate LL	1.70	0	0	0.00		0	0	1.00	0	0	0.00	
		0	0	0.00		0	0	1.00	0	0	0.00	
		0	0	0.00		0	0	1.00	0	0	0.00	

	x	0.00	0.00	0.00		1.00	1.00	1.00		0.00	0.00	0.00		
	P_L	0	0	0		0	0	0		0	0	0		
	P_D	0	0	0		0	0	0		0	0	0		
	w_D		624				792				792			
	w_L						625							
	L		*0.00*				2.00				0.00			

Result of structural analysis

Dead load	R (kg)	792			792		
Shear	(kg)	0	792		792	0	
Moment	(kg-m)	0	-1	395	-1	0	
Live load	R (kg)	625			625		
Shear	(kg)	0	625		625	0	
Moment	(kg-m)	0	-1	311	-1	0	
Service load	R (kg)	1417			1417		
Shear	(kg)	0	1417		1417	0	
Moment	(kg-m)	0	-2	706	-2	0	
Factor load	R (kg)	2171			2171		
Shear	(kg)	0	2171		2171	0	
Moment	(kg-m)	0	-4	1082	-4	0	
M max(wind load)		0	0		0	0	
V max(wind load)		0	0		0	0	

Summary result of design

				B2			
M^{-}_{design}	(kg-m)	-17	152		152	-11	
M^{+}_{design}	(kg-m)			1082			
V_{design}	(kg)	0	1455		1455	0	
$A_{s, required}$		0.02	0.17	1.23	0.17	0.01	
Use		1 -DB16	1 -DB16	1 -DB16	1 -DB16	1 -DB16	
$A_{s}^{'}{}_{, required}$		0.00	0.00	0.00	0.00	0.00	
Use		0 -DB16	0 -DB16	0 -DB16	0 -DB16	0 -DB16	
Stirrup		1-RB-6@0.15	1-RB-6@0.15		1-RB-6@0.15	1-RB-6@0.15	

Serviceability						
Immediate deflection	(cm)	0.00		0.00		0.0000
control at		> 360 OK		> 360 OK		> 360 OK
Long term deflection	(cm)	0.00		0.01		0.0000
control at		> 480 OK		> 480 OK		> 480 OK
Crack width, w	(mm)	0.0000	-0.0074	0.0270	-0.0074	0.0000
		OK	OK	OK	OK	OK

Project **NBTC Cover walkway** **COL. TYPE C1** **7**

COL. LINE **Typical** **FOOTING TYPE F1A**

LOAD FACTOR	DL	1.4
	LL	1.7

FLOOR	SLAB 1			SLAB 2			BEAM 1		BEAM 2		WALL 1			WALL 2			COL		TRANS. LOAD		LOAD/ FLOOR		SUM LOAD(WKL)			LOAD/ AREA	SUM LOAD (ULL.)
	DL. (kg/m^2)	LL. (kg/m^2)	AREA (m^2)	DL. (kg/m^2)	LL. (kg/m^2)	AREA (m^2)	w (kg/m)	L (m)	w (kg/m)	L (m)	w (kg/m^2)	H (m)	L (m)	w (kg/m^2)	H (m)	L (m)	w (kg/m)	H (m)	DL. (kg)	LL. (kg)	DL. (kg)	LL. (kg)	DL. (kg)	LL. (kg)	TOTAL (kg)	(kg/m^2)	(kg)
Roof	50	50	5.00																		538	250	538	250	788	158	1,178
1	480	500	5.00				240	5.00	192	1.00							96	3.00			4,054	2,500	4,592	2,750	7,342	1,311	11,104
PIER																	175	1.50									
																										734	kg/m^2

Project **NBTC Cover walkway**
COL. LINE **Typical**
COL. TYPE **C1**

											LOAD FACTOR											
											DL.	LL.										
											1.4	1.7										
FLOOR	D (m)	B (m)	H	Ag (m^2)	LOAD (kg)	fc' (ksc)	fy (ksc)	Ar (m^2)	fr (ksc)	As (cm^2)	Pg %As	Pg %(As+Ar)	DB 32	DB 28	DB 25	DB 20	DB 16	DB 12	As sq.cm.	LOAD KG	PERCENT %	
1	0.20	0.20	3.00	0.040	1,178	320	4000			4.00	1.00%	1.00%						8	9.04	79,801	2.26%	OK
PIER	0.27	0.27	1.50	0.073	11,104	320	4000			7.29	1.00%	1.00%						12	13.56	139,350	1.86%	OK
																						0

A Design

Material Properties

Fy =	2,400	ksc
E =	2,040,000	ksc

Internal Force input

Shear (kg)	375
Pa (kg)	0
M (kg-m)	547
M2 (kg-m)	0

Load Criteria

Metal Sht.	0	ksm	Total Grav.	125	kg/m
Purlin	0	ksm	0.75(DL+LL+W)	94	kg/m
Ceiling	0	ksm	Max. Dist load	125	kg/m
SDL	50	ksm			
Struc.wt	0	ksm	Point Load	125	kg
LL	50	ksm	Dist. From left side	2.50	m
W (Wind)	0	ksm	Left React.	375	kg
Trib.width	1.25	m	Right React.	375	kg
Span	5.00	m	Max. Moment at x=	2.50	m
Span type	Simple		(from left sup.)		
			Note : Cantilever support on right side		

Section Dimension input

SECTION	H150x14.0
d	15
bf	7.5
tw	0.5
tf	0.7

note ; for flange buckling not provide in table
For Flange 0.56*sqrt(E/Fy) = 16.33
For Web 1.49*sqrt(E/Fy) = 43.4

note : plate girder with different yeild strength not provide in this table
: for plate girder use Fb=0.6Fy

Section Properties

d' , h (cm)	13.6
A(cm2)	17.85
Ix(cm4)	666
Iy(cm4)	50
Sx(cm3)	89
Sy(cm3)	13
rx(cm)	6.1
ry(cm)	1.7
wt(kg/m)	14.00

for flange
0.38*sqrt(E/Fy) = 11.08
0.56*sqrt(E/Fy) = 16.33

for web
3.76*sqrt(E/Fy) = 109.6
4.46*sqrt(E/Fy) = 130.0
5.76*sqrt(E/Fy) = 167.9 for plate girder

Note: Allowable Shear stess with out Tension field action
: not need stiffener when d/tw <260 and
shear allowable more than shear stress
(5E/Fy) ^ 0.5 = 65.19

Compression

0

Appendix C sectionC2 (for I-sectn only)			Appendix C sectionC3 (for I-sectn only)			
bf/2tf	chk. b/2tf ratio	reduce factor (Qs)	h/tw	chk d/tw ratio	eff. Width (be)	eff. Area (Qa)
5.36	no buckling	1.000	27.2	no buckling	13.60	1.000

K	unbrace length (cm)	KL/r	Cc	Kl/r / Cc	inelastic Fa	elastic Fa	fa	fa/Fa
1	250	150.13	129.53	0.00	-	466.47	0.00	0.000

Major Bending

unbrace length (cm)	bf/2tf	d/tw	ar	Rpg	chk unbrace length		
					0.444*bf	0.69*E	Lc (cm)
250	5.36	30.00	1.30	1.00	97.1	226.4	97.1

full lateral brace		not full lateral brace								Stress Check	
Section Classified	Fb	Cb	rT	sqrt(3.517)	sqrt(17.5)	L/rT	Fb1	Fb2	Fb	fb	fb/Fb
compact	-	1	1.81	54.68	122.26	138.03	1182.384	627.6302	1182.384	615.85	0.52

Minor bending

Stress Check		
Fb	fb	fb/Fb
1440	0.00	0.00

Combinded Sress

Cmx	Cmy	F'ex	F'ey	combined stress
0.85	0.85	6276.085	466.4658	0.52

Shear

a	Kv	Cv-a < 0.8	Cv-b > 0.8	Fv	Stress Check	
					fv	fv/Fv
3600	5.340	9.5095	2.7742	960.00	55.15	0.06

Deflection

Deflection=5ML^2/(48EI)= 1.05 cm *(L / 477)*

Summary

fa/Fa	0.00
fb/Fb	0.52
fv/Fv	0.06

ข้อกำหนดที่ใช้ในการออกแบบ (DESIGN CRITERIA)

งานโครงสร้างลานทางเข้าอาคาร B

การออกแบบโดยวิธีกำลัง (Ultimate Strength design method) ACI 318-99 STANDARD

สัมประสิทธิ์น้ำหนักบรรทุก (Load factor)

น้ำหนักบรรทุคงที่ (Dead load : DL)	=	*1.40*
น้ำหนักบรรทุกจร (Live load : LL)	=	*1.70*

กำลังที่ต้องการเพื่อต้านน้ำหนักบรรทุก (U = Required strength to resist factored load)

U = 1.4DL + 1.7 (LL)

ตัวคูณลดกำลัง (Strength reduction factor)

สำหรับแรงดัด (Bending)	=	*0.90*
สำหรับแรงเฉือน (Shear)	=	*0.85*
สำหรับแรงอัด (Compression)	=	*0.70*

คอนกรีต (Concrete)

กำลังอัดประลัย (Ultimate Strength)	=	*320*	ksc	
แรงเฉือนแบบคาน Vc	=	*9.481*	ksc	(For Beam Shear)
แรงเฉือนทะลุ Vc	=	*18.962*	ksc	(For Punching Shear)

เหล็กเส้นกลม (Round Bar)

กำลังดึงสูงสุด (Yield Strength) Fy	=	*2400*	ksc	(SR 24)

เหล็กเส้นข้ออ้อย (Deformed Bar)

กำลังดึงสูงสุด (Yield Strength) Fy	=	*5000*	ksc	(SD 40)

เหล็กรูปพรรณ (Structural Steel)

Structural steel shape	GRADE	SS400
High strength bolt (HTB)	GRADE	F10T
Welding electrode	GRADE	E70
Anchor bolt	GRADE	SS400

น้ำหนักบรรทุกคงที่ (Dead Load)

น้ำหนักคอนกรีต (DL. of Concrete)	=	2400	กก.	ต่อ ลบ.ม.	(kg/Cu.m.)
น้ำหนักอิฐมอญเต็มแผ่น (DL. of Brick Wall)	=	360	กก.	ต่อ ตร.ม.	(kg/Sq.m.)
น้ำหนักอิฐมอญครึ่งแผ่น (DL. of Half Brick Wall)	=	180	กก.	ต่อ ตร.ม.	(kg/Sq.m.)
น้ำหนักผนังก่ออิฐบล็อกหนา 9 ซ.ม.	=	160	กก.	ต่อ ตร.ม.	(kg/Sq.m.)

น้ำหนักบรรทุกจร (Live Load)

น้ำหนักบรรทุกจรทางเท้า ทั่วไป	=	500	กก.	ต่อ ตร.ม.	(kg/Sq.m.)

DESIGN COLUMN LOAD

PROJECT : ลานทางเข้าอาคาร B (RAMP) และ ศาลพระภูมิ

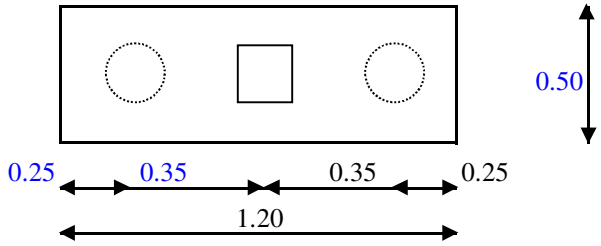
COLUMN	1	2	2	2
GRIDLINE	A1	B4	C2	C4
LOCATION	RAMP	RAMP	RAMP	ศาลพระภูมิ
WIDTH	2.35	2.35	3	3
LENGTH	3	3	6	3
DL G. FLOOR SLAB	3,384	3,384	8,640	4,320
LL G. FLOOR SLAB = 500 kg/	3,525	3,525	9,000	4,500
DL BEAM	936	936	936	936
DL WALL	702	702	702	702
DL COLUMN	288	288	288	288
DL FOOTING	300	300	300	300
TOTAL DEAD LOAD	5,610	5,610	10,866	6,546
TOTAL LIVE LOAD	3,525	3,525	9,000	4,500
TOTAL LOAD	9,135	9,135	19,866	11,046
SAFE load,kg	12,000	12,000	12,000	12,000
NO. OF PILE	1	1	2	1
FOOTING TYPE	F1	F1	F2	F1

Typical Footing

I- Pile0.22 x 0.22 with safe load not less than 12 Tons/Pile

F1	*0.40x0.40x0.50*	Use	**1** I- Pile	**0.22 x**	**0.22**	
	Safe load	12	Tons/Pile	$P_{w,all}$	10	Tons

NF2 *1.2 x 0.5 x 0.5*



Use	**2**	I- Pile	**0.22 x**	**0.22**		
Safe load	12	Tons/Pile	$P_{w,all}$	23.28	Tons	
L.F. =	1.55		W	0.72	Tons	
f_c' =	320	ksc	f_y =	4000	ksc	
h =	0.5	m	d =	43	cm	
b =	50	cm	Column	0.20	m	

Flexural Design

M_u	=	4650	kg-m	
$A_{s,deep\ beam}$	=	4.14	cm^2	
A_s	=	3.04	cm^2	
$A_{s,min}$	=	7.53	cm^2	
Use	***4***	***DB - 16***		@ 10 cm

One-way Shear

V_u	=	18600	kg		
$3.5-2.5M_u/V_u d$	=	2.05			
V_c	=	34791	kg		OK
A_{vh} Use		***DB - 12***		2.0	OK
P_{vh}	1 =	0.0226			OK
A_{vv} Use		***DB - 12***		2.0	OK
P_{vv}	1 =	0.0226			OK
V_s	=	165348			
$V_{u,all}$	=	200139	*kg Vu,all > Vu OK*		
$V_{u,max,all}$		69306	*kg Vu,all > Vu OK*		

LS1 **(0.125)** L = 3.00

case 1 B = 3.00

k	=	1.00				
f_c'	=	240	ksc	t_{min} =	0.067 m.	
Load factor			*DL*	=	1.40	
			LL	=	1.70	
DL	=	*1.4x*	*300*	=	420	kg/m^2
SDL+SCR	=	*1.4x*	*120*	=	168	kg/m^2
LL	=	*1.7x*	*500*	=	850	kg/m^2
w_u				=	**1438**	kg/m^2
M^+_B	=	*0.058*	$w_u B^2$	=	751	kg-m
M^-_B			$w_u B^2$			kg-m
M^+_L	=	*0.058*	$w_u L^2$	=	751	kg-m
M^-_L			$w_u L^2$			kg-m
						kg-m
						kg-m

As+B	=	3.75	cm^2	RB 9 mm. @	0.15 m
As+L	=	3.75	cm^2	RB 9 mm. @	0.15 m

LS1a **(0.125)**

case cantilever L = 1.00

f_c'	=	240	ksc	t_{min} =	0.083 m.	
Load factor			*DL*	=	1.40	
			LL	=	1.70	
DL	=	*1.4x*	*300*	=	420	kg/m^2
SDL+SCR	=	*1.4x*	*120*	=	168	kg/m^2
LL	=	*1.7x*	*500*	=	850	kg/m^2
w_u				=	**1438**	kg/m^2
$P_{u,end}$				=	0	kg
$M^-_{L,w}$	=	*-0.50*	$w_u L^2$	=	-719	kg-m
$M^-_{L,P}$	=	*-1.00*	$P_u L$	=	0	kg-m
M^-_L				=	719	kg-m

As,B min = 3.13 Sq.cm.

$A_s{}^-{}_B$	=	0.00	cm^2	RB 9 mm. @	0.2 m
$A_s{}^-{}_L$	=	4.03	cm^2	RB 9 mm. @	0.15 m

LS2 **(0.15)** L = 6.00

case 1 B = 6.00

k	=	1.00				
f_c'	=	240	ksc	t_{min} =	0.133 m.	
Load factor			*DL*	=	1.40	
			LL	=	1.70	
DL	=	*1.4x*	*360*	=	504	kg/m^2
SDL+SCR	=	*1.4x*	*120*	=	168	kg/m^2
LL	=	*1.7x*	*500*	=	850	kg/m^2
w_u				=	**1522**	kg/m^2
M^+_B	=	*0.058*	$w_u B^2$	=	3178	kg-m
M^-_B			$w_u B^2$			kg-m
M^+_L	=	*0.058*	$w_u L^2$	=	3178	kg-m
M^-_L			$w_u L^2$			kg-m
						kg-m
						kg-m

As+B	=	7.86	cm^2	DB 12 mm. @	0.125 m
As+L	=	7.86	cm^2	DB 12 mm. @	0.125 m

AS1 **(0.15)**

case simple span L = 3.00

f_c'	=	240	ksc	t_{min} =	0.150 m.	
Load factor			*DL*	=	1.40	
			LL	=	1.70	
DL	=	*1.4x*	*360*	=	504	kg/m^2
SDL+SCR	=	*1.4x*	*120*	=	168	kg/m^2
LL	=	*1.7x*	*500*	=	850	kg/m^2
w_u				=	**1522**	kg/m^2
$P_{u,end}$				=	0	kg
$M^+_{L,w}$	=	*0.13*	$w_u L^2$	=	1712	kg-m
$M^+_{L,P}$	=	*0.25*	$P_u L$	=	0	kg-m
M^+_L				=	1712	kg-m

As,B min = 3.75 Sq.cm.

$A_s{}^+_B$	=	0.00	cm^2	RB 9 mm. @	0.15 m
$A_s{}^+_L$	=	4.10	cm^2	DB 12 mm. @	0.275 m

Design Reinforced Concrete Beam

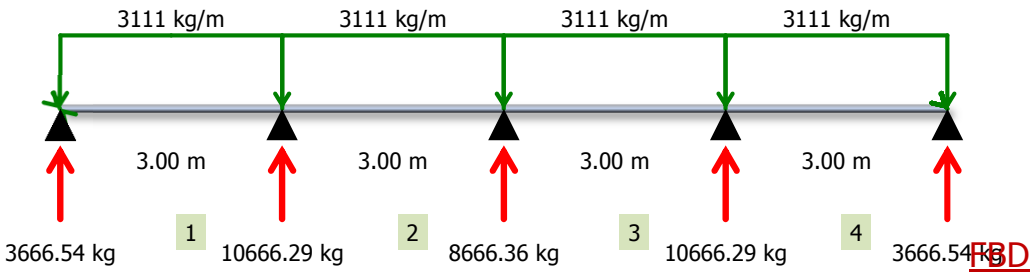
(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. LB1 | Job No. | Date 9/8/69

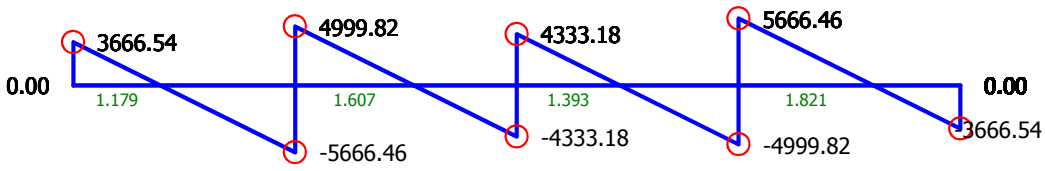
Design load on beam

	SLAB	S =	3	m, L=	3 m
SHORT	Load SLAB on beam	=	wS/3 (3-m2)/2	1.00	m
LONG	Load SLAB on beam	=	wS/3 (3-m^2)/2	1.00	m
				2	sides
	DL SLAB1	=	0.12*2400+120	[kg/m^2]	
	LL SLAB1	=	500	[kg/m^2]	

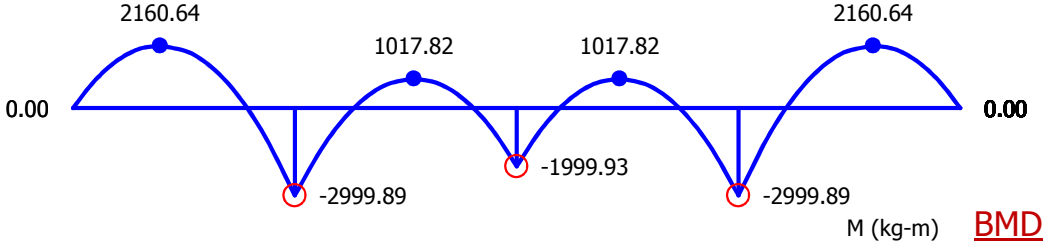
1.4 DL SLAB	=	1,411	[kg/m]
1.4 DL WALL	=	0	[kg/m]
1.7 LL SLAB	=	1,700	[kg/m]
uniform load (w1)	=	3111	[kg/m]
point load (p1)	=	0	kg



FBD



V (kg) SFD



M (kg-m) BMD

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. LB1 | Job No. | Date 9/8/69

Beam size	LB1	b	=	20	[cm]	
		h	=	40	[cm]	
		d	=	36	[cm]	
		fc'	=	320	[kg/cm^2]	
		β	=	0.82		
		fy DB	=	5000	[kg/cm^2]	
		fy stirrup	=	2400	[kg/cm^2]	
		M$^+$u	=	2161	[kg-m]	
		M-u	=	3000	[kg-m]	
		0.9Mn	=	17867	[kg-m]	
		R+u	=	9.26	[kg/cm^2]	
		R-u	=	12.86	[kg/cm^2]	
		ρ_b	=	0.0246		
		0.75ρb	=	0.0184		
		ρ +Req.	=	0.0019		
		A_{s+}	=	1.36	[cm^2]	
	USED	2	DB	16	As = 4.0	[cm^2]
	ρ_{min} =	0.0028		As_{min}	= 2.016	[cm^2]
	As_{min}	=	DB	12	= 2	Bars
		ρ −Req.	=	0.0026		
		A_{s-}	=	1.90	[cm^2]	
	USED	2	DB	16	As = 4.0	[cm^2]
	ρ_{min} =	0.0028		As_{min}	= 2.016	[cm^2]
	As_{min}	=	DB	12	= 2	Bars

Design Stirrup	Wu	=	3111	[kg/m]	
	Vu	=	3,667	[kg]	
	ϕVc	=	5802	[kg]	
	Vu@d	=	2547	[kg]	
	Vu@d/ϕ − Vc	=	0	[kg]	
	RB	6	No of leg	=	2
	A_s	=	0.57	[cm^2]	
Spacing	ϕ fy Av d/(Vu-ϕVc)	=	NA.	cm	
	Av fy/3.5b	=	40.4	cm	
	d/2	=	18.0	cm	
	Use Spacing	=	15.0	cm	

Design Reinforced Concrete Beam

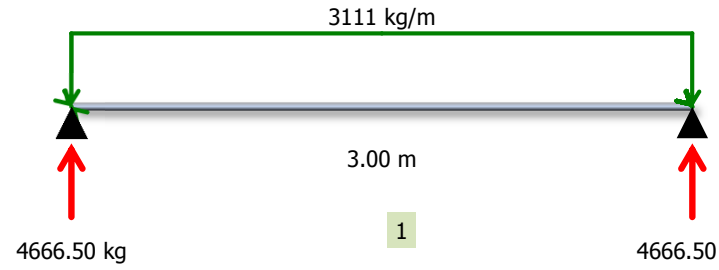
(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. LB2 Job No. Date 9/8/69

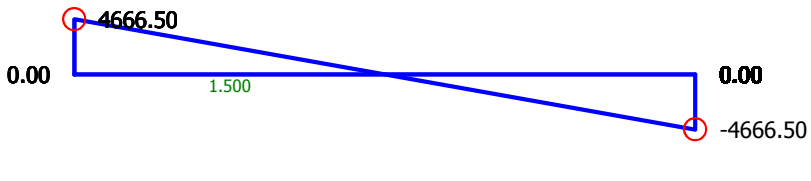
Design load on beam

	SLAB	S =	3	m, L=	3	m
SHORT	Load SLAB on beam	=	wS/3 (3-m2)/2		1.00	m
LONG	Load SLAB on beam	=	wS/3 (3-m^2)/2		1.00	m
					2	sides
	DL SLAB1	=	0.12*2400+120	[kg/m^2]		
	LL SLAB1	=	500	[kg/m^2]		

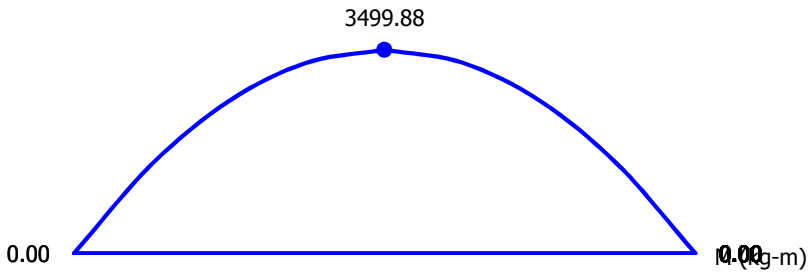
1.4 DL SLAB	=	1,411	[kg/m]
1.4 DL WALL	=	0	[kg/m]
1.7 LL SLAB	=	1,700	[kg/m]
uniform load (w1)	=	3111	[kg/m]
point load (p1)	=	0	kg



