



# รายการคำนวณโครงสร้างกล่องที่ระบายน้ำฝน

โครงการ

“งานปรับปรุงระบบสุขาภิบาล คณะเภสัชศาสตร์

เจ้าของ

มหาวิทยาลัยศรีนครินทรวิโรฒ องค์กรักษ์

วิศวกรโครงสร้าง

นายศุภชัย จันทูมา สย. 11318



บริษัท เฟิร์ส อาร์คิเทค จำกัด

ใช้สำหรับออกแบบทำรายการคำนวณโครงสร้าง  
โครงการ งานออกแบบปรับปรุงอาคารคณะเภสัชศาสตร์



ใบอนุญาตประกอบวิชาชีพวิศวกรรม  
โครงการ Thai Professional Engineering License  
เลขประจำตัว 3-3415-00736-03-3

ชื่อคุณ **นาย สุภชัย จันทูมา**  
Title/Name Surname **Mr. Supachai Jantuma**



ลายเซ็นผู้ได้รับใบอนุญาต (Signature)

เลขทะเบียน License No.	สย.11318	เลขที่สมาชิกสามัญ Member No.	165856
ระดับ Level	สามัญวิศวกร Professional Eng.	สาขา Discipline	โยธา Civil Eng.
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นายสุภชัย จันทูมา  
(นายกสภาวิศวกร President)

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## เกณฑ์กำหนดในการออกแบบ

## 1. น้ำหนักบรรทุกที่ใช้ออกแบบ

## 1.1 น้ำหนักบรรทุกคงที่

- น้ำหนักเหล็ก	7850	กก./ลบ.ม.
- น้ำหนักวัสดุผนังปี ดกกล่องท่อระบายน้ำฝน	30	กก./ตร.ม.

## 1.2 น้ำหนักบรรทุกจร

- น้ำหนักกล่องรับท่อระบายน้ำ	30	กก./ตร.ม.	
แรงลม (ในแนวราบ)	H < 10 ม.	50	กก./ตร.ม.
	10 < H < 20 ม.	80	กก./ตร.ม.
	20 < H < 40 ม.	120	กก./ตร.ม.
	H > 40 ม.	160	กก./ตร.ม.

## 2. วิธีออกแบบ

====&gt; วิธีหน่วยแรงใช้งาน (Working Stress Design)

====&gt; วิธีหน่วยแรงใช้งาน (Allowable stress design method) สำหรับโครงสร้างเหล็ก

หน่วยแรงที่ยอมให้ในการออกแบบ : คอนกรีตเสริมเหล็ก

- แรงอัดประลัยของคอนกรีตรูปทรงระบอบ อายุ 28 วัน	=	173	ksc.
$f_c$	=	173	ksc.
- หน่วยแรงอัด ( $f_c$ ) = $0.375 * f_c'$	=	65	ksc.
- หน่วยแรงกด = $0.25 * f_c'$	=	43	ksc.
- หน่วยแรงเฉือน ( $v_c$ ) = $0.29 * \text{SQR}(f_c')$	=	3.81	ksc.
- หน่วยแรงเฉือนทะลุ ( $v_c$ ) = $0.53 * \text{SQR}(f_c')$	=	6.97	ksc.

หน่วยแรงที่ยอมให้ในการออกแบบ : เหล็กเสริมคอนกรีต

Class : SD40	$F_y$ =	4000	ksc.
- หน่วยแรงยึดหน้าวง : $u = 2.290 * \text{SQR}(f_c')/D$	=	30.12	/D < 25 ksc.
Class : SR24	$F_y$ =	2400	ksc.
- หน่วยแรงยึดหน้าวง : $u = 1.145 * \text{SQR}(f_c')/D$	=	15.06	/D < 11 ksc.

(เมื่อ D = ขนาดเส้นผ่านศูนย์กลางเหล็กเสริม)

## 3. ค่าคงที่ในการออกแบบ

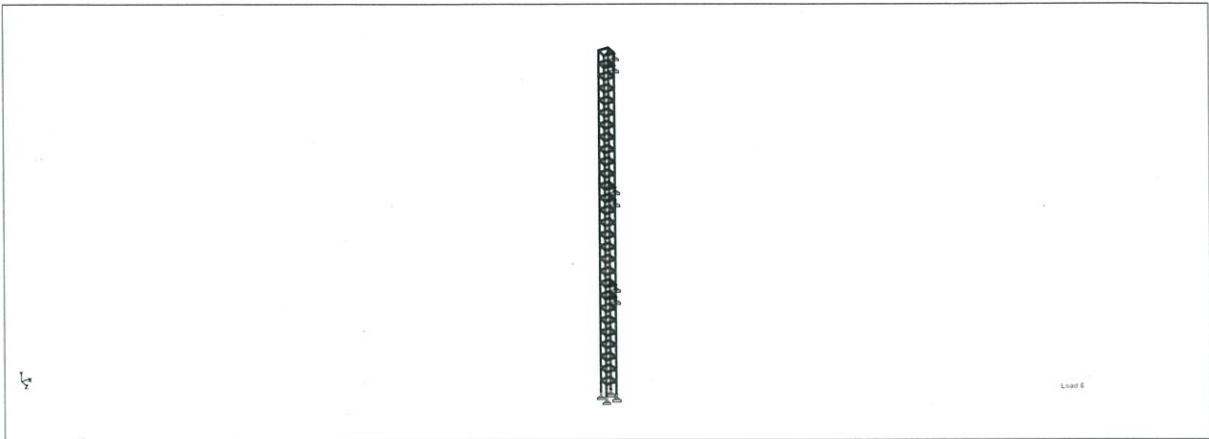
$n = E_s/E_c$	=	10	
Class : SD40	$f_s$ =	1700	ksc.
$k = 1/(1+f_s/nf_c)$	=	0.277	
$j = 1-k/3$	=	0.908	
$R = 1/2 * f_c * j * k$	=	8.161	ksc.
Class : SR24	$f_s$ =	1200	ksc.
$k = 1/(1+f_s/nf_c)$	=	0.351	
$j = 1-k/3$	=	0.883	
$R = 1/2 * f_c * j * k$	=	10.082	ksc.

## 4. โครงสร้างเหล็ก

เหล็กโครงสร้างรูปพรรณ :

- โมดูลัสความยืดหยุ่น $E_s$	=	2100000	ksc.	
- กำลังคลาก เมื่อ ความหนาของปีกคาน, $t_f > 16$ มม.	$F_y$ =	2400	ksc.	
	$t_f \leq 16$ มม.	$F_y$ =	2400	ksc.
- ลวดเชื่อม Class E70xx	$F_y$ =	1470	ksc.	

Code : มาตรฐาน วสท.



