หนังสือนำส่งขออนุมัติ

งานก่อสร้างอุโมงค์ส่งน้ำตามแนวถนนกาญจนาภิเษก จากถนนกัลปพฤกษ์ ถึง สถานีสูบจ่ายน้ำบางมด พร้อมงานที่เกี่ยวข้อง

สัญญาเลขที่ G-TN-9C

หนังสือขออนุมัติ ☐ Method Statement ☐ Material Approval ☐ Test Report ☑ Calculation Report

☐ Shop Drawing ☐ Final Shop Drawing ☐ AS-Built Drawing ☐ อื่นๆ

นำส่งเพื่อ ☑ ขออนุมัติ ☐ เพื่อทราบ ☐ อื่นๆ ....

REF :

G-TN-9C ได้รับเอกสารแล้ว
เลขที่รับเข้า № - 01993
วันที่ 25 มี.ค. 2568
เวลา 10.00 น.

เรียน ผู้ว่าการการประปานครหลวง

หมายเลขนำส่ง : F-Sky 1632 /2568

วันที่ 25 มีนาคม 2568

ผู้รับจ้าง : บริษัท สี่แสงการโยธา (1979) จำกัด SEE SANG KARN YOTAH (1979) CO.,LTD. 56/7 ถ.แจ้งวัฒนะ ต.ปากเกร็ด อ.ปากเกร็ด จ.นนทบุรี 11120 โทร.0-2583-9180-3, 0-2583-7058-9, 0-2583-4683-4

ผู้ควบคุมงาน : TEAM GROUP, GFE The Geotechnical Expert, INDEX

ลำดับ	รหัสเอกสาร /หมายเลขแบบ	ชื่อเอกสาร	Rev.	อนุมัติให้ดำเนินการ	อนุมัติแบบมีเงื่อนไข	แก้ไขแล้วนำส่งใหม่	ไม่อนุมัติ	ข้อคิดเห็น
1		ขออนุมัตินำส่งเอกสารรายการคำนวณโครงสร้างชั่วคราว Platform สำหรับงาน Luanch TBM no.5 ที่บ่อก่อสร้าง 9C-3 (เพิ่มเติม) ของโครงการก่อสร้าง สัญญา G-TN-9C **<u>เอกสารแนบ</u>** จำนวน 1 ชุด เอกสาร รายการคำนวณโครงสร้างชั่วคราว Platform สำหรับงาน Luanch TBM no.5 ที่บ่อก่อสร้าง 9C-3		✓				ตาม Comment № - 02572

ผู้เสนอ : บริษัท สี่แสงการ โยธา (1979) จำกัด

ลงชื่อ พีธกฤตย์ สพลวรรธนัณภ์

(นายพีธกฤตย์ สพลวรรธนัณภ์)

ตำแหน่ง ผู้อำนวยการ โครงการ

วันที่ 25 เดือน มีนาคม พ.ศ. 2568

ขอรับรองว่ารายการทั้งหมดที่นำส่งในเอกสารฉบับนี้ได้รับการตรวจสอบแล้วว่ามีความสอดคล้องตามข้อกำหนดที่ระบุไว้ในสัญญาและได้รับความเห็นชอบจากผู้รับจ้างแล้ว

เรียน คุณ พีธกฤตย์ สพลวรรธนัณภ์ (ผู้อำนวยการ โครงการ)

ลงชื่อ ....

นายพงศธร มะลิแก้ว
วิศวกรประจำโครงการ 3

วันที่ .... เดือน 28 มี.ค. 2568 พ.ศ. 25.......

☐ ต้นฉบับ 1 ชุด สำเนา 3 ชุด พร้อมไฟล์ PDF ส่ง ผู้ควบคุมงาน

☐ สำเนา 2 ชุด พร้อมไฟล์ PDF ส่ง ผู้อำนวยการสำนักโครงการ การประปานครหลวง

☐ ต้นฉบับส่งคืนผู้รับจ้าง

☐ สำเนา พร้อมไฟล์ PDF ส่ง ผู้อำนวยการสำนักโครงการ การประปานครหลวง

โครงการงานก่อสร้างอุโมงค์ส่งน้ำตามแนวถนนกาญจนาภิเษก
จากถนนกัลปพฤกษ์ ถึงสถานีสูบจ่ายน้ำบางมด
พร้อมงานที่เกี่ยวข้อง ในโครงการปรับปรุงกิจการประปาแผนหลักครั้งที่ 9 สัญญา G-TN-9C

TEAM GROUP GFE INDEX

SKY บริษัทสี่แสงการโยธา(1979)จำกัด

ผลการพิจารณาและข้อคิดเห็น (Document Review Comments)

№ - 02572

REF : P05685-SS-9C-C03-GEN-CAL-68095.1

ประเภทเอกสาร ☐ Method Statement ☐ Material Approval ☐ Test Report ☒ Calculation Report

☐ Shop Drawing ☐ Final Shop Drawing ☐ AS-Built Drawing ☐ อื่น ๆ..................

อ้างถึงหนังสือขออนุมัติเลขที่	F-Sky 1632/2568	ลงวันที่	25-มี.ค.-68
เรื่องขออนุมัติ : ขออนุมัตินำส่งเอกสารรายการคำนวนโครงสร้างชั่วคราว Platform สำหรับ Luanch TBM no.5 ที่บ่อก่อสร้าง 9C-3 (เพิ่มเติม)			

ผลการพิจารณา

☒ อนุมัติให้ก่อสร้างได้ ☐ อนุมัติแบบมีเงื่อนไข ☐ แก้ไขแล้วนำส่งใหม่ ☐ ไม่อนุมัติ

ข้อคิดเห็น

ลำดับ	รายละเอียด
1	ผู้ให้บริการควบคุมงานก่อสร้างได้ตรวจสอบเอกสารรายการคำนวนโครงสร้างชั่วคราว platform สำหรับ Luanch TBM no.5 ที่บ่อก่อสร้าง 9C-3 (เพิ่มเติม) แล้ว รายการคำนวนประกอบด้วย โครงสร้าง Plat form เสา คานหลัก คานรองรับพื้น คานค้ำยันเสา BASE Plate Base Plate Beam wall และโครงสร้างรับ Reaction Frame ซึ่งรายการคำนวนเป็นไปตามหลักวิศวกรรม มีความปลอดภัย ผู้ให้บริการควบคุมงานจึงเห็นว่าสามารถอนุมัติให้ใช้งานในโครงการได้

ตรวจสอบ : วิศวกรผู้ให้บริการ สัญญา G-TN-9C

ผู้ตรวจสอบ

(นายพงศธร มะลิแก้ว)
ตำแหน่ง วิศวกรประจำโครงการ 3
28 มี.ค. 2568

รายการคำนวณ โครงสร้างชั่วคราว platform

สำหรับงาน Luanch TBM5 บ่อก่อสร้าง 9C-3

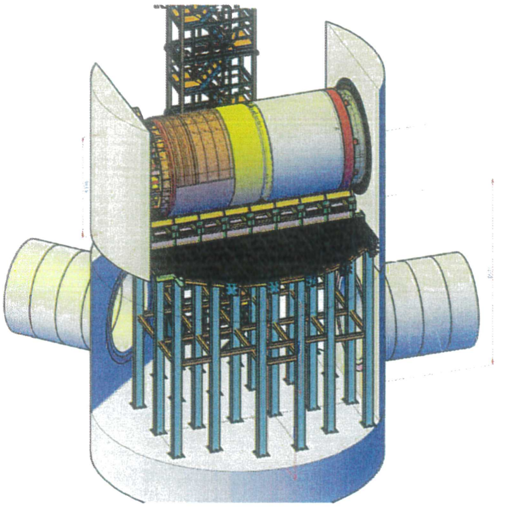
โครงการก่อสร้างอุโมงค์ส่งน้ำตามแนวถนนกาญจนาภิเษก

จากถนนกัลปพฤกษ์ ถึง สถานีจ่ายน้ำบางมดพร้อมงานที่เกี่ยวข้อง

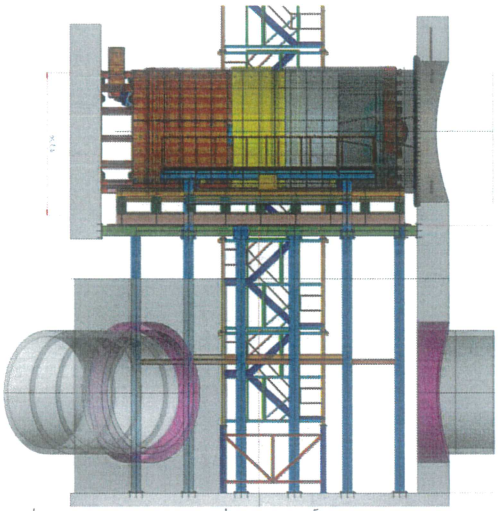
สัญญา G-TN-9C

1 ข้อมูลทั่วไป

1.1 เนื่องจากเกิดความเสียกับ TBM3 เป็นสาเหตุให้ต้องดำเนินการเจาะอุโมงค์ใหม่โดยมีแนวเดิมโดยมีระดับการเจาะสูงกว่า อุโมงค์ที่เจาะแล้ว 7.9 เมตร จำเป็นต้องทำ Platform ชั่วคราวเพื่อวาง Cadle และ อุปกรณ์อื่นที่ใช้ในการ Luanch หัว TBM ใหม่ TBM5 ดังแสดงตามรูป



รูปที่ 1 รูปสามมิติ Platform รองรับหัว TBM5



รูปที่ 2 รูปด้าน PlatForm ที่ยกสูงจากพื้นคอนกรีตบ่อ 8.00 ม.

2 รายละเอียดลักษณะโครงสร้าง

2.1 ลักษณะโครงสร้างเหล็กรูปพรรณ เป็น H-Beam สูงจากพื้นบ่อ 8.00 m. ส่วนโครงสร้างรับพื้นเป็นโครงสร้างคาน H beam และมีโครงสร้างค้ำยันที่กึ่งกลางของความสูง ปลายคานของโครงสร้างรับพื้นยึดติดกับผนังบ่อกลมเพื่อวัตถุประสงค์รับแรงด้านข้างที่เกิดจากแรงต้านแรงบิดของ TBM และแรงเสียดทานที่ต้านในขณะเลื่อน TBM ไปข้างหน้า พื้นทำงานวางด้วย Steel Gratting ปูบนคานH beam

3 มาตรฐานที่ใช้ในการออกแบบและมาตรฐานคุณสมบัติของวัสดุนี้

3.1 ใช้มาตรฐาน หน่วยแรงใช้งาน AISC- ASD89

3.2 ใช้มาตรฐาน วัสดุ Fy = 2.40000e+003, Es = 2.10000e+006, SS400 Fu = 4100 ksc.

3.3 Poisson's Ratio = 0.30

3.4 Weight Density =7850 kg./cu.m.

4 ค่า Load ใช้ในการออกแบบ

1.) Self Load

น้ำหนักที่ โครงสร้างนั่งร้าน น้ำหนัก Cadle รับน้ำหนัก TBM. ถูกคำนวณ Self Weight โดยอัตโนมัติ

2.) TBM Machine Load

Machine Weights	*all weights to be confirmed after final design*	
Cutting Wheel	approx.	14 to
Shield with main drive	approx.	39 to
Push module with cylinders	approx.	31 to
Erector	approx.	9 to
Tailskin	approx.	15 to
Screw conveyor	approx.	11 to

หมายเหตุ เนื่องจากได้ค่าประมาณการ จึงเพิ่ม Factor เพื่อความปลอดภัยเพิ่มขึ้น 25 เปอร์เซนต์

- Cutting Wheel	14.00	X1.25	17.5	tons.
- Shield With main Drive	39.00	X1.25	48.75	tons.
- Push module with cylinder	31.00	X1.25	38.75	tons.
- Erector	9.00	X1.25	11.25	tons.
- Tailskin	15.00	X1.25	18.75	tons.
-Screw conveyor	11.00	X1.25	13.75	tons.
Total Weight	119.00	tons.	148.75	tons.