FBD



SFD



BMD

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. LB2		Job No.		Date	9/8/69

Beam size	LB2	b	=	20	[cm]
		h	=	40	[cm]
		d	=	36	[cm]
		fc'	=	320	[kg/cm^2]
		β	=	0.82	
		fy DB	=	5000	[kg/cm^2]
		fy stirrup	=	2400	[kg/cm^2]
		M^+u	=	3500	[kg-m]
		M-u	=	0	[kg-m]
		0.9Mn	=	17867	[kg-m]
		R+u	=	15.00	[kg/cm^2]
		R-u	=	0.00	[kg/cm^2]
		ρ_b	=	0.0246	
		0.75ρb	=	0.0184	
		ρ +Req.	=	0.0031	
		A_{s+}	=	2.22	[cm^2]
	USED	2	DB	16	As = 4.0 [cm^2]
	ρ_{min} =	0.0028		As_{min} =	2.016 [cm^2]
	As_{min} =		DB	12 =	2 Bars
		ρ −Req.	=	0.0000	
		A_{s-}	=	0.00	[cm^2]
	USED	2	DB	16	As = 4.0 [cm^2]
	ρ_{min} =	0.0028		As_{min} =	2.016 [cm^2]
	As_{min} =		DB	12 =	2 Bars

Design Stirrup		Wu	=	3111	[kg/m]
		Vu	=	4,667	[kg]
		ϕVc	=	5802	[kg]
		Vu@d	=	3547	[kg]
		Vu@d/ϕ − Vc	=	0	[kg]
	RB	6		No of leg =	2
		A_s	=	0.57 [cm^2]	
	Spacing	ϕ fy Av d/(Vu-ϕVc)	=	NA.	cm
		Av fy/3.5b	=	40.4	cm
		d/2	=	18.0	cm
		Use Spacing	=	15.0	cm

Design Reinforced Concrete Beam

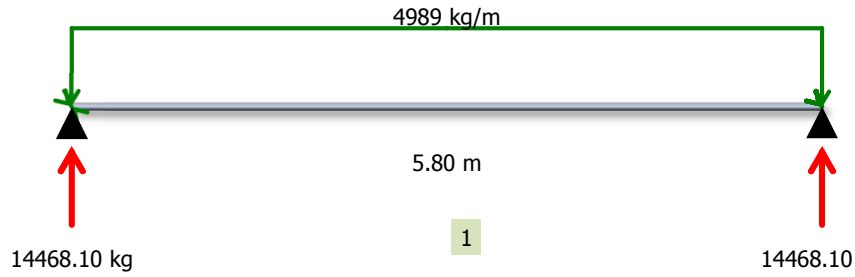
(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. LB3 Job No. Date 9/8/69

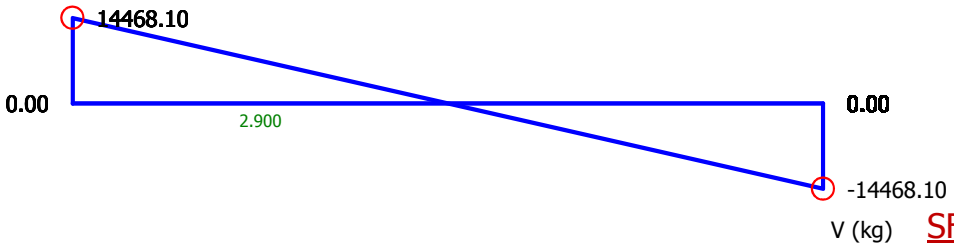
Design load on beam

	SLAB	S =	5.8	m, L=	5.8	m
SHORT	Load SLAB on beam	=	wS/3 (3-m2)/2		1.93	m
LONG	Load SLAB on beam	=	wS/3 (3-m^2)/2		1.93	m
					1	sides
	DL SLAB1	=	0.15*2400+120	[kg/m^2]		
	LL SLAB1	=	500	[kg/m^2]		

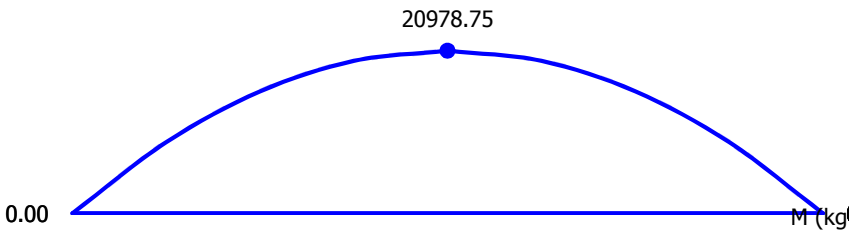
1.4 DL SLAB	=	1,702	[kg/m]
1.4 DL WALL	=	0	[kg/m]
1.7 LL SLAB	=	3,287	[kg/m]
uniform load (w1)	=	4989	[kg/m]
point load (p1)	=	0	kg



FBD



SFD



BMD

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. LB3		Job No.		Date	9/8/69

Beam size	LB3	b	=	20	[cm]		
		h	=	60	[cm]		
		d	=	54	[cm]		
		fc'	=	320	[kg/cm^2]		
		β	=	0.82			
		fy DB	=	5000	[kg/cm^2]		
		fy stirrup	=	2400	[kg/cm^2]		
		M^+u	=	20979	[kg-m]		
		M-u	=	0	[kg-m]		
		0.9Mn	=	40200	[kg-m]		
		R+u	=	39.97	[kg/cm^2]		
		R-u	=	0.00	[kg/cm^2]		
		ρ_b	=	0.0246			
		0.75ρb	=	0.0184			
		ρ +Req.	=	0.0087			
		A_{s+}	=	9.38	[cm^2]		
	USED	4	DB	20	As = 12.6	[cm^2]	
	ρ_{min} =	0.0028		As_{min}	=	3.024	[cm^2]
	As_{min}	=	DB	12	=	3	Bars
		ρ −Req.	=	0.0000			
		A_{s-}	=	0.00	[cm^2]		
	USED	2	DB	20	As = 6.3	[cm^2]	
	ρ_{min} =	0.0028		As_{min}	=	3.024	[cm^2]
	As_{min}	=	DB	12	=	3	Bars

Design Stirrup		**Wu**	=	4989	[kg/m]	
		Vu	=	14,468	[kg]	
		ϕVc	=	8703	[kg]	
		Vu@d	=	11774	[kg]	
		Vu@d/ϕ − Vc	=	3612	[kg]	
	RB	9		No of leg =	2	
		A_s	=	1.27	[cm^2]	
	Spacing	ϕ fy Av d/(Vu-ϕVc)	=	44.7	cm	
		Av fy/3.5b	=	90.9	cm	
		d/2	=	27.0	cm	
		Use Spacing	=	20.0	cm	

ข้อกำหนดที่ใช้ในการออกแบบ (DESIGN CRITERIA)

โครงการ : งานโยธา และงานโครงสร้างภายนอก สำนักงานใหญ่ กสทช.

ถ.รัตนาธิเบศ จ.นนทบุรี

โครงสร้าง รั้วกำแพงกันดิน ถนน รอบอาคาร G และที่จอดรถ

การออกแบบโดยวิธีกำลัง (Ultimate Strength design method)

สัมประสิทธิ์น้ำหนักบรรทุก (Load factor)

น้ำหนักบรรทุกคงที่ (Dead load : DL)	=	*1.40*
น้ำหนักบรรทุกจร (Live load : LL)	=	*1.70*
แรงลม (Wind load : WL)	=	*1.70*

กำลังที่ต้องการเพื่อต้านน้ำหนักบรรทุก (U = Required strength to resist factored load)

U = 1.4DL + 1.7 LL

U = 0.75(1.4DL + 1.7LL + 1.7WL)

ตัวคูณลดกำลัง (Strength reduction factor)

สำหรับแรงดัด (Bending)	=	*0.90*
สำหรับแรงเฉือน (Shear)	=	*0.85*
สำหรับแรงอัด (Compression)	=	*0.70*

คอนกรีต (Concrete)

กำลังอัดประลัย (Ultimate Strength) Fc'	=	*240*	ksc	
แรงเฉือนแบบคาน Vc	=	*8.211*	ksc	(For Beam Shear)
แรงเฉือนทะลุ Vc	=	*16.421*	ksc	(For Punching Shear)

เหล็กเส้นกลม (Round Bar)

กำลังดึงสูงสุด (Yield Strength) Fy	=	*2400*	ksc	(SR 24)

เหล็กเส้นข้ออ้อย (Deformed Bar)

กำลังดึงสูงสุด (Yield Strength) Fy	=	*4000*	ksc	(SD 40)

เหล็กรูปพรรณ (Structural Steel)

Structural steel shape	GRADE	SS400
High strength bolt (HTB)	GRADE	F10T
Welding electrode	GRADE	E70
Anchor bolt	GRADE	SS400

น้ำหนักบรรทุกคงที่ (Dead Load)

น้ำหนักคอนกรีต (DL. of Concrete)	=	2400	กก. ต่อ ลบ.ม. (kg/Cu.m.)
น้ำหนักอิฐมอญครึ่งแผ่น (DL. of Half Brick Wall)	=	180	กก. ต่อ ตร.ม. (kg/Sq.m.)
น้ำหนักผนังก่ออิฐบล็อกหนา 9 ซ.ม.	=	160	กก. ต่อ ตร.ม. (kg/Sq.m.)

น้ำหนักบรรทุกจร (Live Load)

น้ำหนักบรรทุกจรถนนและที่จอดรถ	=	2000	กก. ต่อ ตร.ม. (kg/Sq.m.)
น้ำหนักบรรทุกจรทางเท้า ทั่วไป	=	300	กก. ต่อ ตร.ม. (kg/Sq.m.)

DESIGN COLUMN LOAD

PROJECT : ROAD&FENCE (BUILDING G)

SECTION	G1	G1	G4	G4	G4	G5	G6-G8	G2	G2	G3	G3
LOCATION	ROAD		GEN			PARKING		GK	GK	G4/A-G4/K	
width of load	5	5	7	1.5	1.5	0	6	1.75	1.75	1	1
length of load	3	3	1.5	7	7	0	6	4	4	4	4
DL ROOFING	0	0	3,024	3,024	3,024	0	1,800	0	0	0	0
LL ROOFING	0	0	1,050	1,050	1,050	0	1,800	0	0	0	0
DL BEAM	0	0	2,550	2,550	2,550	0	0	1,104	1,104	960	960
width of load	5	5	3.75	3.75	3.75	5	5	1.75	1.75	1	1
length of load	3	3	3.35	3.35	3.35	3	3	4	4	4	4
TYPE OF SLAB	HC200	HC200	HC200	HC200	HC200	HC200	HC200	HC80	HC80	HC80	HC80
DL G.SLAB	7,050	7,050	5,904	5,904	5,904	7,050	7,050	1,960	1,960	1,120	1,120
LL SLAB kg/m2	1,500	1,500	1,000	1,000	1,000	1,500	1,500	400	400	400	400
LL SLAB kg	22,500	22,500	12,563	12,563	12,563	22,500	22,500	2,800	2,800	1,600	1,600
DL BEAM	4,032	4,032	3,578	3,578	3,578	4,032	4,032	1,104	1,104	960	960
DL WALL	4,800		3,451	3,451	0	1,800	1,800	4,140	0	5,400	0
DLGUTTER		6,150			4,613				3,480		3,480
DL COLUMN	441	441	648	648	648	441	441	225	225	225	225
DL FOOTING	1,680	1,680	154	154	154	1,680	1,680	154	154	154	154
TOTAL DL	18,003	19,353	19,309	19,309	20,471	15,003	15,003	8,687	8,027	8,819	6,899
TOTAL LL	22,500	22,500	13,613	13,613	13,613	22,500	24,300	2,800	2,800	1,600	1,600
TOTAL LOAD	**40,503**	**41,853**	**32,921**	**32,921**	**34,083**	**37,503**	**39,303**	**11,487**	**10,827**	**10,419**	**8,499**
Safe pile capacity	**42,000**	**42,000**	**42,000**	**42,000**	**42,000**	**42,000**	**42,000**	**15,000**	**15,000**	**15,000**	**15,000**
No. OF PILE	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
PILE SIZE	**0.60**	**0.60**	**0.60**	**0.60**	**0.60**	**0.60**	**0.60**	**0.20**	**0.20**	**0.20**	**0.20**
TYPE	**NF1**	**NF1**	**NF1**	**NF1**	**NF1**	**NF1**	**NF1**	**NF1x**	**NF1x**	**NF1x**	**NF1x**

หมายเหตุ กำหนด น้ำหนักจรรถบรรทุก 1500 กก./ตรม. ลงฐานราก เนื่องจาก น้ำหนักจากล้อรถ 1 แนวล้อ/คัน เฉลี่ยลงฐานรากหลายฐาน

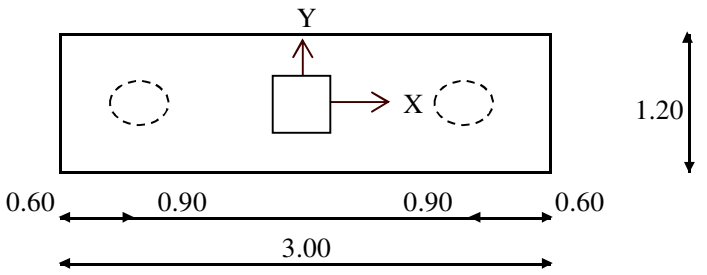
Typical Footing

Bored piledia = 0.6 with safe load not less than 42 Tons/Pile

NF1 *1 x 1 x 0.7*

		Use	**1**	Bored pile	dia =	**0.60**
h =	0.80	Use	***5***	***DB - 16***		
b =	1.00		$A_{s,\ vertical}$	40.21	cm^2	**0.63%**
Safe load	42	Tons	$P_{w,all}$	42	Tons	

NF2 *3 x 1.2 x 0.8*



Use	**2**	Bored pile	**dia =**	**0.60**		
Safe load	42	Tons/Pile	$P_{w,all}$	77.09	Tons	
L.F. =	1.70		W	6.91	Tons	8.97%
f_c' =	240	ksc	f_y =	4000	ksc	
h =	0.80	m	*d* =	70	cm	
b =	120	cm	Column	0.70	m	

Flexural Design

M_u		=	39270	kg-m	
$A_{s,deep\ beam}$		=	17.04	cm^2	
A_s		=	15.88	cm^2	
$A_{s,min}$	= 14/fy bd	=	29.40	cm^2	***6DB -25***
	Use	6	***DB - 25***		@ 20 cm

One-way Shear

V_u		=	71400	kg	
$3.5-2.5M_u/V_ud$		=	1.54		
V_c		=	93531	kg	OK
A_{vh}	Use	***DB - 12***		0.25	OK
P_{vh}	4	=	0.30		OK
A_{vv}	Use	***DB - 12.00***		0.25	OK
P_{vv}	2	=	0.15		OK
V_s		=	7331723		
$V_{u,all}$		=	7425254	*kg Vu,all > Vu OK*	
$V_{u,max,all}$			234498	*kg Vu,all > Vu OK*	

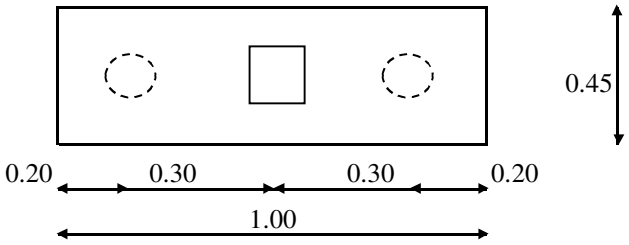
PROJECT : กสทช อาคาร G งานถนนและรั้ว

Typical Footing SPUN piles0.2 x 0.2 with safe load not less than 15 Tons/Pile

NF1x *0.45 x 0.45 x 0.5* Use **1** SPUN piles **0.2 x 0.20**

Safe load 15 Tons/Pile $P_{w,all}$ 15 Tons

NF2x *1.1 x 0.45 x 0.5*



Use	**2**	SPUN piles	**0.2 x**	**0.20**		
Safe load	15	Tons/Pile	$P_{w,all}$	29.46	Tons	
L.F. =	1.70		W	0.54	Tons	1.83%
f_c' =	240	ksc	f_y =	4000	ksc	
h =	0.5	m	d =	40	cm	
b =	45	cm	Column	0.25	m	

Flexural Design

M_u	=	4462.5	kg-m	
$A_{s,deep\ beam}$	=	4.43	cm^2	
A_s	=	3.15	cm^2	
$A_{s,min}$	=	3.60	cm^2	
Use	***4***	***DB - 12***		@ 8.33 cm

One-way Shear

V_u	=	25500	kg	
V_s	=	28028		
$V_{u,all}$	=	60188	*kg Vu,all > Vu OK*	
$V_{u,max,all}$		50250	*kg Vu,all > Vu OK*	

Column NC1 ROAD

Section properties

width	$c1$ =	35	cm		
depth	$c2$ =	35	cm		
chamfer		0	cm		
area	A_g =	1225	cm^2		
moment of inertia	I_g =	125052	cm^4		
concrete strength	f_c' =	240	ksc		
moment of inertia of reinf.	I_{se} =	2543	cm^4		
Column load	P_d =	12000	kg		
	P_l =	30000	kg		
	$P_u = 1.4P_d+1.7P_l$ =	67800	kg	678	kN
	M_u =	0	kg-m		
	$min\ M_u$ =	1729	kg-m	(e_min)	
sustained load ratio	$\beta_d = 1.4P_d / P_u$ =	0.25			
flexural stiffness	$EI = (0.2EcIg+EsIse)/(1+Bd)$ =	8.9E+09	$kg\text{-}cm^2$		
equivalent moment coeff.	$C_m = 0.6+0.4M_1/M_2$ =	1.00			
effective length factor	k =	2.00			
unsupported length	l_u =	3.00	m		
critical load	$P_c = \pi^2 EI / (k.l_u)^2$ =	243450	kg		
moment magnification fac	$\delta_{ns} = C_m/(1-P_u/0.75P_c)$ =	1.591			
design moment	$M_c = \delta_{ns} M_u$ =	2750	kg-m	28	kN-m
		2373	kg-m	24	kN-m
		(e=0.10D)		(e=0.10D)	

Reinforcement Data

no. of reinf layer = 3

(in order to skip this part, please fill no. of layer = 0)

diameter of reinforcement 20 mm Area = 3.14 cm^2

diameter of tie 9 mm clear = 23.2 cm

computed Ise = 2542.7 cm^4

user-input Ise = 0 cm^4

layer	no.	As	dist. from top		
1	3	9.42	0	5.9	1268
2	2	6.28	0	17.5	0
3	3	9.42	0	29.1	1268
total	8	25.13	0	0	2543
	As/Ag	2.05	%		

Column NC2 ตอม่อ ROAD

Section properties

width	$c1$ =	35	cm		
depth	$c2$ =	35	cm		
chamfer		0	cm		
area	A_g =	1225	cm^2		
moment of inertia	I_g =	125052	cm^4		
concrete strength	f_c' =	240	ksc		
moment of inertia of reinf.	I_{se} =	2543	cm^4		
Column load	P_d =	12000	kg		
	P_l =	30000	kg		
	$P_u = 1.4P_d+1.7P_l$ =	67800	kg	678	kN
	M_u =	0	kg-m		
	$min\ M_u$ =	1729	kg-m	(e_min)	
sustained load ratio	$\beta_d = 1.4P_d / P_u$ =	0.25			
flexural stiffness	$EI = (0.2EcIg+EsIse)/(1+Bd)$ =	8.9E+09	$kg\text{-}cm^2$		
equivalent moment coeff.	$C_m = 0.6+0.4M_1/M_2$ =	1.00			
effective length factor	k =	2.00			
unsupported length	l_u =	3.00	m		
critical load	$P_c = \pi^2 EI / (k.l_u)^2$ =	243450	kg		
moment magnification fac	$\delta_{ns} = C_m/(1-P_u/0.75P_c)$ =	1.591			
design moment	$M_c = \delta_{ns} M_u$ =	2750	kg-m	28	kN-m
		2373	kg-m	24	kN-m
		(e=0.10D)		(e=0.10D)	

Reinforcement Data

no. of reinf layer = 3

(in order to skip this part, please fill no. of layer = 0)

diameter of reinforcement 20 mm Area = 3.14 cm^2

diameter of tie 9 mm clear = 23.2 cm

computed Ise = 2542.7 cm^4

user-input Ise = 0 cm^4

layer	no.	As	dist. from top		
1	3	9.42	0	5.9	1268
2	2	6.28	0	17.5	0
3	3	9.42	0	29.1	1268
total	8	25.13	0	0	2543
	As/Ag	2.05	%		

Column NC2 รับหลังคา คสล. ห้องเครื่องปั้นไฟ

Section properties

width	$c1$ =	25	cm		
depth	$c2$ =	25	cm		
chamfer		0	cm		
area	A_g =	625	cm^2		
moment of inertia	I_g =	32552	cm^4		
concrete strength	f_c' =	240	ksc		
moment of inertia of reinf.	I_{se} =	373	cm^4		
Column load	P_d =	6750	kg		
	P_l =	1125	kg		
	$P_u = 1.4P_d+1.7P_l$ =	11363	kg	114	kN
	M_u =	0	kg-m		
	$min\ M_u$ =	256	kg-m	(e_min)	
sustained load ratio	$\beta_d = 1.4P_d / P_u$ =	0.83			
flexural stiffness	$EI = (0.2EcIg+EsIse)/(1+Bd)$ =	1.3E+09	$kg\text{-}cm^2$		
equivalent moment coeff.	$C_m = 0.6+0.4M_1/M_2$ =	1.00			
effective length factor	k =	2.00			
unsupported length	l_u =	3.00	m		
critical load	$P_c = \pi^2 EI / (k.l_u)^2$ =	34355	kg		
moment magnification fac	$\delta_{ns} = C_m/(1-P_u/0.75P_c)$ =	1.789			
design moment	$M_c = \delta_{ns} M_u$ =	457	kg-m	5	kN-m
		284	kg-m	*3*	kN-m
		(e=0.10D)		(e=0.10D)	

Reinforcement Data

no. of reinf layer = 2

(in order to skip this part, please fill no. of layer = 0)

diameter of reinforcement 16 mm Area = 2.01 cm^2

diameter of tie 9 mm clear = 13.6 cm

computed Ise = 373.17 cm^4

user-input Ise = 0 cm^4

layer	no.	As	dist. from top		
1	2	4.02	0	5.7	186
2	2	4.02	0	19.3	186
-	0		0		
total	4	8.04	0	0	373
	As/Ag	1.29	%		

Column NC3

Section properties

width	$c1$ =	25	cm		
depth	$c2$ =	25	cm		
chamfer		0	cm		
area	A_g =	625	cm^2		
moment of inertia	I_g =	32552	cm^4		
concrete strength	f_c' =	240	ksc		
moment of inertia of reinf.	I_{se} =	373	cm^4		
Column load	P_d =	6010	kg		
	P_l =	2400	kg		
	$P_u = 1.4P_d+1.7P_l$ =	12494	kg	125	kN
	M_u =	0	kg-m		
	$min\ M_u$ =	281	kg-m	(e_min)	
sustained load ratio	$\beta_d = 1.4P_d / P_u$ =	0.67			
flexural stiffness	$EI = (0.2EcIg+EsIse)/(1+Bd)$ =	1.4E+09	$kg\text{-}cm^2$		
equivalent moment coeff.	$C_m = 0.6+0.4M_1/M_2$ =	1.00			
effective length factor	k =	2.00			
unsupported length	l_u =	3.00	m		
critical load	$P_c = \pi^2 EI / (k.l_u)^2$ =	37604	kg		
moment magnification fac	$\delta_{ns} = C_m/(1-P_u/0.75P_c)$ =	1.795			
design moment	$M_c = \delta_{ns} M_u$ =	505	kg-m	5	kN-m
		312	kg-m	3	kN-m
		(e=0.10D)		(e=0.10D)	

Reinforcement Data

no. of reinf layer = 2

(in order to skip this part, please fill no. of layer = 0)

diameter of reinforcement 16 mm Area = 2.01 cm^2

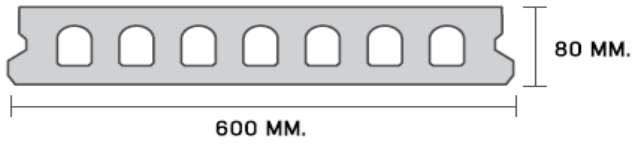
diameter of tie 9 mm clear = 13.6 cm

computed Ise = 373.17 cm^4

user-input Ise = 0 cm^4

layer	no.	As	dist. from top		
1	2	4.02	0	5.7	186
2	2	4.02	0	19.3	186
-	0		0		
total	4	8.04	0	0	373
	As/Ag	1.29	%		

Hollow core Slab HC80



Strand properties TIS 420

fpu	17700	ksc
fpy = 0.9 fpu	15930	ksc

	LAYER1	LAYER2	
No. of strand	4	4	
Dia.	4	4	mm
Area	0.126	0.126	cm^2

Aps	1.008	cm^2
initial jacking force, Pj	14273	kg
immediate losses	10	%
effective losses	20	%
Pi	12489.12	kg

			Composite Section
Span	4	m	
LL	400	kg/m^2	
SDL	0	kg/m^2	
Topping			5 cm
fci	280	ksc	
Eci	254512	ksc	
fc'	400	ksc	240 ksc
Ec	304200	ksc	235632.3 ksc
Section properties		n	0.7746
b	60	cm	60 cm
thick	8	cm	
Area	353	cm^2	
I	2338	cm^4	8797.44 cm^4
Yt	4.03	cm	6.44 cm
Yb	3.97	cm	6.56 cm
Zt	580.1489	cm^3	1366.53 cm^3
Zb	588.9169	cm^3	1340.62 cm^3
w	141	kg/m	261 kg/m
e	2	cm	4.59 cm
bw	60	cm	