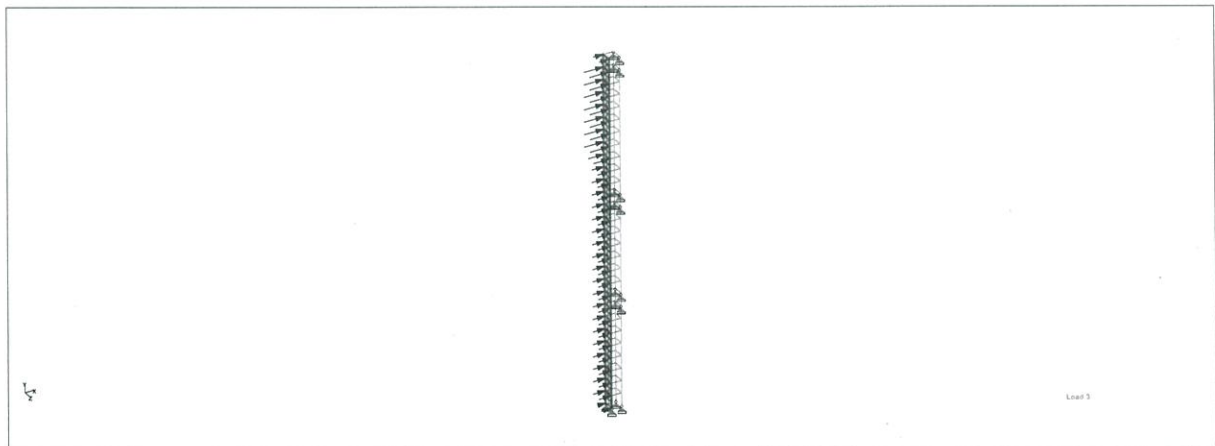
Whole Structure

## Section Properties

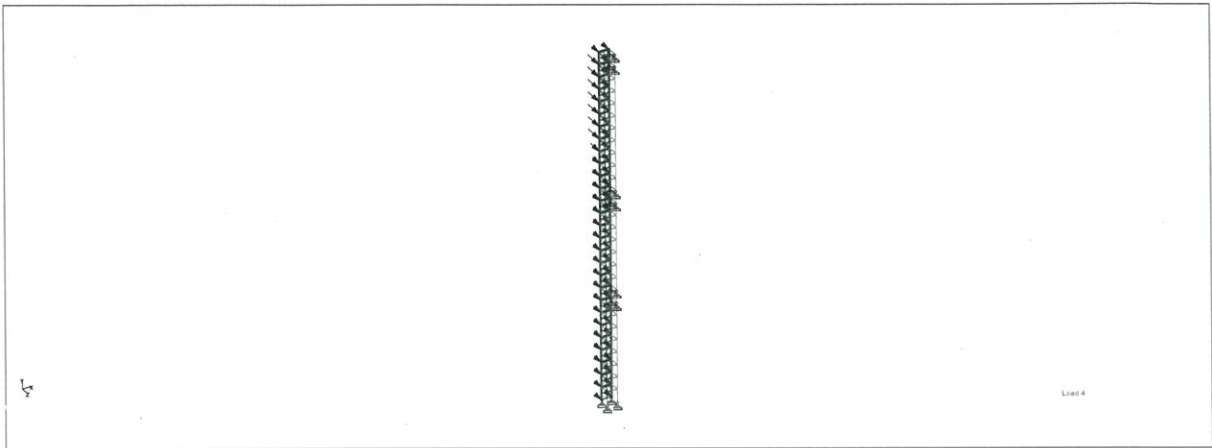
Prop	Section	Area (cm <sup>2</sup> )	I <sub>yy</sub> (cm <sup>4</sup> )	I <sub>zz</sub> (cm <sup>4</sup> )	J (cm <sup>4</sup> )	Material
1	TUB50502.3	4.252	15.900	15.900	24.962	STEEL

## Supports

Node	X (kN/mm)	Y (kN/mm)	Z (kN/mm)	rX (kN <sup>2</sup> m/deg)	rY (kN <sup>2</sup> m/deg)	rZ (kN <sup>2</sup> m/deg)
1	Fixed	Fixed	Fixed	-	-	-
2	Fixed	Fixed	Fixed	-	-	-
3	Fixed	Fixed	Fixed	-	-	-
4	Fixed	Fixed	Fixed	-	-	-
34	Fixed	Fixed	Fixed	-	-	-
36	Fixed	Fixed	Fixed	-	-	-
38	Fixed	Fixed	Fixed	-	-	-
40	Fixed	Fixed	Fixed	-	-	-
66	Fixed	Fixed	Fixed	-	-	-
68	Fixed	Fixed	Fixed	-	-	-
70	Fixed	Fixed	Fixed	-	-	-
72	Fixed	Fixed	Fixed	-	-	-
102	Fixed	Fixed	Fixed	-	-	-
104	Fixed	Fixed	Fixed	-	-	-
106	Fixed	Fixed	Fixed	-	-	-
108	Fixed	Fixed	Fixed	-	-	-



Whole Structure



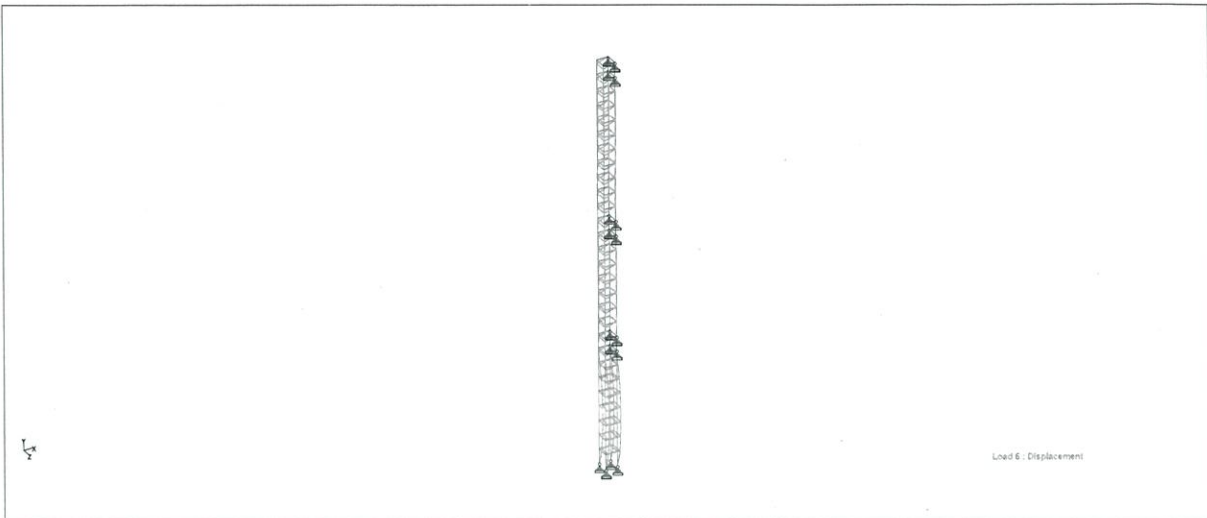
Whole Structure

### Primary Load Cases

Number	Name	Type
1	DL	Dead
2	LL	Live
3	WX	Wind
4	WZ	Wind

### Combination Load Cases

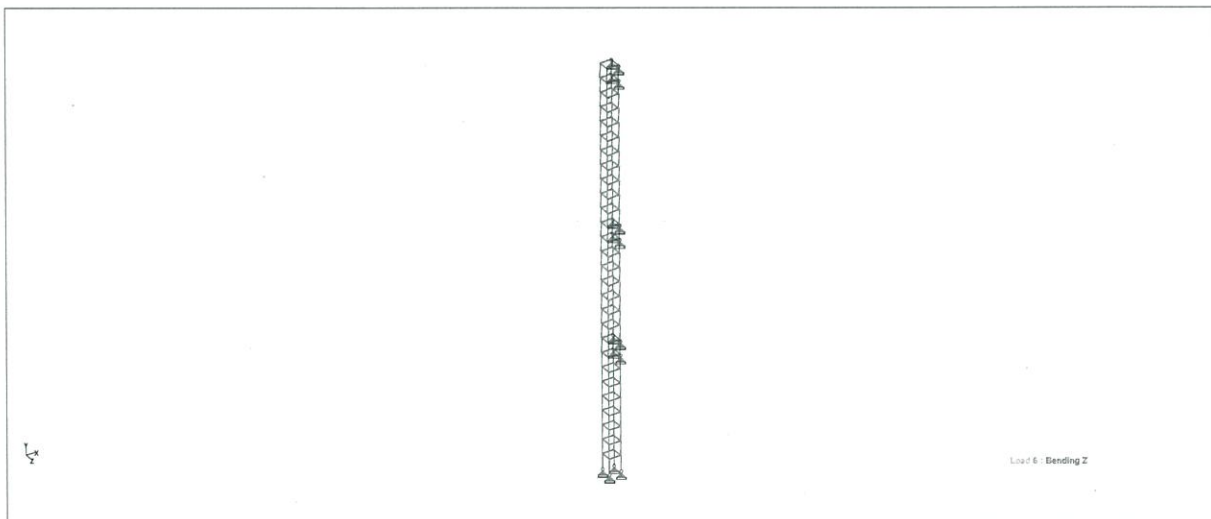
Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
5	GENERATED AISC GENERAL 1	1	DL	1.00
6	GENERATED AISC GENERAL 2	1	DL	1.00
		2	LL	1.00
7	GENERATED AISC GENERAL 3	1	DL	1.00
		2	LL	0.75
8	GENERATED AISC GENERAL 4	1	DL	1.00
		3	WX	1.00
9	GENERATED AISC GENERAL 5	1	DL	1.00
		4	WZ	1.00
10	GENERATED AISC GENERAL 6	1	DL	1.00
		2	LL	0.75
		3	WX	0.75
11	GENERATED AISC GENERAL 7	1	DL	1.00
		2	LL	0.75
		4	WZ	0.75
12	GENERATED AISC GENERAL 8	1	DL	0.60
		3	WX	1.00
13	GENERATED AISC GENERAL 9	1	DL	0.60
		4	WZ	1.00
14	GENERATED AISC GENERAL 10	1	DL	0.60