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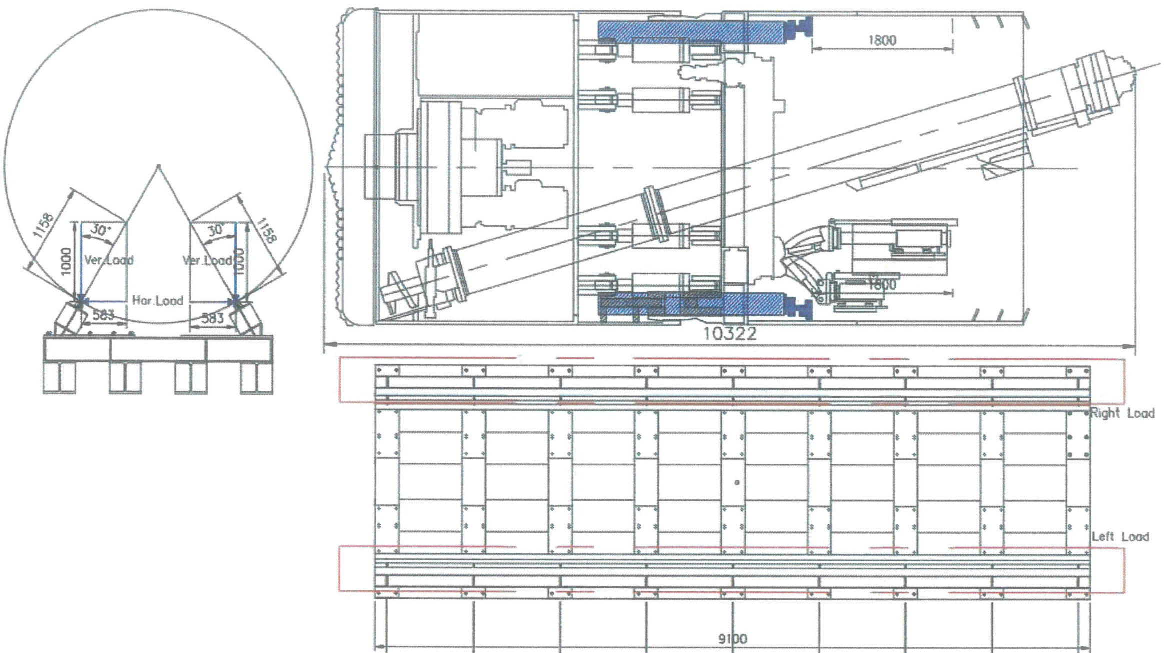

Part List TBM Machine	Weight(tons)	0–1.1 (tons)	1.1–2.2 (tons)	2.2–3.3 (tons)	3.3–4.4 (tons)	4.4–5.5 (tons)	5.5–6.6 (tons)	6.6–7.7 (tons)	7.7–8.8 (tons)	
		1100	1100	1100	1100	1100	1100	1100	1100	
		8800								
Cutting Wheel	17.5	17.5								17.5
Shield With main Drive	48.75	16.25	16.25	16.25						48.75
Push module with cylinder	38.75				15.50	15.50	7.75			38.75
Erector	11.25				2.8125	2.8125	2.8125	2.8125		11.25
Tailskin	18.75						6.25	6.25	6.25	18.75
Screw conveyor	13.75	1.527	1.527	1.527	1.527	1.527	1.527	1.527	3.055	13.75
รวมแรงแนวดิ่ง	148.75	35.28	17.77	17.77	19.84	19.84	18.34	10.59	9.30	148.75
รวมแรงแนวราบ	86.72	20.57	10.36	10.36	11.57	11.57	10.69	6.17	5.42	
แรงแนวดิ่ง/เมตร/ข้าง		16.04tons./m.	8.08tons./m.	8.08tons./m.	9.02tons./m.	9.02tons./m.	8.34tons./m.	4.81tons./m.	4.23tons./m.	
แรงแนวราบ/เมตร/ข้าง		9.35tons./m.	4.71tons./m.	4.71tons./m.	5.26tons./m.	5.26tons./m.	4.86tons./m.	2.81tons./m.	2.46tons./m.	

3.) Segment Load ประมาณ 6.0 tons./m.

List	Weight(tons)	0–1.1 (tons)	1.1–2.2 (tons)	2.2–3.3 (tons)	3.3–4.4 (tons)	4.4–5.5 (tons)	5.5–6.6 (tons)	6.6–7.7 (tons)	7.7–8.8 (tons)
		1100	1100	1100	1100	1100	1100	1100	1100
		8800							
Segment Load 6 tons./m						6.6	6.6	6.6	6.6
รวมแรงแนวดิ่ง	26.40					6.6	6.6	6.6	6.6
รวมแรงแนวราบ	15.39					3.85	3.85	3.85	3.85
แรงแนวดิ่ง/เมตร/ข้าง						3.0tons./m.	3.0tons./m.	3.0tons./m.	3.0tons./m.
แรงแนวราบ/เมตร/ข้าง						1.75tons./m.	1.75tons./m.	1.75tons./m.	1.75tons./m.

4.) Friction Load

ใช้สัมประสิทธิ์แรงเสียทาน ระหว่าง TBM กับ รางเหล็ก =0.30

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		1100	1100	1100	1100	1100	1100	1100	1100	
		8800								
Part List TBM Machine	Weight(tons)	0-1.1 (tons)	1.1-2.2 (tons)	2.2-3.3 (tons)	3.3-4.4 (tons)	4.4-5.5 (tons)	5.5-6.6 (tons)	6.6-7.7 (tons)	7.7-8.8 (tons)	
Cutting Wheel	17.5	17.5								17.5
Shield With main Drive	48.75	16.25	16.25	16.25						48.75
Push module with cylinder	38.75				15.50	15.50	7.75			38.75
Erector	11.25				2.8125	2.8125	2.8125	2.8125		11.25
Tailskin	18.75						6.25	6.25	6.25	18.75
Screw conveyor	13.75	1.527	1.527	1.527	1.527	1.527	1.527	1.527	3.055	13.75
Segment	6.0 tons/m.					6.60	6.60	6.60	6.60	26.40
รวมแรงแนวดิ่ง	175.15	35.28	17.77	17.77	19.84	26.44	24.94	17.19	15.90	175.15
รวมแรงเสียดทาน(0.30)		10.58	5.33	5.33	5.95	7.93	7.48	5.16	4.77	52.54
แรงเสียดทาน/เมตร/ด้าน		4.81tons./m	2.42tons./m.	2.42tons./m.	2.71tons./m	3.61tons./m	3.40tons./m.	2.34tons./m.	1.91tons./m	

5.) Torque Resistance Force +Y และ -Y

- Cuter torque 1200 kN-m
- Diameter of Shield = 1.961

F = 1200/1.961 611.93 kN

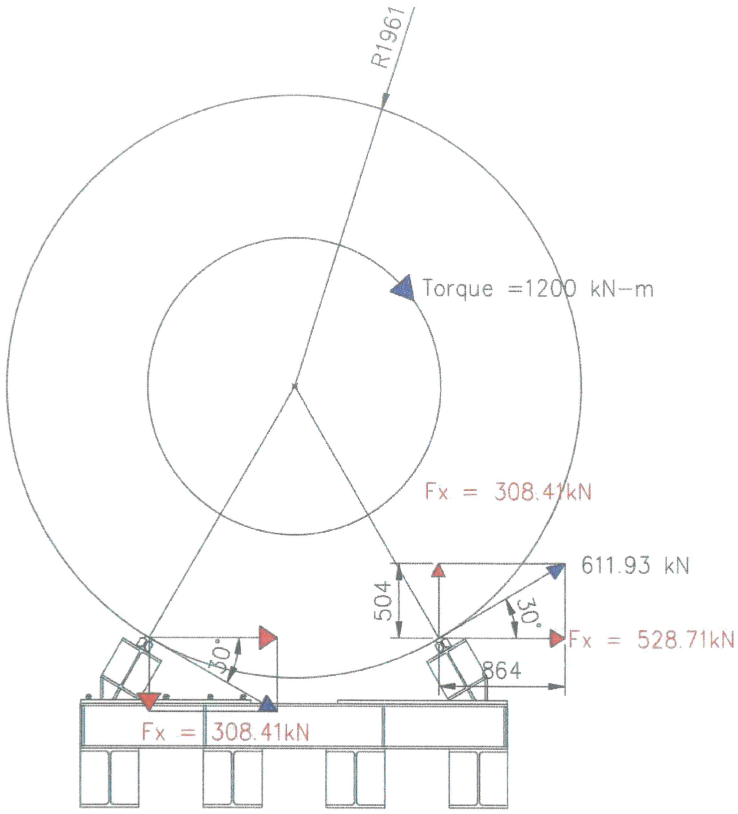
Fx = 611.93*0.864 528.71 kN

Fy = 611.93*0.504 308.41 kN

ความยาว shield body ที่กระจายแรงต้าน = 6.6 m.

Fx = 528.71/6.6 80.11 kN/m. หรือ 8.17 Tons/m.

Fy = 308.41/6.6 46.73 kN/m. หรือ 4.76 Tons/m.

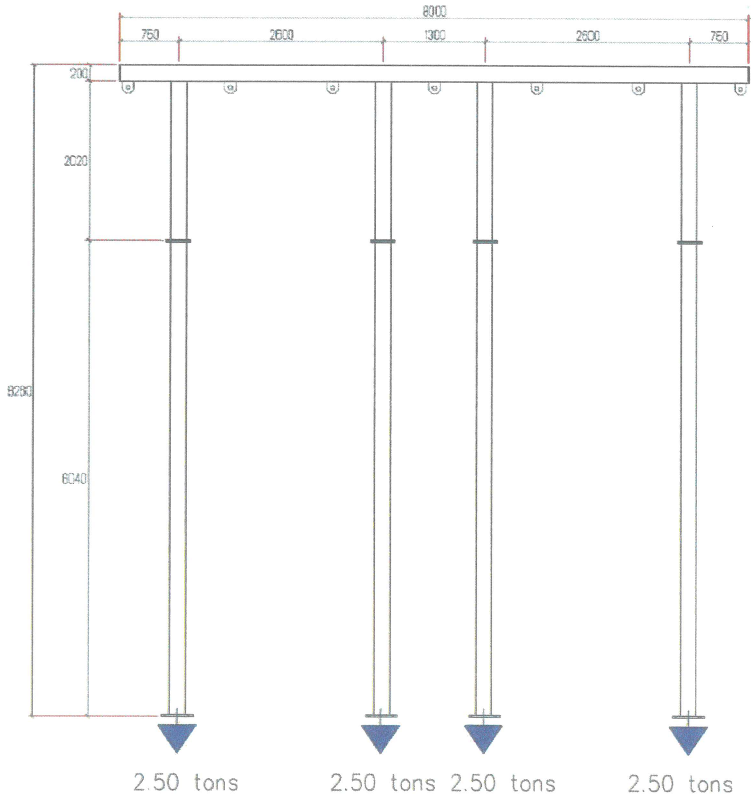


นาย สุวิทย์ กมลวานนท์

6.) Gratting Load 50 Kg./sq.m.

7.) Living Load 1,000 kg./sq.m.

9.) Hydraulic Hose Support น้ำหนัก 10 tons. น้ำหนัก ลงเสา 4 ต้น ต้นละ 2.5 tons



9.) Electric cable Support น้ำหนัก 1.50 tons. น้ำหนัก ลงเสา 3 ต้น ต้นละ 0.50 tons

10.) Reaction Frame Load **น้ำหนัก 1.67 tons/ ขา**

นาย สุวิทย์ กมลวานนท์

5 propertry

5.1 Material propertry

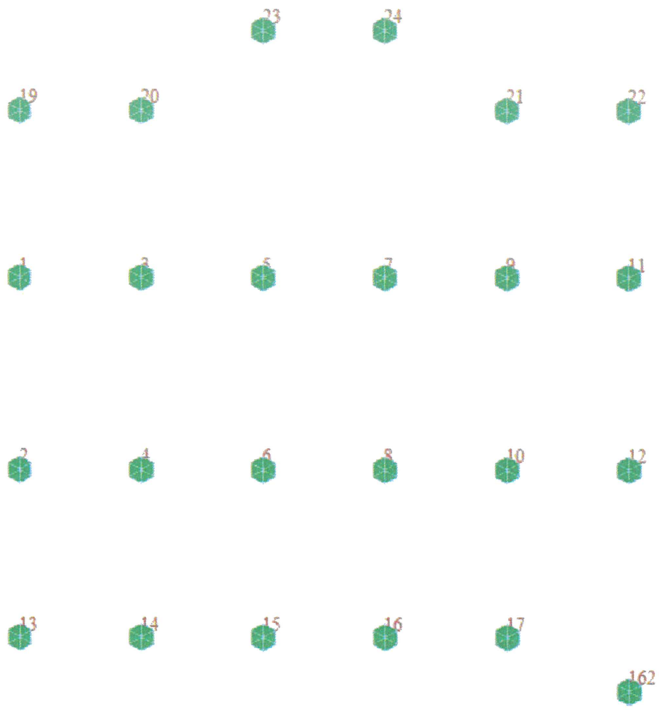
ID	Name	Type	Standard	DB
1	SS400	Steel	KS(S)	SS400

5.2 Section propertry

ID	Name
1	H 300x300x10/15(Column)
2	H 300x300x10/15(Beam)
3	H 150x150x7/10(SubBeam)
4	H 150x150x7/10(Bracing)
5	H 400x400x13/21(B)
6	H 300x300x10/15(T)
7	H 300x300x10/15(C)
8	H 300x300x10/15(I)

6 Boundary Support

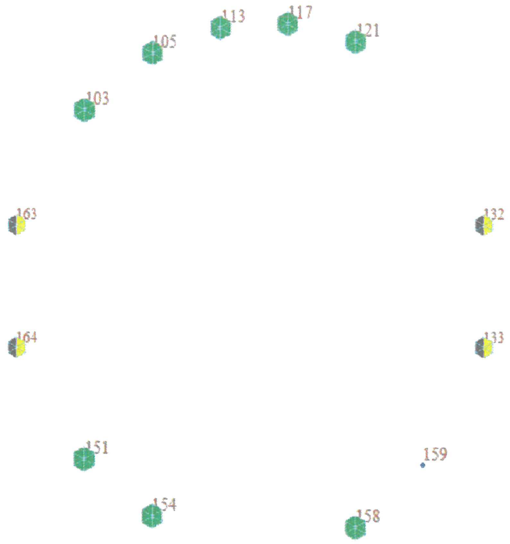
6.1 Boundary Support Column ที่ระดับ EL.- 29.93