At tranfer force from prestress @ support compression = +

Pi	12489.12	kg		
P/A	35.380	ksc	Compression	
P.e/Zt	-43.055	ksc	Tension	
P.e/Zb	42.414	ksc	Compression	
Allowable compression stress		0.6fc' =	168	ksc
Allowable tensile stress		-0.795sqrt(fc') =	-13.3	ksc
stress @top	-7.675	ksc	Tension	OK
stress @bottom	77.794	ksc	Compression	OK

At tranfer force from prestress @ midspan compression = +

Pi	12489.12	kg		
Mg	169.20	kg-m		
P/A	35.380	ksc	Compression	
P.e/Zt	-43.055	ksc	Tension	
P.e/Zb	42.414	ksc	Compression	
Mg/Zt	29.165	ksc	Compression	
Mg/Zb	-28.731	ksc	Tension	
Allowable compression stress		0.6fc' =	168.00	ksc
Allowable tensile stress		-0.795sqrt(fc') =	-13.3	ksc
stress @top	21.490	ksc	Compression	OK
stress @bottom	49.063	ksc	Compression	OK

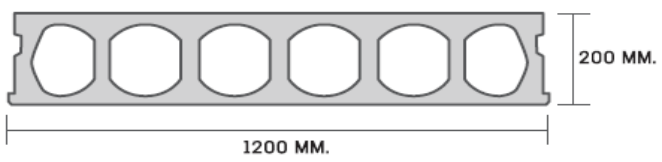
At midspan while placing topping compression = +

Pe	11418.62	kg		
Mg	169.20	kg-m		
Mtopping	144.00	kg-m		
P/A	32.347	ksc	Compression	
P.e/Zt	-39.364	ksc	Tension	
P.e/Zb	38.778	ksc	Compression	
Mg/Zt	29.165	ksc	Compression	
Mg/Zb	-28.731	ksc	Tension	
M topping/Zt	24.821	ksc	Compression	
M topping/Zb	-24.452	ksc	Tension	
Allowable compression stress		0.45fc' =	180.00	ksc
Allowable tensile stress		-1.59sqrt(fc') =	-31.8	ksc
stress @top	46.969	ksc	Compression	OK
stress @bottom	17.943	ksc	Compression	OK

Hollow core Slab HC80

At service @ midspan				compression = +	
Pe	11418.62	kg			
Mg	169.20	kg-m			
Mtopping	144.00	kg-m			
M LL	480.00	kg-m			
P/A	32.347	ksc	Compression		
P.e/Zt	-39.364	ksc	Tension		
P.e/Zb	38.778	ksc	Compression		
Mg/Zt	29.165	ksc	Compression		
Mg/Zb	-28.731	ksc	Tension		
M topping/Zt	24.821	ksc	Compression		
M topping/Zb	-24.452	ksc	Tension		
M LL/Zt	35.125	ksc	Compression		
M LL/Zb	-35.804	ksc	Tension		
Allowable compression stress		0.45fc' =		180.00	ksc
Allowable tensile stress		-1.59sqrt(fc') =		-31.8	ksc
stress @top	82.094	ksc	Compression	OK	
stress @bottom	-17.861	ksc	Tension	OK	

Hollow core Slab HC200



Span	5	m	
LL	2000	kg/m^2	
SDL	0	kg/m^2	**Composite Section**
		Topping	10 cm
fci	280	ksc	
Eci	254512	ksc	
fc'	400	ksc	240 ksc
Ec	304200	ksc	235632.3 ksc

Strand properties TIS 420

fpu	18600	ksc
fpy = 0.9 fpu	16740	ksc

	LAYER1	LAYER2	
No. of strand	3	4	
Dia.	1/2	3/8	inch
Area	0.987	0.548	cm^2

Aps	5.153	cm^2
initial jacking force, Pj	76677	kg
immediate losses	10	%
effective losses	20	%
Pi	67092.06	kg

Section properties

n			0.7746	
b	120	cm	120	cm
thick	20	cm		
Area	1148	cm^2		
I	59557	cm^4	179353.87	cm^4
Yt	9.77	cm	13.16	cm
Yb	10.23	cm	16.84	cm
Zt	6095.906	cm^3	13627.00	cm^3
Zb	5821.799	cm^3	10651.51	cm^3
w	230	kg/m	470	kg/m
e	5	cm	11.61	cm
bw	120	cm		

At tranfer force from prestress @ support compression = +

Pi	67092.06	kg		
P/A	58.443	ksc	Compression	
P.e/Zt	-55.030	ksc	Tension	
P.e/Zb	57.621	ksc	Compression	
Allowable compression stress	0.6fc' =		168	ksc
Allowable tensile stress	-0.795sqrt(fc') =		-13.3	ksc
stress @top	3.412	ksc	Compression	OK
stress @bottom	116.064	ksc	Compression	OK

At tranfer force from prestress @ midspan compression = +

Pi	67092.06	kg		
Mg	862.50	kg-m		
P/A	58.443	ksc	Compression	
P.e/Zt	-55.030	ksc	Tension	
P.e/Zb	57.621	ksc	Compression	
Mg/Zt	14.149	ksc	Compression	
Mg/Zb	-14.815	ksc	Tension	
Allowable compression stress	0.6fc' =		168.00	ksc
Allowable tensile stress	-0.795sqrt(fc') =		-13.3	ksc
stress @top	17.561	ksc	Compression	OK
stress @bottom	101.249	ksc	Compression	OK

At midspan while placing topping compression = +

Pe	61341.31	kg		
Mg	862.50	kg-m		
Mtopping	900.00	kg-m		
P/A	53.433	ksc	Compression	
P.e/Zt	-50.314	ksc	Tension	
P.e/Zb	52.682	ksc	Compression	
Mg/Zt	14.149	ksc	Compression	
Mg/Zb	-14.815	ksc	Tension	
M topping/Zt	14.764	ksc	Compression	
M topping/Zb	-15.459	ksc	Tension	
Allowable compression stress	0.45fc' =		180.00	ksc
Allowable tensile stress	-1.59sqrt(fc') =		-31.8	ksc
stress @top	32.033	ksc	Compression	OK
stress @bottom	75.841	ksc	Compression	OK

Hollow core Slab HC200

At service @ midspan				compression = +	
Pe	61341.31	kg			
Mg	862.50	kg-m			
Mtopping	900.00	kg-m			
M LL	7500.00	kg-m			
P/A	53.433	ksc	Compression		
P.e/Zt	-50.314	ksc	Tension		
P.e/Zb	52.682	ksc	Compression		
Mg/Zt	14.149	ksc	Compression		
Mg/Zb	-14.815	ksc	Tension		
M topping/Zt	14.764	ksc	Compression		
M topping/Zb	-15.459	ksc	Tension		
M LL/Zt	55.038	ksc	Compression		
M LL/Zb	-70.413	ksc	Tension		
Allowable compression stress		0.45fc' =		180.00	ksc
Allowable tensile stress		-1.59sqrt(fc') =		-31.8	ksc
stress @top	87.070	ksc	Compression	OK	
stress @bottom	5.429	ksc	Compression	OK	

NS1 **(0.27)**

case simple span

L = 1.50

f_c'	=	240	ksc	t_{min} =	0.125	m.
Load factor			*DL*	=	1.40	
			LL	=	1.70	
DL	=	*1.4x*	*648*	=	907.2	kg/m^2
SDL+SCR	=	*1.4x*	*120*	=	168	kg/m^2
LL	=	*1.7x*	*2000*	=	3400	kg/m^2
w_u				=	**4475.2**	kg/m^2
$P_{u,end}$				=	0	kg
$M^+_{L,w}$	=	*0.13*	$w_u L^2$	=	1259	kg-m
$M^+_{L,P}$	=	*0.25*	$P_u L$	=	0	kg-m
M^+_L				=	1259	kg-m

As,B min = 5.40 Sq.cm.
As min = 5.40 Sq.cm.

$A_s^-{}_B$	=	0.00	cm^2	DB 12 mm. @	0.2 m
$A_s^-{}_L$	=	1.53	cm^2	DB 12 mm. @	0.2 m

NS2 **(0.15)**

case simple span

L = 1.50

f_c'	=	240	ksc	t_{min} =	0.075	m.
Load factor			*DL*	=	1.40	
			LL	=	1.70	
DL	=	*1.4x*	*360*	=	504	kg/m^2
SDL+SCR	=	*1.4x*	*120*	=	168	kg/m^2
LL	=	*1.7x*	*400*	=	680	kg/m^2
w_u				=	**1352**	kg/m^2
$P_{u,end}$				=	0	kg
$M^+_{L,w}$	=	*0.13*	$w_u L^2$	=	380	kg-m
$M^+_{L,P}$	=	*0.25*	$P_u L$	=	0	kg-m
M^+_L				=	380	kg-m

As,B min = 3.75 Sq.cm.
As min = 3.75 Sq.cm.

$A_s^+{}_B$	=	0.00	cm^2	RB 9 mm. @	0.15 m
$A_s^+{}_L$	=	1.61	cm^2	RB 9 mm. @	0.15 m

NS3 **(0.27)**

case simple span

L = 1.50

f_c'	=	240	ksc	t_{min} =	0.125	m.
Load factor			*DL*	=	1.40	
			LL	=	1.70	
DL	=	*1.4x*	*648*	=	907.2	kg/m^2
SDL+SCR	=	*1.4x*	*120*	=	168	kg/m^2
LL	=	*1.7x*	*2000*	=	3400	kg/m^2
w_u				=	**4475.2**	kg/m^2
$P_{u,end}$				=	0	kg
$M^+_{L,w}$	=	*0.13*	$w_u L^2$	=	1259	kg-m
$M^+_{L,P}$	=	*0.25*	$P_u L$	=	0	kg-m
M^+_L				=	1259	kg-m

As,B min = 5.40 Sq.cm.
As min = 5.40 Sq.cm.

$A_s^-{}_B$	=	0.00	cm^2	DB 12 mm. @	0.2 m
$A_s^-{}_L$	=	1.53	cm^2	DB 12 mm. @	0.2 m

NS4 **(0.27)**

case simple span

L = 1.80

f_c'	=	240	ksc	t_{min} =	0.090	m.
Load factor			*DL*	=	1.40	
			LL	=	1.70	
DL	=	*1.4x*	*648*	=	907.2	kg/m^2
SDL+SCR	=	*1.4x*	*120*	=	168	kg/m^2
LL	=	*1.7x*	*2000*	=	3400	kg/m^2
w_u				=	**4475.2**	kg/m^2
$P_{u,end}$				=	0	kg
$M^+_{L,w}$	=	*0.13*	$w_u L^2$	=	1812	kg-m
$M^+_{L,P}$	=	*0.25*	$P_u L$	=	0	kg-m
M^+_L				=	1812	kg-m

As,B min = 5.40 Sq.cm.
As min = 5.40 Sq.cm.

$A_s^+{}_B$	=	0.00	cm^2	DB 12 mm. @	0.2 m
$A_s^+{}_L$	=	2.21	cm^2	DB 12 mm. @	0.2 m

NS1a **(0.27)**

case cantilever

L = 1.00

f_c'	=	240	ksc	t_{min} =	0.083	m.
Load factor			*DL*	=	1.40	
			LL	=	1.70	
DL	=	*1.4x*	*648*	=	907.2	kg/m^2
SDL+SCR	=	*1.4x*	*120*	=	168	kg/m^2
LL	=	*1.7x*	*2000*	=	3400	kg/m^2
w_u				=	**4475.2**	kg/m^2
$P_{u,end}$				=	0	kg
$M^-_{L,w}$	=	*-0.50*	$w_u L^2$	=	-2238	kg-m
$M^-_{L,P}$	=	*-1.00*	$P_u L$	=	0	kg-m
M^-_L				=	2238	kg-m

As,B min = 5.40 Sq.cm.
As min = 5.40 Sq.cm.

$A_s^-{}_B$	=	0.00	cm^2	DB 12 mm. @	0.225 m
$A_s^-{}_L$	=	2.73	cm^2	DB 12 mm. @	0.225 m

NRS1 **0.150**

case simple span

L = 3.00

f_c'	=	240	ksc	t_{min} =	0.150	m.
Load factor			*DL*	=	1.40	
			LL	=	1.70	
DL	=	*1.4x*	*360*	=	504	kg/m^2
SDL+SCR	=	*1.4x*	*0*	=	0	kg/m^2
LL	=	*1.7x*	*100*	=	170	kg/m^2
w_u				=	**674**	kg/m^2
$P_{u,end}$				=	0	kg
$M^+_{L,w}$	=	*0.13*	$w_u L^2$	=	758	kg-m
$M^+_{L,P}$	=	*0.25*	$P_u L$	=	0	kg-m
M^+_L				=	758	kg-m

As,B min = 3.75 Sq.cm.
As min = 3.75 Sq.cm.

$A_s^+{}_B$	=	0.00	cm^2	RB 9 mm. @	0.15 m
$A_s^+{}_L$	=	2.97	cm^2	RB 9 mm. @	0.15 m

NRS1 **0.150**

case simple span

L = 3.00

f_c'	=	240 ksc	t_{min}	=	0.150 m.	
Load factor		*DL*		=	1.40	
		LL		=	1.70	
DL	=	*1.4x* *360*		=	504	kg/m^2
SDL+SCR	=	*1.4x* *0*		=	0	kg/m^2
LL	=	*1.7x* *100*		=	170	kg/m^2
w_u				=	**674**	kg/m^2
$P_{u,end}$				=	0	kg
$M^+_{L,w}$	=	*0.13* $w_u L^2$		=	758	kg-m
$M^+_{L,P}$	=	*0.25* $P_u L$		=	0	kg-m
M^+_L				=	758	kg-m

As,B min = 3.75 Sq.cm.
As min = 3.75 Sq.cm.

$A_s{}^+{}_B$	=	0.00	cm^2	RB 9 mm. @	0.15 m
$A_s{}^+{}_L$	=	2.97	cm^2	RB 9 mm. @	0.15 m

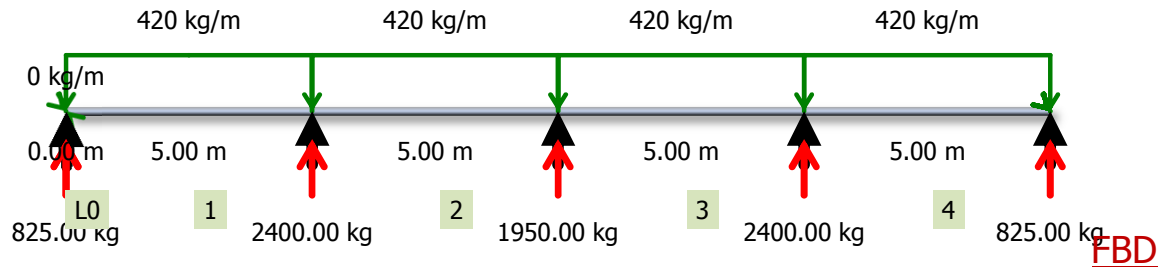
Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

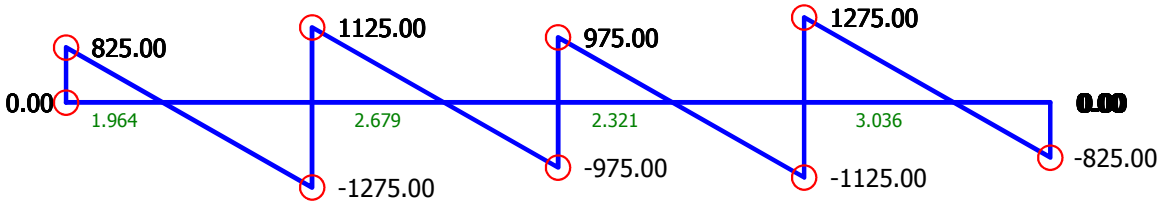
Beam No. GB1 Job No. Date 20/9/64

Design load on beam

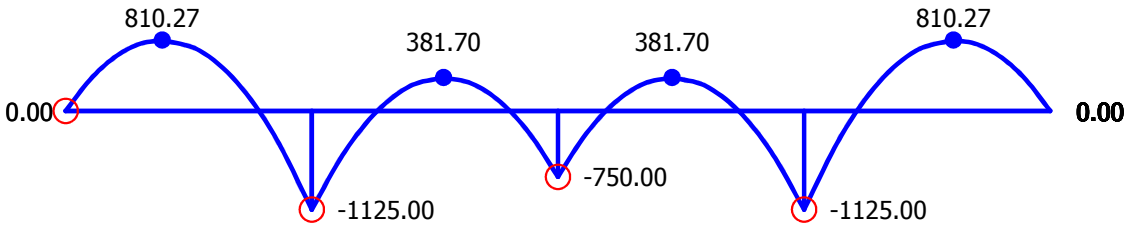
1.4 DL BEAM	=	420	[kg/m]
1.4 DL WALL	=	560	[kg/m]
1.7 LL SLAB1	=	0	[kg/m]
uniform load (w1)	=	980	[kg/m]



FBD



V (kg) SFD



M (kg-m) BMD

Beam size	GB1	b	=	25	[cm]
		h	=	50	[cm]
		d	=	44	[cm]
		fc'	=	240	[kg/cm^2]
		β	=	0.85	
		fy DB	=	4000	[kg/cm^2]
		fy stirrup	=	2400	[kg/cm^2]

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No.	GB1		Job No.			Date	20/9/64
		M^+u	=	810		[kg-m]	
		M-u	=	1125		[kg-m]	
		0.9Mn	=	27655		[kg-m]	
		R+u	=	1.86		[kg/cm^2]	
		R-u	=	2.58		[kg/cm^2]	
		ρ_b	=	0.0262			
		0.75ρb	=	0.0197			
		ρ +Req.	=	0.0005			
		A_{s+}	=	0.51		[cm^2]	
	USED	2	DB	16		As = 4.0	[cm^2]
	ρ_{min} =	0.0035		As_{min}	=	3.85	[cm^2]
	As_{min}	=	DB	16	=	2	Bars
		ρ −Req.	=	0.0006			
		A_{s-}	=	0.71		[cm^2]	
	USED	2	DB	16		As = 4.0	[cm^2]
	ρ_{min} =	0.0035		As_{min}	=	3.85	[cm^2]
	As_{min}	=	DB	16	=	2	Bars

Design Stirrup		**Wu**	=	980	[kg/m]	
		Vu	=	1,275	[kg]	
		ϕVc	=	7677	[kg]	
		Vu@d	=	844	[kg]	
		Vu@d/ϕ − Vc	=	0	[kg]	
	DB	12		No of leg	=	2
		A_s	=	2.26	[cm^2]	
	Spacing	ϕ fy Av d/(Vu-ϕVc)	=	NA.	cm	
		Av fy/3.5b	=	103.4	cm	
		d/2	=	22.0	cm	
		Use Spacing	=	20.0	cm	

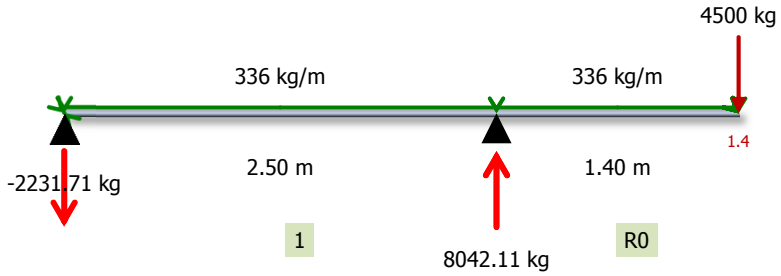
Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

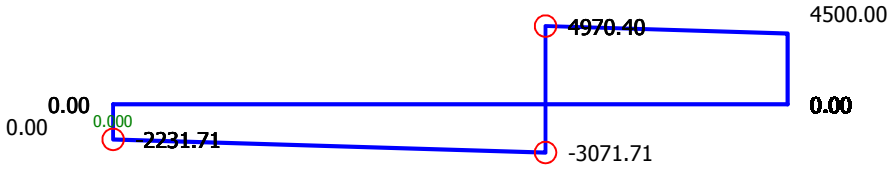
Beam No. GB2&GB2a Job No. Date 20/9/64

Design load on beam

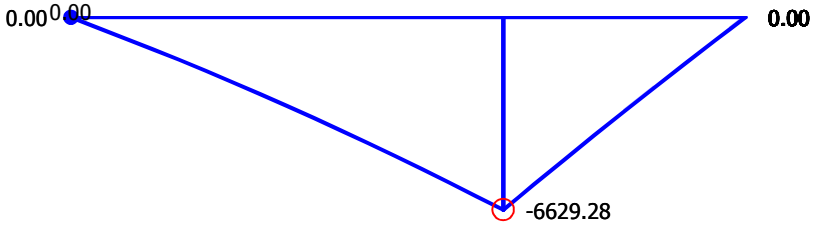
1.4 DL BEAM	=	336	[kg/m]
1.4 DL WALL	=	0	[kg/m]
1.7 LL SLAB1	=	0	[kg/m]
uniform load (w1)	=	336	[kg/m]
1.4 DL BEAM&FENCE	=	4500	[kg]
1.4 DL GUTTER	=	0	[kg]



FBD



V (kg) SFD



M (kg-m) BMD

Beam	GB2&GB2a	b	=	20	[cm]
		h	=	50	[cm]
		d	=	45	[cm]
		fc'	=	240	[kg/cm^2]
		β	=	0.85	

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. GB2&GB2a Job No. Date 20/9/64

fy DB	=	4000	[kg/cm^2]	
fy stirrup	=	2400	[kg/cm^2]	
M^+u	=	0	[kg-m]	
M-u	=	6629	[kg-m]	
0.9Mn	=	23141	[kg-m]	
R+u	=	0.00	[kg/cm^2]	
R-u	=	18.19	[kg/cm^2]	
ρ_b	=	0.0262		
0.75ρb	=	0.0197		
ρ +Req.	=	0.0000		
A_{s+}	=	0.00	[cm^2]	
USED	2 DB	16	As = 4.0	[cm^2]
ρ_{min} =	0.0035	As_{min} =	3.15	[cm^2]
As_{min} =	DB	16 =	2	Bars

ρ –Req.	=	0.0048		
A_{s-}	=	4.29	[cm^2]	
USED	4 DB	16	As = 8.0	[cm^2]
ρ_{min} =	0.0035	As_{min} =	3.15	[cm^2]
As_{min} =	DB	16 =	2	Bars

Design Stirrup

Wu	=	336	[kg/m]
Vu	=	4,970	[kg]
ϕVc	=	6281	[kg]
Vu@d	=	4819	[kg]
Vu@d/ϕ – Vc	=	0	[kg]

RB 9 No of leg = 2

A_s = 1.27 [cm^2]

Spacing	ϕ fy Av d/(Vu-ϕVc)	=	NA. cm
	Av fy/3.5b	=	72.7 cm
	d/2	=	22.5 cm
	Use Spacing	=	20.0 cm

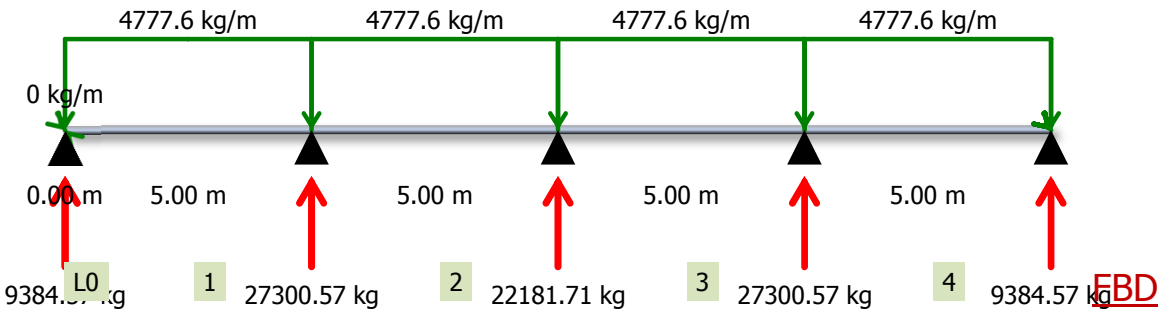
Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

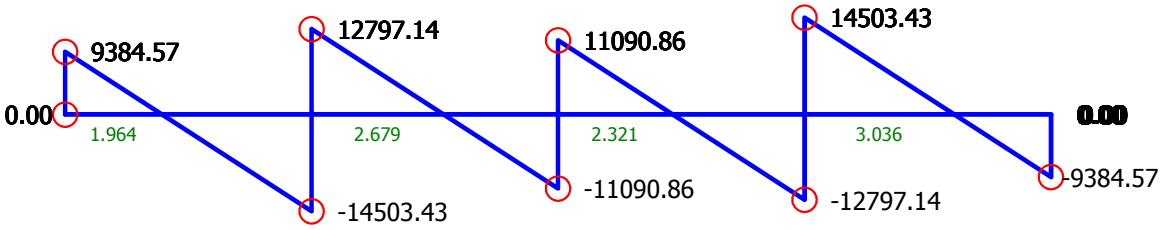
Beam No. NB1 Job No. Date 20/9/64

Design load on beam

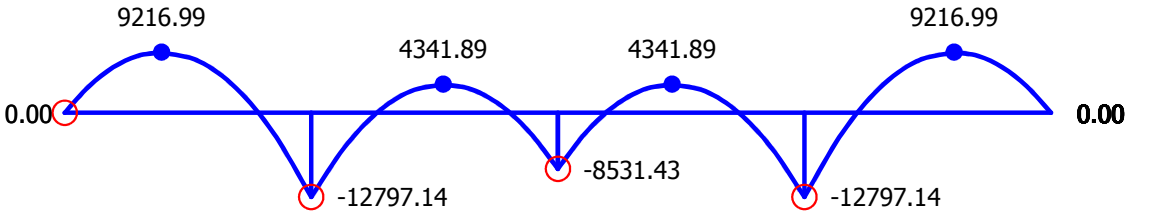
1.4 DL SLAB1	=	1378	[kg/m]
1.4 DL WALL	=	1064	[kg/m]
1.7 LL SLAB1	=	3400	[kg/m]
uniform load (w1)	=	5842	[kg/m]