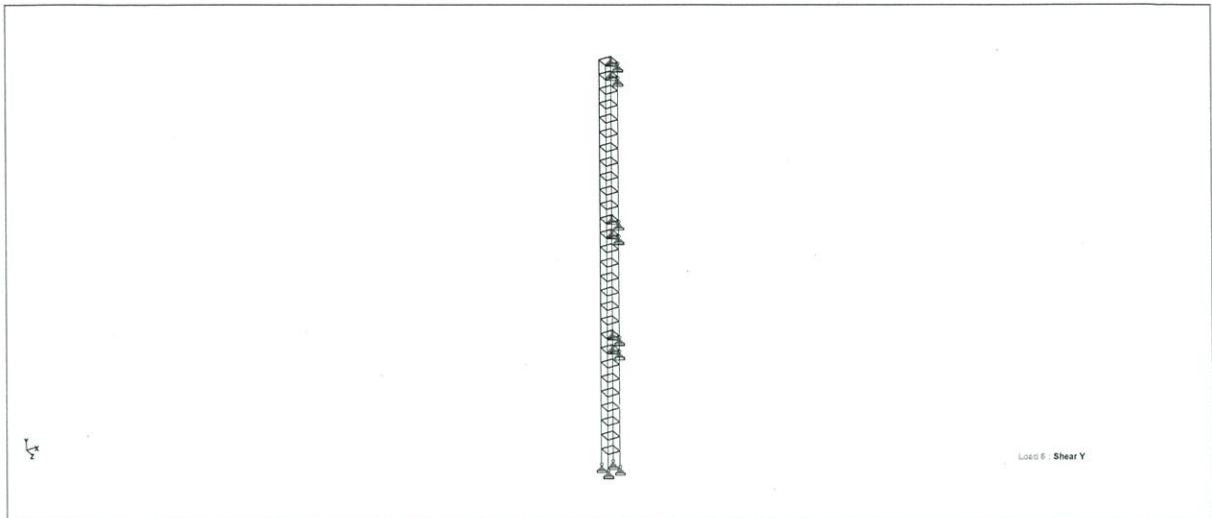
Whole Structure Displacements 0.06cm:1m 6 GENERATED AISC GENERAL 2

### Node Displacement Summary

	Node	L/C	X (cm)	Y (cm)	Z (cm)	Resultant (cm)	rX (rad)	rY (rad)	rZ (rad)
Max X	81	8:GENERATEC	<b>0.045</b>	-0.004	0.000	0.045	0.00	0.00	0.00
Min X	114	9:GENERATEC	<b>-0.002</b>	-0.000	0.025	0.025	0.00	0.00	0.00
Max Y	103	4:WZ	0.000	<b>0.001</b>	0.006	0.006	-0.00	0.00	-0.00
Min Y	97	10:GENERATE	0.011	<b>-0.008</b>	0.000	0.013	0.00	0.00	0.00
Max Z	81	4:WZ	-0.002	-0.000	<b>0.049</b>	0.049	0.00	0.00	0.00
Min Z	107	6:GENERATEC	-0.000	-0.007	<b>-0.000</b>	0.007	-0.00	-0.00	0.00
Max rX	3	9:GENERATEC	0.000	0.000	0.000	0.000	<b>0.00</b>	0.00	-0.00
Min rX	100	9:GENERATEC	0.002	0.000	0.014	0.015	<b>-0.00</b>	0.00	0.00
Max rY	97	9:GENERATEC	-0.001	-0.005	0.018	0.019	-0.00	<b>0.00</b>	0.00
Min rY	108	6:GENERATEC	0.000	0.000	0.000	0.000	-0.00	<b>-0.00</b>	0.00
Max rZ	98	8:GENERATEC	0.014	-0.000	0.000	0.014	0.00	0.00	<b>0.00</b>
Min rZ	2	8:GENERATEC	0.000	0.000	0.000	0.000	-0.00	-0.00	<b>-0.00</b>
Max Rst	81	9:GENERATEC	-0.001	-0.003	0.049	<b>0.049</b>	0.00	0.00	0.00