Node	Dx	Dy	Dz	Rx	Ry	Rz	Rw(
1	1	1	1	1	1	1	0
2	1	1	1	1	1	1	0
3	1	1	1	1	1	1	0
4	1	1	1	1	1	1	0
5	1	1	1	1	1	1	0
6	1	1	1	1	1	1	0
7	1	1	1	1	1	1	0
8	1	1	1	1	1	1	0
9	1	1	1	1	1	1	0
10	1	1	1	1	1	1	0
11	1	1	1	1	1	1	0
12	1	1	1	1	1	1	0
13	1	1	1	1	1	1	0
14	1	1	1	1	1	1	0
15	1	1	1	1	1	1	0
16	1	1	1	1	1	1	0
17	1	1	1	1	1	1	0
19	1	1	1	1	1	1	0
20	1	1	1	1	1	1	0
21	1	1	1	1	1	1	0
22	1	1	1	1	1	1	0
23	1	1	1	1	1	1	0
24	1	1	1	1	1	1	0
162	1	1	1	1	1	1	1

สุวิทย์ กมลวานนท์

6.2 Point Spring Suppoet ที่ระดับ EL.- 22.005



Node	Dx	Dy	Dz	Rx	Ry	Rz	Rw(
103	1	1	1	1	1	1	0
105	1	1	1	1	1	1	0
113	1	1	1	1	1	1	0
117	1	1	1	1	1	1	0
121	1	1	1	1	1	1	0
151	1	1	1	1	1	1	0
154	1	1	1	1	1	1	0
158	1	1	1	1	1	1	0

Node	Type	Fixed	SDx (kN/m)	SDy (kN/m)	SDz (kN/m)	SRx (kN*m/[rad])	SRy (kN*m/[rad])	SRz (kN*m/[rad])
132	Linear	011111	455000.000	0.0000	0.0000	0.00	136100.00	0.00
133	Linear	011111	455000.000	0.0000	0.0000	0.00	136100.00	0.00
163	Linear	011111	11995000.0	0.0000	0.0000	0.00	136100.00	0.00
164	Linear	011101	11995000.0	0.0000	0.0000	0.00	136100.00	0.00

6 Static Load

6.1 Static Load Case

No	Name	Type	Description
1	Self Load	Dead Load (D)	Plateform Weight and Cadle Weig
2	TBM Machine Load	Live Load (L)	TBM Machine Load
3	Segment Load	Live Load (L)	Segment Load
4	Friction Load	Live Load (L)	Friction Load for Slide TBM
5	Torque Resistance Force +Y	Live Load (L)	Cuter torque Resistance Force
6	Grating Load	Dead Load (D)	Grating Load
7	Living Load	Live Load (L)	People and Material tool Orter ma
8	Torque Resistance Force -Y	Live Load (L)	Cuter torque Resistance Force -Y
9	Hydraulic Hose Suport	Live Load (L)	Hydraulic Hose Suport 2.5 tons/P
10	Cable Suport	Live Load (L)	Cable Suport 0.75 tons/Point
11	Reaction Frame Load	Live Load (L)	

6.1 Load Combination LC1

No	Name	Active	Type	Description
1	LC1	Strengt	Add	
2	LC2	Strengt	Add	

LoadCase	Factor
Self Load(ST)	1.0000
TBM Machine Load(ST)	1.0000
Segment Load(ST)	1.0000
Friction Load(ST)	1.0000
Torque Resistance Force +Y(ST)	1.0000
Gratting Load(ST)	1.0000
Living Load(ST)	1.0000
Hydraulic Hose Suport(ST)	1.0000
Cable Suport(ST)	1.0000
Reaction Frame Load(ST)	1.0000

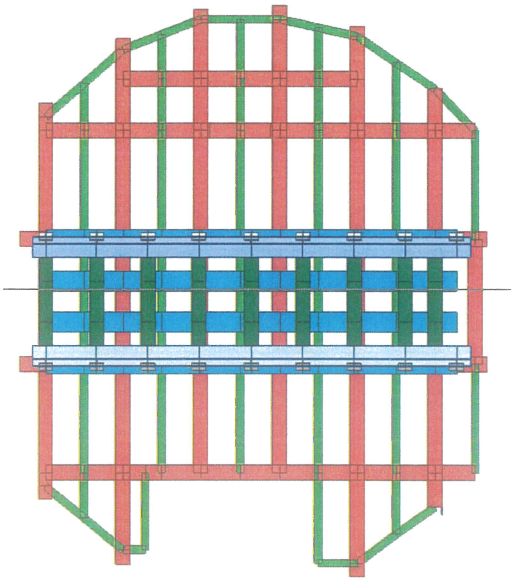
6.2 Load Combination LC2

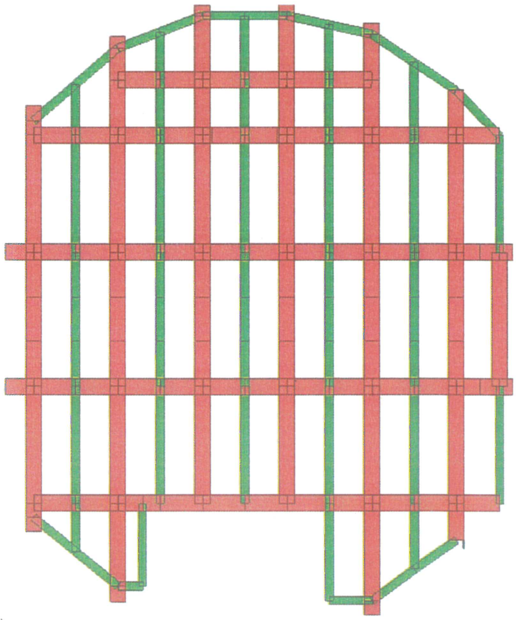
	No	Name	Active	Type	Description
	1	LC1	Strengt	Add	
▶	2	LC2	Strengt	Add	
*					

	LoadCase	Factor
▶	Self Load(ST)	1.0000
	TBM Machine Load(ST)	1.0000
	Segment Load(ST)	1.0000
	Friction Load(ST)	1.0000
	Torque Resistance Force -Y(ST)	1.0000
	Gratting Load(ST)	1.0000
	Living Load(ST)	1.0000
	Hydraulic Hose Suport(ST)	1.0000
	Cable Suport(ST)	1.0000
	Reaction Frame Load(ST)	1.0000
*		

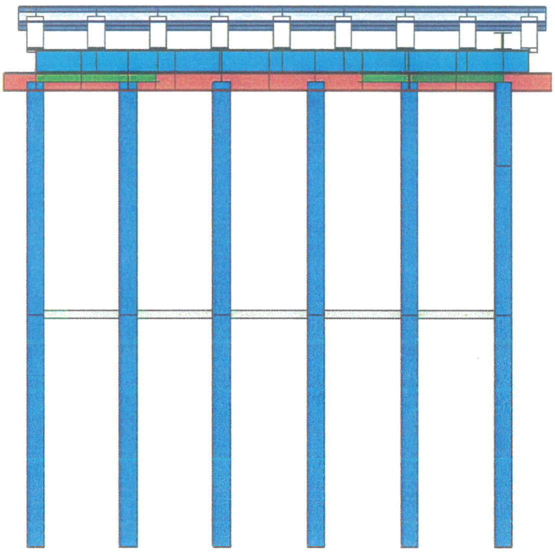
7 รายละอียดการ InPut แบบจำลองโครงสร้าง

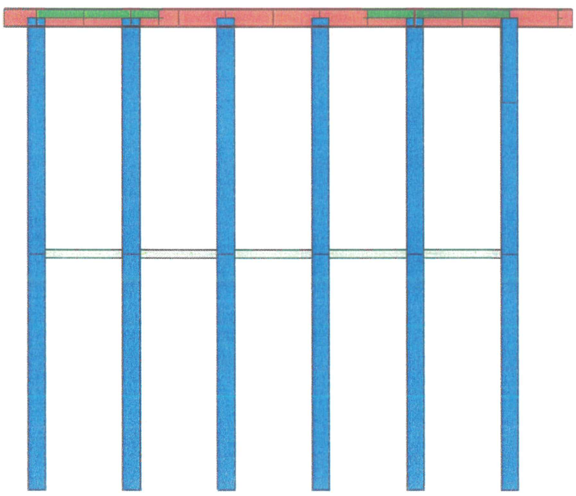
7.1 Geometry ของการป้อนข้อมูล





รูป Geometry ของรูป แปลน





รูป Geometry ของรูปด้าน

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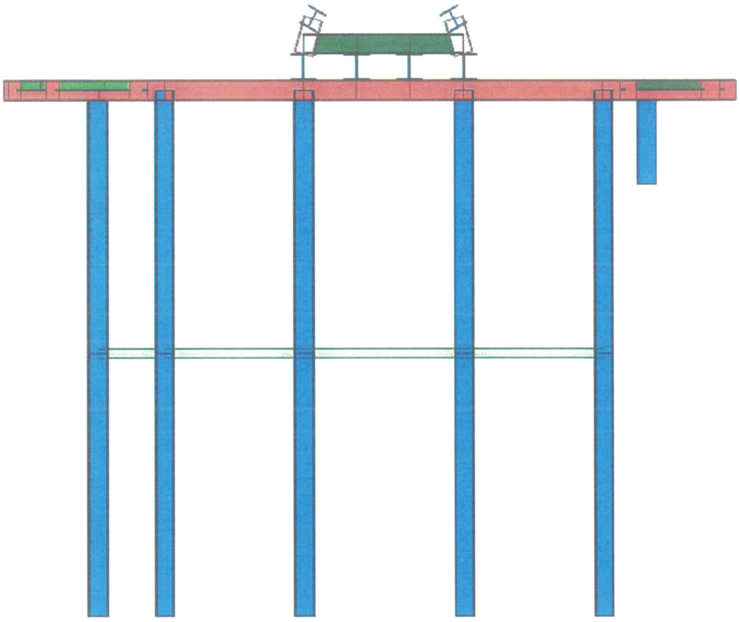
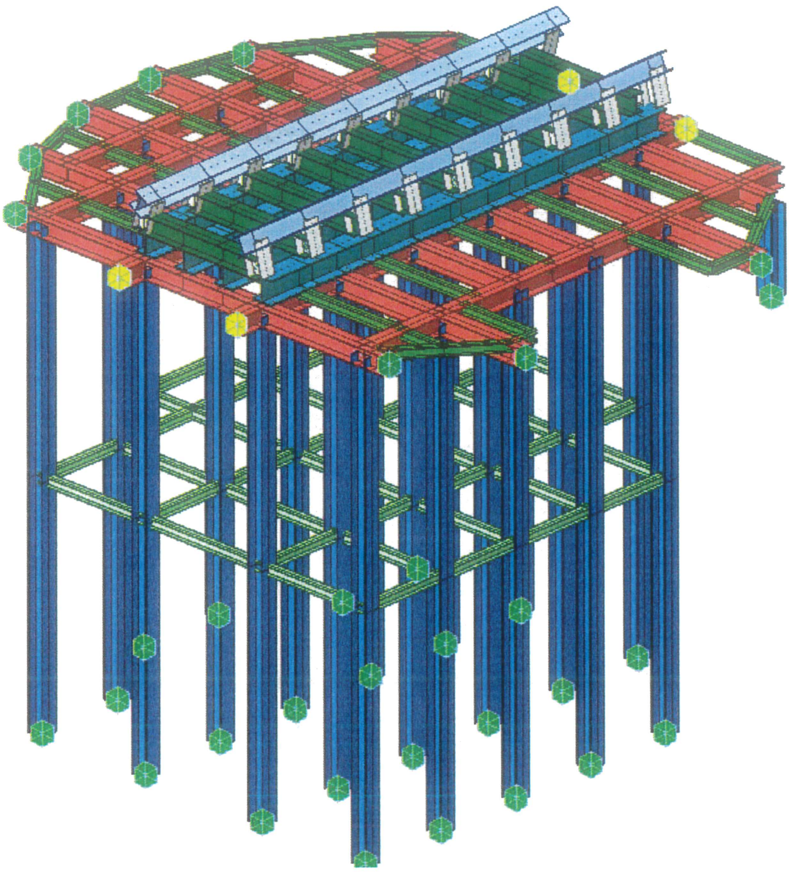


รูป Geometry ของรูปหน้า



รูป Geometry ของรูปสามมิติ

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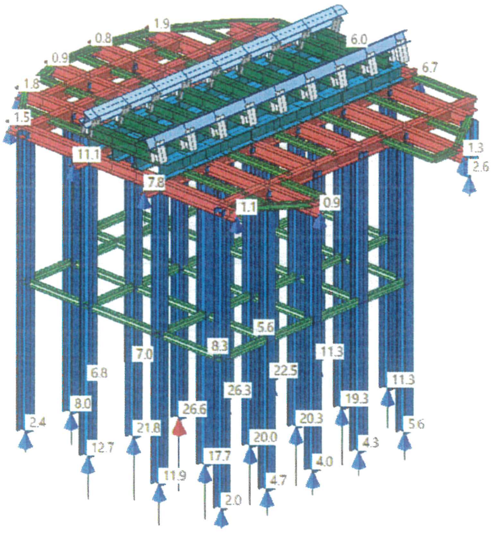
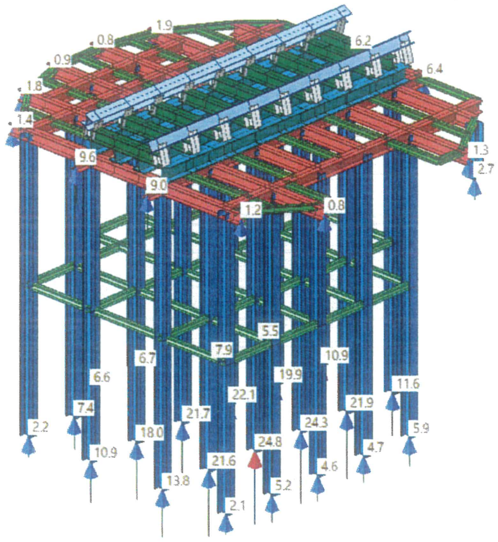
8 Graphic Reaction Force