EBD



V (kg) SFD



M (kg-m) BMD

Beam size NB1	b	=	25	[cm]
	h	=	60	[cm]
	d	=	54	[cm]
	fc'	=	240	[kg/cm^2]
	β	=	0.85	
	fy DB	=	4000	[kg/cm^2]
	fy stirrup	=	2400	[kg/cm^2]

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. NB1 Job No. Date 20/9/64

M^+u	=	9217	[kg-m]	
M-u	=	12797	[kg-m]	
0.9Mn	=	41654	[kg-m]	
R+u	=	14.05	[kg/cm^2]	
R-u	=	19.50	[kg/cm^2]	
ρ_b	=	0.0262		
0.75ρb	=	0.0197		
ρ +Req.	=	0.0036		
A_{s+}	=	4.92	[cm^2]	
USED	4 DB	16	As = 8.0	[cm^2]
ρ_{min} =	0.0035	As_{min} =	4.725	[cm^2]
As_{min} =	DB	16 =	2	Bars

ρ −Req.	=	0.0051		
A_{s-}	=	6.93	[cm^2]	
USED	4 DB	16	As = 8.0	[cm^2]
ρ_{min} =	0.0035	As_{min} =	4.725	[cm^2]
As_{min} =	DB	16 =	2	Bars

Design Stirrup

Wu	=	5842	[kg/m]
Vu	=	14,503	[kg]
ϕVc	=	9422	[kg]
Vu@d	=	11349	[kg]
Vu@d/ϕ − Vc	=	2267	[kg]

DB 12 No of leg = 2

A_s = 2.26 [cm^2]

Spacing	ϕ fy Av d/(Vu-ϕVc)	=	72.1 cm
	Av fy/3.5b	=	103.4 cm
	d/2	=	27.0 cm
	Use Spacing	=	20.0 cm

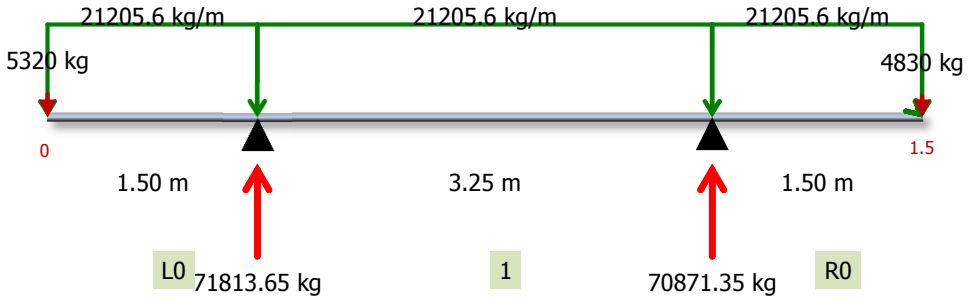
Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

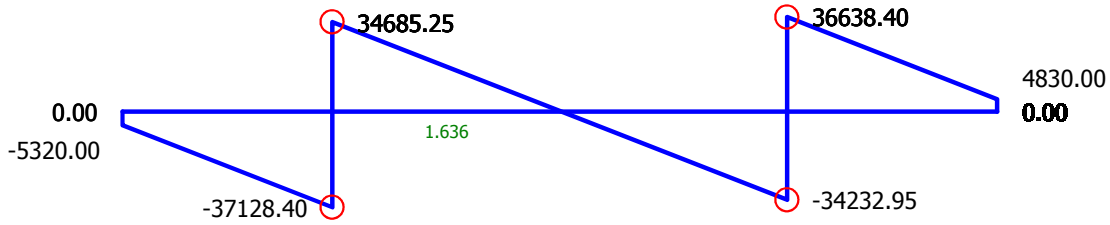
Beam No. NB2&NB2a Job No. Date 20/9/64

Design load on beam

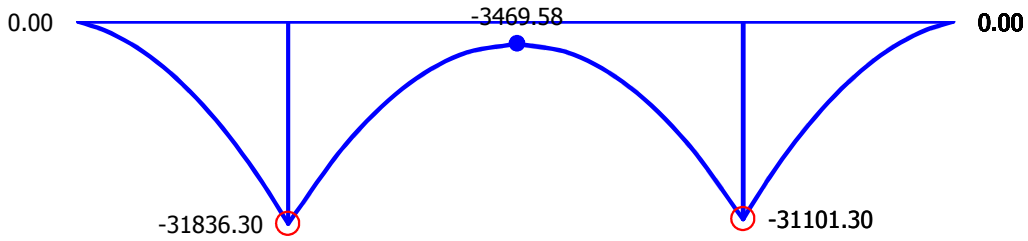
1.4 DL SLAB1	=	4206	[kg/m]
1.4 DL WALL	=	0	[kg/m]
1.7 LL SLAB1	=	17000	[kg/m]
uniform load (w1)	=	21206	[kg/m]
1.4 DL FENCE	=	5320	[kg]
1.4 DL GUTTER	=	4830	[kg]



FBD



V (kg) SFD



M (kg-m) BMD

Beam	NB2&NB2a	b	=	35	[cm]
		h	=	60	[cm]
		d	=	50	[cm]
		fc'	=	240	[kg/cm^2]
		β	=	0.85	

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. NB2&NB2a Job No. Date 20/9/64

	fy DB	=	4000	[kg/cm^2]	
	fy stirrup	=	2400	[kg/cm^2]	
	M^+u	=	-3470	[kg-m]	
	M-u	=	31101	[kg-m]	
	0.9Mn	=	49996	[kg-m]	
	R+u	=	-4.41	[kg/cm^2]	
	R-u	=	39.49	[kg/cm^2]	
	ρ_b	=	0.0262		
	0.75ρb	=	0.0197		
	ρ +Req.	=	-0.0011		
	A_{s+}	=	-1.91	[cm^2]	
USED	4	DB	20	As = 12.6	[cm^2]
ρ_{min} =	0.0035		As_{min} =	6.125	[cm^2]
As_{min} =		DB	25 =	1	Bars

	ρ −Req.	=	0.0111		
	A_{s-}	=	19.38	[cm^2]	
USED	7	DB	20	As = 22.0	[cm^2]
ρ_{min} =	0.0035		As_{min} =	6.125	[cm^2]
As_{min} =		DB	25 =	1	Bars

Design Stirrup

	Wu	=	21206	[kg/m]
	Vu	=	34,685	[kg]
	ϕVc	=	12213	[kg]
	Vu@d	=	24082	[kg]
	Vu@d/ϕ − Vc	=	13964	[kg]

DB 12 No of leg = 2

A_s = 2.26 [cm^2]

Spacing	ϕ fy Av d/(Vu-ϕVc)	=	15.1	cm
	Av fy/3.5b	=	73.9	cm
	d/2	=	25.0	cm
	Use Spacing	=	20.0	cm

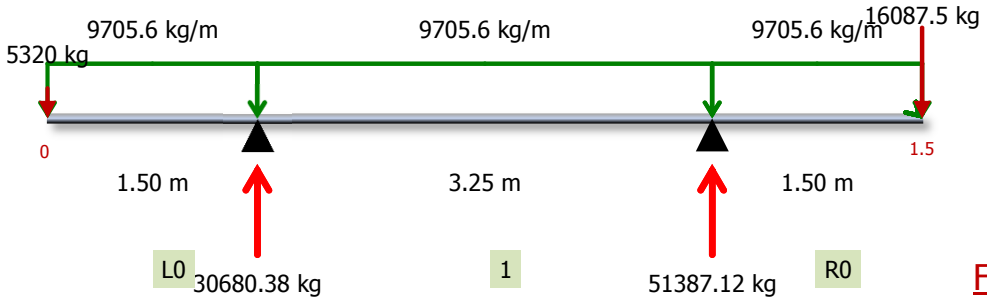
Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

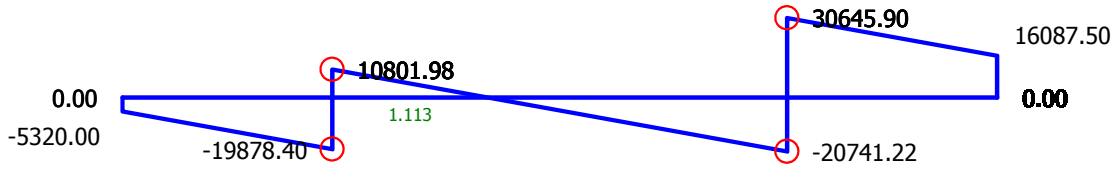
Beam No. NB2&NB4a Job No. Date 20/9/64

Design load on beam

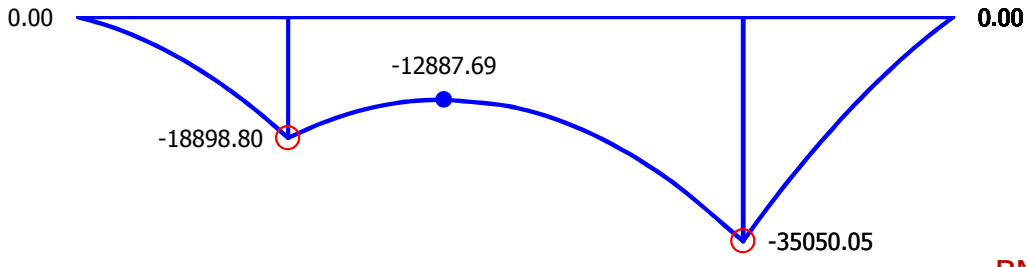
1.4 DL SLAB1	=	3331	[kg/m]
1.4 DL WALL	=	0	[kg/m]
1.7 LL SLAB1	=	6375	[kg/m]
uniform load (w1)	=	9706	[kg/m]
1.4 DL FENCE	=	5320	[kg]
1.4 DL roof&NB&wall+1.7 LL roof	=	16088	[kg]



FBD



V (kg) SFD



M (kg-m) BMD

Beam	NB2&NB4a	b	=	35	[cm]
		h	=	60	[cm]
		d	=	50	[cm]
		fc'	=	240	[kg/cm^2]
		β	=	0.85	

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. NB2&NB4a Job No. Date 20/9/64

fy DB	=	4000	[kg/cm^2]	
fy stirrup	=	2400	[kg/cm^2]	
M^+u	=	12888	[kg-m]	
M-u	=	35050	[kg-m]	
0.9Mn	=	49996	[kg-m]	
R+u	=	16.37	[kg/cm^2]	
R-u	=	44.51	[kg/cm^2]	
ρ_b	=	0.0262		
0.75ρb	=	0.0197		
ρ +Req.	=	0.0043		
A_{s+}	=	7.47	[cm^2]	
USED	4 DB	20	As = 12.6	[cm^2]
ρ_{min} =	0.0035	As_{min} =	6.125	[cm^2]
As_{min} =	DB	20 =	2	Bars

ρ −Req.	=	0.0127		
A_{s-}	=	22.24	[cm^2]	
USED	8 DB	20	As = 25.1	[cm^2]
ρ_{min} =	0.0035	As_{min} =	6.125	[cm^2]
As_{min} =	DB	20 =	2	Bars

Design Stirrup

Wu	=	9706	[kg/m]
Vu	=	10,802	[kg]
ϕVc	=	12213	[kg]
Vu@d	=	5949	[kg]
Vu@d/ϕ − Vc	=	0	[kg]

DB 12 No of leg = 4

A_s = 4.52 [cm^2]

Spacing	ϕ fy Av d/(Vu-ϕVc)	=	NA. cm
	Av fy/3.5b	=	147.7 cm
	d/2	=	25.0 cm
	Use Spacing	=	25.0 cm

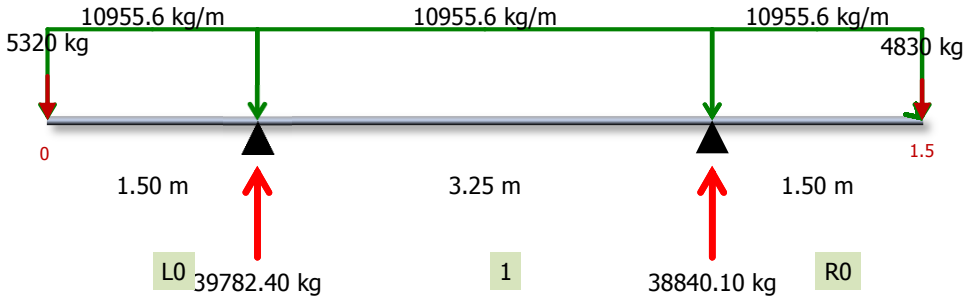
Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

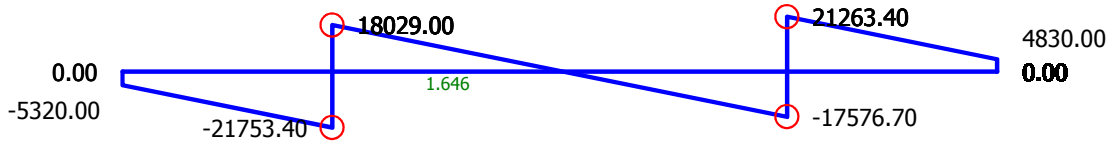
Beam No. NB3&NB3a Job No. Date 20/9/64

Design load on beam

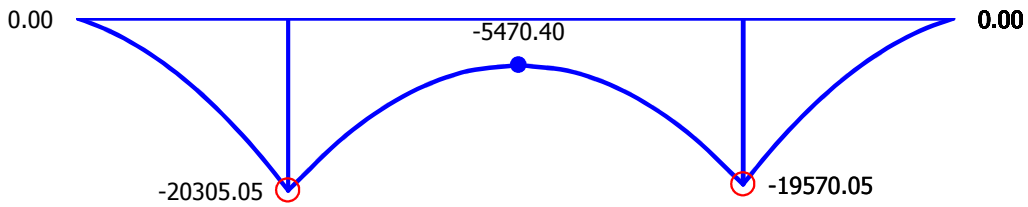
1.4 DL SLAB1	=	2456	[kg/m]
1.4 DL WALL	=	0	[kg/m]
1.7 LL SLAB1	=	8500	[kg/m]
uniform load (w1)	=	10956	[kg/m]
1.4 DL FENCE	=	5320	[kg]
1.4 DL GUTTER	=	4830	[kg]



FBD



V (kg) SFD



M (kg-m) BMD

Beam	NB3&NB3a	b	=	35	[cm]
		h	=	60	[cm]
		d	=	50	[cm]
		fc'	=	240	[kg/cm^2]
		β	=	0.85	

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. NB3&NB3a Job No. Date 20/9/64

	fy DB	=	4000	[kg/cm^2]	
	fy stirrup	=	2400	[kg/cm^2]	
	M^+u	=	5470	[kg-m]	
	M-u	=	19570	[kg-m]	
	0.9Mn	=	49996	[kg-m]	
	R+u	=	6.95	[kg/cm^2]	
	R-u	=	24.85	[kg/cm^2]	
	ρ_b	=	0.0262		
	0.75ρb	=	0.0197		
	ρ +Req.	=	0.0018		
	A_{s+}	=	3.09	[cm^2]	
USED	4	DB	20	As = 12.6	[cm^2]
ρ_{min} =	0.0035		As_{min} =	6.125	[cm^2]
As_{min} =		DB	20 =	2	Bars

	ρ −Req.	=	0.0066		
	A_{s-}	=	11.63	[cm^2]	
USED	8	DB	20	As = 25.1	[cm^2]
ρ_{min} =	0.0035		As_{min} =	6.125	[cm^2]
As_{min} =		DB	20 =	2	Bars

Design Stirrup

Wu	=	10956	[kg/m]	
Vu	=	18,029	[kg]	
ϕVc	=	12213	[kg]	
Vu@d	=	12551	[kg]	
Vu@d/ϕ − Vc	=	397	[kg]	
DB 12		No of leg =	4	
A_s	=	4.52	[cm^2]	
Spacing ϕ fy Av d/(Vu-ϕVc)	=	116.7	cm	
Av fy/3.5b	=	147.7	cm	
d/2	=	25.0	cm	
Use Spacing	=	25.0	cm	

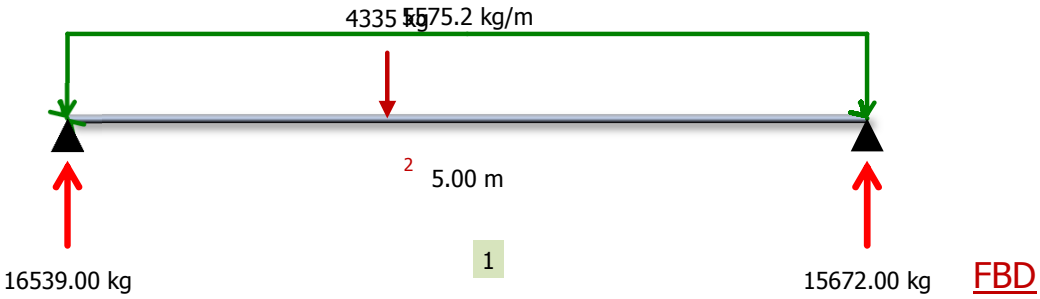
Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

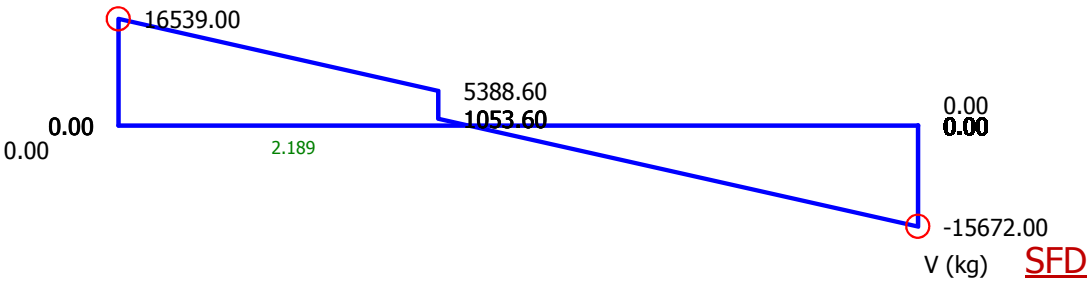
Beam No. NB4 Job No. Date 20/9/64

Design load on beam

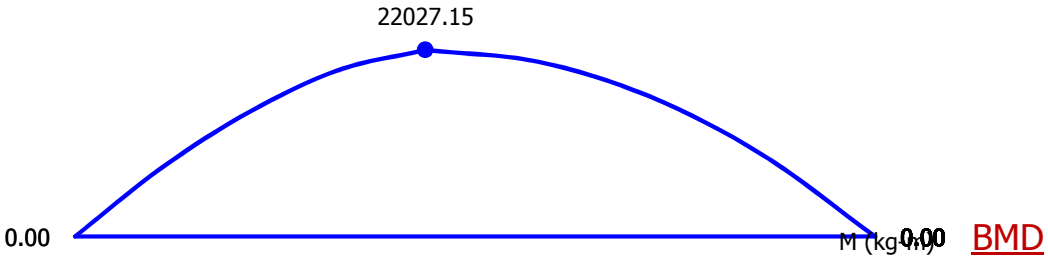
1.4 DL SLAB1	=	1495	[kg/m]
1.4 DL WALL	=	0	[kg/m]
1.7 LL SLAB1	=	4080	[kg/m]
uniform load (w1)	=	5575	[kg/m]
1.7 LL FENCE	=	4335	[kg]
1.7 MLL FENCE	=	4055	[kg]



FBD



SFD



BMD

Beam	NB4	b	=	35	[cm]
		h	=	60	[cm]
		d	=	50	[cm]
		fc'	=	240	[kg/cm^2]
		β	=	0.85	

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. NB4 Job No. Date 20/9/64

fy DB	=	4000	[kg/cm^2]		
fy stirrup	=	2400	[kg/cm^2]		
M^+u	=	26082	[kg-m]		
M-u	=	0	[kg-m]		
0.9Mn	=	49996	[kg-m]		
R+u	=	33.12	[kg/cm^2]		
R-u	=	0.00	[kg/cm^2]		
ρ_b	=	0.0262			
0.75ρb	=	0.0197			
ρ +Req.	=	0.0091			
A_{s+}	=	15.91	[cm^2]		
USED	6	DB	20	As = 18.8	[cm^2]
ρ_{min} =	0.0035		As_{min} =	6.125	[cm^2]
As_{min} =		DB	20 =	2	Bars

ρ −Req.	=	0.0000			
A_{s-}	=	0.00	[cm^2]		
USED	2	DB	20	As = 6.3	[cm^2]
ρ_{min} =	0.0035		As_{min} =	6.125	[cm^2]
As_{min} =		DB	20 =	2	Bars

Design Stirrup

Wu	=	5575	[kg/m]	
Vu	=	16,539	[kg]	
ϕVc	=	12213	[kg]	
Vu@d	=	13751	[kg]	
Vu@d/ϕ − Vc	=	1809	[kg]	
DB 12		No of leg =	2	
A_s	=	2.26	[cm^2]	

Spacing	ϕ fy Av d/(Vu-ϕVc)	=	78.4 cm
	Av fy/3.5b	=	73.9 cm
	d/2	=	25.0 cm
	Use Spacing	=	20.0 cm

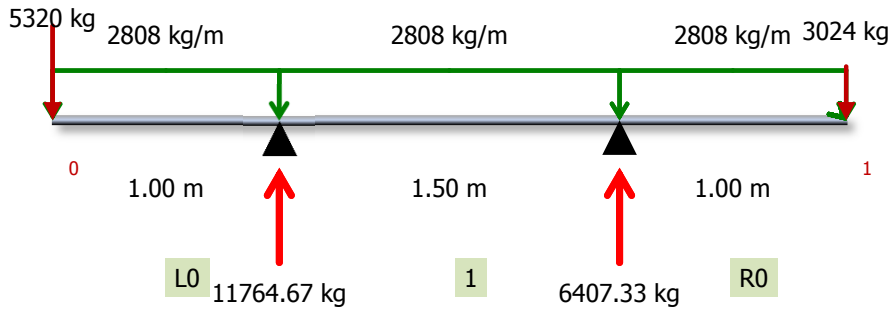
Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

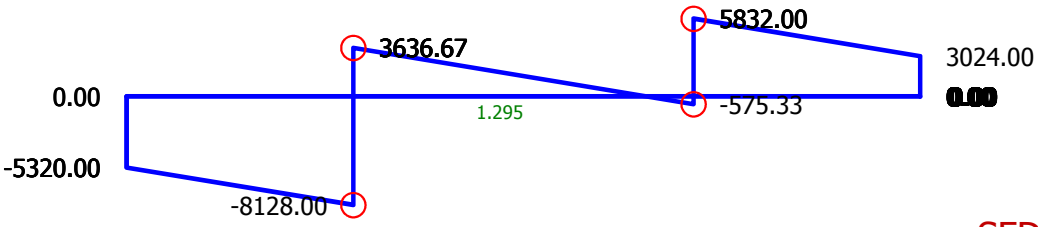
Beam No.LB5&NB5a Job No. Date 20/9/64

Design load on beam

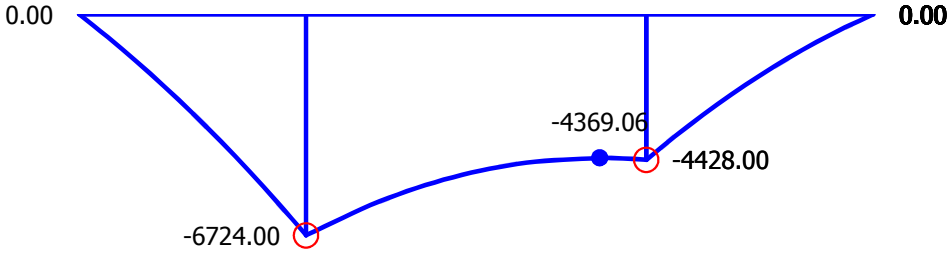
1.4 DL SLAB1	=	1176	[kg/m]
1.4 DL WALL	=	0	[kg/m]
1.7 LL SLAB1	=	1632	[kg/m]
uniform load (w1)	=	2808	[kg/m]



FBD



V (kg) SFD



M (kg-m) BMD

Beam size LB5&NB5a	b	=	25	[cm]
	h	=	60	[cm]
	d	=	53	[cm]
	fc'	=	240	[kg/cm^2]
	β	=	0.85	
	fy DB	=	4000	[kg/cm^2]
	fy stirrup	=	2400	[kg/cm^2]

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No.LB5&NB5a Job No. Date 20/9/64

$M^{+}u$	=	0	[kg-m]	
M-u	=	6724	[kg-m]	
0.9Mn	=	40125	[kg-m]	
R+u	=	0.00	[kg/cm^2]	
R-u	=	10.64	[kg/cm^2]	
ρ_b	=	0.0262		
0.75ρb	=	0.0197		
ρ +Req.	=	0.0000		
A_{s+}	=	0.00	[cm^2]	
USED 2	DB	16	As = 4.0	[cm^2]
ρ_{min} = 0.0035		As_{min} =	4.6375	[cm^2]
As_{min} =	DB	16 =	2	Bars