Whole Structure Mz 0.0815773Mton-m:1m 6 GENERATED AISC GENERAL 2

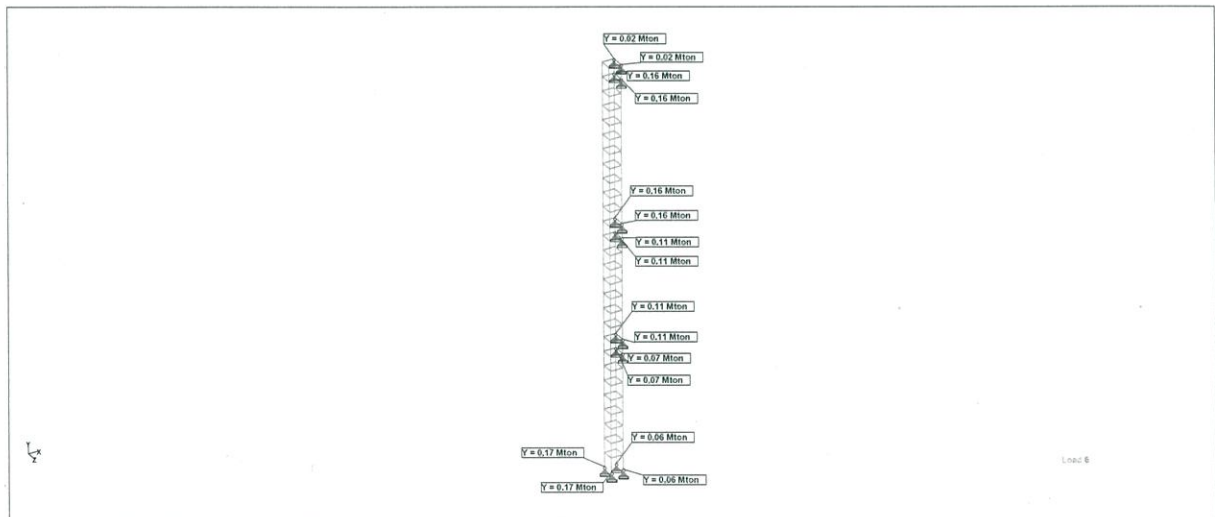


Whole Structure Fy 10.1972Mton:1m 6 GENERATED AISC GENERAL 2

### 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.

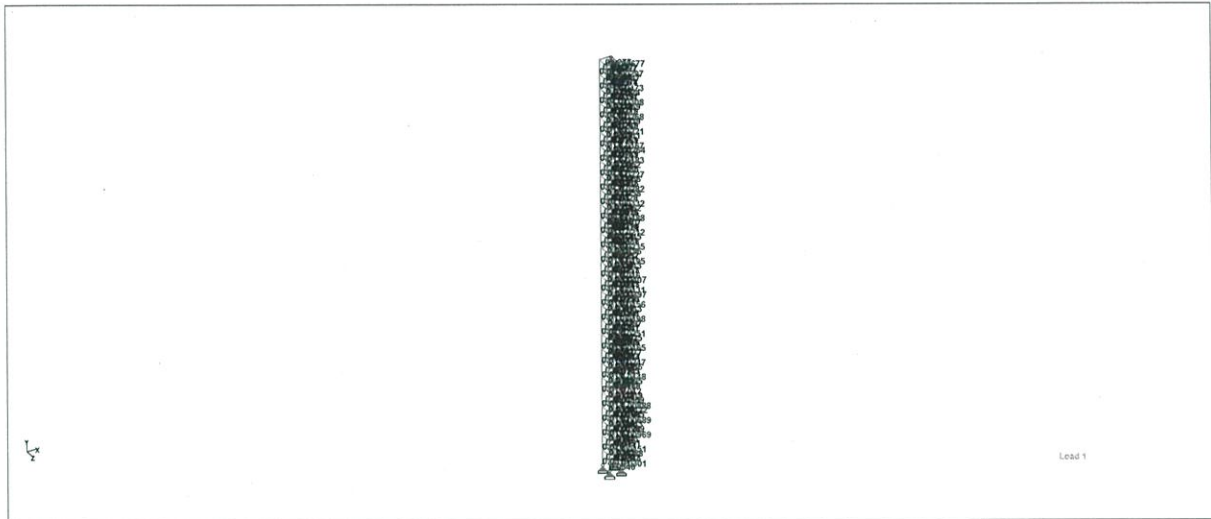
	Beam	L/C	d (m)	Axial			Shear			Torsion	Bending	
				Fx (Mton)	Fy (Mton)	Fz (Mton)	Mx (MTon·m)	Fy (Mton)	Fz (Mton)	Mx (MTon·m)	My (MTon·m)	Mz (MTon·m)
Max Fx	44	6:GENERATEC	0.500	0.17	0.00	0.00	-0.00	0.00	0.00	-0.00	-0.00	
Min Fx	202	11:GENERATE	0.000	-0.16	0.01	-0.02	0.00	0.00	0.00	0.00	0.00	
Max Fy	192	9:GENERATEC	0.000	0.00	0.04	-0.00	-0.00	0.00	0.00	0.00	0.01	
Min Fy	213	10:GENERATE	0.400	0.00	-0.05	-0.00	0.00	-0.00	0.00	-0.00	0.01	
Max Fz	220	9:GENERATEC	0.000	0.12	0.01	0.02	-0.00	-0.00	0.00	-0.00	0.00	
Min Fz	202	9:GENERATEC	0.000	-0.12	0.01	-0.02	0.00	0.01	0.00	0.01	0.00	
Max Mx	211	4:WZ	0.000	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Min Mx	206	9:GENERATEC	0.000	-0.00	-0.00	0.00	-0.00	-0.00	0.00	-0.00	-0.00	
Max My	202	9:GENERATEC	0.000	-0.12	0.01	-0.02	0.00	0.01	0.00	0.01	0.00	
Min My	202	9:GENERATEC	0.500	-0.12	0.01	-0.02	0.00	-0.00	0.00	-0.00	-0.00	
Max Mz	213	10:GENERATE	0.400	0.00	-0.05	-0.00	0.00	-0.00	0.00	-0.00	0.01	
Min Mz	213	10:GENERATE	0.000	0.00	-0.04	-0.00	0.00	0.00	0.00	0.00	-0.01	



Whole Structure

## Reaction Summary

	Node	L/C	Horizontal	Vertical	Horizontal	Moment		
			FX (Mton)	FY (Mton)	FZ (Mton)	MX (Mton·m)	MY (Mton·m)	MZ (Mton·m)
Max FX	102	4:WZ	0.04	0.09	-0.05	0.00	0.00	0.00
Min FX	102	8:GENERATEL	-0.06	0.02	0.00	0.00	0.00	0.00
Max FY	102	11:GENERATE	0.02	0.21	-0.04	0.00	0.00	0.00
Min FY	104	4:WZ	-0.04	-0.09	-0.04	0.00	0.00	0.00
Max FZ	108	9:GENERATEL	0.00	0.01	0.00	0.00	0.00	0.00
Min FZ	102	4:WZ	0.04	0.09	-0.05	0.00	0.00	0.00
Max MX	1	1:DL	-0.00	0.07	0.00	0.00	0.00	0.00
Min MX	1	1:DL	-0.00	0.07	0.00	0.00	0.00	0.00
Max MY	1	1:DL	-0.00	0.07	0.00	0.00	0.00	0.00
Min MY	1	1:DL	-0.00	0.07	0.00	0.00	0.00	0.00
Max MZ	1	1:DL	-0.00	0.07	0.00	0.00	0.00	0.00
Min MZ	1	1:DL	-0.00	0.07	0.00	0.00	0.00	0.00



Whole Structure

## Utilization Ratio

Beam	Analysis Property	Design Property	Actual Allowable		Ratio (Act./Allow.)	Clause	L/C	Ax (cm <sup>2</sup> )	Iz (cm <sup>4</sup> )	Iy (cm <sup>4</sup> )	Ix (cm <sup>4</sup> )
			Ratio	Ratio							
5	TUB50502.3	TUB50502.3	0.034	1.000	0.034	Eq. H1-1b	8	4.252	15.900	15.900	24.960
6	TUB50502.3	TUB50502.3	0.034	1.000	0.034	Eq. H1-1b	8	4.252	15.900	15.900	24.960
7	TUB50502.3	TUB50502.3	0.030	1.000	0.030	Eq. H1-1b	9	4.252	15.900	15.900	24.960
8	TUB50502.3	TUB50502.3	0.029	1.000	0.029	Eq. H1-1b	9	4.252	15.900	15.900	24.960
9	TUB50502.3	TUB50502.3	0.019	1.000	0.019	Eq. H1-1b	10	4.252	15.900	15.900	24.960
10	TUB50502.3	TUB50502.3	0.019	1.000	0.019	Eq. H1-1b	10	4.252	15.900	15.900	24.960
11	TUB50502.3	TUB50502.3	0.014	1.000	0.014	Eq. H1-1b	9	4.252	15.900	15.900	24.960
12	TUB50502.3	TUB50502.3	0.013	1.000	0.013	Eq. H1-1b	9	4.252	15.900	15.900	24.960
13	TUB50502.3	TUB50502.3	0.012	1.000	0.012	Eq. H1-1b	10	4.252	15.900	15.900	24.960
14	TUB50502.3	TUB50502.3	0.012	1.000	0.012	Eq. H1-1b	10	4.252	15.900	15.900	24.960
15	TUB50502.3	TUB50502.3	0.006	1.000	0.006	Eq. H1-1b	9	4.252	15.900	15.900	24.960
16	TUB50502.3	TUB50502.3	0.004	1.000	0.004	Eq. H1-1b	9	4.252	15.900	15.900	24.960
17	TUB50502.3	TUB50502.3	0.011	1.000	0.011	Eq. H1-1b	6	4.252	15.900	15.900	24.960
18	TUB50502.3	TUB50502.3	0.011	1.000	0.011	Eq. H1-1b	6	4.252	15.900	15.900	24.960
19	TUB50502.3	TUB50502.3	0.004	1.000	0.004	Eq. H1-1b	11	4.252	15.900	15.900	24.960
20	TUB50502.3	TUB50502.3	0.004	1.000	0.004	Eq. H1-1b	9	4.252	15.900	15.900	24.960
21	TUB50502.3	TUB50502.3	0.012	1.000	0.012	Eq. H1-1b	3	4.252	15.900	15.900	24.960
22	TUB50502.3	TUB50502.3	0.012	1.000	0.012	Eq. H1-1b	3	4.252	15.900	15.900	24.960
23	TUB50502.3	TUB50502.3	0.011	1.000	0.011	Eq. H1-1b	9	4.252	15.900	15.900	24.960