8.1 Reaction Force จุดรองรับเสา ระดับพื้น บ่อ EL.-29.93



Reaction Force Z Direction LC-1



Reaction Force Z Direction LC-2

Node	Load	FX (tonf)	FY (tonf)	FZ (tonf)	MX (tonf*m)	MY (tonf*m)	MZ (tonf*m)
1	LC1	-0.01	0.01	12.67	0.00	0.01	0.00
2	LC1	-0.01	-0.01	11.85	0.02	0.01	0.00
3	LC1	0.02	0.00	21.84	0.01	0.04	0.00
4	LC1	0.02	-0.02	17.74	0.03	0.05	0.00
5	LC1	0.01	-0.01	26.64	0.04	0.03	0.00
6	LC1	0.01	0.00	20.00	0.01	0.03	0.00
7	LC1	0.01	-0.01	26.26	0.03	0.02	0.00
8	LC1	0.01	0.00	20.30	0.01	0.03	0.00
9	LC1	0.00	0.01	22.54	0.01	0.01	0.00
10	LC1	0.01	-0.02	19.29	0.04	0.02	0.00
11	LC1	0.01	-0.02	11.25	0.05	0.03	0.00
12	LC1	0.02	-0.02	11.28	0.05	0.03	0.00
13	LC1	0.01	-0.02	1.95	0.03	0.02	0.00
14	LC1	0.01	-0.02	4.73	0.03	0.03	0.00
15	LC1	0.01	-0.02	4.00	0.04	0.02	0.00
16	LC1	0.01	-0.02	4.30	0.03	0.02	0.00
17	LC1	0.01	-0.03	5.56	0.05	0.02	0.00
19	LC1	0.00	0.00	2.38	0.01	0.01	0.00
20	LC1	0.01	0.02	7.95	-0.01	0.02	0.00
21	LC1	0.01	0.01	8.33	0.02	0.02	0.00
22	LC1	0.01	-0.02	5.56	0.05	0.02	0.00
23	LC1	0.00	0.04	6.83	-0.02	0.01	0.00
24	LC1	0.01	0.05	6.97	-0.05	0.01	0.00
162	LC1	0.09	0.59	2.59	-0.19	0.24	0.00
1	LC2	0.00	0.01	10.91	-0.02	0.01	0.00
2	LC2	-0.01	-0.01	13.81	0.00	0.00	0.00
3	LC2	0.02	0.03	18.01	-0.05	0.04	0.00
4	LC2	0.02	0.00	21.61	-0.02	0.04	0.00
5	LC2	0.01	0.01	21.71	-0.06	0.03	0.00
6	LC2	0.01	0.02	24.75	-0.08	0.03	0.00
7	LC2	0.01	0.02	22.12	-0.06	0.02	0.00
8	LC2	0.01	0.02	24.30	-0.07	0.03	0.00
9	LC2	0.00	0.02	19.86	-0.05	0.02	0.00
10	LC2	0.00	0.00	21.92	-0.02	0.02	0.00
11	LC2	0.01	-0.01	10.87	0.02	0.03	0.00
12	LC2	0.02	-0.01	11.65	0.02	0.03	0.00
13	LC2	0.01	0.00	2.13	-0.01	0.02	0.00
14	LC2	0.01	0.00	5.18	-0.02	0.03	0.00
15	LC2	0.01	-0.02	4.58	-0.03	0.02	0.00
16	LC2	0.01	-0.02	4.73	-0.03	0.02	0.00
17	LC2	0.01	0.00	5.88	-0.03	0.02	0.00
19	LC2	0.00	0.02	2.22	-0.03	0.01	0.00
20	LC2	0.01	0.03	7.44	-0.05	0.02	0.00
21	LC2	0.01	0.03	7.92	-0.06	0.02	0.00
22	LC2	0.01	-0.01	5.53	0.02	0.02	0.00
23	LC2	0.00	0.10	6.58	-0.16	0.01	0.00
24	LC2	0.01	0.09	6.74	-0.14	0.02	0.00
162	LC2	-0.03	0.81	2.68	-0.37	0.07	0.00
SUMMATION OF REACTION FORCES PRINTOUT							
	Load	FX (tonf)	FY (tonf)	FZ (tonf)			
	LC1	53.23	-53.92	324.51			
	LC2	53.23	53.92	324.51			

Reaction Force Table

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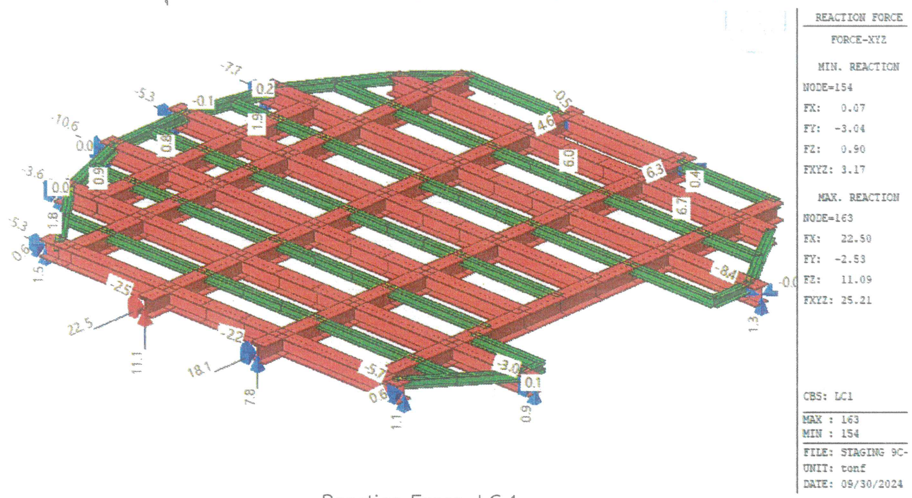
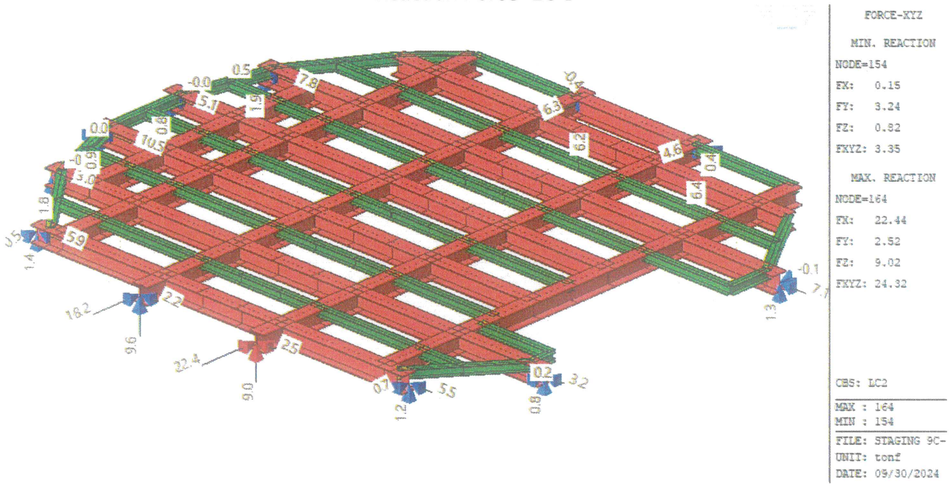
8.2 Reaction Force จุดรองรับปลายคานยึดติดกับผนัง ระดับพื้น PlateForm EL.-21.855



Reaction Force LC-1



Reaction Force LC-2

Node	Load	FX (tonf)	FY (tonf)	FZ (tonf)	MX (tonf*m)	MY (tonf*m)	MZ (tonf*m)
103	LC1	0.55	-5.31	1.45	-1.09	0.00	0.13
105	LC1	0.02	-3.62	1.78	-1.21	0.00	0.02
113	LC1	0.04	-10.58	0.85	-1.08	0.00	0.02
117	LC1	-0.10	-5.26	0.79	-1.02	0.00	-0.02
121	LC1	0.21	-7.72	1.93	-1.22	0.00	0.03
132	LC1	4.65	-0.47	5.96	0.00	3.32	0.42
133	LC1	6.29	0.41	6.68	0.00	3.47	-0.24
151	LC1	0.62	-5.70	1.12	0.93	0.00	-0.24
154	LC1	0.07	-3.04	0.90	0.69	0.00	-0.04
158	LC1	-0.05	-8.43	1.31	0.86	0.01	-0.03
163	LC1	22.50	-2.53	11.09	0.00	-5.59	-0.77
164	LC1	18.14	-2.17	7.81	0.00	-3.03	-0.78
103	LC2	0.48	5.88	1.42	-0.97	0.00	0.17
105	LC2	-0.17	3.03	1.79	-1.20	0.00	0.00
113	LC2	0.00	10.46	0.88	-1.08	0.00	0.02
117	LC2	0.00	5.11	0.83	-1.02	0.00	0.00
121	LC2	0.53	7.83	1.93	-1.22	0.00	0.10
132	LC2	6.30	-0.38	6.23	0.00	3.31	0.28
133	LC2	4.63	0.40	6.41	0.00	3.48	-0.36
151	LC2	0.67	5.46	1.19	1.06	0.00	-0.19
154	LC2	0.15	3.24	0.82	0.65	0.00	-0.02
158	LC2	-0.15	7.06	1.28	0.84	0.01	0.00
163	LC2	18.17	2.17	9.59	0.00	-4.75	0.78
164	LC2	22.44	2.52	9.02	0.00	-3.57	0.77

Reaction Force Table

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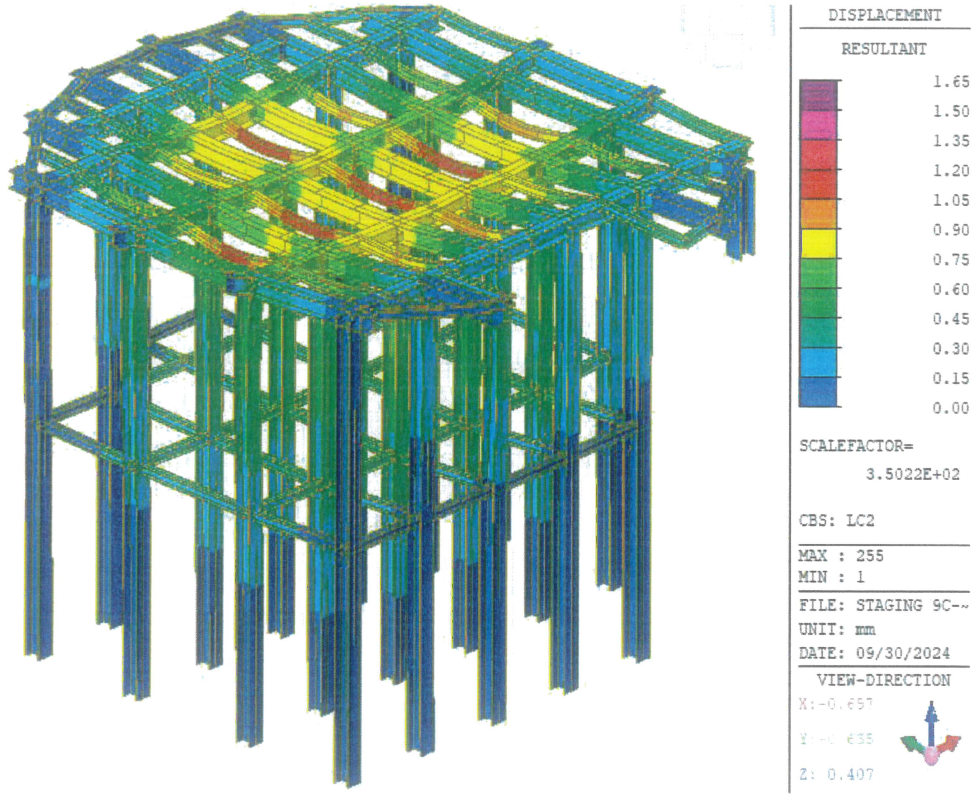
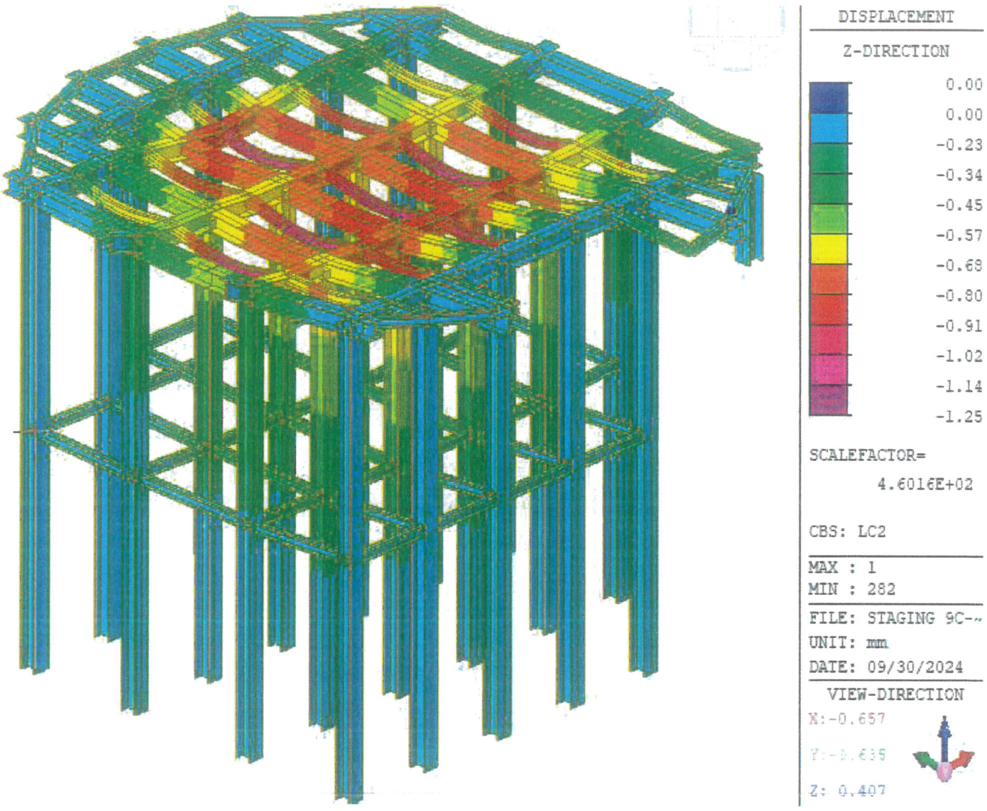
9 Graphic Deflection