ρ −Req.	=	0.0027		
A_{s-}	=	3.62	[cm^2]	
USED 2	DB	16	As = 4.0	[cm^2]
ρ_{min} = 0.0035		As_{min} =	4.6375	[cm^2]
As_{min} =	DB	16 =	2	Bars

Design Stirrup

Wu	=	2808	[kg/m]	
Vu	=	3,637	[kg]	
ϕVc	=	9247	[kg]	
Vu@d	=	2148	[kg]	
Vu@d/ϕ − Vc	=	0	[kg]	

RB 9 No of leg = 2

A_s = 1.27 [cm^2]

Spacing	ϕ fy Av d/(Vu-ϕVc)	=	NA.	cm
	Av fy/3.5b	=	58.2	cm
	d/2	=	26.5	cm
	Use Spacing	=	20.0	cm

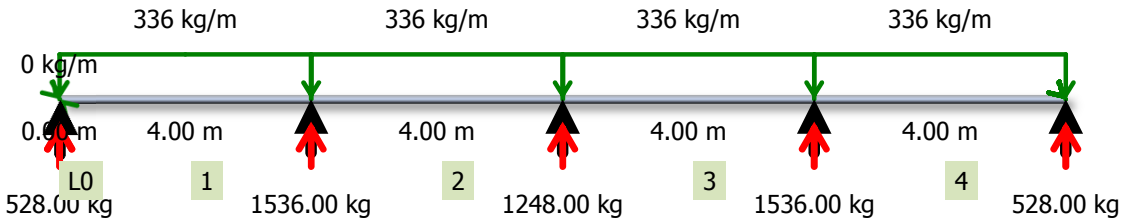
Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

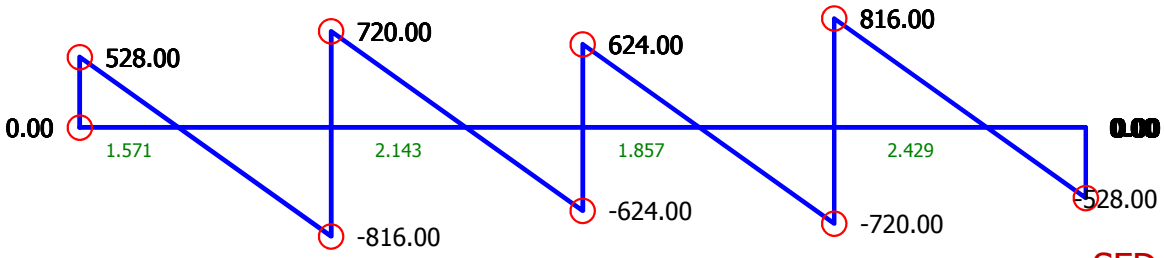
Beam No. NB6 Job No. Date 20/9/64

Design load on beam

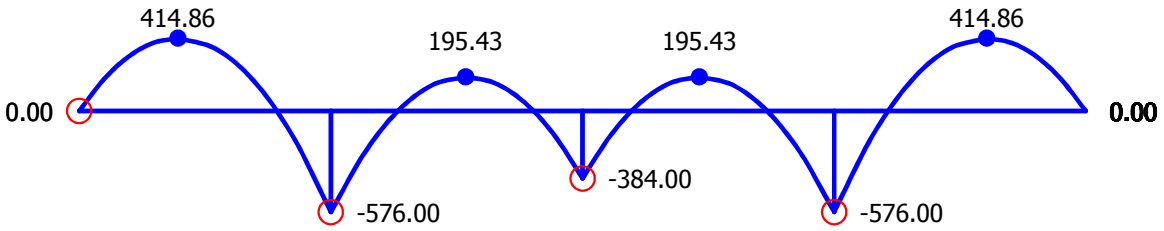
1.4 DL BEAM	=	336	[kg/m]
1.4 DL WALL	=	840	[kg/m]
1.7 LL SLAB1	=	0	[kg/m]
uniform load (w1)	=	1176	[kg/m]



FBD



V (kg) SFD



M (kg-m) BMD

Beam size	NB6	b	=	20	[cm]
		h	=	50	[cm]
		d	=	44	[cm]
		fc'	=	240	[kg/cm^2]
		β	=	0.85	
		fy DB	=	4000	[kg/cm^2]
		fy stirrup	=	2400	[kg/cm^2]

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. NB6 Job No. Date 20/9/64

M^+u	=	415	[kg-m]	
M-u	=	576	[kg-m]	
0.9Mn	=	22124	[kg-m]	
R+u	=	1.19	[kg/cm^2]	
R-u	=	1.65	[kg/cm^2]	
ρ_b	=	0.0262		
0.75ρb	=	0.0197		
ρ +Req.	=	0.0003		
A_{s+}	=	0.26	[cm^2]	
USED 2	DB	16	As = 4.0	[cm^2]
ρ_{min} = 0.0035		As_{min} =	3.08	[cm^2]
As_{min} =	DB	16 =	2	Bars

ρ −Req.	=	0.0004		
A_{s-}	=	0.37	[cm^2]	
USED 2	DB	16	As = 4.0	[cm^2]
ρ_{min} = 0.0035		As_{min} =	3.08	[cm^2]
As_{min} =	DB	16 =	2	Bars

Design Stirrup

Wu	=	1176	[kg/m]
Vu	=	816	[kg]
ϕVc	=	6142	[kg]
Vu@d	=	299	[kg]
Vu@d/ϕ − Vc	=	0	[kg]

RB 9 No of leg = 2

A_s = 1.27 [cm^2]

Spacing	ϕ fy Av d/(Vu-ϕVc)	=	NA. cm
	Av fy/3.5b	=	72.7 cm
	d/2	=	22.0 cm
	Use Spacing	=	20.0 cm

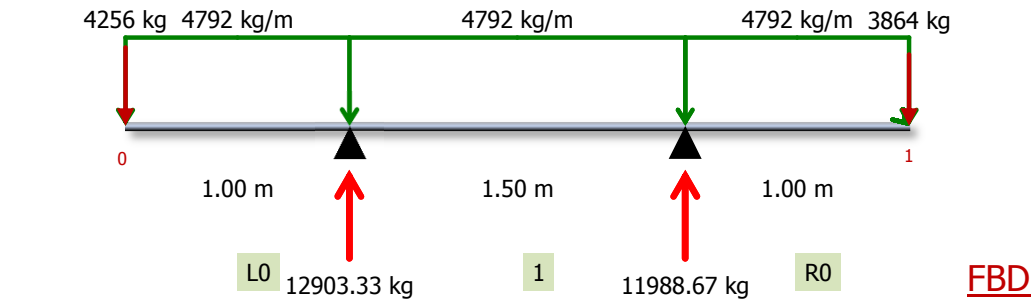
Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

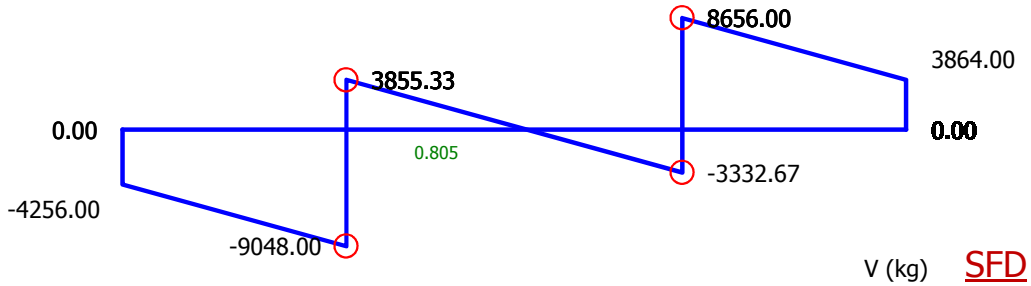
Beam No. NB7&NB7a Job No. Date 20/9/64

Design load on beam

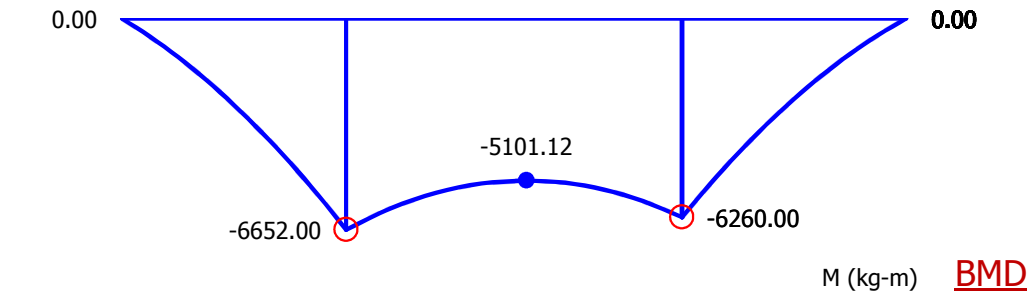
1.4 DL SLAB1	=	2072	[kg/m]
1.4 DL WALL	=	0	[kg/m]
1.7 LL SLAB1	=	2720	[kg/m]
uniform load (w1)	=	4792	[kg/m]
1.4 DL FENCE	=	4256	[kg]
1.4 DL GUTTER	=	3864	[kg]



FBD



V (kg) SFD



M (kg-m) BMD

Beam	NB7&NB7a	b	=	20	[cm]
		h	=	50	[cm]
		d	=	45	[cm]
		fc'	=	240	[kg/cm^2]
		β	=	0.85	

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. NB7&NB7a | Job No. | Date 20/9/64

fy DB	=	4000	[kg/cm^2]	
fy stirrup	=	2400	[kg/cm^2]	
M^+u	=	5101	[kg-m]	
M-u	=	6260	[kg-m]	
0.9Mn	=	23141	[kg-m]	
R+u	=	13.99	[kg/cm^2]	
R-u	=	17.17	[kg/cm^2]	
ρ_b	=	0.0262		
0.75ρb	=	0.0197		
ρ +Req.	=	0.0036		
A_{s+}	=	3.26	[cm^2]	

USED 2 DB 16 As = 4.0 [cm^2]

ρ_{min} = 0.0035 As_{min} = 3.15 [cm^2]

As_{min} = DB 16 = 2 Bars

ρ −Req.	=	0.0045		
A_{s-}	=	4.04	[cm^2]	

USED 2 DB 16 As = 4.0 [cm^2]

ρ_{min} = 0.0035 As_{min} = 3.15 [cm^2]

As_{min} = DB 16 = 2 Bars

Design Stirrup

Wu	=	4792	[kg/m]	
Vu	=	3,855	[kg]	
ϕVc	=	6281	[kg]	
Vu@d	=	1699	[kg]	
Vu@d/ϕ − Vc	=	0	[kg]	

RB 9 No of leg = 2

A_s = 1.27 [cm^2]

Spacing	ϕ fy Av d/(Vu-ϕVc)	=	NA. cm
	Av fy/3.5b	=	72.7 cm
	d/2	=	22.5 cm
	Use Spacing	=	20.0 cm

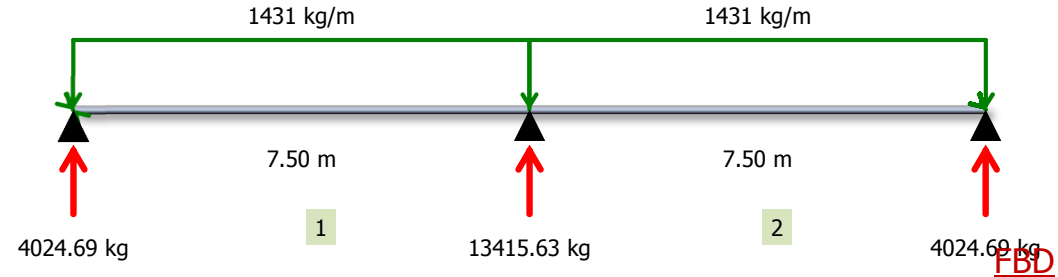
Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

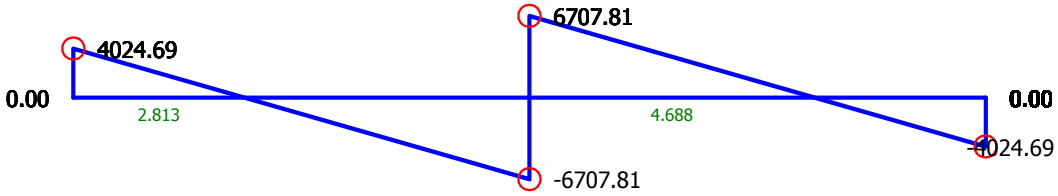
Beam No. NRB1 Job No. Date 20/9/64

Design load on beam

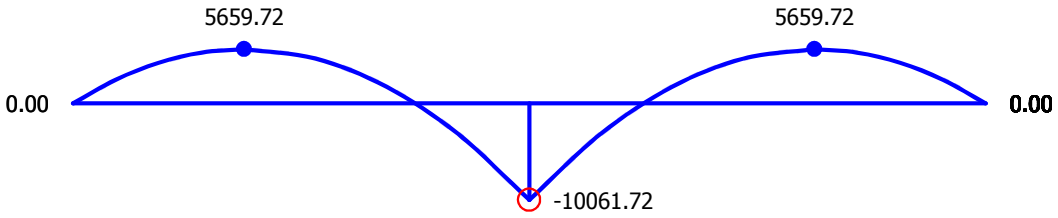
1.4 DL SLAB1	=	1176	[kg/m]
1.4 DL WALL	=	0	[kg/m]
1.7 LL SLAB1	=	255	[kg/m]
uniform load (w1)	=	1431	[kg/m]
point load (p1)	=	0	kg



FBD



V (kg) SFD



M (kg-m) BMD

Beam size	NRB1	b	=	25	[cm]
		h	=	50	[cm]
		d	=	44	[cm]
		fc'	=	240	[kg/cm^2]
		β	=	0.85	
		fy DB	=	4000	[kg/cm^2]
		fy stirrup	=	2400	[kg/cm^2]

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No.	NRB1		Job No.		Date	20/9/64
		M^+u	=	5660	[kg-m]	
		M-u	=	10062	[kg-m]	
		0.9Mn	=	27655	[kg-m]	
		R+u	=	12.99	[kg/cm^2]	
		R-u	=	23.10	[kg/cm^2]	
		ρ_b	=	0.0262		
		0.75ρb	=	0.0197		
		ρ +Req.	=	0.0034		
		A_{s+}	=	3.69	[cm^2]	
	USED	4	DB	16	As = 8.0	[cm^2]
	ρ_{min} =	0.0035		As_{min} =	3.85	[cm^2]
	As_{min} =		DB	16 =	2	Bars
		ρ −Req.	=	0.0061		
		A_{s-}	=	6.76	[cm^2]	
	USED	4	DB	16	As = 8.0	[cm^2]
	ρ_{min} =	0.0035		As_{min} =	3.85	[cm^2]
	As_{min} =		DB	16 =	2	Bars

Design Stirrup	Wu	=	1431	[kg/m]	
	Vu	=	6,708	[kg]	
	ϕVc	=	7677	[kg]	
	Vu@d	=	6078	[kg]	
	Vu@d/ϕ − Vc	=	0	[kg]	
	RB 9		No of leg =	2	
	A_s	=	1.27	[cm^2]	
Spacing	ϕ fy Av d/(Vu-ϕVc)	=	NA.	cm	
	Av fy/3.5b	=	58.2	cm	
	d/2	=	22.0	cm	
	Use Spacing	=	20.0	cm	

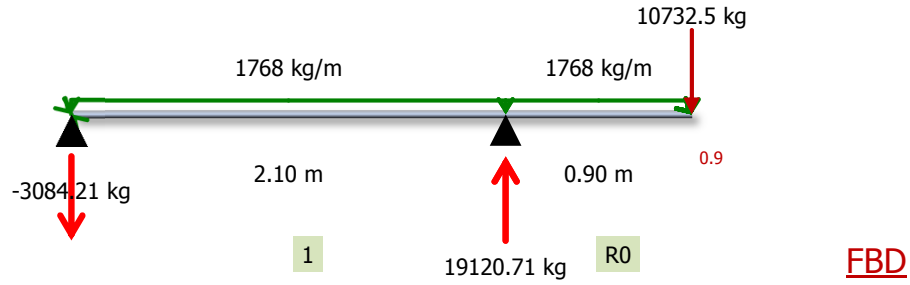
Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. NRB2&2a Job No. Date 20/9/64

Design load on beam

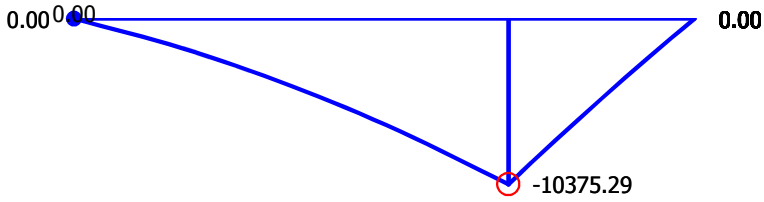
1.4 DL SLAB1	=	1428	[kg/m]
1.4 DL WALL	=	0	[kg/m]
1.7 LL SLAB1	=	340	[kg/m]
uniform load (w1)	=	1768	[kg/m]
point load (p1)	=	10733	kg



FBD



V (kg) SFD



M (kg-m) BMD

Beam size NRB2&2a	b	=	25	[cm]
	h	=	50	[cm]
	d	=	44	[cm]
	fc'	=	240	[kg/cm^2]
	β	=	0.85	
	fy DB	=	4000	[kg/cm^2]
	fy stirrup	=	2400	[kg/cm^2]

Design Reinforced Concrete Beam

(Ultimate Stress Design method in accordance with ACI 318-89)

Beam No. NRB2&2a Job No. Date 20/9/64

$M^{+}u$	=	0	[kg-m]	
M-u	=	10375	[kg-m]	
0.9Mn	=	27655	[kg-m]	
R+u	=	0.00	[kg/cm^2]	
R-u	=	23.82	[kg/cm^2]	
ρ_b	=	0.0262		
0.75ρb	=	0.0197		
ρ +Req.	=	0.0000		
A_{s+}	=	0.00	[cm^2]	
USED 2	DB	16	As = 4.0	[cm^2]
ρ_{min} = 0.0035		As_{min} =	3.85	[cm^2]
As_{min} =	DB	16 =	2	Bars

ρ −Req.	=	0.0063		
A_{s-}	=	6.98	[cm^2]	
USED 4	DB	16	As = 8.0	[cm^2]
ρ_{min} = 0.0035		As_{min} =	3.85	[cm^2]
As_{min} =	DB	16 =	2	Bars

Design Stirrup

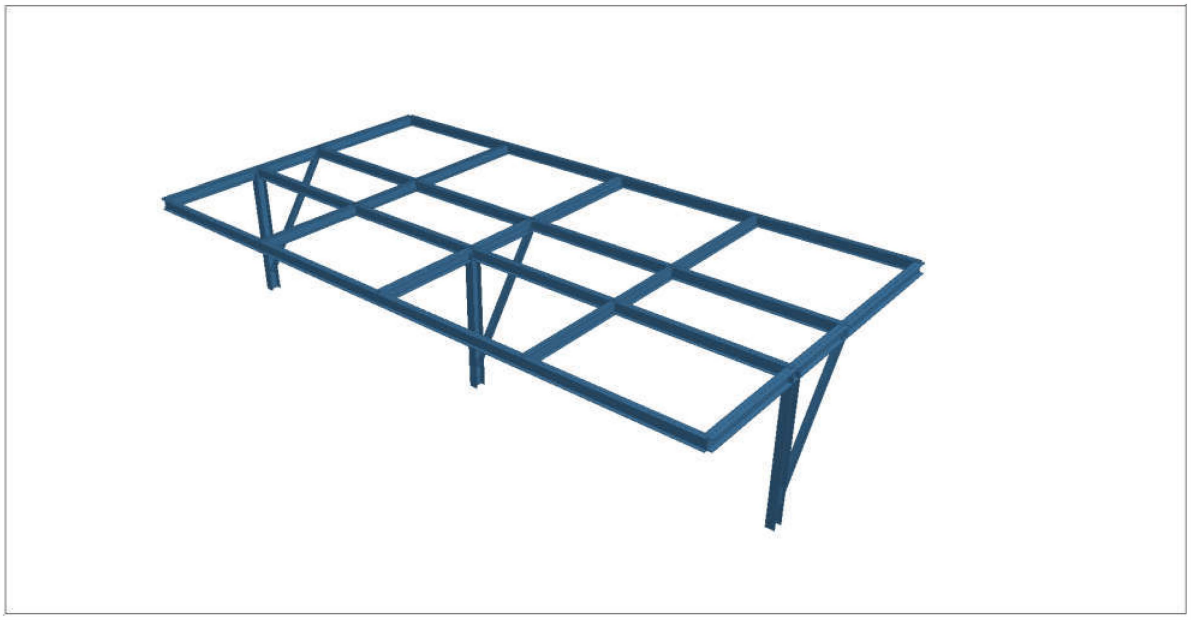
Wu	=	1768	[kg/m]	
Vu	=	12,324	[kg]	
ϕVc	=	7677	[kg]	
Vu@d	=	11546	[kg]	
Vu@d/ϕ − Vc	=	4551	[kg]	

RB 9 No of leg = 2

A_s = 1.27 [cm^2]

Spacing	ϕ fy Av d/(Vu-ϕVc)	=	36.1	cm
	Av fy/3.5b	=	58.2	cm
	d/2	=	22.0	cm
	Use Spacing	=	20.0	cm

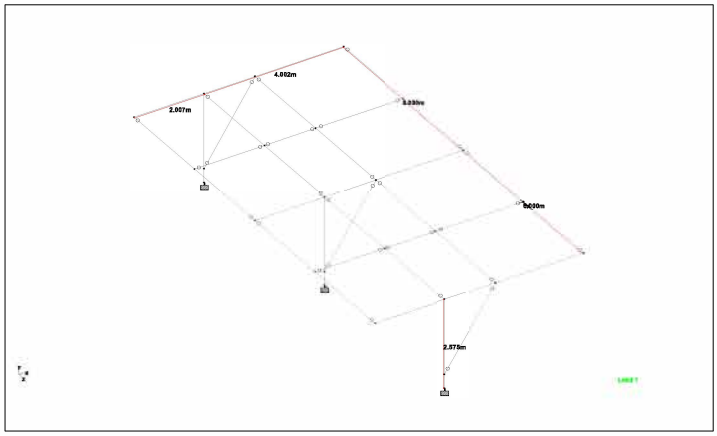
Software licensed to	Job No	Sheet No 1	Rev
	Part car park roof		
Job Title Office of the NBTC (building G)	Ref		
	By	Date	Chd
Client NBTC	File car roof---.std	Date/Time 13-Sep-2021 16:50	



3D Rendered View

Materials

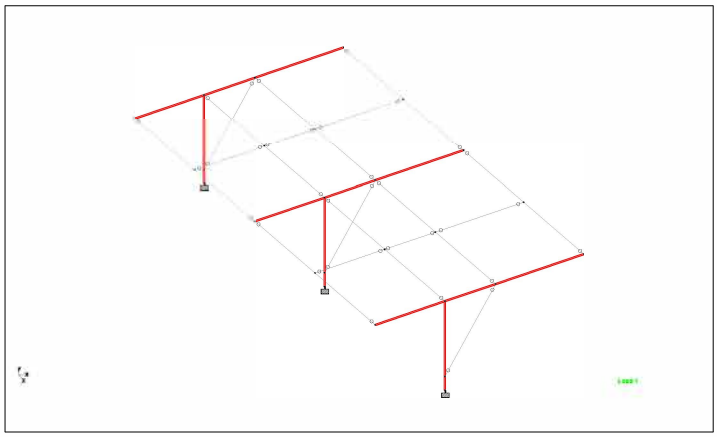
Mat	Name	E (kN/mm^2)	ν	Density (kg/m^3)	α (/°C)
1	STEEL	205.000	0.300	7.83E+3	12E -6
2	STAINLESSSTEEL	197.930	0.300	7.83E+3	18E -6
3	ALUMINUM	68.948	0.330	2.71E+3	23E -6
4	CONCRETE	21.718	0.170	2.4E+3	10E -6