## Utilization Ratio Cont...

Beam	Analysis Property	Design Property	Actual Allowable		Ratio (Act./Allow.)	Clause	L/C	Ax (cm <sup>2</sup> )	Iz (cm <sup>4</sup> )	Iy (cm <sup>4</sup> )	Ix (cm <sup>4</sup> )
			Ratio	Ratio							
24	TUB50502.3	TUB50502.3	0.012	1.000	0.012	Eq. H1-1b	9	4.252	15.900	15.900	24.960
25	TUB50502.3	TUB50502.3	0.019	1.000	0.019	Eq. H1-1b	3	4.252	15.900	15.900	24.960
26	TUB50502.3	TUB50502.3	0.019	1.000	0.019	Eq. H1-1b	3	4.252	15.900	15.900	24.960
27	TUB50502.3	TUB50502.3	0.018	1.000	0.018	Eq. H1-1b	9	4.252	15.900	15.900	24.960
28	TUB50502.3	TUB50502.3	0.020	1.000	0.020	Eq. H1-1b	9	4.252	15.900	15.900	24.960
29	TUB50502.3	TUB50502.3	0.024	1.000	0.024	Eq. H1-1b	3	4.252	15.900	15.900	24.960
30	TUB50502.3	TUB50502.3	0.024	1.000	0.024	Eq. H1-1b	3	4.252	15.900	15.900	24.960
31	TUB50502.3	TUB50502.3	0.024	1.000	0.024	Eq. H1-1b	9	4.252	15.900	15.900	24.960
32	TUB50502.3	TUB50502.3	0.029	1.000	0.029	Eq. H1-1b	9	4.252	15.900	15.900	24.960
33	TUB50502.3	TUB50502.3	0.028	1.000	0.028	Eq. H1-1b	11	4.252	15.900	15.900	24.960
34	TUB50502.3	TUB50502.3	0.024	1.000	0.024	Eq. H1-1b	11	4.252	15.900	15.900	24.960
35	TUB50502.3	TUB50502.3	0.024	1.000	0.024	Eq. H1-1b	9	4.252	15.900	15.900	24.960
36	TUB50502.3	TUB50502.3	0.028	1.000	0.028	Eq. H1-1b	9	4.252	15.900	15.900	24.960
37	TUB50502.3	TUB50502.3	0.019	1.000	0.019	Eq. H1-1b	3	4.252	15.900	15.900	24.960
38	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	11	4.252	15.900	15.900	24.960
39	TUB50502.3	TUB50502.3	0.012	1.000	0.012	Eq. H1-1b	11	4.252	15.900	15.900	24.960
40	TUB50502.3	TUB50502.3	0.013	1.000	0.013	Sec. E1	10	4.252	15.900	15.900	24.960
41	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Sec. E1	10	4.252	15.900	15.900	24.960
42	TUB50502.3	TUB50502.3	0.016	1.000	0.016	Sec. E1	6	4.252	15.900	15.900	24.960
43	TUB50502.3	TUB50502.3	0.020	1.000	0.020	Eq. H1-1b	10	4.252	15.900	15.900	24.960
44	TUB50502.3	TUB50502.3	0.035	1.000	0.035	Eq. H1-1b	11	4.252	15.900	15.900	24.960
45	TUB50502.3	TUB50502.3	0.028	1.000	0.028	Eq. H1-1b	9	4.252	15.900	15.900	24.960
46	TUB50502.3	TUB50502.3	0.016	1.000	0.016	Eq. H1-1b	9	4.252	15.900	15.900	24.960
47	TUB50502.3	TUB50502.3	0.012	1.000	0.012	Eq. H1-1b	11	4.252	15.900	15.900	24.960
48	TUB50502.3	TUB50502.3	0.008	1.000	0.008	Eq. H1-1b	11	4.252	15.900	15.900	24.960
49	TUB50502.3	TUB50502.3	0.007	1.000	0.007	Eq. H1-1b	10	4.252	15.900	15.900	24.960
50	TUB50502.3	TUB50502.3	0.010	1.000	0.010	Eq. H1-1b	10	4.252	15.900	15.900	24.960
51	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	11	4.252	15.900	15.900	24.960
52	TUB50502.3	TUB50502.3	0.030	1.000	0.030	Eq. H1-1b	8	4.252	15.900	15.900	24.960
53	TUB50502.3	TUB50502.3	0.019	1.000	0.019	Eq. H1-1b	3	4.252	15.900	15.900	24.960
54	TUB50502.3	TUB50502.3	0.016	1.000	0.016	Eq. H1-1b	11	4.252	15.900	15.900	24.960
55	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	11	4.252	15.900	15.900	24.960
56	TUB50502.3	TUB50502.3	0.013	1.000	0.013	Eq. H1-1b	11	4.252	15.900	15.900	24.960
57	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Sec. E1	10	4.252	15.900	15.900	24.960
58	TUB50502.3	TUB50502.3	0.016	1.000	0.016	Sec. E1	6	4.252	15.900	15.900	24.960
59	TUB50502.3	TUB50502.3	0.020	1.000	0.020	Eq. H1-1b	10	4.252	15.900	15.900	24.960
60	TUB50502.3	TUB50502.3	0.032	1.000	0.032	Eq. H1-1b	10	4.252	15.900	15.900	24.960
61	TUB50502.3	TUB50502.3	0.025	1.000	0.025	Eq. H1-1b	4	4.252	15.900	15.900	24.960
62	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	9	4.252	15.900	15.900	24.960
63	TUB50502.3	TUB50502.3	0.012	1.000	0.012	Eq. H1-1b	11	4.252	15.900	15.900	24.960
64	TUB50502.3	TUB50502.3	0.009	1.000	0.009	Eq. H1-1b	11	4.252	15.900	15.900	24.960
65	TUB50502.3	TUB50502.3	0.007	1.000	0.007	Eq. H1-1b	11	4.252	15.900	15.900	24.960
66	TUB50502.3	TUB50502.3	0.010	1.000	0.010	Eq. H1-1b	10	4.252	15.900	15.900	24.960
67	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	11	4.252	15.900	15.900	24.960
68	TUB50502.3	TUB50502.3	0.030	1.000	0.030	Eq. H1-1b	9	4.252	15.900	15.900	24.960
69	TUB50502.3	TUB50502.3	0.031	1.000	0.031	Eq. H1-1b	10	4.252	15.900	15.900	24.960
70	TUB50502.3	TUB50502.3	0.031	1.000	0.031	Eq. H1-1b	11	4.252	15.900	15.900	24.960
71	TUB50502.3	TUB50502.3	0.020	1.000	0.020	Eq. H1-1b	9	4.252	15.900	15.900	24.960
72	TUB50502.3	TUB50502.3	0.022	1.000	0.022	Eq. H1-1b	9	4.252	15.900	15.900	24.960
73	TUB50502.3	TUB50502.3	0.035	1.000	0.035	Eq. H1-1b	10	4.252	15.900	15.900	24.960
74	TUB50502.3	TUB50502.3	0.035	1.000	0.035	Eq. H1-1b	10	4.252	15.900	15.900	24.960
75	TUB50502.3	TUB50502.3	0.018	1.000	0.018	Eq. H1-1b	9	4.252	15.900	15.900	24.960
76	TUB50502.3	TUB50502.3	0.020	1.000	0.020	Eq. H1-1b	9	4.252	15.900	15.900	24.960
82	TUB50502.3	TUB50502.3	0.021	1.000	0.021	Eq. H1-1b	10	4.252	15.900	15.900	24.960
83	TUB50502.3	TUB50502.3	0.016	1.000	0.016	Eq. H1-1b	10	4.252	15.900	15.900	24.960
85	TUB50502.3	TUB50502.3	0.025	1.000	0.025	Eq. H1-1b	10	4.252	15.900	15.900	24.960