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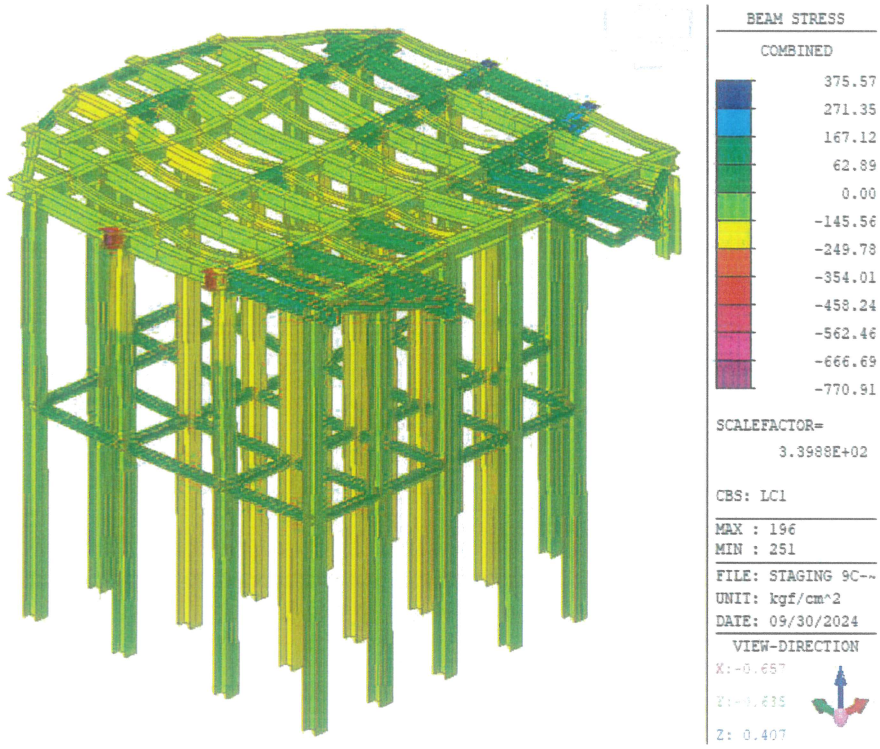
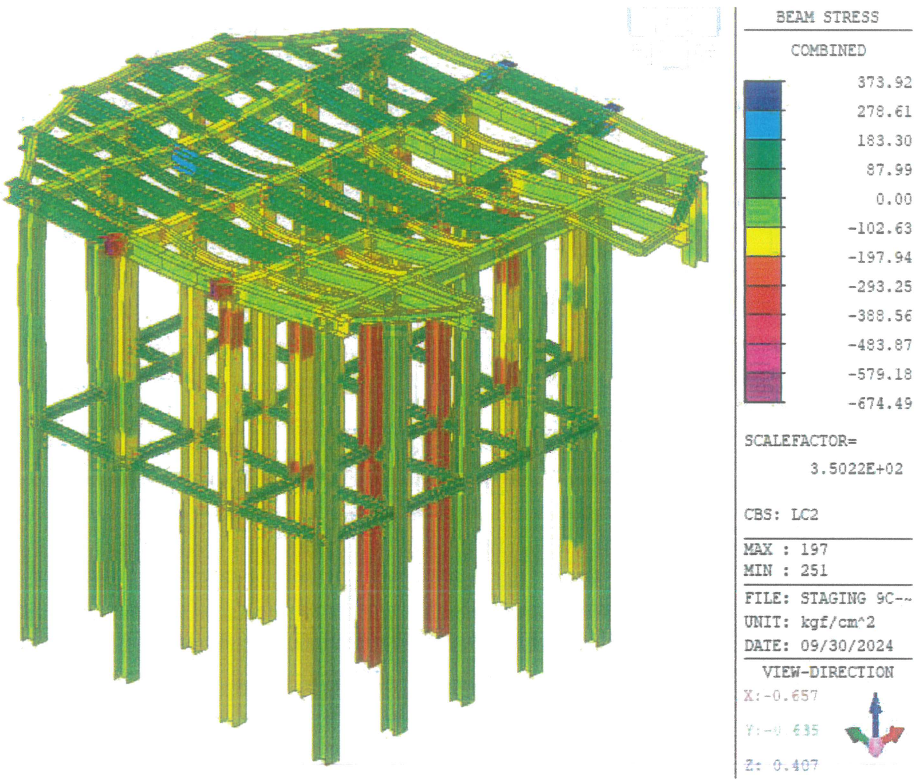
10 Graphic Stress

10.1 Load Case LCB1 Combibed Stress



10.2 Load Case LCB2 Combibed Stress



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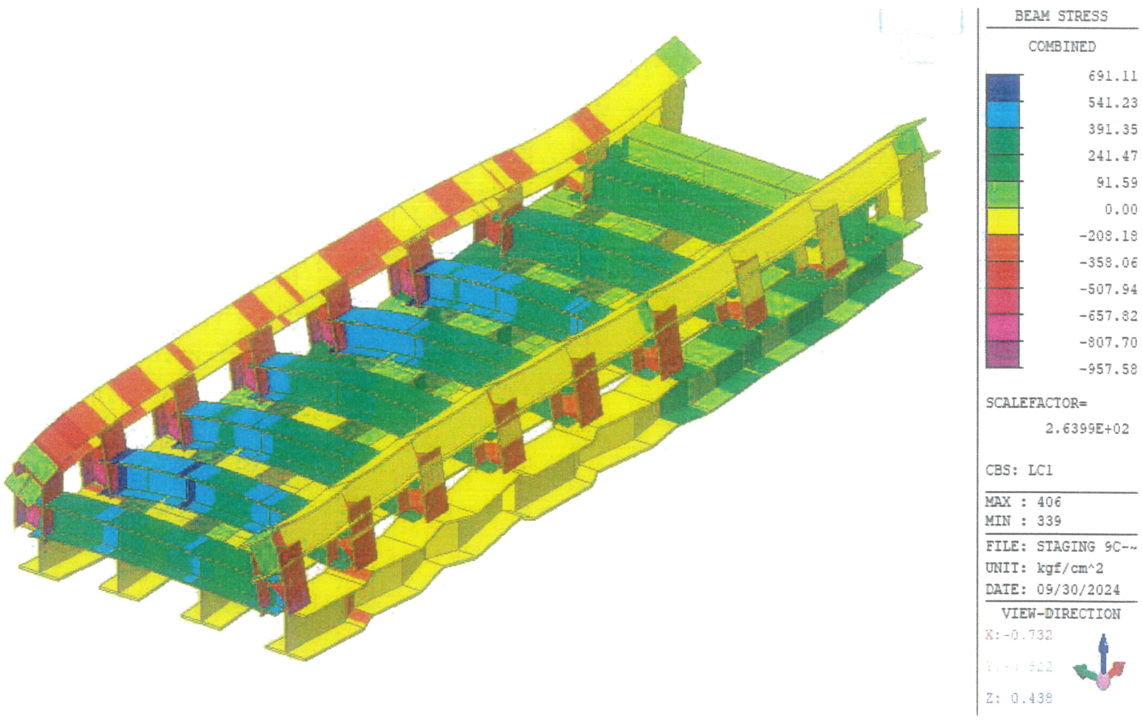
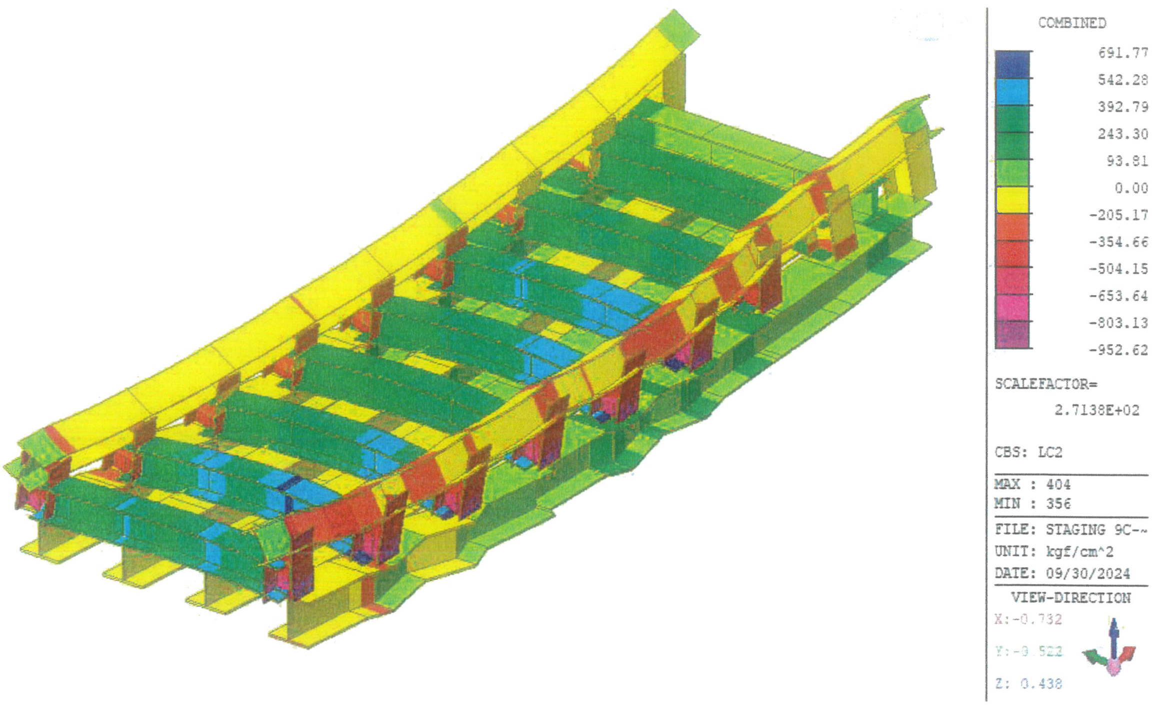
10.3 Load Case LCB1 Combibed Stress Cadle



10.4 Load Case LCB2 Combibed Stress Cadle



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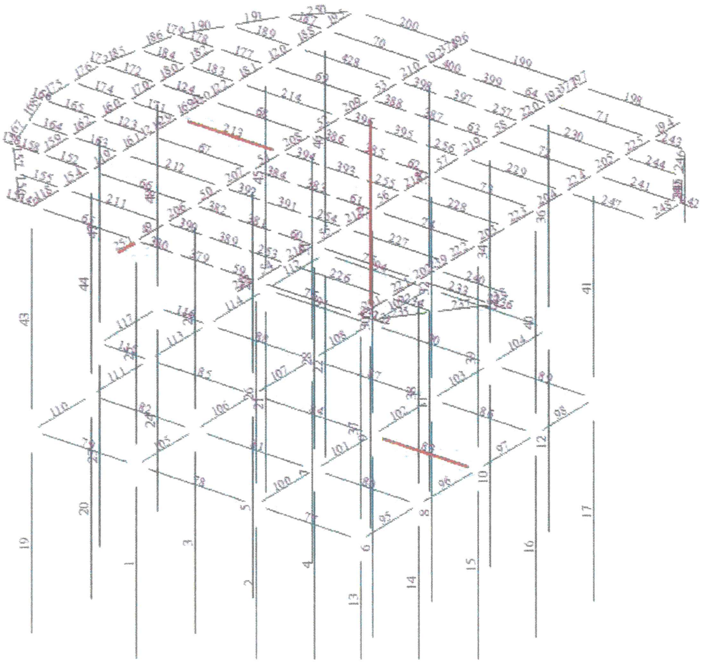
Steel Member Applicable Code Checking Based Or AISC-ASD89

11. รายการคำนวณ member Check

Code check member ที่ มีหน่วยแรงสูงสุดในแต่ละชนิดโครงสร้าง member33 เสา 251 คานหลัก 213 คานรองรับ พื้น และ 83 ค้ำยันเสา

	CHK	MEMB / COM	SECT / SHR	SEL	Section / Material	Fy
11.1	OK	33	1		H 300x300x10/15(Column),	
		0.194	0.005		SS400	2400.00
11.2	OK	251	2		H 300x300x10/15(Beam), H	
		0.487	0.385		SS400	2400.00
11.3	OK	213	3		H 150x150x7/10(SubBeam)	
		0.210	0.102		SS400	2400.00
11.4	OK	83	4		H 150x150x7/10(Bracing),	
		0.070	0.019		SS400	2400.00



```
    LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
-----------------------------------------------------------------------------------------
      1  1        Self Load( 1.000) +TBM Machine Load( 1.000) + Segment  Load( 1.000)
               +Friction  Load( 1.000) +Torque Resistance Force +Y( 1.000) + Gratting Load( 1.000)
               +  Living Load( 1.000) +Hydraulic Hose Suport( 1.000) + Cable  Suport( 1.000)
               +Reaction Frame Load( 1.000)
      2  1        Self Load( 1.000) +TBM Machine Load( 1.000) + Segment  Load( 1.000)
               +Friction  Load( 1.000) +Torque Resistance Force -Y( 1.000) + Gratting Load( 1.000)
               +  Living Load( 1.000) +Hydraulic Hose Suport( 1.000) + Cable  Suport( 1.000)
               +Reaction Frame Load( 1.000)
```