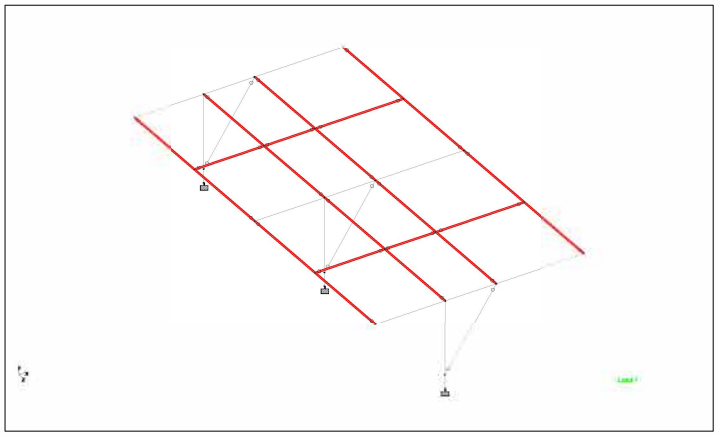
Dimensions

Section Properties

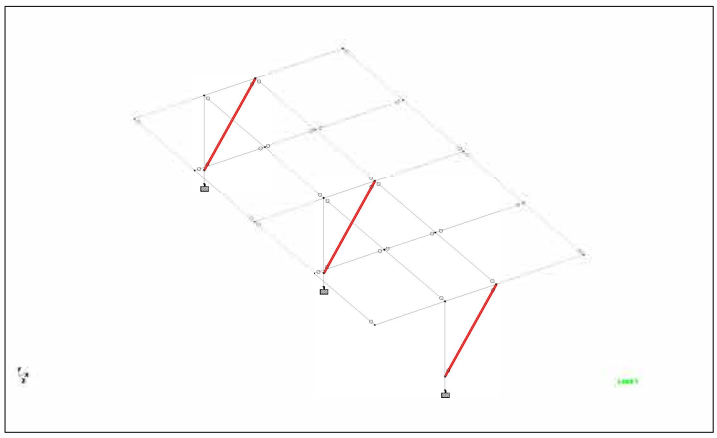
Prop	Section	Area (cm^2)	I_{yy} (cm^4)	I_{zz} (cm^4)	J (cm^4)	Material
1	H194X150X6	38.110	507.000	2.63E+3	8.622	STEEL
2	H200X100X5.5	26.670	134.000	1.81E+3	4.478	STEEL
3	H100X100X6	21.590	134.000	378.000	4.076	STEEL



H200x150



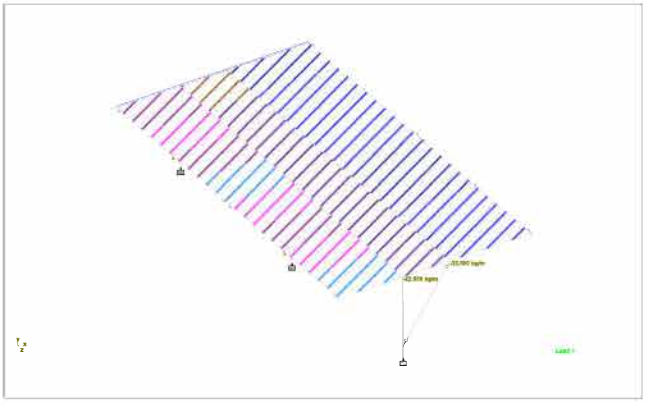
H200x100



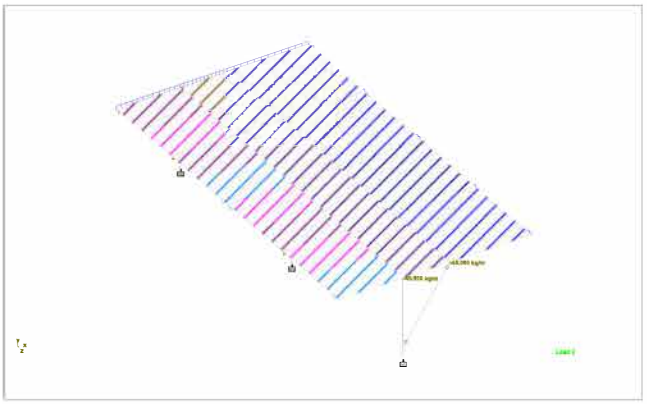
H100x100

Primary Load Cases

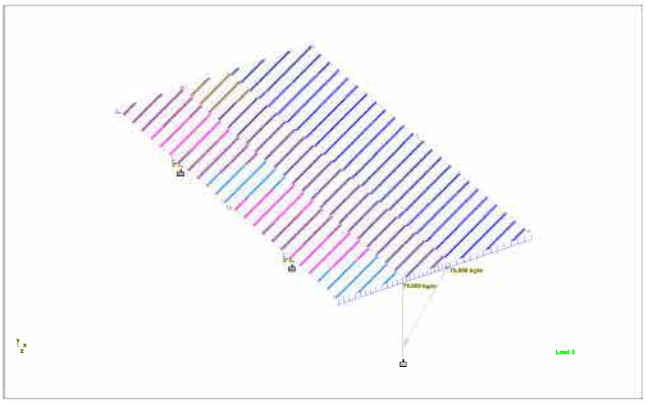
Number	Name	Type
1	DL	Dead
2	LL	Live
3	WL	Wind



DL+SDL



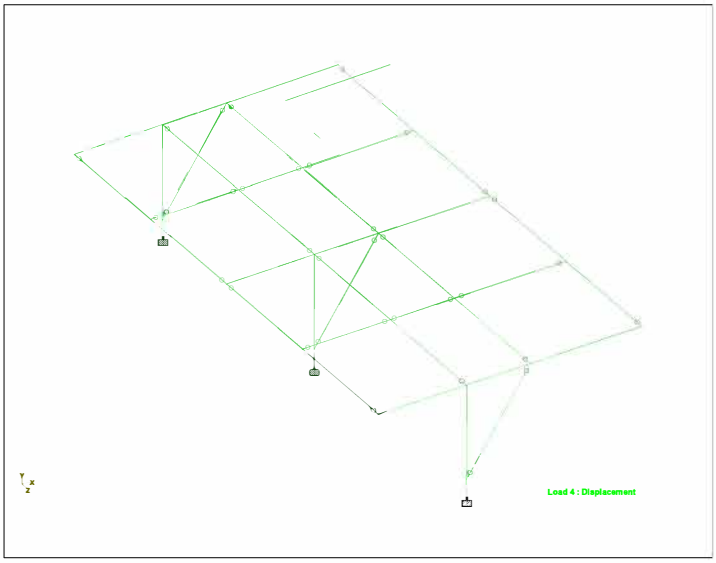
LL



WL

Combination Load Cases

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
4	COMBINATION LOAD CASE 4	1	DL	1.00
		2	LL	1.00
5	COMBINATION LOAD CASE 5	1	DL	1.00
		3	WL	1.00



Whole Structure Displacements 1000mm:1m 4 COMBINATION LOAD CASE 4

Node Displacement Summary

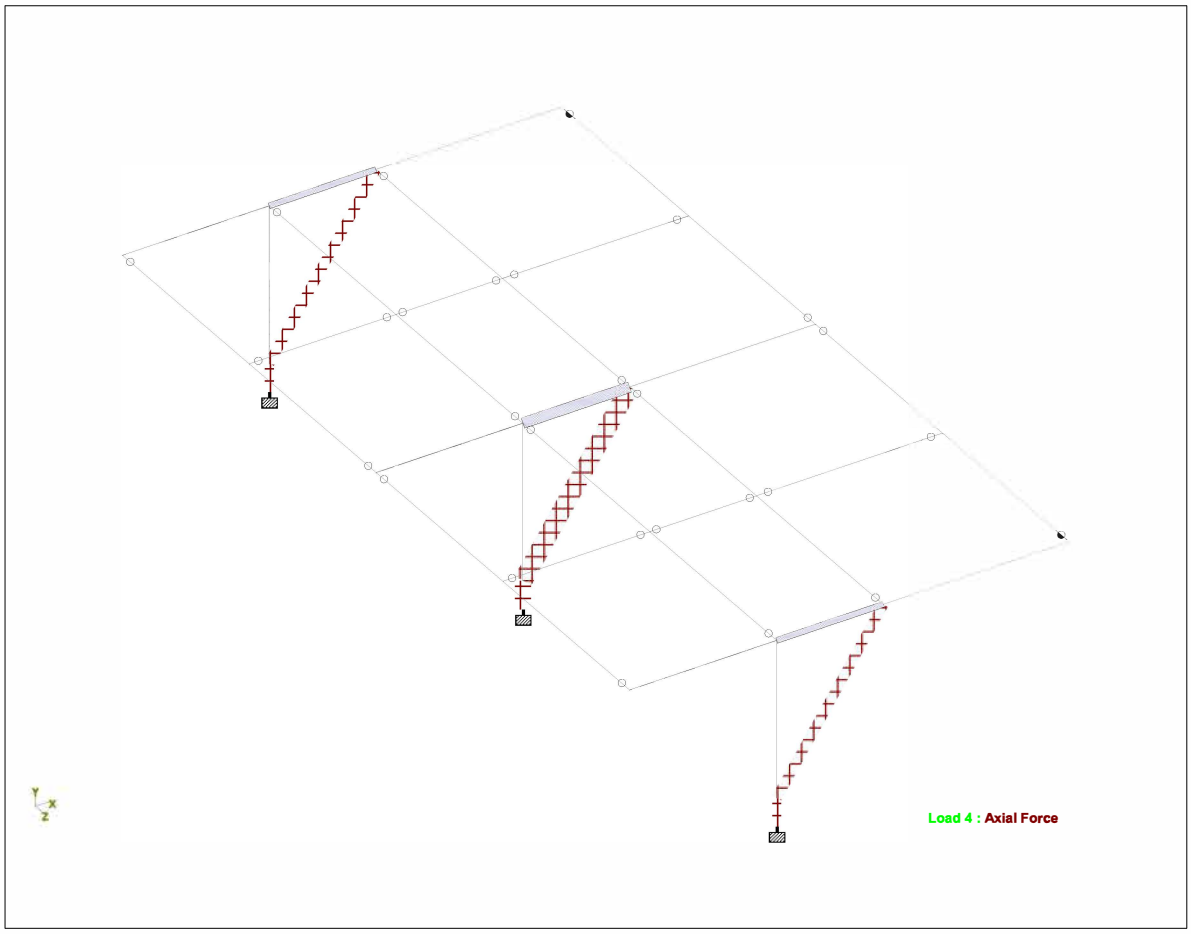
	Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)	rX (rad)	rY (rad)	rZ (rad)
Max X	11	4:COMBINATIC	**11.110**	-25.816	0.000	28.105	0.000	0.000	-0.008
Min X	11	3:WL	**-8.398**	19.072	0.000	20.839	0.000	0.000	0.006
Max Y	11	3:WL	-8.398	**19.072**	0.000	20.839	0.000	0.000	0.006
Min Y	11	4:COMBINATIC	11.110	**-25.816**	0.000	28.105	0.000	0.000	-0.008
Max Z	1	1:DL	3.533	-8.238	**0.000**	8.963	0.000	0.000	-0.003
Min Z	1	1:DL	3.533	-8.238	**0.000**	8.963	0.000	0.000	-0.003
Max rX	27	4:COMBINATIC	8.547	-23.221	0.000	24.744	**0.002**	0.001	0.000
Min rX	28	4:COMBINATIC	8.547	-23.221	0.000	24.744	**-0.002**	-0.001	0.000
Max rY	27	4:COMBINATIC	8.547	-23.221	0.000	24.744	0.002	**0.001**	0.000
Min rY	28	4:COMBINATIC	8.547	-23.221	0.000	24.744	-0.002	**-0.001**	0.000
Max rZ	11	3:WL	-8.398	19.072	0.000	20.839	0.000	0.000	**0.006**
Min rZ	11	4:COMBINATIC	11.110	-25.816	0.000	28.105	0.000	0.000	**-0.008**
Max Rst	11	4:COMBINATIC	11.110	-25.816	0.000	**28.105**	0.000	0.000	-0.008

Beam End Displacement Summary

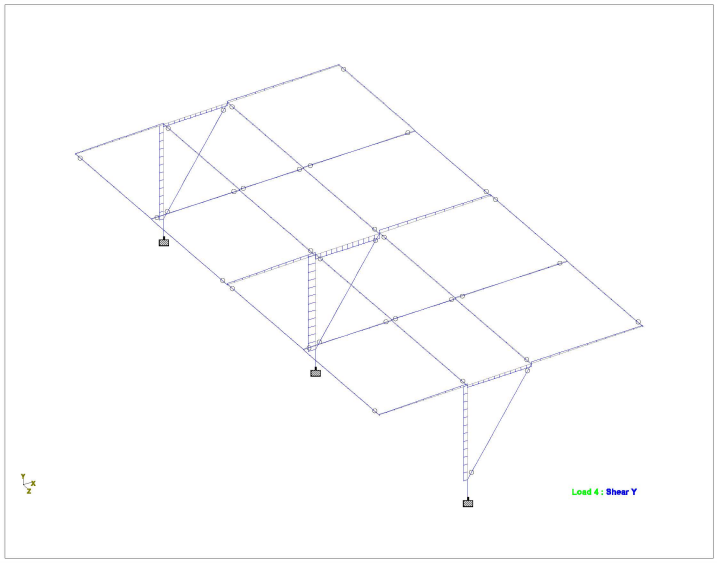
Displacements shown in italic indicate the presence of an offset

	Beam	Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	29	11	4:COMBINATIC	**11.111**	-25.816	0.000	28.105
Min X	29	11	3:WL	**-8.398**	19.072	0.000	20.839
Max Y	29	11	3:WL	-8.398	**19.072**	0.000	20.839
Min Y	29	11	4:COMBINATIC	11.111	**-25.816**	0.000	28.105
Max Z	2	3	1:DL	0.000	0.000	**0.000**	0.000
Min Z	2	3	1:DL	0.000	0.000	**0.000**	0.000
Max Rst	29	11	4:COMBINATIC	11.111	-25.816	0.000	**28.105**

Software licensed to	Job No	Sheet No 5	Rev
	Part car park roof		
Job Title Office of the NBTC (building G)	Ref		
	By	Date	Chd
Client NBTC	File car roof---.std	Date/Time 13-Sep-2021 16:50	

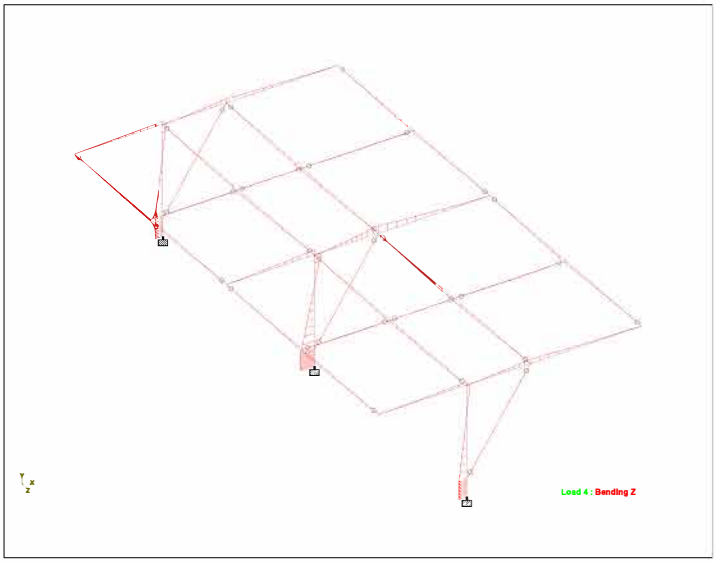


Whole Structure Fx 26512.6kg:1m 4 COMBINATION LOAD CASE 4



Whole Structure Fy 10197.2kg:1m 4 COMBINATION LOAD CASE 4

Software licensed to	Job No	Sheet No 6	Rev
	Part car park roof		
Job Title Office of the NBTC (building G)	Ref		
	By	Date	Chd
Client NBTC	File car roof---.std	Date/Time 13-Sep-2021 16:50	



Whole Structure Mz 7647.87kg-m:1m 4 COMBINATION LOAD CASE 4

Beam End Force Summary

The signs of the forces at end B of each beam have been reversed. For example: this means that the Min Fx entry gives the largest tension value for an beam.

	Beam	Node	L/C	Axial Fx (kg)	Shear Fy (kg)	Shear Fz (kg)	Torsion Mx (kg-m)	Bending My (kg-m)	Bending Mz (kg-m)
Max Fx	24	15	4:COMBINATIC	**2987.83**	12.31	0.00	0.000	0.000	0.000
Min Fx	24	15	3:WL	**-2201.53**	-0.00	0.00	0.000	0.000	0.000
Max Fy	26	15	4:COMBINATIC	23.42	**1612.52**	0.00	0.000	0.000	2.38E+3
Min Fy	28	16	4:COMBINATIC	-1677.84	**-1203.75**	-0.00	-0.000	-0.000	1.35E+3
Max Fz	56	2	3:WL	0.00	-75.26	**0.12**	0.000	0.000	0.000
Min Fz	64	29	3:WL	0.00	75.26	**-0.12**	0.000	0.361	225.768
Max Mx	2	3	1:DL	885.42	-0.00	0.00	**0.000**	0.000	759.648
Min Mx	2	3	1:DL	885.42	-0.00	0.00	**0.000**	0.000	759.648
Max My	56	29	3:WL	-0.00	-75.26	0.12	-0.000	**0.361**	225.768
Min My	60	33	3:WL	-0.00	-150.05	-0.12	-0.000	**-0.360**	450.160
Max Mz	23	13	4:COMBINATIC	2550.73	0.00	0.00	0.000	0.000	**2.38E+3**
Min Mz	23	13	3:WL	-1802.47	-0.00	0.00	0.000	0.000	**-1.8E+3**

Beam Force Detail Summary

Sign convention as diagrams:- positive above line, negative below line except Fx where positive is compression. Distance d is given from beam end A.

	Beam	L/C	d (m)	Axial Fx (kg)	Shear Fy (kg)	Shear Fz (kg)	Torsion Mx (kg-m)	Bending My (kg-m)	Bending Mz (kg-m)
Max Fx	24	4:COMBINATIC	0.000	**2987.83**	12.31	0.00	0.000	0.000	0.000
Min Fx	24	3:WL	0.000	**-2201.53**	-0.00	0.00	0.000	0.000	0.000
Max Fy	26	4:COMBINATIC	0.000	23.42	**1612.52**	0.00	0.000	0.000	2.38E+3
Min Fy	28	4:COMBINATIC	1.458	-1677.84	**-1203.75**	-0.00	-0.000	-0.000	1.35E+3
Max Fz	56	3:WL	0.000	0.00	-75.26	**0.12**	0.000	0.000	0.000
Min Fz	64	3:WL	0.000	0.00	75.26	**-0.12**	0.000	0.361	225.768
Max Mx	2	1:DL	0.000	885.42	-0.00	0.00	**0.000**	0.000	759.648
Min Mx	2	1:DL	0.000	885.42	-0.00	0.00	**0.000**	0.000	759.648
Max My	56	3:WL	3.000	-0.00	-75.26	0.12	-0.000	**0.361**	225.768
Min My	60	3:WL	3.000	-0.00	-150.05	-0.12	-0.000	**-0.360**	450.160
Max Mz	23	4:COMBINATIC	0.000	2550.73	0.00	0.00	0.000	0.000	**2.38E+3**
Min Mz	23	3:WL	0.000	-1802.47	-0.00	0.00	0.000	0.000	**-1.8E+3**

Utilization Ratio

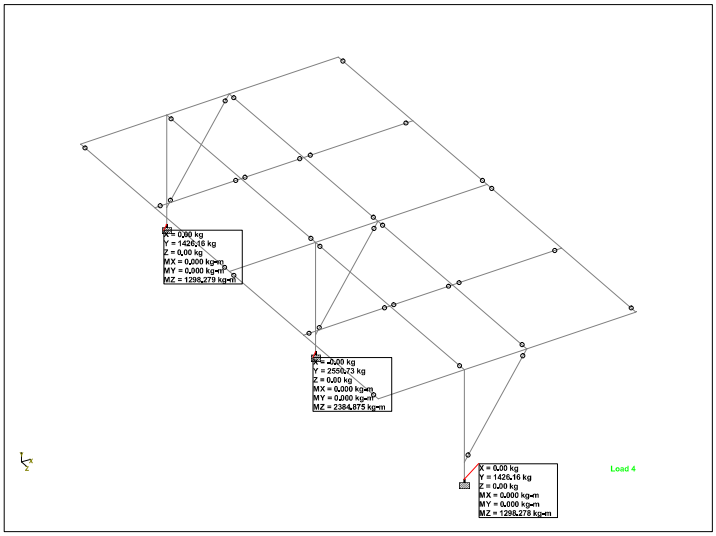
Beam	Analysis Property	Design Property	Actual Ratio	Allowable Ratio	Ratio (Act./Allow.)	Clause	L/C	Ax (cm^2)	Iz (cm^4)	Iy (cm^4)	Ix (cm^4)
2	H194X150X(	H194X150X(	0.368	1.000	0.368	AISC- H1-3	4	38.110	2.63E+3	507.000	8.600
3	H100X100X(	H100X100X(	0.097	1.000	0.097	AISC- H1-3	4	21.590	378.000	134.000	4.000
4	H194X150X(	H194X150X(	0.123	1.000	0.123	AISC- H2-1	4	38.110	2.63E+3	507.000	8.600
6	H194X150X(	H194X150X(	0.334	1.000	0.334	AISC- H1-3	4	38.110	2.63E+3	507.000	8.600
8	H194X150X(	H194X150X(	0.185	1.000	0.185	AISC- H2-1	4	38.110	2.63E+3	507.000	8.600
10	H194X150X(	H194X150X(	0.186	1.000	0.186	AISC- H1-3	4	38.110	2.63E+3	507.000	8.600
23	H194X150X(	H194X150X(	0.672	1.000	0.672	AISC- H1-3	4	38.110	2.63E+3	507.000	8.600
24	H100X100X(	H100X100X(	0.171	1.000	0.171	AISC- H1-1	4	21.590	378.000	134.000	4.000
25	H194X150X(	H194X150X(	0.230	1.000	0.230	AISC- H2-1	4	38.110	2.63E+3	507.000	8.600
26	H194X150X(	H194X150X(	0.612	1.000	0.612	AISC- H1-3	4	38.110	2.63E+3	507.000	8.600
28	H194X150X(	H194X150X(	0.346	1.000	0.346	AISC- H2-1	4	38.110	2.63E+3	507.000	8.600
29	H194X150X(	H194X150X(	0.348	1.000	0.348	AISC- H1-3	4	38.110	2.63E+3	507.000	8.600
42	H194X150X(	H194X150X(	0.368	1.000	0.368	AISC- H1-3	4	38.110	2.63E+3	507.000	8.600
43	H100X100X(	H100X100X(	0.097	1.000	0.097	AISC- H1-3	4	21.590	378.000	134.000	4.000
44	H194X150X(	H194X150X(	0.123	1.000	0.123	AISC- H2-1	4	38.110	2.63E+3	507.000	8.600
45	H194X150X(	H194X150X(	0.334	1.000	0.334	AISC- H1-3	4	38.110	2.63E+3	507.000	8.600
47	H194X150X(	H194X150X(	0.185	1.000	0.185	AISC- H2-1	4	38.110	2.63E+3	507.000	8.600
48	H194X150X(	H194X150X(	0.186	1.000	0.186	AISC- H1-3	4	38.110	2.63E+3	507.000	8.600
52	H200X100X9	H200X100X9	0.193	1.000	0.193	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
53	H200X100X9	H200X100X9	0.193	1.000	0.193	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
56	H200X100X9	H200X100X9	0.162	1.000	0.162	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
57	H200X100X9	H200X100X9	0.162	1.000	0.162	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
58	H200X100X9	H200X100X9	0.246	1.000	0.246	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
59	H200X100X9	H200X100X9	0.246	1.000	0.246	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
60	H200X100X9	H200X100X9	0.277	1.000	0.277	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
61	H200X100X9	H200X100X9	0.277	1.000	0.277	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
62	H200X100X9	H200X100X9	0.193	1.000	0.193	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
63	H200X100X9	H200X100X9	0.193	1.000	0.193	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
64	H200X100X9	H200X100X9	0.162	1.000	0.162	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
65	H200X100X9	H200X100X9	0.162	1.000	0.162	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
66	H200X100X9	H200X100X9	0.246	1.000	0.246	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
67	H200X100X9	H200X100X9	0.246	1.000	0.246	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
68	H200X100X9	H200X100X9	0.277	1.000	0.277	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
69	H200X100X9	H200X100X9	0.277	1.000	0.277	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
70	H200X100X9	H200X100X9	0.030	1.000	0.030	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
71	H200X100X9	H200X100X9	0.016	1.000	0.016	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
72	H200X100X9	H200X100X9	0.052	1.000	0.052	AISC- H2-1	4	26.670	1.81E+3	134.000	4.400
73	H200X100X9	H200X100X9	0.030	1.000	0.030	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
74	H200X100X9	H200X100X9	0.016	1.000	0.016	AISC- H1-3	4	26.670	1.81E+3	134.000	4.400
75	H200X100X9	H200X100X9	0.052	1.000	0.052	AISC- H2-1	4	26.670	1.81E+3	134.000	4.400

Failed Members

There is no data of this type.