## Utilization Ratio Cont...

Beam	Analysis Property	Design Property	Actual Allowable		Ratio (Act./Allow.)	Clause	L/C	Ax (cm <sup>2</sup> )	Iz (cm <sup>4</sup> )	Iy (cm <sup>4</sup> )	Ix (cm <sup>4</sup> )
			Ratio	Ratio							
86	TUB50502.3	TUB50502.3	0.016	1.000	0.016	Eq. H1-1b	10	4.252	15.900	15.900	24.960
88	TUB50502.3	TUB50502.3	0.021	1.000	0.021	Eq. H1-1b	10	4.252	15.900	15.900	24.960
89	TUB50502.3	TUB50502.3	0.016	1.000	0.016	Eq. H1-1b	10	4.252	15.900	15.900	24.960
91	TUB50502.3	TUB50502.3	0.025	1.000	0.025	Eq. H1-1b	10	4.252	15.900	15.900	24.960
92	TUB50502.3	TUB50502.3	0.016	1.000	0.016	Eq. H1-1b	11	4.252	15.900	15.900	24.960
93	TUB50502.3	TUB50502.3	0.030	1.000	0.030	Eq. H1-1b	10	4.252	15.900	15.900	24.960
94	TUB50502.3	TUB50502.3	0.030	1.000	0.030	Eq. H1-1b	10	4.252	15.900	15.900	24.960
95	TUB50502.3	TUB50502.3	0.012	1.000	0.012	Eq. H1-1b	9	4.252	15.900	15.900	24.960
96	TUB50502.3	TUB50502.3	0.011	1.000	0.011	Eq. H1-1b	9	4.252	15.900	15.900	24.960
97	TUB50502.3	TUB50502.3	0.017	1.000	0.017	Eq. H1-1b	10	4.252	15.900	15.900	24.960
98	TUB50502.3	TUB50502.3	0.020	1.000	0.020	Eq. H1-1b	10	4.252	15.900	15.900	24.960
99	TUB50502.3	TUB50502.3	0.017	1.000	0.017	Eq. H1-1b	10	4.252	15.900	15.900	24.960
100	TUB50502.3	TUB50502.3	0.020	1.000	0.020	Eq. H1-1b	10	4.252	15.900	15.900	24.960
101	TUB50502.3	TUB50502.3	0.025	1.000	0.025	Eq. H1-1b	6	4.252	15.900	15.900	24.960
102	TUB50502.3	TUB50502.3	0.025	1.000	0.025	Eq. H1-1b	6	4.252	15.900	15.900	24.960
103	TUB50502.3	TUB50502.3	0.004	1.000	0.004	Eq. H1-1b	9	4.252	15.900	15.900	24.960
104	TUB50502.3	TUB50502.3	0.004	1.000	0.004	Eq. H1-1b	9	4.252	15.900	15.900	24.960
105	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	10	4.252	15.900	15.900	24.960
106	TUB50502.3	TUB50502.3	0.016	1.000	0.016	Eq. H1-1b	10	4.252	15.900	15.900	24.960
107	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	10	4.252	15.900	15.900	24.960
108	TUB50502.3	TUB50502.3	0.016	1.000	0.016	Eq. H1-1b	10	4.252	15.900	15.900	24.960
109	TUB50502.3	TUB50502.3	0.025	1.000	0.025	Eq. H1-1b	6	4.252	15.900	15.900	24.960
110	TUB50502.3	TUB50502.3	0.025	1.000	0.025	Eq. H1-1b	6	4.252	15.900	15.900	24.960
111	TUB50502.3	TUB50502.3	0.006	1.000	0.006	Eq. H1-1b	9	4.252	15.900	15.900	24.960
112	TUB50502.3	TUB50502.3	0.004	1.000	0.004	Eq. H1-1b	9	4.252	15.900	15.900	24.960
113	TUB50502.3	TUB50502.3	0.013	1.000	0.013	Eq. H1-1b	6	4.252	15.900	15.900	24.960
114	TUB50502.3	TUB50502.3	0.013	1.000	0.013	Eq. H1-1b	6	4.252	15.900	15.900	24.960
115	TUB50502.3	TUB50502.3	0.013	1.000	0.013	Eq. H1-1b	6	4.252	15.900	15.900	24.960
116	TUB50502.3	TUB50502.3	0.013	1.000	0.013	Eq. H1-1b	6	4.252	15.900	15.900	24.960
117	TUB50502.3	TUB50502.3	0.025	1.000	0.025	Eq. H1-1b	6	4.252	15.900	15.900	24.960
118	TUB50502.3	TUB50502.3	0.025	1.000	0.025	Eq. H1-1b	6	4.252	15.900	15.900	24.960
119	TUB50502.3	TUB50502.3	0.013	1.000	0.013	Eq. H1-1b	9	4.252	15.900	15.900	24.960
120	TUB50502.3	TUB50502.3	0.011	1.000	0.011	Eq. H1-1b	9	4.252	15.900	15.900	24.960
121	TUB50502.3	TUB50502.3	0.013	1.000	0.013	Eq. H1-1b	11	4.252	15.900	15.900	24.960
122	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	11	4.252	15.900	15.900	24.960
123	TUB50502.3	TUB50502.3	0.014	1.000	0.014	Eq. H1-1b	11	4.252	15.900	15.900	24.960
124	TUB50502.3	TUB50502.3	0.016	1.000	0.016	Eq. H1-1b	11	4.252	15.900	15.900	24.960
125	TUB50502.3	TUB50502.3	0.026	1.000	0.026	Eq. H1-1b	6	4.252	15.900	15.900	24.960
126	TUB50502.3	TUB50502.3	0.026	1.000	0.026	Eq. H1-1b	6	4.252	15.900	15.900	24.960
127	TUB50502.3	TUB50502.3	0.019	1.000	0.019	Eq. H1-1b	9	4.252	15.900	15.900	24.960
128	TUB50502.3	TUB50502.3	0.020	1.000	0.020	Eq. H1-1b	9	4.252	15.900	15.900	24.960
129	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	11	4.252	15.900	15.900	24.960
130	TUB50502.3	TUB50502.3	0.019	1.000	0.019	Eq. H1-1b	11	4.252	15.900	15.900	24.960
131	TUB50502.3	TUB50502.3	0.016	1.000	0.016	Eq. H1-1b	11	4.252	15.900	15.900	24.960
132	TUB50502.3	TUB50502.3	0.019	1.000	0.019	Eq. H1-1b	11	4.252	15.900	15.900	24.960
133	TUB50502.3	TUB50502.3	0.034	1.000	0.034	Eq. H1-1b	11	4.252	15.900	15.900	24.960
134	TUB50502.3	TUB50502.3	0.034	1.000	0.034	Eq. H1-1b	11	4.252	15.900	15.900	24.960
135	TUB50502.3	TUB50502.3	0.021	1.000	0.021	Eq. H1-1b	9	4.252	15.900	15.900	24.960
136	TUB50502.3	TUB50502.3	0.025	1.000	0.025	Eq. H1-1b	9	4.252	15.900	15.900	24.960
137	TUB50502.3	TUB50502.3	0.017	1.000	0.017	Eq. H1-1b	9	4.252	15.900	15.900	24.960
138	TUB50502.3	TUB50502.3	0.027	1.000	0.027	Eq. H1-1b	11	4.252	15.900	15.900	24.960
139	TUB50502.3	TUB50502.3	0.021	1.000	0.021	Eq. H1-1b	11	4.252	15.900	15.900	24.960
140	TUB50502.3	TUB50502.3	0.023	1.000	0.023	Eq. H1-1b	11	4.252	15.900	15.900	24.960
141	TUB50502.3	TUB50502.3	0.041	1.000	0.041	Eq. H1-1b	10	4.252	15.900	15.900	24.960
142	TUB50502.3	TUB50502.3	0.043	1.000	0.043	Eq. H1-1b	11	4.252	15.900	15.900	24.960
143	TUB50502.3	TUB50502.3	0.036	1.000	0.036	Eq. H1-1b	9	4.252	15.900	15.900	24.960