11.1 รายการคำนวณ member Check Column Member NO.33

```
*. MEMBER NO   =      33,  ELEMENT TYPE = Beam
*. LOADCOMB NO =       1,  MATERIAL NO  =      1,  SECTION NO =      1
*. UNIT SYSTEM : kgf, cm

*. SECTION PROPERTIES : Designation = H 300x300x10/15(Column), H 300x300x10/15
   Shape      = I - Section. (Rolled)
   Depth      =     30.000,  Top F Width =     30.000,  Bot.F Width =     30.000
   Web Thick  =      1.000,  Top F Thick =      1.500,  Bot.F Thick =      1.500

   Area = 1.19800e+02,  Asy  = 6.00000e+01,  Asz  = 3.00000e+01
   Ybar = 1.50000e+01,  Zbar = 1.50000e+01,  Qyb  = 7.32375e+02,  Qzb  = 1.12500e+02
   Syy  = 1.36000e+03,  Szz  = 4.50000e+02,  Zyy  = 1.50000e+03,  Zzz  = 6.84000e+02
   Iyy  = 2.04000e+04,  Izz  = 6.75000e+03,  Iyz  = 0.00000e+00
   ry   = 1.31000e+01,  rz   = 7.51000e+00
   J    = 7.65000e+01,  Cwp  = 1.37000e+06

*. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
   Ly   = 3.96300e+02,  Lz   = 3.96300e+02,  Lu   = 3.96300e+02
   Ky   = 1.00000e+00,  Kz   = 1.00000e+00

*. MATERIAL PROPERTIES :
   Fy   = 2.40000e+03,  Es   = 2.10000e+06,  MATERIAL NAME  = SS400

*. FORCES AND MOMENTS AT (J) POINT :
   Axial Force       Fxx =-2.18667e+04
   Shear Forces      Fyy = 7.42484e+01,  Fzz = 1.45676e+02
   Bending Moments   My  =-4.15753e+04,  Mz  =-1.91002e+04
   End Moments       Myi = 1.61560e+04,  Myj =-4.15753e+04  (for Lb)
                     Myi = 1.61560e+04,  Myj =-4.15753e+04  (for Ly)
                     Mzi = 1.03244e+04,  Mzj =-1.91002e+04  (for Lz)
```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```
==============================================================================
   [[[*]]]   CHECK AXIAL STRESS.
==============================================================================

      ( ). Check slenderness ratio of axial compression member (Kl/r).
           [ AISC-ASD89 Specification B7. ]
           -. Kl/r =     52.8  <   200.0   ---> O.K.

      ( ). Check width-thickness ratio of rolled flange (BTR).
           [ AISC-ASD89 Specification B5.1 ]
           -. BTR  =  bf/2tf =    10.00  <  65/SQRT[Fy]   ---> COMPACT SECTION !

      ( ). Check depth-thickness ratio of web (DTR).
           [ AISC-ASD89 Specification B5.1 ]
           -. DTR  =  Dweb/tw     =      27.000
           -. axial stress : fa     =   -182.526 kgf/cm^2.

          -. fa/Fy  =    0.076  <  0.16
                         640                  fa
          -. DTR  <   ---------- [1 - 3.74 ----]  --->  COMPACT SECTION !
                       SQRT[Fy]               Fy

      ( ). Calculate allowable compressive stress (Fa).
           [ AISC-ASD89 Specification E2. (E2-1) ]
                             [  2*(Pi^2)*Es   ]
          -. Cc    =  SQRT [ ------------- ]  =     131.42
                             [       Fy       ]
          -. Kl/r  <  Cc
                              [      (Kl/r)^2   ]
                              [ 1 - ---------- ]*Fy
                              [       2*Cc^2    ]
          -. Fa    =  --------------------------------  =   1219.652 kgf/cm^2.
                          5      3*(Kl/r)      (Kl/r)^3
                         --- + ---------- - ----------
                          3       8*Cc         8*Cc^3

      ( ). Calculate axial compressive stress of member (fa).
          -. fa    =  Fxx/Area  =   -182.526 kgf/cm^2.

      ( ). Check ratio of axial stress (fa/Fa).
              fa           182.526
          -. ----  =   ------------  =  0.150  <  1.000   ---> O.K.
              Fa          1219.652

==============================================================================
   [[[*]]]   CHECK BENDING STRESSES ABOUT MAJOR AXIS.
==============================================================================

      ( ). Check laterally unbraced length of compression flange (Lu).
           [ AISC-ASD89 Specification F1.1 (F1-2) ]
           -. Lcr1   =  (76*bf)/SQRT[Fy]    =     390.24 cm.
           -. Lcr2   =  20000/((d/Af)*Fy)   =     878.84 cm.
           -. Lcr    =  MIN[ Lcr1, Lcr2 ]   =     390.24 cm.
           -. Lu     =     396.30 cm.  >  Lcr

      ( ). Check depth-thickness ratio of web (DTR).
           [ AISC-ASD89 Specification B5.1 ]
           -. DTR  =  Dweb/tw     =     27.000
           -. axial stress : fa     =   -182.526 kgf/cm^2.
           -. fa/Fy  =   0.076  <  0.16
                         640                  fa
           -. DTR  <   ---------- [1 - 3.74 ----]  --->  COMPACT SECTION !
                        SQRT[Fy]              Fy

      ( ). Calculate bending coefficient (Cb).
           [ AISC-ASD89 Specification F1.3 ]
           -. Cb     =  1.000 (User defined or default value)

      ( ). Calculate radius of gyration (rT)
           -. Azz  =  Bf*tf + tw*(Ccom-tf)/3                =      49.5000 cm^2.
           -. Izz  =  tf*Bf^3/12 + ((Ccom-tf)/3)*tw^3/12 =     3375.3750 cm^4.
           -. rT   =  SQRT[Izz/Azz]                       =     8.258 cm.

      ( ). Check ratio of Lu-rT (Lu/rT).
           [ AISC-ASD89 Specification F1.3 ]
           -. CRrog1   =  SQRT[ (102000*Cb)/Fy ]  =     54.663
           -. Lu/rT    =     47.992  <  CRrog1

      ( ). Calculate allowable compressive bending stresses (FBC).
           [ AISC-ASD89 Specification F1.3 ]
           -. FBC  =  0.6*Fy  =    1440.000 kgf/cm^2.

      ( ). Check width-thickness ratio of rolled flange (BTR).
           [ AISC-ASD89 Specification B5.1 ]
           -. BTR  =  bf/2tf =    10.00  <  65/SQRT[Fy]   ---> COMPACT SECTION !
```


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```
( ). Calculate allowable bending stresses (FBCy,FBTy).
     -. FBCy  =  MIN[ FBC, Qs*0.6*Fy ]  =   1440.000 kgf/cm^2.
     -. FBTy  =  0.6*Fy                 =   1440.000 kgf/cm^2.

( ). Calculate actual bending stresses of member (fbcy,fbty).
     -. fbcy  =  (My*Ccom)/Iyy    =    -30.570 kgf/cm^2.
     -. fbty  =  (My*Cten)/Iyy    =     30.570 kgf/cm^2.

( ). Check ratios of stresses (fbcy/FBCy,fbty/FBTy).
          fbcy            30.570
     -. ------  =  ------------  =  0.021  <  1.000  --->  O.K.
          FBCy          1440.000
          fbty            30.570
     -. ------  =  ------------  =  0.021  <  1.000  --->  O.K.
          FBTy          1440.000

================================================================================
   [[[*]]]   CHECK BENDING STRESSES ABOUT MINOR AXIS.
================================================================================

( ). Check width-thickness ratio of flange (BTR).
     [ AISC-ASD89 Specification B5.1 ]
     -. BTR  =  bf/2tf =   10.00
     -. BTR  <  65/SQRT[Fy]  --->  COMPACT SECTION !

( ). Calculate allowable bending stresses (FBCz,FBTz).
     [ AISC-ASD89 Specification F2.1 (F2-1) ]
     -. FBCz,FBTz  =  0.75*Fy  =   1800.000 kgf/cm^2.  if Fy < 65 ksi.

( ). Calculate actual bending stresses of member (fbcz,fbtz).
     -. fbcz  =  (Mz*Ccom)/Izz    =    -42.445 kgf/cm^2.
     -. fbtz  =  (Mz*Cten)/Izz    =     42.445 kgf/cm^2.


( ). Check ratios of stresses (fbcz/FBCz,fbtz/FBTz).
          fbcz            42.445
     -. ------  =  ------------  =  0.024  <  1.000  --->  O.K.
          FBCz          1800.000
          fbtz            42.445
     -. ------  =  ------------  =  0.024  <  1.000  --->  O.K.
          FBTz          1800.000

================================================================================
   [[[*]]]   CHECK COMBINED STRESSES.
================================================================================

( ). Check interaction ratio of combined stresses (Axial compression + bending).
     [ AISC-ASD89 Specification H1. (H1-3) ]
     -. fa/Fa  <  0.15
                     fa      fbcy      fbcz
     -. Rmax   =   ---- + ------ + ------
                     Fa      FBCy      FBCz
               =  0.194  <  1.000  --->  O.K.

================================================================================
   [[[*]]]   CHECK SHEAR STRESSES.
================================================================================

( ). Calculate allowable shear stress in local-y direction (Fvy).
     [ AISC-ASD89 Specification F4 ]
     -. Fvy  =  0.40*Fy  =     960.000 kgf/cm^2.

( ). Calculate shear stress in local-y direction (fvy).
     ( LCB =     1, POS =     J )
     -. Applied shear force : Fyy =       74.25 kgf.
     -. fvy  =  Fyy / Asy           =      1.237 kgf/cm^2.

( ). Check ratio of shear stress (fvy/Fvy).
          fvy            1.237
     -. -----  =  ------------  =  0.001  <  1.000  --->  O.K.
          Fvy          960.000

( ). Calculate allowable shear stress in local-z direction (Fvz).
     [ AISC-ASD89 Specification F4 ]
     -. DTR  =  h/tw  =   27.00  <  380/SQRT[Fy]  --->  (F4.1)
     -. Fvz  =  0.40*Fy  =     960.000 kgf/cm^2.

( ). Calculate shear stress in local-z direction (fvz).
     ( LCB =     1, POS =     J )
     -. Applied shear force : Fzz =      145.68 kgf.
     -. fvz  =  Fzz / Asz           =      4.856 kgf/cm^2.

( ). Check ratio of shear stress (fvz/Fvz).
          fvz            4.856
     -. -----  =  ------------  =  0.005  <  1.000  --->  O.K.
          Fvz          960.000
```