Reaction Summary

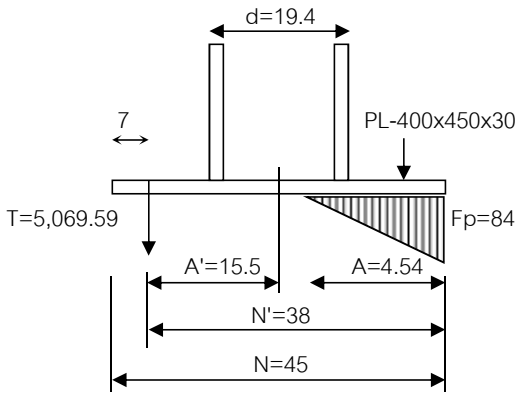
	Node	L/C	Horizontal FX (kg)	Vertical FY (kg)	Horizontal FZ (kg)	Moment MX (kg-m)	MY (kg-m)	MZ (kg-m)
Max FX	13	5:COMBINATIC	**0.00**	-333.22	0.00	0.000	0.000	-487.820
Min FX	13	2:LL	**-0.00**	1081.48	0.00	0.000	0.000	1.08E+3
Max FY	13	4:COMBINATIC	-0.00	**2550.73**	0.00	0.000	0.000	2.38E+3
Min FY	13	3:WL	0.00	**-1802.47**	0.00	0.000	0.000	-1.8E+3
Max FZ	3	1:DL	0.00	885.42	**0.00**	0.000	0.000	759.648
Min FZ	3	1:DL	0.00	885.42	**0.00**	0.000	0.000	759.648
Max MX	3	1:DL	0.00	885.42	0.00	**0.000**	0.000	759.648
Min MX	3	1:DL	0.00	885.42	0.00	**0.000**	0.000	759.648
Max MY	3	1:DL	0.00	885.42	0.00	0.000	**0.000**	759.648
Min MY	3	1:DL	0.00	885.42	0.00	0.000	**0.000**	759.648
Max MZ	13	4:COMBINATIC	-0.00	2550.73	0.00	0.000	0.000	**2.38E+3**
Min MZ	13	3:WL	0.00	-1802.47	0.00	0.000	0.000	**-1.8E+3**

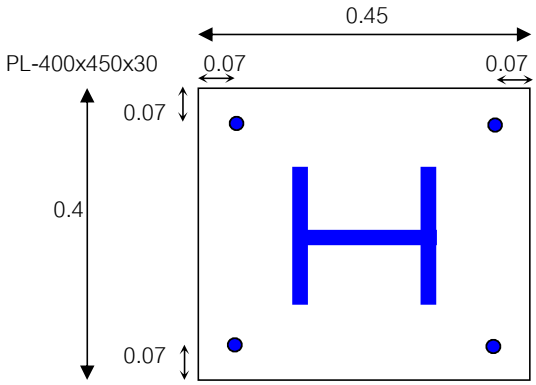


Reactions

Baseplate(M-large)

fc'	240	ksc.	fy	2400	ksc.
B	40	cm.	N	45	cm.
A1	1800	cm^2.	A2	1800	cm^2.
A2/A1	1		Fp	84	ksc.
Moment	2385	kg-m.	P	2550	kg.
e	93.52941	cm.	N/6 =	7.5	cm.
e > N/2			N/2 =	22.5	cm.
edge to bolt	7	cm.			
N'	38	cm.			
A'	15.5	cm.			
FpB/6	560	kg.			
FpBN'/2	63840	kg.			
PA'+M	278025	kg-m.			
A =	109.4645	cm.	4.535471	cm.	
T	5069.592	kg.			
bf	15	cm.			
d	19.4	cm.			
critical section	13.285	cm.			
Mpl @ comp.side	2242.67	kg-cm.			
Mpl @ bolt .side	2534.796	kg-cm.			
tp	2.906771	cm.			





ข้อกำหนดที่ใช้ในการออกแบบ (DESIGN CRITERIA)

โครงการ : กสทช

อาคารห้องเครื่องกำเนิดไฟฟ้า (Generator)

การออกแบบโดยวิธีกำลัง (Ultimate Strength design method)

สัมประสิทธิ์น้ำหนักบรรทุก (Load factor)

น้ำหนักบรรทุคงที่ (Dead load : DL)	=	*1.40*
น้ำหนักบรรทุกจร (Live load : LL)	=	*1.70*
แรงลม (Wind load : WL)	=	*1.70*
แรงแผ่นดินไหว (Earthquake load : EL)	=	*1.87*

กำลังที่ต้องการเพื่อต้านน้ำหนักบรรทุก (U = Required strength to resist factored load)

U = 1.4DL + 1.7 LL

U = 0.75 (1.4DL + 1.7LL + 1.7WL) หรือ 0.9DL + 1.3WL

U = 0.75(1.4DL + 1.7LL + 1.87EL) หรือ 0.9DL + 1.43EL

ตัวคูณลดกำลัง (Strength reduction factor)

สำหรับแรงดัด (Bending)	=	*0.90*
สำหรับแแรงเฉือน (Shear)	=	*0.85*
สำหรับแรงเฉือน (Compression)	=	*0.70*

คอนกรีต (Concrete)

กำลังอัดประลัย (Ultimate Strength) Fc'	=	*320*	ksc
แรงเฉือนแบบคาน Vc	=	*9.481*	ksc (For Beam Shear)
แรงเฉือนทะลุ Vc	=	*18.962*	ksc (For Punching Shear)

เหล็กเส้นกลม (Round Bar)

กำลังดึงสูงสุด (Yield Strength)	Fy	=	*2400*	ksc	(SR 24)

เหล็กเส้นข้ออ้อย (Deformed Bar)

กำลังดึงสูงสุด (Yield Strength)	Fy	=	*4000*	ksc	(SD 40)
กำลังดึงสูงสุด (Yield Strength)	Fy	=	*5000*	ksc	(SD 50)

เหล็กรูปพรรณ (Structural Steel)

Structural steel shape	GRADE	SS400
High strength bolt (HTB)	GRADE	F10T
Welding electrode	GRADE	E70
Anchor bolt	GRADE	SS400

น้ำหนักบรรทุกคงที่ (Dead Load)

น้ำหนักคอนกรีต (DL. of Concrete)	=	2400	กก. ต่อ ลบ.ม.	(kg/Cu.m.)
น้ำหนักอิฐมอญเต็มแผ่น (DL. of Brick Wall)	=	360	กก. ต่อ ตร.ม.	(kg/Sq.m.)
น้ำหนักอิฐมอญครึ่งแผ่น (DL. of Half Brick Wall)	=	180	กก. ต่อ ตร.ม.	(kg/Sq.m.)
น้ำหนักผนังก่ออิฐบล็อกหนา 9 ซ.ม.	=	160	กก. ต่อ ตร.ม.	(kg/Sq.m.)
น้ำหนักผนังกระจก	=	120	กก. ต่อ ตร.ม.	(kg/Sq.m.)

น้ำหนักบรรทุกจร (Live Load)

น้ำหนักบรรทุกจรหลังคาคอนกรีตเสริมเหล็ก	=	200	กก. ต่อ ตร.ม.	(kg/Sq.m.)
น้ำหนักบรรทุกจรห้องเครื่องกำเนิดไฟฟ้า (Generator)	=	2000	กก. ต่อ ตร.ม.	(kg/Sq.m.)

EGS1 **(0.20)** L = 3.20

case 1 B = 2.50

k = 1.28

f_c' = 320 ksc t_{min} = 0.063 m.

Load factor *DL* = 1.40

LL = 1.70

DL	=	*1.4x* *480*	=	672	kg/m^2
SDL+SCR	=	*1.4x* *120*	=	168	kg/m^2
LL	=	*1.7x* *2000*	=	3400	kg/m^2
w_u			=	**4240**	kg/m^2
M^+_B	=	*0.084* $w_u B^2$	=	2237	kg-m
M^-_B		$w_u B^2$			kg-m
M^+_L	=	*0.034* $w_u L^2$	=	1494	kg-m
M^-_L		$w_u L^2$			kg-m
					kg-m
					kg-m

As min = 4.00 Sq.cm.

As min = 4.00 Sq.cm.

As+B	=	3.96	cm^2	DB 12 mm. @	0.275 m
As+L	=	2.62	cm^2	DB 12 mm. @	0.275 m

ERS1 **(0.15)** L = 7.50

case 1 B = 4.00

k = 1.88

f_c' = 320 ksc t_{min} = 0.128 m.

Load factor *DL* = 1.40

LL = 1.70

DL	=	*1.4x* *360*	=	504	kg/m^2
SDL+SCR	=	*1.4x* *170*	=	238	kg/m^2
LL	=	*1.7x* *200*	=	340	kg/m^2
w_u			=	**1082**	kg/m^2
M^+_B	=	*0.110* $w_u B^2$	=	1896	kg-m
M^-_B		$w_u B^2$			kg-m
M^+_L	=	*0.013* $w_u L^2$	=	761	kg-m
M^-_L		$w_u L^2$			kg-m
					kg-m
					kg-m

As min = 3.00 Sq.cm.

As+B	=	4.51	cm^2	DB 12 mm. @	0.25 m
As+L	=	1.78	cm^2	DB 12 mm. @	0.3 m

EGS1x **(0.20)**

case simple span L = 0.80

f_c' = 320 ksc t_{min} = 0.040 m.

Load factor *DL* = 1.40

LL = 1.70

DL	=	*1.4x* *480*	=	672	kg/m^2
SDL+SCR	=	*1.4x* *120*	=	168	kg/m^2
LL	=	*1.7x* *2000*	=	3400	kg/m^2
w_u			=	**4240**	kg/m^2
$P_{u,mid}$			=	0	kg
$M^+_{L,w}$	=	*0.13* $w_u L^2$	=	339	kg-m
$M^+_{L,P}$	=	*0.25* $P_u L$	=	0	kg-m
M^+_L			=	339	kg-m

As,B min = 4.00 Sq.cm.

As min = 4.00 Sq.cm.

$A_s{}^+_B$	=	0.00	cm^2	DB 12 mm. @	0.275 m
$A_s{}^+_L$	=	0.59	cm^2	DB 12 mm. @	0.275 m

ERS1a **(0.15)**

case cantilever L = 1.00

f_c' = 320 ksc t_{min} = 0.083 m.

Load factor *DL* = 1.40

LL = 1.70

DL	=	*1.4x* *360*	=	504	kg/m^2
SDL+SCR	=	*1.4x* *170*	=	238	kg/m^2
LL	=	*1.7x* *200*	=	340	kg/m^2
w_u			=	**1082**	kg/m^2
$P_{u,end}$			=	302	kg
$M^+_{L,w}$	=	*-0.50* $w_u L^2$	=	-541	kg-m
$M^+_{L,P}$	=	*-1.00* $P_u L$	=	-302	kg-m
M^+_L			=	843	kg-m

As,B min = 3.00 Sq.cm.

As min = 3.00 Sq.cm.

$A_s{}^+_B$	=	0.00	cm^2	DB 12 mm. @	0.3 m
$A_s{}^+_L$	=	1.98	cm^2	DB 12 mm. @	0.3 m

EGS1a **(0.20)**

case cantilever L = 1.00

f_c' = 320 ksc t_{min} = 0.083 m.

Load factor *DL* = 1.40

LL = 1.70

DL	=	*1.4x* *480*	=	672	kg/m^2
SDL+SCR	=	*1.4x* *120*	=	168	kg/m^2
LL	=	*1.7x* *2000*	=	3400	kg/m^2
w_u			=	**4240**	kg/m^2
$P_{u,end}$			=	970	kg
$M^-_{L,w}$	=	*-0.50* $w_u L^2$	=	-2120	kg-m
$M^-_{L,P}$	=	*-1.00* $P_u L$	=	-970	kg-m
M^-_L			=	3090	kg-m

As,B min = 4.00 Sq.cm.

$A_s{}^-_B$	=	0.00	cm^2	DB 12 mm. @	0.275 m
$A_s{}^-_L$	=	5.17	cm^2	DB 12 mm. @	0.2 m

Approach **(0.20)**

case simple span L = 2.40

f_c' = 240 ksc t_{min} = 0.120 m.

Load factor *DL* = 1.40

LL = 1.70

DL	=	*1.4x* *480*	=	672	kg/m^2
SDL+SCR	=	*1.4x* *0*	=	0	kg/m^2
LL	=	*1.7x* *2000*	=	3400	kg/m^2
w_u			=	**4072**	kg/m^2
$P_{u,mid}$			=	0	kg
$M^+_{L,w}$	=	*0.13* $w_u L^2$	=	2932	kg-m
$M^+_{L,P}$	=	*0.25* $P_u L$	=	0	kg-m
M^+_L			=	2932	kg-m

As,B min = 4.00 Sq.cm.

$A_s{}^+_B$	=	0.00	cm^2	DB 12 mm. @	0.275 m
$A_s{}^+_L$	=	5.26	cm^2	DB 12 mm. @	0.2 m

NBTC Building G Generator room EGB1(0.25x0.5),EGB1(0.25x0.5),EGB1(0.25x0.5),EGB1(0.25x0.5)

| | | |

NBTC Building G Generator room EGB2(0.25x0.8)

Load factor				**EGB2**							
DL =	1.40			CANT L			SPAN 1			CANT R	
LL =	1.70										
Span length	(m)			0.00			3.20			1.00	
Slab thickness	(m)			0.01			0.20			0.20	
Strip width	(m)			3.00			1.00			0.25	
Beam width	(m)			0.25			0.25			0.25	
Beam depth	(m)			0.80			0.80			0.80	
SDL	(kg/m)	120	360			120			30		
$DL_{, slab}$	(kg/m)	24	72			480			120		
$DL_{, girder}$	(kg/m)		1200			1200			1200		
$DL_{, total}$	(kg/m)		1632			1800			1350		
L.L.	(kg/m)	2000	6000	1.00		2000	1.00		500	1.00	
Service load	(kg/m)		7632			3800			1850		
Ultimate load	(kg/m)		12485			5920			2740		
Concentrate Load (kg)		Service load	Factor load	x (m)		Service load	Factor load	x (m)	Service load	Factor load	x (m)
Concentrate DL	1.40	0	0	0.00		0	0	0.24	11577	16208	1.00
		0	0	0.00		0	0	0.24	0	0	1.00
		0	0	0.00		0	0	0.24	0	0	1.00
Concentrate LL	1.70	0	0	0.00		0	0	0.24	4701	7991	1.00
		0	0	0.00		0	0	0.24	0	0	1.00
		0	0	0.00		0	0	0.24	0	0	1.00

x		0.00	0.00	0.00		0.24	0.24	0.24		1.00	1.00	1.00	
P_L		0	0	0		0	0	0		4701	0	0	
P_D		0	0	0		0	0	0		11577	0	0	
w_D			1632				1800				1350		
w_L							2000						
L			*0.00*				3.20				1.00		

Result of structural analysis

Dead load	R (kg)	-933			19621		
Shear	(kg)	0	-933		6693	12927	
Moment	(kg-m)	0	-5	-286	-12208	-12252	
Live load	R (kg)	1659			9942		
Shear	(kg)	0	1659		4741	5201	
Moment	(kg-m)	0	-7	339	-4937	-4951	
Service load	R (kg)	726			29562		
Shear	(kg)	0	726		11434	18128	
Moment	(kg-m)	0	-12	52	-17145	-17203	
Factor load	R (kg)	1514			44370		
Shear	(kg)	0	1514		17430	26939	
Moment	(kg-m)	0	-18	175	-25485	-25569	
M max(wind load)		0	0		0	0	
V max(wind load)		0	0		0	0	

Summary result of design

		EGB2				
M^{-}_{design}	(kg-m)	-98	93		-23352	-22223
M^{+}_{design}	(kg-m)			175		
V_{design}	(kg)	0	-2017		13227	26939
$A_{s, required}$		0.05	0.05	0.09	9.51	9.03
Use		1 -DB16	1 -DB16	1 -DB16	5 -DB16	5 -DB16
$A_{s}^{'}{}_{, required}$		0.00	0.00	0.00	0.00	0.00
Use		0 -DB16	0 -DB16	0 -DB16	0 -DB16	0 -DB16
Stirrup		1-DB-12@0.25	1-DB-12@0.25		1-DB-12@0.25	1-DB-12@0.25

Serviceability

Immediate deflection	(cm)	0.00		0.00		0.0286
control at		> 360 OK		> 360 OK		> 360 OK
Long term deflection	(cm)	0.00		-0.01		0.0693
control at		> 480 OK		> 480 OK		> 480 OK
Crack width, w	(mm)	0.0000	-0.0014	0.0012	0.1812	0.1845

NBTC Building G Generator room EGB3(0.25x0.6)

Load factor						**EGB3**					
DL =	1.40			CANT L			SPAN 1			CANT R	
LL =	1.70										
Span length	(m)			0.00			3.20			1.00	
Slab thickness	(m)			0.01			0.20			0.20	
Strip width	(m)			3.00			2.00			0.50	
Beam width	(m)			0.25			0.25			0.25	
Beam depth	(m)			0.60			0.60			0.60	
SDL	(kg/m)	120	360			240			60		
$DL_{, slab}$	(kg/m)	24	72			960			240		
$DL_{, girder}$	(kg/m)		1080			1080			1080		
$DL_{, total}$	(kg/m)		1512			2280			1380		
L.L.	(kg/m)	2000	6000	1.00		4000	1.00		1000	1.00	
Service load	(kg/m)		7512			6280			2380		
Ultimate load	(kg/m)		12317			9992			3632		
Concentrate Load (kg)		Service load	Factor load	x (m)		Service load	Factor load	x (m)	Service load	Factor load	x (m)
Concentrate DL	1.40	0	0	0.00		0	0	1.00	4318	6045	1.00
		0	0	0.00		0	0	1.00	0	0	1.00
		0	0	0.00		0	0	1.00	0	0	1.00
Concentrate LL	1.70	0	0	0.00		0	0	1.00	6500	11051	1.00
		0	0	0.00		0	0	1.00	0	0	1.00
		0	0	0.00		0	0	1.00	0	0	1.00

x		0.00	0.00	0.00		1.00	1.00	1.00		1.00	1.00	1.00	
P_L		0	0	0		0	0	0		6500	0	0	
P_D		0	0	0		0	0	0		4318	0	0	
w_D			1512				2280				1380		
w_L							4000						
L			*0.00*				3.20				1.00		

Result of structural analysis

Dead load	R (kg)	2090			10905		
Shear	(kg)	0	2090		5206	5698	
Moment	(kg-m)	0	-8	942	-4995	-5008	
Live load	R (kg)	4222			16079		
Shear	(kg)	0	4222		8578	7500	
Moment	(kg-m)	0	-14	2207	-6985	-7000	
Service load	R (kg)	6311			26983		
Shear	(kg)	0	6311		13785	13199	
Moment	(kg-m)	0	-22	3149	-11980	-12009	
Factor load	R (kg)	10102			42600		
Shear	(kg)	0	10102		21872	20728	
Moment	(kg-m)	0	-35	5071	-18868	-18912	
M max(wind load)		0	0		0	0	
V max(wind load)		0	0		0	0	

Summary result of design

				EGB3		
M^-_{design}	(kg-m)	-96	862		-16212	-16349
M^+_{design}	(kg-m)			5071		
V_{design}	(kg)	0	5006		16776	20728
$A_{s, required}$		0.07	0.63	3.74	9.33	9.42
Use		1 -DB16	1 -DB16	2 -DB16	5 -DB16	5 -DB16
$A_{s}^{'}{}_{, required}$		0.00	0.00	0.00	0.00	0.00
Use		0 -DB16	0 -DB16	0 -DB16	0 -DB16	0 -DB16
Stirrup		1-DB-12@0.25	1-DB-12@0.25		1-DB-12@0.25	1-DB-12@0.25

Serviceability

Immediate deflection	(cm)	0.00		0.01		0.0771
control at		> 360 OK		> 360 OK		> 360 OK
Long term deflection	(cm)	0.00		0.02		0.1116
control at		> 480 OK		> 480 OK		> 480 OK
Crack width, w	(mm)	0.0000	-0.0107	0.0332	0.2328	0.2326

NBTC Building G Generator room EGB4(0.25x1)

Load factor	DL =	1.40				**EGB4**						
	LL =	1.70		CANT L			SPAN 1			CANT R		
Span length	(m)			0.00			3.20			1.00		
Slab thickness	(m)			0.01			0.20			0.20		
Strip width	(m)			3.00			2.00			0.50		
Beam width	(m)			0.25			0.25			0.25		
Beam depth	(m)			1.00			1.00			1.00		
SDL	(kg/m)		120	360			240			60		
$DL_{, slab}$	(kg/m)		24	72			960			240		
$DL_{, girder}$	(kg/m)			1320			1320			1320		
$DL_{, total}$	(kg/m)			1752			2520			1620		
L.L.	(kg/m)		2000	6000	1.00		4000	1.00		1000	1.00	
Service load	(kg/m)			7752			6520			2620		
Ultimate load	(kg/m)			12653			10328			3968		
Concentrate Load (kg)			Service load	Factor load	x (m)	Service load	Factor load	x (m)	Service load	Factor load	x (m)	
Concentrate DL		1.40	0	0	0.00	0	0	0.51	14068	19695	1.00	
			0	0	0.00	0	0	0.51	0	0	1.00	
			0	0	0.00	0	0	0.51	0	0	1.00	
Concentrate LL		1.70	0	0	0.00	0	0	0.51	8450	14366	1.00	
			0	0	0.00	0	0	0.51	0	0	1.00	
			0	0	0.00	0	0	0.51	0	0	1.00	

	x	0.00	0.00	0.00		0.51	0.51	0.51		1.00	1.00	1.00		
	P_L	0	0	0		0	0	0		8450	0	0		
	P_D	0	0	0		0	0	0		14068	0	0		
	w_D		1752				2520				1620			
	w_L						4000							
	L		*0.00*				3.20				1.00			

Result of structural analysis

Dead load	R (kg)	-599			24351	
Shear	(kg)	0	-599		8663	15688
Moment	(kg-m)	0	-8	-649	-14827	-14878
Live load	R (kg)	3614			18636	
Shear	(kg)	0	3614		9186	9450
Moment	(kg-m)	0	-13	1316	-8928	-8950
Service load	R (kg)	3015			42987	
Shear	(kg)	0	3015		17849	25139
Moment	(kg-m)	0	-21	667	-23755	-23829
Factor load	R (kg)	5306			65773	
Shear	(kg)	0	5305		27744	38029
Moment	(kg-m)	0	-34	1329	-35936	-36045
M max(wind load)		0	0		0	0
V max(wind load)		0	0		0	0

Summary result of design

				EGB4		
M^-_{design}	(kg-m)	-99	412		-32548	-31322
M^+_{design}	(kg-m)			1329		
V_{design}	(kg)	0	-3070		18346	38029
$A_{s, required}$		0.04	0.17	0.54	10.28	9.88
Use		1 -DB16	1 -DB16	1 -DB16	6 -DB16	5 -DB16
$A_{s}^{'}{}_{, required}$		0.00	0.00	0.00	0.00	0.00
Use		0 -DB16	0 -DB16	0 -DB16	0 -DB16	0 -DB16
Stirrup		1-DB-12@0.25	1-DB-12@0.25		1-DB-12@0.25	1-DB-12@0.25

Serviceability						
Immediate deflection	(cm)	0.00		0.00		0.0236
control at		> 360 OK		> 360 OK		> 360 OK
Long term deflection	(cm)	0.00		0.00		0.0411
control at		> 480 OK		> 480 OK		> 480 OK
Crack width, w	(mm)	0.0000	-0.0028	0.0054	0.1403	0.1419

NBTC Building G Generator room ERB1(0.25x0.6),ERB1(0.25x0.6)

Load factor	DL =	1.40						**ERB1**						**ERB1**									
	LL =	1.70		CANT L				SPAN 1						SPAN 2						CANT R			
Span length	(m)			0.00				7.50						7.50						0.00			
Slab thickness	(m)			0.15				0.15						0.15						0.15			
Strip width	(m)			2.30				2.30						2.30						2.30			
Beam width	(m)			0.25				0.25						0.25						0.25			
Beam depth	(m)			0.60				0.60						0.60						0.60			
SDL	(kg/m)		170	391				391						391						391			
DL_{slab}	(kg/m)		360	828				828						828						828			
DL_{girder}	(kg/m)			576				576						576						576			
DL_{total}	(kg/m)			1795				1795						1795						1795			
L.L.	(kg/m)		200	460	1.00			460	1.00					460	1.00					460	1.00		
Service load	(kg/m)			2255				2255						2255						2255			
Ultimate load	(kg/m)			3295				3295						3295						3295			
Concentrate Load (kg)			Service load	Factor load	x (m)		Service load	Factor load	x (m)		Service load	Factor load	x (m)		Service load	Factor load	x (m)		Service load	Factor load	x (m)		
Concentrate DL	1.40		0	0	0.00		0	0	2.81		0	0	4.69		0	0	0.00						
			0	0	0.00		0	0	2.81		0	0	4.69		0	0	0.00						
			0	0	0.00		0	0	2.81		0	0	4.69		0	0	0.00						
Concentrate LL	1.70		0	0	0.00		0	0	2.81		0	0	4.69		0	0	0.00						
			0	0	0.00		0	0	2.81		0	0	4.69		0	0	0.00						
			0	0	0.00		0	0	2.81		0	0	4.69		0	0	0.00						

x	0.00	0.00	0.00		2.81	2.81	2.81		4.69	4.69	4.69		0.00	0.00	0.00								
P_L	0	0	0		0	0	0		0	0	0		0	0	0								
P_D	0	0	0		0	0	0		0	0	0		0	0	0								
w_D		1795				1795				1795				1795									
w_L						460				460													
L		*0.00*				7.50				7.50				0.00									