## Utilization Ratio Cont...

Beam	Analysis Property	Design Property	Actual Allowable		Ratio (Act./Allow.)	Clause	L/C	Ax (cm <sup>2</sup> )	Iz (cm <sup>4</sup> )	Iy (cm <sup>4</sup> )	Ix (cm <sup>4</sup> )
			Ratio	Ratio							
144	TUB50502.3	TUB50502.3	0.041	1.000	0.041	Eq. H1-1b	9	4.252	15.900	15.900	24.960
145	TUB50502.3	TUB50502.3	0.017	1.000	0.017	Eq. H1-1b	11	4.252	15.900	15.900	24.960
146	TUB50502.3	TUB50502.3	0.021	1.000	0.021	Eq. H1-1b	11	4.252	15.900	15.900	24.960
147	TUB50502.3	TUB50502.3	0.017	1.000	0.017	Eq. H1-1b	11	4.252	15.900	15.900	24.960
148	TUB50502.3	TUB50502.3	0.021	1.000	0.021	Eq. H1-1b	11	4.252	15.900	15.900	24.960
149	TUB50502.3	TUB50502.3	0.035	1.000	0.035	Eq. H1-1b	10	4.252	15.900	15.900	24.960
150	TUB50502.3	TUB50502.3	0.035	1.000	0.035	Eq. H1-1b	10	4.252	15.900	15.900	24.960
151	TUB50502.3	TUB50502.3	0.017	1.000	0.017	Eq. H1-1b	9	4.252	15.900	15.900	24.960
152	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	9	4.252	15.900	15.900	24.960
153	TUB50502.3	TUB50502.3	0.023	1.000	0.023	Eq. H1-1b	10	4.252	15.900	15.900	24.960
154	TUB50502.3	TUB50502.3	0.023	1.000	0.023	Eq. H1-1b	10	4.252	15.900	15.900	24.960
155	TUB50502.3	TUB50502.3	0.023	1.000	0.023	Eq. H1-1b	10	4.252	15.900	15.900	24.960
156	TUB50502.3	TUB50502.3	0.023	1.000	0.023	Eq. H1-1b	10	4.252	15.900	15.900	24.960
157	TUB50502.3	TUB50502.3	0.027	1.000	0.027	Eq. H1-1b	6	4.252	15.900	15.900	24.960
158	TUB50502.3	TUB50502.3	0.027	1.000	0.027	Eq. H1-1b	6	4.252	15.900	15.900	24.960
159	TUB50502.3	TUB50502.3	0.005	1.000	0.005	Eq. H1-1b	9	4.252	15.900	15.900	24.960
160	TUB50502.3	TUB50502.3	0.003	1.000	0.003	Eq. H1-1b	9	4.252	15.900	15.900	24.960
161	TUB50502.3	TUB50502.3	0.019	1.000	0.019	Eq. H1-1b	10	4.252	15.900	15.900	24.960
162	TUB50502.3	TUB50502.3	0.018	1.000	0.018	Eq. H1-1b	10	4.252	15.900	15.900	24.960
163	TUB50502.3	TUB50502.3	0.019	1.000	0.019	Eq. H1-1b	10	4.252	15.900	15.900	24.960
164	TUB50502.3	TUB50502.3	0.018	1.000	0.018	Eq. H1-1b	10	4.252	15.900	15.900	24.960
165	TUB50502.3	TUB50502.3	0.027	1.000	0.027	Eq. H1-1b	6	4.252	15.900	15.900	24.960
166	TUB50502.3	TUB50502.3	0.027	1.000	0.027	Eq. H1-1b	6	4.252	15.900	15.900	24.960
167	TUB50502.3	TUB50502.3	0.008	1.000	0.008	Eq. H1-1b	9	4.252	15.900	15.900	24.960
168	TUB50502.3	TUB50502.3	0.011	1.000	0.011	Eq. H1-1b	9	4.252	15.900	15.900	24.960
169	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	10	4.252	15.900	15.900	24.960
170	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	10	4.252	15.900	15.900	24.960
171	TUB50502.3	TUB50502.3	0.015	1.000	0.015	Eq. H1-1b	10	4.252	15.900	15.900	24.960
172	TUB50502.3	TUB50502.3	0.017	1.000	0.017	Eq. H1-1b	11	4.252	15.900	15.900	24.960
173	TUB50502.3	TUB50502.3	0.027	1.000	0.027	Eq. H1-1b	6	4.252	15.900	15.900	24.960
174	TUB50502.3	TUB50502.3	0.027	1.000	0.027	Eq. H1-1b	6	4.252	15.900	15.900	24.960
175	TUB50502.3	TUB50502.3	0.020	1.000	0.020	Eq. H1-1b	9	4.252	15.900	15.900	24.960
176	TUB50502.3	TUB50502.3	0.024	1.000	0.024	Eq. H1-1b	9	4.252	15.900	15.900	24.960
177	TUB50502.3	TUB50502.3	0.018	1.000	0.018	Eq. H1-1b	11	4.252	15.900	15.900	24.960
178	TUB50502.3	TUB50502.3	0.021	1.000	0.021	Eq. H1-1b	11	4.252	15.900	15.900	24.960
179	TUB50502.3	TUB50502.3	0.019	1.000	0.019	Eq. H1-1b	9	4.252	15.900	15.900	24.960
180	TUB50502.3	TUB50502.3	0.022	1.000	0.022	Eq. H1-1b	11	4.252	15.900	15.900	24.960
181	TUB50502.3	TUB50502.3	0.032	1.000	0.032	Eq. H1-1b	3	4.252	15.900	15.900	24.960
182	TUB50502.3	TUB50502.3	0.032	1.000	0.032	Eq. H1-1b	3	4.252	15.900	15.900	24.960
183	TUB50502.3	TUB50502.3	0.031	1.000	0.031	Eq. H1-1b	9	4.252	15.900	15.900	24.960
184	TUB50502.3	TUB50502.3	0.037	1.000	0.037	Eq. H1-1b	9	4.252	15.900	15.900	24.960
185	TUB50502.3	TUB50502.3	0.021	1.000	0.021	Eq. H1-1b	11	4.252	15.900	15.900	24.960
186	TUB50502.3	TUB50502.3	0.028	1.000	0.028	Eq. H1-1b	11	4.252	15.900	15.900	24.960
187	TUB50502.3	TUB50502.3	0.025	1.000	0.025	Eq. H1-1b	11	4.252	15.900	15.900	24.960
188	TUB50502.3	TUB50502.3	0.027	1.000	0.027	Eq. H1-1b	11	4.252	15.900	15.900	24.960
189	TUB50502.3	TUB50502.3	0.040	1.000	0.040	Eq. H1-1b	3	4.252	15.900	15.900	24.960
190	TUB50502.3	TUB50502.3	0.040	1.000	0.040	Eq. H1-1b	3	4.252	15.900	15.900	24.960
191	TUB50502.3	TUB50502.3	0.039	1.000	0.039	Eq. H1-1b	9	4.252	15.900	15.900	24.960
192	TUB50502.3	TUB50502.3	0.052	1.000	0.052	Eq. H1-1b	9	4.252	15.900	15.900	24.960
193	TUB50502.3	TUB50502.3	0.023	1.000	0.023	Eq. H1-1b	9	4.252	15.900	15.900	24.960
194	TUB50502.3	TUB50502.3	0.035	1.000	0.035	Eq. H1-1b	11	4.252	15.900	15.900	24.960
195	TUB50502.3	TUB50502.3	0.028	1.000	0.028	Eq. H1-1b	9	4.252	15.900	15.900	24.960
196	TUB50502.3	TUB50502.3	0.031	1.000	0.031	Eq. H1-1b	11	4.252	15.900	15.900	24.960
197	TUB50502.3	TUB50502.3	0.051	1.000	0.051	Eq. H1-1b	11	4.252	15.900	15.900	24.960
198	TUB50502.3	TUB50502.3	0.037	1.000	0.037	Eq. H1-1b	11	4.252	15.900	15.900	24.960
199	TUB50502.3	TUB50502.3	0.038	1.000	0.038	Eq. H1-1b	9	4.252	15.900	15.900	24.960