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11.2 รายการคำนวณ member Check Beam Member NO.251

```
*. MEMBER NO    =     251,   ELEMENT TYPE = Beam
*. LOADCOMB NO =        1,   MATERIAL NO   =       1,   SECTION NO =       2
*. UNIT SYSTEM : kgf, cm

*. SECTION PROPERTIES : Designation = H 300x300x10/15(Beam), H 300x300x10/15
   Shape      = I - Section. (Rolled)
   Depth      =      30.000,  Top F Width =      30.000,  Bot.F Width =      30.000
   Web Thick =       1.000,  Top F Thick =       1.500,  Bot.F Thick =       1.500

   Area = 1.19800e+02,  Asy  = 6.00000e+01,  Asz  = 3.00000e+01
   Ybar = 1.50000e+01,  Zbar = 1.50000e+01,  Qyb  = 7.32375e+02,  Qzb  = 1.12500e+02
   Syy  = 1.36000e+03,  Szz  = 4.50000e+02,  Zyy  = 1.50000e+03,  Zzz  = 6.84000e+02
   Iyy  = 2.04000e+04,  Izz  = 6.75000e+03,  Iyz  = 0.00000e+00
   ry   = 1.31000e+01,  rz   = 7.51000e+00
   J    = 7.65000e+01,  Cwp  = 1.37000e+06

*. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
   Ly   = 5.60000e+01,  Lz   = 5.60000e+01,  Lu   = 5.60000e+01
   Ky   = 1.00000e+00,  Kz   = 1.00000e+00

*. MATERIAL PROPERTIES :
   Fy   = 2.40000e+03,  Es   = 2.10000e+06,  MATERIAL NAME  = SS400


*. FORCES AND MOMENTS AT (I) POINT :
   Axial Force        Fxx =-2.24987e+04
   Shear Forces       Fyy = 2.53279e+03,  Fzz =-1.10917e+04
   Bending Moments   My   =-5.59426e+05,  Mz   = 7.72960e+04
   End Moments        Myi =-5.59426e+05,  Myj = 6.02338e+04  (for Lb)
                      Myi =-5.59426e+05,  Myj = 6.02338e+04  (for Ly)
                      Mzi = 7.72960e+04,  Mzj =-6.45400e+04  (for Lz)

=================================================================================
 [[[*]]]   CHECK AXIAL STRESS.
=================================================================================

    ( ). Check slenderness ratio of axial compression member (Kl/r).
         [ AISC-ASD89 Specification B7. ]
         -. Kl/r =      7.5  <   200.0   ---> O.K.

    ( ). Check width-thickness ratio of rolled flange (BTR).
         [ AISC-ASD89 Specification B5.1 ]
         -. BTR  =  bf/2tf =    10.00  <  65/SQRT[Fy]   --->  COMPACT SECTION !

    ( ). Check depth-thickness ratio of web (DTR).
         [ AISC-ASD89 Specification B5.1 ]
         -. DTR  =  Dweb/tw     =     27.000
         -. axial stress : fa    =    -187.803 kgf/cm^2.
         -. fa/Fy  =    0.078  <  0.16
                       640                    fa
         -. DTR  <   ---------- [1 - 3.74 ----]  --->  COMPACT SECTION !
                     SQRT[Fy]                 Fy

    ( ). Calculate allowable compressive stress (Fa).
         [ AISC-ASD89 Specification E2. (E2-1) ]
                          [  2*(Pi^2)*Es  ]
         -. Cc    =  SQRT [ ------------- ]   =    131.42
                          [       Fy      ]
         -. Kl/r  <  Cc
                           [      (Kl/r)^2   ]
                           [ 1 - ---------- ]*Fy
                           [       2*Cc^2    ]
         -. Fa    =   ------------------------------   =   1419.579 kgf/cm^2.
                        5      3*(Kl/r)      (Kl/r)^3
                       --- + ---------- - ----------
                        3       8*Cc         8*Cc^3

    ( ). Calculate axial compressive stress of member (fa).
         -. fa    =  Fxx/Area  =   -187.803 kgf/cm^2.

    ( ). Check ratio of axial stress (fa/Fa).
              fa         187.803
         -. ----   =  ------------   =  0.132  <  1.000   ---> O.K.
              Fa        1419.579

=================================================================================
 [[[*]]]   CHECK BENDING STRESSES ABOUT MAJOR AXIS.
=================================================================================

    ( ). Check laterally unbraced length of compression flange (Lu).
         [ AISC-ASD89 Specification F1.1 (F1-2) ]
         -. Lcr1  =  (76*bf)/SQRT[Fy]     =    390.24 cm.
         -. Lcr2  =  20000/((d/Af)*Fy)    =    878.84 cm.
         -. Lcr   =  MIN[ Lcr1, Lcr2 ]   =    390.24 cm.
         -. Lu    =      56.00 cm.   <  Lcr
```

```
( ). Check depth-thickness ratio of web (DTR).
     [ AISC-ASD89 Specification B5.1 ]
     -. DTR  =  Dweb/tw     =     27.000
     -. axial stress : fa     =   -187.803 kgf/cm^2.
     -. fa/Fy  =   0.078  <  0.16
                  640                      fa
     -. DTR  <  ---------- [1 - 3.74 ----]  --->  COMPACT SECTION !
                SQRT[Fy]                   Fy

( ). Check width-thickness ratio of flange (BTR).
     [ AISC-ASD89 Specification B5.1 ]
     -. BTR  =  bf/2tf =    10.00
     -. BTR  <  65/SQRT[Fy]  --->  COMPACT SECTION !

( ). Calculate allowable bending stresses (FBCy,FBTy).
     [ AISC-ASD89 Specification F1.1 (F1-1) ]
     -. FBCy,FBTy  =  0.66*Fy  =   1584.000 kgf/cm^2.  if Fy < 65 ksi.

( ). Calculate actual bending stresses of member (fbcy,fbty).
     -. fbcy  =  (My*Ccom)/Iyy   =   -411.343 kgf/cm^2.
     -. fbty  =  (My*Cten)/Iyy   =    411.343 kgf/cm^2.

( ). Check ratios of stresses (fbcy/FBCy,fbty/FBTy).
        fbcy           411.343
     -. ------  =  ------------  =  0.260  <  1.000  --->  O.K.
        FBCy          1584.000
        fbty           411.343
     -. ------  =  ------------  =  0.260  <  1.000  --->  O.K.
        FBTy          1584.000

================================================================================
   [[[*]]]   CHECK BENDING STRESSES ABOUT MINOR AXIS.
================================================================================

( ). Check width-thickness ratio of flange (BTR).
     [ AISC-ASD89 Specification B5.1 ]
     -. BTR  =  bf/2tf =    10.00
     -. BTR  <  65/SQRT[Fy]  --->  COMPACT SECTION !

( ). Calculate allowable bending stresses (FBCz,FBTz).
     [ AISC-ASD89 Specification F2.1 (F2-1) ]
     -. FBCz,FBTz  =  0.75*Fy  =   1800.000 kgf/cm^2.  if Fy < 65 ksi.

( ). Calculate actual bending stresses of member (fbcz,fbtz).
     -. fbcz  =  (Mz*Ccom)/Izz   =   -171.769 kgf/cm^2.
     -. fbtz  =  (Mz*Cten)/Izz   =    171.769 kgf/cm^2.

( ). Check ratios of stresses (fbcz/FBCz,fbtz/FBTz).
        fbcz           171.769
     -. ------  =  ------------  =  0.095  <  1.000  --->  O.K.
        FBCz          1800.000
        fbtz           171.769
     -. ------  =  ------------  =  0.095  <  1.000  --->  O.K.
        FBTz          1800.000

================================================================================
   [[[*]]]   CHECK COMBINED STRESSES.
================================================================================

( ). Check interaction ratio of combined stresses (Axial compression + bending).
     [ AISC-ASD89 Specification H1. (H1-3) ]
     -. fa/Fa  <  0.15

                     fa      fbcy      fbcz
     -. Rmax  =    ---- + ------ + ------
                     Fa      FBCy      FBCz
              =   0.487  <  1.000  --->  O.K.

================================================================================
   [[[*]]]   CHECK SHEAR STRESSES.
================================================================================

( ). Calculate allowable shear stress in local-y direction (Fvy).
     [ AISC-ASD89 Specification F4 ]
     -. Fvy  =  0.40*Fy  =     960.000 kgf/cm^2.

( ). Calculate shear stress in local-y direction (fvy).
     ( LCB =     1, POS =      J )
     -. Applied shear force : Fyy =       2532.79 kgf.
     -. fvy  =  Fyy / Asy          =      42.213 kgf/cm^2.

( ). Check ratio of shear stress (fvy/Fvy).
        fvy            42.213
     -. -----  =  ------------  =  0.044  <  1.000  --->  O.K.
        Fvy           960.000
```


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```
( ). Calculate allowable shear stress in local-z direction (Fvz).
     [ AISC-ASD89 Specification F4 ]
     -. DTR  =  h/tw  =   27.00  <  380/SQRT[Fy]  --->  (F4.1)
     -. Fvz  =  0.40*Fy  =    960.000 kgf/cm^2.

( ). Calculate shear stress in local-z direction (fvz).
     ( LCB =    1, POS =    I )
     -. Applied shear force : Fzz =   -11091.69 kgf.
     -. fvz  =  Fzz / Asz        =    369.723 kgf/cm^2.

( ). Check ratio of shear stress (fvz/Fvz).
         fvz           369.723
     -. -----  =  ------------  =  0.385  <  1.000  --->  O.K.
         Fvz           960.000
```


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11.3 รายการคำนวณ member Check SubBeam Member NO.213

```
*. MEMBER NO    =      213,  ELEMENT TYPE = Beam
*. LOADCOMB NO =        1,  MATERIAL NO   =      1,   SECTION NO =      3
*. UNIT SYSTEM : kgf, cm

*. SECTION PROPERTIES : Designation = H 150x150x7/10(SubBeam), H 150x150x7/10
   Shape       = I - Section. (Rolled)
   Depth       =      15.000,  Top F Width =      15.000,  Bot.F Width =      15.000
   Web Thick =       0.700,  Top F Thick =       1.000,  Bot.F Thick =       1.000

   Area = 4.01400e+01,  Asy  = 2.00000e+01,  Asz  = 1.05000e+01
   Ybar = 7.50000e+00,  Zbar = 7.50000e+00,  Qyb  = 1.71125e+02,  Qzb  = 2.81250e+01
   Syy  = 2.19000e+02,  Szz  = 7.51000e+01,  Zyy  = 2.46000e+02,  Zzz  = 1.15000e+02
   Iyy  = 1.64000e+03,  Izz  = 5.63000e+02,  Iyz  = 0.00000e+00
   ry   = 6.39000e+00,  rz   = 3.75000e+00
   J    = 1.15000e+01,  Cwp  = 2.76000e+04

*. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
   Ly   = 2.20000e+02,  Lz   = 2.20000e+02,  Lu   = 2.20000e+02
   Ky   = 1.00000e+00,  Kz   = 1.00000e+00

*. MATERIAL PROPERTIES :
   Fy   = 2.40000e+03,  Es   = 2.10000e+06,  MATERIAL NAME  = SS400


*. FORCES AND MOMENTS AT (I) POINT :
   Axial Force       Fxx =-2.55402e+03
   Shear Forces      Fyy = 2.51111e+00,  Fzz =-1.01901e+03
   Bending Moments   My  =-4.79077e+04,  Mz  = 5.02196e+02
   End Moments       Myi =-4.79077e+04,  Myj =-3.02355e+03  (for Lb)
                     Myi =-4.79077e+04,  Myj =-3.02355e+03  (for Ly)
                     Mzi = 5.02196e+02,  Mzj =-5.02478e+01  (for Lz)


================================================================================
   [[[*]]]   CHECK AXIAL STRESS.
================================================================================

      ( ). Check slenderness ratio of axial compression member (Kl/r).
           [ AISC-ASD89 Specification B7. ]
           -. Kl/r =     58.7  <    200.0   ---> O.K.

      ( ). Check width-thickness ratio of rolled flange (BTR).
           [ AISC-ASD89 Specification B5.1 ]
           -. BTR  =  bf/2tf =     7.50  <  65/SQRT[Fy]  --->  COMPACT SECTION !

      ( ). Check depth-thickness ratio of web (DTR).
           [ AISC-ASD89 Specification B5.1 ]
           -. DTR  =  Dweb/tw      =      18.571
           -. axial stress : fa    =     -63.628 kgf/cm^2.


           -. fa/Fy  =    0.027  <  0.16
                        640                  fa
           -. DTR  <  ---------- [1 - 3.74 ----]  --->  COMPACT SECTION !
                       SQRT[Fy]              Fy

      ( ). Calculate allowable compressive stress (Fa).
           [ AISC-ASD89 Specification E2. (E2-1) ]
                              [  2*(Pi^2)*Es  ]
           -. Cc    =  SQRT [ ------------- ]  =    131.42
                              [       Fy      ]
           -. Kl/r  <  Cc
                               [      (Kl/r)^2  ]
                               [ 1 - ---------- ]*Fy
                               [       2*Cc^2   ]
           -. Fa    =  -------------------------------  =   1185.374 kgf/cm^2.
                         5     3*(Kl/r)      (Kl/r)^3
                        --- + ---------- - ----------
                         3       8*Cc         8*Cc^3

      ( ). Calculate axial compressive stress of member (fa).
           -. fa    =  Fxx/Area  =    -63.628 kgf/cm^2.

      ( ). Check ratio of axial stress (fa/Fa).
                fa          63.628
           -. ----  =  ------------  =  0.054  <  1.000  --->  O.K.
                Fa        1185.374
```


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================================================================================
  [[[*]]]   CHECK BENDING STRESSES ABOUT MAJOR AXIS.
================================================================================

      ( ). Check laterally unbraced length of compression flange (Lu).
           [ AISC-ASD89 Specification F1.1 (F1-2) ]
           -. Lcr1  =  (76*bf)/SQRT[Fy]    =    195.12 cm.
           -. Lcr2  =  20000/((d/Af)*Fy)   =    585.89 cm.
           -. Lcr   =  MIN[ Lcr1, Lcr2 ]   =    195.12 cm.
           -. Lu    =    220.00 cm.  >  Lcr

      ( ). Check depth-thickness ratio of web (DTR).
           [ AISC-ASD89 Specification B5.1 ]
           -. DTR  =  Dweb/tw      =     18.571
           -. axial stress : fa    =    -63.628 kgf/cm^2.
           -. fa/Fy  =    0.027  <  0.16
                          640                fa
           -. DTR  <  ---------- [1 - 3.74 ----]  --->  COMPACT SECTION !
                       SQRT[Fy]              Fy

      ( ). Calculate bending coefficient (Cb).
           [ AISC-ASD89 Specification F1.3 ]
           -. Cb     =  1.000 (User defined or default value)

      ( ). Calculate radius of gyration (rT)
           -. Azz  =  Bf*tf + tw*(Ccom-tf)/3             =      16.5167 cm^2.
           -. Izz  =  tf*Bf^3/12 + {(Ccom-tf)/3}*tw^3/12 =     281.3119 cm^4.
           -. rT   =  SQRT[Izz/Azz]                      =     4.127 cm.

      ( ). Check ratio of Lu-rT (Lu/rT).
           [ AISC-ASD89 Specification F1.3 ]
           -. CRrog1  =  SQRT[ (102000*Cb)/Fy ]  =    54.663
           -. Lu/rT   =    53.308  <  CRrog1

      ( ). Calculate allowable compressive bending stresses (FBC).
           [ AISC-ASD89 Specification F1.3 ]
           -. FBC  =  0.6*Fy  =   1440.000 kgf/cm^2.

      ( ). Check width-thickness ratio of rolled flange (BTR).
           [ AISC-ASD89 Specification B5.1 ]
           -. BTR  =  bf/2tf =    7.50  <  65/SQRT[Fy]  --->  COMPACT SECTION !

      ( ). Calculate allowable bending stresses (FBCy,FBTy).
           -. FBCy  =  MIN[ FBC, Qs*0.6*Fy ]  =   1440.000 kgf/cm^2.
           -. FBTy  =  0.6*Fy                 =   1440.000 kgf/cm^2.

      ( ). Calculate actual bending stresses of member (fbcy,fbty).
           -. fbcy  =  (My*Ccom)/Iyy   =    -219.090 kgf/cm^2.
           -. fbty  =  (My*Cten)/Iyy   =     219.090 kgf/cm^2.

      ( ). Check ratios of stresses (fbcy/FBCy,fbty/FBTy).
                fbcy          219.090
           -. ------  =  ------------  =  0.152  <  1.000  --->  O.K.
                FBCy         1440.000
                fbty          219.090
           -. ------  =  ------------  =  0.152  <  1.000  --->  O.K.
                FBTy         1440.000

================================================================================
  [[[*]]]   CHECK BENDING STRESSES ABOUT MINOR AXIS.
================================================================================

      ( ). Check width-thickness ratio of flange (BTR).
           [ AISC-ASD89 Specification B5.1 ]
           -. BTR  =  bf/2tf =     7.50
           -. BTR  <  65/SQRT[Fy]  --->  COMPACT SECTION !

      ( ). Calculate allowable bending stresses (FBCz,FBTz).
           [ AISC-ASD89 Specification F2.1 (F2-1) ]
           -. FBCz,FBTz  =  0.75*Fy  =   1800.000 kgf/cm^2.  if Fy < 65 ksi.

      ( ). Calculate actual bending stresses of member (fbcz,fbtz).
           -. fbcz  =  (Mz*Ccom)/Izz   =      -6.690 kgf/cm^2.
           -. fbtz  =  (Mz*Cten)/Izz   =       6.690 kgf/cm^2.

      ( ). Check ratios of stresses (fbcz/FBCz,fbtz/FBTz).
                fbcz            6.690
           -. ------  =  ------------  =  0.004  <  1.000  --->  O.K.
                FBCz         1800.000
                fbtz            6.690
           -. ------  =  ------------  =  0.004  <  1.000  --->  O.K.
                FBTz         1800.000
```