Result of structural analysis																							
Dead load	R (kg)			5050					16824					5050									
Shear	(kg)			0	5050				8412	8412				5050	0								
Moment	(kg-m)			0	-9		7095		-12617	-12617		7095		-9	0								
Live load	R (kg)			1294					4312					1294									
Shear	(kg)			0	1294				2156	2156				1294	0								
Moment	(kg-m)			0	-2		1818		-3233	-3233		1818		-2	0								
Service load	R (kg)			6345					21136					6345									
Shear	(kg)			0	6344				10568	10568				6344	0								
Moment	(kg-m)			0	-11		8914		-15850	-15850		8914		-11	0								
Factor load	R (kg)			9271					30884					9271									
Shear	(kg)			0	9271				15442	15442				9271	0								
Moment	(kg-m)			0	-17		13025		-23160	-23160		13025		-17	0								
M max(wind load)				0	0				0	0				0	0								
V max(wind load)				0	0				0	0				0	0								
Summary result of design																							
							ERB1							**ERB1**									
M^-_{design}	(kg-m)			-26	837				-21255	-21255				837	-26								
M^+_{design}	(kg-m)						13025					13025											
V_{design}	(kg)			0	7689				13860	13860				7689	0								
$A_{s,required}$				0.02	0.65		7.92		13.40	13.40		7.92		0.65	0.02								
Use				1 -DB16	1 -DB16		4 -DB16		7 -DB16	7 -DB16		4 -DB16		1 -DB16	1 -DB16								
$A_{s}^{'},_{required}$				0.00	0.00		0.00		0.00	0.00		0.00		0.00	0.00								
Use				0 -DB16	0 -DB16		0 -DB16		0 -DB16	0 -DB16		0 -DB16		0 -DB16	0 -DB16								
Stirrup				1-RB-9@0.225	1-RB-9@0.225				1-RB-9@0.225	1-RB-9@0.225				1-RB-9@0.225	1-RB-9@0.225								
Serviceability																							
Immediate deflection	(cm)			0.00			0.28					0.28			0.0000								
control at				> 360 OK			> 360 OK					> 360 OK			> 360 OK								
Long term deflection	(cm)			0.00			1.09					1.09			0.0000								
control at				> 480 OK			> 480 OK					> 480 OK			> 480 OK								
Crack width, w	(mm)			0.0000	-0.0119		0.2027		0.2996	0.2996		0.2027		-0.0119	0.0000								
				OK	OK		OK		OK	OK		OK		OK	OK								

NBTC Building G Generator room ERB2(0.25x0.5)

Load factor	DL =	1.40				**ERB2**					
	LL =	1.70		CANT L			SPAN 1			CANT R	
Span length	(m)			0.00			4.00			0.00	
Slab thickness	(m)			0.01			0.15			0.15	
Strip width	(m)			3.00			2.50			2.50	
Beam width	(m)			0.25			0.25			0.25	
Beam depth	(m)			0.50			0.50			0.50	
SDL	(kg/m)		170	510			425			425	
$DL_{, slab}$	(kg/m)		24	72			900			900	
$DL_{, girder}$	(kg/m)			300			300			300	
$DL_{, total}$	(kg/m)			882			1625			1625	
L.L.	(kg/m)		200	600	1.00		500	1.00		500	1.00
Service load	(kg/m)			1482			2125			2125	
Ultimate load	(kg/m)			2255			3125			3125	
Concentrate Load (kg)			Service load	Factor load	x (m)	Service load	Factor load	x (m)	Service load	Factor load	x (m)
Concentrate DL		1.40	0	0	0.00	0	0	2.00	0	0	0.00
			0	0	0.00	0	0	2.00	0	0	0.00
			0	0	0.00	0	0	2.00	0	0	0.00
Concentrate LL		1.70	0	0	0.00	0	0	2.00	0	0	0.00
			0	0	0.00	0	0	2.00	0	0	0.00
			0	0	0.00	0	0	2.00	0	0	0.00

	x	0.00	0.00	0.00		2.00	2.00	2.00		0.00	0.00	0.00
	P_L	0	0	0		0	0	0		0	0	0
	P_D	0	0	0		0	0	0		0	0	0
	w_D		882				1625				1625	
	w_L						500					
	L		*0.00*				4.00				0.00	

Result of structural analysis

Dead load	R (kg)	3250			3250		
Shear	(kg)	0	3250		3250	0	
Moment	(kg-m)	0	-13	3237	-13	0	
Live load	R (kg)	1000			1000		
Shear	(kg)	0	1000		1000	0	
Moment	(kg-m)	0	-4	996	-4	0	
Service load	R (kg)	4250			4250		
Shear	(kg)	0	4250		4250	0	
Moment	(kg-m)	0	-17	4233	-17	0	
Factor load	R (kg)	6250			6250		
Shear	(kg)	0	6250		6250	0	
Moment	(kg-m)	0	-24	6226	-24	0	
M max(wind load)		0	0		0	0	
V max(wind load)		0	0		0	0	

Summary result of design

				ERB2		
M^-_{design}	(kg-m)	-18	549		549	-24
M^+_{design}	(kg-m)			6226		
V_{design}	(kg)	0	4969		4969	0
$A_{s, required}$		0.02	0.50	4.35	0.50	0.02
Use		1 -DB16	1 -DB16	3 -DB16	1 -DB16	1 -DB16
$A_{s}^{'}{}_{, required}$		0.00	0.00	0.00	0.00	0.00
Use		0 -DB16	0 -DB16	0 -DB16	0 -DB16	0 -DB16
Stirrup		1-RB-9@0.2	1-RB-9@0.2		1-RB-9@0.2	1-RB-9@0.2

Serviceability						
Immediate deflection	(cm)	0.00		0.05		0.0000
control at		> 360 OK		> 360 OK		> 360 OK
Long term deflection	(cm)	0.00		0.17		0.0000
control at		> 480 OK		> 480 OK		> 480 OK
Crack width, w	(mm)	0.0000	-0.0112	0.0834	-0.0112	0.0000

Project NBTC Building G (Generator room) **COL. TYPE C1** **21**

COL. LINE GI,GK/1 **FOOTING TYPE F2A**

LOAD FACTOR	DL	1.4
	LL	1.7

FLOOR	SLAB 1			SLAB 2			BEAM 1		BEAM 2		WALL 1			WALL 2			COL		TRANS. LOAD		LOAD/ FLOOR		SUM LOAD(WKL)			LOAD/ AREA	SUM LOAD (ULL.)
	DL. (kg/m^2)	LL. (kg/m^2)	AREA (m^2)	DL. (kg/m^2)	LL. (kg/m^2)	AREA (m^2)	w (kg/m)	L (m)	w (kg/m)	L (m)	w (kg/m^2)	H (m)	L (m)	w (kg/m^2)	H (m)	L (m)	w (kg/m)	H (m)	DL. (kg)	LL. (kg)	DL. (kg)	LL. (kg)	DL. (kg)	LL. (kg)	TOTAL (kg)	(kg/m^2)	(kg)
Roof	530	200	7.50				300	2.00	360	3.75	180	1.20	5.75								7,767	1,500	7,767	1,500	9,267	1,236	13,424
1	600	1500	2.00	480	1500	2.00	300	1.25	480	1.60	180	4.00	2.85				150	4.00			5,701	6,000	13,468	7,500	20,968	2,925	31,605
PIER																	231	1.50									
																										1,823	kg/m²

COL. LINE NBTC Building G (Generator room) **COL. TYPE C0** **31**

GI,GK/2 **FOOTING TYPE F3A**

LOAD FACTOR	DL	1.4
	LL	1.7

FLOOR	SLAB 1			SLAB 2			BEAM 1		BEAM 2		WALL 1			WALL 2			COL		TRANS. LOAD		LOAD/ FLOOR		SUM LOAD(WKL)			LOAD/ AREA	SUM LOAD (ULL.)
	DL. (kg/m^2)	LL. (kg/m^2)	AREA (m^2)	DL. (kg/m^2)	LL. (kg/m^2)	AREA (m^2)	w (kg/m)	L (m)	w (kg/m)	L (m)	w (kg/m^2)	H (m)	L (m)	w (kg/m^2)	H (m)	L (m)	w (kg/m)	H (m)	DL. (kg)	LL. (kg)	DL. (kg)	LL. (kg)	DL. (kg)	LL. (kg)	TOTAL (kg)	(kg/m^2)	(kg)
Roof	530	200	9.75				300	2.00	360	3.75	180	1.20	2.60				0	0.00			8,279	1,950	8,279	1,950	10,229	1,049	14,906
1	600	1500	4.50	480	1500	3.00	300	2.50	480	3.60	180	4.00	3.60				150	4.00			9,556	11,250	17,835	13,200	31,035	2,774	47,409
PIER																	231	1.50									
																										1,799	kg/m²

COL. LINE NBTC Building G (Generator room) **COL. TYPE C0** **12**

GI-GJ/1,GJ-GK/1 **FOOTING TYPE F1A**

LOAD FACTOR	DL	1.4
	LL	1.7

FLOOR	SLAB 1			SLAB 2			BEAM 1		BEAM 2		WALL 1			WALL 2			COL		TRANS. LOAD		LOAD/ FLOOR		SUM LOAD(WKL)			LOAD/ AREA	SUM LOAD (ULL.)
	DL. (kg/m^2)	LL. (kg/m^2)	AREA (m^2)	DL. (kg/m^2)	LL. (kg/m^2)	AREA (m^2)	w (kg/m)	L (m)	w (kg/m)	L (m)	w (kg/m^2)	H (m)	L (m)	w (kg/m^2)	H (m)	L (m)	w (kg/m)	H (m)	DL. (kg)	LL. (kg)	DL. (kg)	LL. (kg)	DL. (kg)	LL. (kg)	TOTAL (kg)	(kg/m^2)	(kg)
Roof																											
1	600	1500	4.00				300	2.50	360	1.60	180	4.00	2.50								5,872	6,000	5,872	6,000	11,872	2,968	18,421
PIER																	231	1.50									
																										2,968	kg/m²

Project **NBTC Building G (Generator room)**
COL. LINE **GI,GK/1**
COL. TYPE **C1**

											LOAD FACTOR											
											DL.	LL.										
											1.4	1.7										
FLOOR	D (m)	B (m)	H	Ag (m^2)	LOAD (kg)	fc' (ksc)	fy (ksc)	Ar (m^2)	fr (ksc)	As (cm^2)	Pg %As	Pg %(As+Ar)	DB 32	DB 28	DB 25	DB 20	DB 16	DB 12	As sq.cm.	LOAD KG	PERCENT %	
1	0.25	0.25	4.00	0.063	13,424	320	4000			6.25	1.00%	1.00%					8		16.08	128,770	2.57%	OK
PIER	0.31	0.31	1.50	0.096	31,605	320	4000			9.61	1.00%	1.00%					8		16.08	179,949	1.67%	OK
																						0

Project **NBTC Building G (Generator room)**
COL. LINE **GI,GK/2**
COL. TYPE **C0**

											LOAD FACTOR											
											DL.	LL.										
											1.4	1.7										
FLOOR	D (m)	B (m)	H	Ag (m^2)	LOAD (kg)	fc' (ksc)	fy (ksc)	Ar (m^2)	fr (ksc)	As (cm^2)	Pg %As	Pg %(As+Ar)	DB 32	DB 28	DB 25	DB 20	DB 16	DB 12	As sq.cm.	LOAD KG	PERCENT %	
1	0.25	0.25	4.00	0.063	14,906	320	4000			6.25	1.00%	1.00%					8		16.08	128,770	2.57%	OK
PIER	0.31	0.31	1.50	0.096	47,409	320	4000			9.61	1.00%	1.00%					8		16.08	179,949	1.67%	OK
																						0

Project **NBTC Building G (Generator room)**
COL. LINE **GI-GJ/1,GJ-GK/1**
COL. TYPE **C0**

											LOAD FACTOR											
											DL.	LL.										
											1.4	1.7										
FLOOR	D (m)	B (m)	H	Ag (m^2)	LOAD (kg)	fc' (ksc)	fy (ksc)	Ar (m^2)	fr (ksc)	As (cm^2)	Pg %As	Pg %(As+Ar)	DB 32	DB 28	DB 25	DB 20	DB 16	DB 12	As sq.cm.	LOAD KG	PERCENT %	
1																						
PIER	0.31	0.31	1.50	0.096	18,421	320	4000			9.61	1.00%	1.00%					8		16.08	179,949	1.67%	OK
																						0

Project NBTC Building G (Generator room) **COL. TYPE C0 24**

COL. LINE GI-GJ/1,GJ-GK/2 **FOOTING TYPE F2A**

FLOOR	SLAB 1			SLAB 2			BEAM 1		BEAM 2		WALL 1			WALL 2			COL		TRANS. LOAD		LOAD/ FLOOR		SUM LOAD(WKL)			LOAD FACTOR	DL	1.4
																											LL	1.7
	DL.	LL.	AREA	DL.	LL.	AREA	w	L	w	L	w	H	L	w	H	L	w	H	DL.	LL.	DL.	LL.	DL.	LL.	TOTAL	LOAD/ AREA	SUM LOAD (ULL.)
	(kg/m^2)	(kg/m^2)	(m^2)	(kg/m^2)	(kg/m^2)	(m^2)	(kg/m)	(m)	(kg/m)	(m)	(kg/m^2)	(m)	(m)	(kg/m^2)	(m)	(m)	(kg/m)	(m)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg/m^2)	(kg)
Roof																											
1	600	1500	9.00				300	5.00	360	3.60	180	4.00	2.50								10,342	13,500	10,342	13,500	23,842	2,649	37,429
PIER																	231	1.50									
																										2,649	kg/m^2

Project NBTC Building G (Generator room) **COL. TYPE C1 29**

COL. LINE GJ/1 **FOOTING TYPE F2A**

FLOOR	SLAB 1			SLAB 2			BEAM 1		BEAM 2		WALL 1			WALL 2			COL		TRANS. LOAD		LOAD/ FLOOR		SUM LOAD(WKL)			LOAD FACTOR	DL	1.4
																											LL	1.7
	DL.	LL.	AREA	DL.	LL.	AREA	w	L	w	L	w	H	L	w	H	L	w	H	DL.	LL.	DL.	LL.	DL.	LL.	TOTAL	LOAD/ AREA	SUM LOAD (ULL.)
	(kg/m^2)	(kg/m^2)	(m^2)	(kg/m^2)	(kg/m^2)	(m^2)	(kg/m)	(m)	(kg/m)	(m)	(kg/m^2)	(m)	(m)	(kg/m^2)	(m)	(m)	(kg/m)	(m)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg/m^2)	(kg)
Roof	530	200	15.00				300	2.00	360	7.50	180	1.20	7.50								13,470	3,000	13,470	3,000	16,470	1,098	23,958
1	600	1500	4.00				300	2.50	600	1.60	180	4.00	2.50				150	4.00			6,256	6,000	19,726	9,000	28,726	3,064	42,916
PIER																	231	1.50									
																										1,512	kg/m^2

Project NBTC Building G (Generator room) **COL. TYPE C0 44**

COL. LINE GJ/2 **FOOTING TYPE F3A**

FLOOR	SLAB 1			SLAB 2			BEAM 1		BEAM 2		WALL 1			WALL 2			COL		TRANS. LOAD		LOAD/ FLOOR		SUM LOAD(WKL)			LOAD FACTOR	DL	1.4
																											LL	1.7
	DL.	LL.	AREA	DL.	LL.	AREA	w	L	w	L	w	H	L	w	H	L	w	H	DL.	LL.	DL.	LL.	DL.	LL.	TOTAL	LOAD/ AREA	SUM LOAD (ULL.)
	(kg/m^2)	(kg/m^2)	(m^2)	(kg/m^2)	(kg/m^2)	(m^2)	(kg/m)	(m)	(kg/m)	(m)	(kg/m^2)	(m)	(m)	(kg/m^2)	(m)	(m)	(kg/m)	(m)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg/m^2)	(kg)
Roof	530	200	19.50				300	2.00	360	7.50	180	1.20	7.50				0	0.00			15,855	3,900	15,855	3,900	19,755	1,013	28,827
1	600	1500	9.00				300	5.00	600	3.60	180	4.00	2.50				150	4.00			11,206	13,500	27,061	17,400	44,461	2,745	67,465
PIER																	231	1.50									
																										1,560	kg/m^2

Project **NBTC Building G (Generator room)**
COL. LINE **GI-GJ/1,GJ-GK/2**
COL. TYPE **C0**

											LOAD FACTOR											
											DL.	LL.										
											1.4	1.7										
FLOOR	D (m)	B (m)	H	Ag (m^2)	LOAD (kg)	fc' (ksc)	fy (ksc)	Ar (m^2)	fr (ksc)	As (cm^2)	Pg %As	Pg %(As+Ar)	DB 32	DB 28	DB 25	DB 20	DB 16	DB 12	As sq.cm.	LOAD KG	PERCENT %	
1																						
PIER	0.31	0.31	1.50	0.096	37,429	320	4000			9.61	1.00%	1.00%					8		16.08	179,949	1.67%	OK
																						0

Project **NBTC Building G (Generator room)**
COL. LINE **GJ/1**
COL. TYPE **C1**

											LOAD FACTOR											
											DL.	LL.										
											1.4	1.7										
FLOOR	D (m)	B (m)	H	Ag (m^2)	LOAD (kg)	fc' (ksc)	fy (ksc)	Ar (m^2)	fr (ksc)	As (cm^2)	Pg %As	Pg %(As+Ar)	DB 32	DB 28	DB 25	DB 20	DB 16	DB 12	As sq.cm.	LOAD KG	PERCENT %	
1	0.25	0.25	4.00	0.063	23,958	320	4000			6.25	1.00%	1.00%					8		16.08	128,770	2.57%	OK
PIER	0.31	0.31	1.50	0.096	42,916	320	4000			9.61	1.00%	1.00%					8		16.08	179,949	1.67%	OK
																						0

Project **NBTC Building G (Generator room)**
COL. LINE **GJ/2**
COL. TYPE **C0**

											LOAD FACTOR											
											DL.	LL.										
											1.4	1.7										
FLOOR	D (m)	B (m)	H	Ag (m^2)	LOAD (kg)	fc' (ksc)	fy (ksc)	Ar (m^2)	fr (ksc)	As (cm^2)	Pg %As	Pg %(As+Ar)	DB 32	DB 28	DB 25	DB 20	DB 16	DB 12	As sq.cm.	LOAD KG	PERCENT %	
1	0.25	0.25	4.00	0.063	28,827	320	4000			6.25	1.00%	1.00%					8		16.08	128,770	2.57%	OK
PIER	0.31	0.31	1.50	0.096	67,465	320	4000			9.61	1.00%	1.00%					8		16.08	179,949	1.67%	OK
																						0

Typical Footing

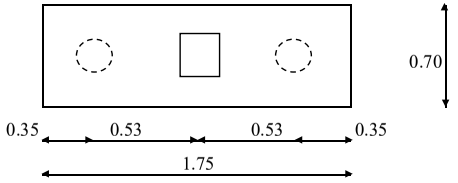
Bored pile0.35 x 0.35 with safe load not less than 15 Tons/Pile

Cost	Mat.	Workman	total
Concrete (m^3)	2100	250	2350
Steel (kg)	23	3	26
Formwork (m^2)	300	110	410

F1 0.7 x 0.7 x 0.6 Use **1** Bored pile **0.35 x 0.35**

Safe load 15 Tons/Pile $P_{w,all}$ 15 Tons

F2 1.75 x 0.7 x 0.6



Use	2	Bored pile	0.35 x	0.35		
Safe load	15	Tons/Pile	$P_{w,all}$	28.24	Tons	
L.F. =	1.55		W	1.76	Tons	6.25%
f_c' =	320	ksc	f_y =	4000	ksc	
h =	**0.60**	m	d =	50	cm	
b =	70	cm	Column	**0.25**	m	

Flexural Design

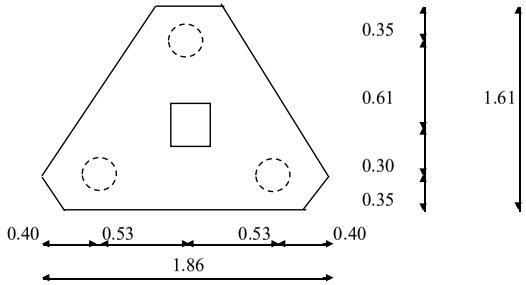
M_u	=	9300	kg-m	
$A_{s,deep\ beam}$	=	6.30	cm^2	
A_s	=	5.22	cm^2	
$A_{s,min}$	=	12.25	cm^2	
Use	**4**	**DB -**	**20**	@ 16.66 cm

One-way Shear

V_u	=	23250	kg		
$3.5-2.5M_u/V_ud$	=	1.50			
V_c	=	43350	kg	OK	
A_{vh}	Use	**DB -**	**12**	**16.0**	OK
P_{vh}	**2**	=	0.0040		OK
A_{vv}	Use	**DB -**	**12**	**10.0**	OK
P_{vv}	**2**	=	0.0065		OK
V_s	=	55517			
$V_{u,all}$	=	98867	kg	Vu,all > Vu	OK
$V_{u,max,all}$		112823	kg	Vu,all > Vu	OK

Steel (kg)	Conc. (m^3)	Form. (m^3)	Steel (B)	Conc. (B)	Form. (B)	Total(B)
176	0.74	2.94	4573	1727	1205	**7506**

F3 1.86 x 1.61 x 0.6



Use	3	Bored pile	0.35 x	0.35		
Safe load	15	Tons/Pile	$P_{w,all}$	42.11	Tons	
L.F. =	1.55		W	2.89	Tons	6.85%
f_c' =	320	ksc	f_y =	4000	ksc	
h =	**0.60**	m	d =	50	cm	
b =	161	cm	b_{moment} =	131	cm	
Column	**0.25**	m	b_{shear} =	88	cm	

Flexural Design

M_u	=	11188	kg-m	
A_s	=	6.26	cm^2	
$A_{s,min}$	=	8.35	cm^2	
Use	**8**	**DB -**	**12**	
		@	20.13	cm three-way

One-way Shear

V_u	=	10376	kg	0.446
V_c	=	35329	kg	OK

Two-way Shear

V_u	=	69750	kg	3.000
V_c	=	241764	kg	OK

Steel (kg)	Conc. (m^3)	Form. (m^3)	Steel (B)	Conc. (B)	Form. (B)	Total(B)
50	1.20	3.34488	1306	2826	1371	**5504**

Typical Footing

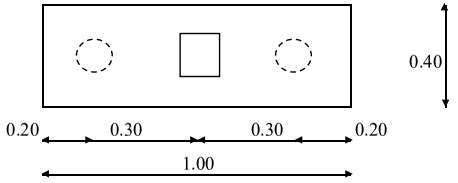
Bored pile0.2 x 0.2 with safe load not less than 15 Tons/Pile

Cost	Mat.	Workman	total
Concrete (m^3)	2100	250	2350
Steel (kg)	23	3	26
Formwork (m^2)	300	110	410

F1 0.4 x 0.4 x 0.6 Use **1** Bored pile **0.2 x 0.20**

Safe load 15 Tons/Pile $P_{w,all}$ 15 Tons

F2 1 x 0.4 x 0.6



Use	2	Bored pile	0.2 x	0.20		
Safe load	15	Tons/Pile	$P_{w,all}$	29.42	Tons	
L.F. =	1.55		W	0.58	Tons	1.96%
f_c' =	320	ksc	f_y =	4000	ksc	
h =	**0.60**	m	d =	50	cm	
b =	40	cm	Column	**0.25**	m	

Flexural Design

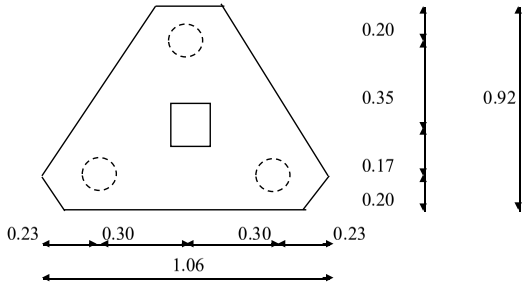
M_u	=	4068.75	kg-m	
$A_{s,deep\ beam}$	=	3.53	cm^2	
A_s	=	2.28	cm^2	
$A_{s,min}$	=	7.00	cm^2	
Use	**4**	**DB -**	**16**	@ 6.66 cm

One-way Shear

V_u	=	23250	kg		
$3.5-2.5M_u/V_ud$	=	2.50			
V_c	=	45493	kg	OK	
A_{vh}	Use	**DB -**	**12**	**16.0**	OK
P_{vh}	**2**	=	0.0071		OK
A_{vv}	Use	**DB -**	**12**	**10.0**	OK
P_{vv}	**2**	=	0.0113		OK
V_s	=	53354			
$V_{u,all}$	=	98847	kg	Vu,all > Vu	OK
$V_{u,max,all}$		64470	kg	Vu,all > Vu	OK

Steel (kg)	Conc. (m^3)	Form. (m^3)	Steel (B)	Conc. (B)	Form. (B)	Total(B)
70	0.24	1.68	1829	564	689	**3081**

F3 1.07 x 0.92 x 0.5



Use	3	Bored pile	0.2 x	0.20		
Safe load	15	Tons/Pile	$P_{w,all}$	44.21	Tons	
L.F. =	1.55		W	0.79	Tons	1.78%
f_c' =	320	ksc	f_y =	4000	ksc	
h =	**0.50**	m	d =	40	cm	
b =	92	cm	b_{moment} =	69	cm	
Column	**0.25**	m	b_{shear} =	37	cm	

Flexural Design

M_u	=	5148	kg-m	
A_s	=	3.61	cm^2	
$A_{s,min}$	=	4.81	cm^2	
Use	**5**	**DB -**	**12**	
		@	17.99	cm three-way

One-way Shear

V_u	=	0	kg	0.000
V_c	=	11896	kg	OK

Two-way Shear

V_u	=	42338	kg	1.821
V_c	=	167623	kg	OK

Steel (kg)	Conc. (m^3)	Form. (m^3)	Steel (B)	Conc. (B)	Form. (B)	Total(B)
19	0.33	1.5928	506	769	653	**1928**