### Utilization Ratio Cont...

Beam	Analysis Property	Design Property	Actual Allowable		Ratio (Act./Allow.)	Clause	L/C	Ax (cm <sup>2</sup> )	Iz (cm <sup>4</sup> )	Iy (cm <sup>4</sup> )	Ix (cm <sup>4</sup> )
			Ratio	Ratio							
200	TUB50502.3	TUB50502.3	0.045	1.000	0.045	Eq. H1-1b	9	4.252	15.900	15.900	24.960
201	TUB50502.3	TUB50502.3	0.030	1.000	0.030	Eq. H1-1b	3	4.252	15.900	15.900	24.960
202	TUB50502.3	TUB50502.3	0.056	1.000	0.056	Eq. H1-1b	9	4.252	15.900	15.900	24.960
203	TUB50502.3	TUB50502.3	0.033	1.000	0.033	Eq. H1-1b	9	4.252	15.900	15.900	24.960
204	TUB50502.3	TUB50502.3	0.047	1.000	0.047	Eq. H1-1b	4	4.252	15.900	15.900	24.960
205	TUB50502.3	TUB50502.3	0.028	1.000	0.028	Eq. H1-1b	10	4.252	15.900	15.900	24.960
206	TUB50502.3	TUB50502.3	0.028	1.000	0.028	Eq. H1-1b	10	4.252	15.900	15.900	24.960
207	TUB50502.3	TUB50502.3	0.005	1.000	0.005	Eq. H1-1b	9	4.252	15.900	15.900	24.960
208	TUB50502.3	TUB50502.3	0.007	1.000	0.007	Eq. H1-1b	9	4.252	15.900	15.900	24.960
209	TUB50502.3	TUB50502.3	0.028	1.000	0.028	Eq. H1-1b	10	4.252	15.900	15.900	24.960
210	TUB50502.3	TUB50502.3	0.030	1.000	0.030	Eq. H1-1b	10	4.252	15.900	15.900	24.960
211	TUB50502.3	TUB50502.3	0.028	1.000	0.028	Eq. H1-1b	10	4.252	15.900	15.900	24.960
212	TUB50502.3	TUB50502.3	0.030	1.000	0.030	Eq. H1-1b	10	4.252	15.900	15.900	24.960
213	TUB50502.3	TUB50502.3	0.054	1.000	0.054	Eq. H1-1b	10	4.252	15.900	15.900	24.960
214	TUB50502.3	TUB50502.3	0.054	1.000	0.054	Eq. H1-1b	10	4.252	15.900	15.900	24.960
215	TUB50502.3	TUB50502.3	0.039	1.000	0.039	Eq. H1-1b	9	4.252	15.900	15.900	24.960
216	TUB50502.3	TUB50502.3	0.046	1.000	0.046	Eq. H1-1b	9	4.252	15.900	15.900	24.960
217	TUB50502.3	TUB50502.3	0.034	1.000	0.034	Eq. H1-1b	9	4.252	15.900	15.900	24.960
218	TUB50502.3	TUB50502.3	0.042	1.000	0.042	Eq. H1-1b	10	4.252	15.900	15.900	24.960
219	TUB50502.3	TUB50502.3	0.033	1.000	0.033	Eq. H1-1b	8	4.252	15.900	15.900	24.960
220	TUB50502.3	TUB50502.3	0.049	1.000	0.049	Eq. H1-1b	9	4.252	15.900	15.900	24.960
221	TUB50502.3	TUB50502.3	0.050	1.000	0.050	Eq. H1-1b	10	4.252	15.900	15.900	24.960
222	TUB50502.3	TUB50502.3	0.050	1.000	0.050	Eq. H1-1b	10	4.252	15.900	15.900	24.960
223	TUB50502.3	TUB50502.3	0.035	1.000	0.035	Eq. H1-1b	9	4.252	15.900	15.900	24.960
224	TUB50502.3	TUB50502.3	0.036	1.000	0.036	Eq. H1-1b	9	4.252	15.900	15.900	24.960
225	TUB50502.3	TUB50502.3	0.027	1.000	0.027	Eq. H1-1b	10	4.252	15.900	15.900	24.960
226	TUB50502.3	TUB50502.3	0.033	1.000	0.033	Eq. H1-1b	10	4.252	15.900	15.900	24.960
227	TUB50502.3	TUB50502.3	0.027	1.000	0.027	Eq. H1-1b	10	4.252	15.900	15.900	24.960
228	TUB50502.3	TUB50502.3	0.033	1.000	0.033	Eq. H1-1b	11	4.252	15.900	15.900	24.960
229	TUB50502.3	TUB50502.3	0.044	1.000	0.044	Eq. H1-1b	10	4.252	15.900	15.900	24.960
230	TUB50502.3	TUB50502.3	0.044	1.000	0.044	Eq. H1-1b	10	4.252	15.900	15.900	24.960
231	TUB50502.3	TUB50502.3	0.027	1.000	0.027	Eq. H1-1b	9	4.252	15.900	15.900	24.960
232	TUB50502.3	TUB50502.3	0.027	1.000	0.027	Eq. H1-1b	9	4.252	15.900	15.900	24.960
233	TUB50502.3	TUB50502.3	0.026	1.000	0.026	Eq. H1-1b	10	4.252	15.900	15.900	24.960
234	TUB50502.3	TUB50502.3	0.028	1.000	0.028	Eq. H1-1b	10	4.252	15.900	15.900	24.960
235	TUB50502.3	TUB50502.3	0.026	1.000	0.026	Eq. H1-1b	10	4.252	15.900	15.900	24.960
236	TUB50502.3	TUB50502.3	0.028	1.000	0.028	Eq. H1-1b	10	4.252	15.900	15.900	24.960

## CALULATION SHEET FOR BOLT JOINT

PROJECT :  
 MAIN CONTRACTOR :  
 ENGINEER :

Bolt Joint no. แบบขยาย "J2"

Total Shear Load = 220.00 kg.

Check Shear Stress For Bolt Grade 8.8 & A325			
High Strength Bolt Dia	=	16.00	mm.
Sectional Area	=	2.01	cm. <sup>2</sup> / set
Use High Strength Bolt	=	2.00	set / joint
Total Sectional Area	=	4.02	cm. <sup>2</sup> / set
Min.Yield Stress Fy	=	5,800.00	ksc.
Shearing Stress Fv(allow)	=	1,050.00	ksc.
Actual Shear Stress fv	=	54.73	ksc.
fv < Fv(allow.)----->		OK	
Check Shear Stress For Stiffener Plate			
Use Stiffener Plate thickness	=	7.00	mm.
Use Stiffener Plate Length	=	5.00	cm.
Net Stress Area	=	3.50	cm. <sup>2</sup> / joint
Min.Yield Stress Fy	=	2,400.00	ksc.
Shearing Stress Fv(allow)	=	960.00	ksc.
Actual Shear Stress fv	=	62.86	ksc.
fv < Fv(allow.)----->		OK	

## CALULATION SHEET FOR BOLT JOINT

PROJECT :  
 MAIN CONTRACTOR :  
 ENGINEER :

Bolt Joint no. แบบขยาย "J3"

Total Shear Load = 1,000.00 kg.

Check Shear Stress For Bolt Grade 8.8 & A325			
High Strength Bolt Dia	=	12.00	mm.
Sectional Area	=	1.13	cm. <sup>2</sup> / set
Use High Strength Bolt	=	4.00	set / joint
Total Sectional Area	=	4.52	cm. <sup>2</sup> / set
Min.Yield Stress Fy	=	5,800.00	ksc.
Shearing Stress Fv(allow)	=	1,050.00	ksc.
Actual Shear Stress fv	=	221.24	ksc.
fv < Fv(allow.)----->		OK	
Check Shear Stress For Stiffener Plate			
Use Stiffener Plate thickness	=	6.00	mm.
Use Stiffener Plate Length	=	5.00	cm.
Net Stress Area	=	3.00	cm. <sup>2</sup> / joint
Min.Yield Stress Fy	=	2,400.00	ksc.
Shearing Stress Fv(allow)	=	960.00	ksc.
Actual Shear Stress fv	=	333.33	ksc.
fv < Fv(allow.)----->		OK	

PROJECT :	Date :
SUBJECT :	Cal. by :
REF : Slab on Ground	Check by :

**SLAB**

SIZE OF SLAB : Thickness,t = 10 cm.

As = 0.0025 x b x t = 2.50 cm<sup>2</sup>

Used...RB 9 mm. @ 0.15 : As = 4.24 cm<sup>2</sup>