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==============================================================================
   [[[*]]]   CHECK COMBINED STRESSES.
==============================================================================

      ( ). Check interaction ratio of combined stresses (Axial compression + bending).
           [ AISC-ASD89 Specification H1. (H1-3) ]
           -. fa/Fa  <  0.15
                         fa      fbcy      fbcz
           -. Rmax  =  ---- + ------ + ------
                         Fa      FBCy      FBCz
                    =  0.210  <  1.000  --->  O.K.

==============================================================================
   [[[*]]]   CHECK SHEAR STRESSES.
==============================================================================

      ( ). Calculate allowable shear stress in local-y direction (Fvy).
           [ AISC-ASD89 Specification F4 ]
           -. Fvy  =  0.40*Fy  =    960.000 kgf/cm^2.

      ( ). Calculate shear stress in local-y direction (fvy).
           ( LCB =    2, POS =    J )
           -. Applied shear force : Fyy =      -34.41 kgf.
           -. fvy  =  Fyy / Asy         =      1.721 kgf/cm^2.

      ( ). Check ratio of shear stress (fvy/Fvy).
               fvy            1.721
           -. -----  =  ------------  =  0.002  <  1.000  --->  O.K.
               Fvy          960.000

      ( ). Calculate allowable shear stress in local-z direction (Fvz).
           [ AISC-ASD89 Specification F4 ]
           -. DTR  =  h/tw  =   18.57  <  380/SQRT[Fy]  --->  (F4.1)
           -. Fvz  =  0.40*Fy  =    960.000 kgf/cm^2.

      ( ). Calculate shear stress in local-z direction (fvz).
           ( LCB =    2, POS =    I )
           -. Applied shear force : Fzz =    -1032.92 kgf.
           -. fvz  =  Fzz / Asz         =     98.373 kgf/cm^2.

      ( ). Check ratio of shear stress (fvz/Fvz).
               fvz           87.851
           -. -----  =  ------------  =  0.092  <  1.000  --->  O.K.
               Fvz          960.000

      ( ). Check ratio of shear stress (fvz/Fvz).
               fvz           98.373
           -. -----  =  ------------  =  0.102  <  1.000  --->  O.K.
               Fvz          960.000
```


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11.4 รายการคำนวณ member Check Bracing Member NO83

```
*. MEMBER NO    =      83,  ELEMENT TYPE = Beam
*. LOADCOMB NO =       2,  MATERIAL NO  =     1,  SECTION NO =     4
*. UNIT SYSTEM : kgf, cm

*. SECTION PROPERTIES : Designation = H 150x150x7/10(Bracing), H 150x150x7/10
   Shape       = I - Section. (Rolled)
   Depth       =     15.000,  Top F Width =     15.000,  Bot.F Width =     15.000
   Web Thick =      0.700,  Top F Thick =      1.000,  Bot.F Thick =      1.000

   Area = 4.01400e+01,  Asy  = 2.00000e+01,  Asz  = 1.05000e+01
   Ybar = 7.50000e+00,  Zbar = 7.50000e+00,  Qyb  = 1.71125e+02,  Qzb  = 2.81250e+01
   Syy  = 2.19000e+02,  Szz  = 7.51000e+01,  Zyy  = 2.46000e+02,  Zzz  = 1.15000e+02
   Iyy  = 1.64000e+03,  Izz  = 5.63000e+02,  Iyz  = 0.00000e+00
   ry   = 6.39000e+00,  rz   = 3.75000e+00
   J    = 1.15000e+01,  Cwp  = 2.76000e+04

*. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
   Ly   = 2.20000e+02,  Lz   = 2.20000e+02,  Lu    = 2.20000e+02
   Ky   = 1.00000e+00,  Kz   = 1.00000e+00

*. MATERIAL PROPERTIES :
   Fy   = 2.40000e+03,  Es   = 2.10000e+06,  MATERIAL NAME  = SS400

*. FORCES AND MOMENTS AT (I) POINT :
   Axial Force       Fxx = 3.40388e+02
   Shear Forces      Fyy = 5.26829e+00,  Fzz =-1.89453e+02
   Bending Moments   My  =-1.88131e+04,  Mz  = 6.02877e+02
   End Moments       Myi =-1.88131e+04,  Myj = 1.52412e+04  (for Lb)
                     Myi =-1.88131e+04,  Myj = 1.52412e+04  (for Ly)
                     Mzi = 6.02877e+02,  Mzj =-5.56147e+02  (for Lz)

================================================================================
  [[[*]]]   CHECK AXIAL STRESS.
================================================================================

   ( ). Check slenderness ratio of axial tension member (l/r).
        [ AISC-ASD89 Specification B7. ]
        -. l/r   =     58.7  <   300.0   ---> O.K.

   ( ). Calculate allowable tensile stress (Ft).
        [ AISC-ASD89 Specification D1. ]
        -. Ft    =  0.6*Fy     =    1440.000 kgf/cm^2.

   ( ). Calculate axial tensile stress of member (ft).
        -. ft    =  Fxx/Area   =       8.480 kgf/cm^2.
   ( ). Check ratio of axial stress (ft/Ft).
            ft          8.480
        -. ----  =  ------------  =  0.006  <  1.000  ---> O.K.
            Ft        1440.000

================================================================================
  [[[*]]]   CHECK BENDING STRESSES ABOUT MAJOR AXIS.
================================================================================

   ( ). Check laterally unbraced length of compression flange (Lu).
        [ AISC-ASD89 Specification F1.1 (F1-2) ]
        -. Lcr1  =  (76*bf)/SQRT[Fy]    =    195.12 cm.
        -. Lcr2  =  20000/((d/Af)*Fy)   =    585.89 cm.
        -. Lcr   =  MIN[ Lcr1, Lcr2 ]   =    195.12 cm.
        -. Lu    =    220.00 cm.  >  Lcr

   ( ). Check depth-thickness ratio of web (DTR).
        [ AISC-ASD89 Specification B5.1 ]
        -. DTR  =  Dweb/tw     =     18.571
        -. axial stress : fa = ft - |My*Zbar/Iyy| - |Mz*Ybar/Izz| =    -85.587
        -. fa  <  0.0 (Webs in flexural compression.)
        -. DTR  <  640/SQRT[Fy]   --->  COMPACT SECTION !

   ( ). Calculate bending coefficient (Cb).
        [ AISC-ASD89 Specification F1.3 ]
        -. Cb     =  1.000 (User defined or default value)

   ( ). Calculate radius of gyration (rT)
        -. Azz  =  Bf*tf + tw*(Ccom-tf)/3               =      16.5167 cm^2.
        -. Izz  =  tf*Bf^3/12 + {(Ccom-tf)/3}*tw^3/12 =      281.3119 cm^4.
        -. rT   =  SQRT[Izz/Azz]                        =     4.127 cm.

   ( ). Check ratio of Lu-rT (Lu/rT).
        [ AISC-ASD89 Specification F1.3 ]
        -. CRrog1   =  SQRT[ (102000*Cb)/Fy ]  =     54.663
        -. Lu/rT    =     53.308  <  CRrog1
```


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```
( ). Calculate allowable compressive bending stresses (FBC).
     [ AISC-ASD89 Specification F1.3 ]
     -. FBC  =  0.6*Fy  =   1440.000 kgf/cm^2.

( ). Check width-thickness ratio of rolled flange (BTR).
     [ AISC-ASD89 Specification B5.1 ]
     -. BTR  =  bf/2tf =     7.50  <  65/SQRT[Fy]  --->  COMPACT SECTION !

( ). Calculate allowable bending stresses (FBCy,FBTy).
     -. FBCy  =  MIN[ FBC, Qs*0.6*Fy ]  =   1440.000 kgf/cm^2.
     -. FBTy  =  0.6*Fy                 =   1440.000 kgf/cm^2.
( ). Calculate actual bending stresses of member (fbcy,fbty).
     -. fbcy  =  (My*Ccom)/Iyy     =     -86.035 kgf/cm^2.
     -. fbty  =  (My*Cten)/Iyy     =      86.035 kgf/cm^2.

( ). Check ratios of stresses (fbcy/FBCy,fbty/FBTy).
         fbcy           86.035
     -. ------  =  ------------  =  0.060  <  1.000  --->  O.K.
         FBCy         1440.000
         fbty           86.035
     -. ------  =  ------------  =  0.060  <  1.000  --->  O.K.
         FBTy         1440.000

================================================================================
   [[[*]]]   CHECK BENDING STRESSES ABOUT MINOR AXIS.
================================================================================

( ). Check width-thickness ratio of flange (BTR).
     [ AISC-ASD89 Specification B5.1 ]
     -. BTR  =  bf/2tf =     7.50
     -. BTR  <  65/SQRT[Fy]  --->  COMPACT SECTION !

( ). Calculate allowable bending stresses (FBCz,FBTz).
     [ AISC-ASD89 Specification F2.1 (F2-1) ]
     -. FBCz,FBTz  =  0.75*Fy  =   1800.000 kgf/cm^2.  if Fy < 65 ksi.

( ). Calculate actual bending stresses of member (fbcz,fbtz).
     -. fbcz  =  (Mz*Ccom)/Izz     =      -8.031 kgf/cm^2.
     -. fbtz  =  (Mz*Cten)/Izz     =       8.031 kgf/cm^2.

( ). Check ratios of stresses (fbcz/FBCz,fbtz/FBTz).
         fbcz            8.031
     -. ------  =  ------------  =  0.004  <  1.000  --->  O.K.
         FBCz         1800.000
         fbtz            8.031
     -. ------  =  ------------  =  0.004  <  1.000  --->  O.K.
         FBTz         1800.000

================================================================================
   [[[*]]]   CHECK COMBINED STRESSES.
================================================================================

( ). Check interaction ratio of combined stresses (Axial tension + bending).
     [ AISC-ASD89 Specification H2. (H2-1) ]
                       ft      fbty      fbtz
     -. Rmax1   =     ---- + ------ + ------
                       Ft      FBTy      FBTz
                =    0.070  <  1.000  --->  O.K.
                      fbcy      fbcz
     -. Rmax2   =   ------ + ------
                      FBCy      FBCz
                =    0.064  <  1.000  --->  O.K.
================================================================================
   [[[*]]]   CHECK SHEAR STRESSES.
================================================================================

( ). Calculate allowable shear stress in local-y direction (Fvy).
     [ AISC-ASD89 Specification F4 ]
     -. Fvy  =  0.40*Fy  =     960.000 kgf/cm^2.

( ). Calculate shear stress in local-y direction (fvy).
     ( LCB =     2, POS =      J )
     -. Applied shear force : Fyy =         5.27 kgf.
     -. fvy  =  Fyy / Asy           =       0.263 kgf/cm^2.

( ). Check ratio of shear stress (fvy/Fvy).
         fvy             0.263
     -. -----  =  ------------  =2.744e-04  <  1.000  --->  O.K.
         Fvy           960.000

( ). Calculate allowable shear stress in local-z direction (Fvz).
     [ AISC-ASD89 Specification F4 ]
     -. DTR  =  h/tw  =    18.57  <  380/SQRT[Fy]  --->  (F4.1)
     -. Fvz  =  0.40*Fy  =     960.000 kgf/cm^2.

( ). Calculate shear stress in local-z direction (fvz).
     ( LCB =     2, POS =      I )
     -. Applied shear force : Fzz =      -189.45 kgf.
     -. fvz  =  Fzz / Asz           =      18.043 kgf/cm^2.

( ). Check ratio of shear stress (fvz/Fvz).
         fvz            18.043
     -. -----  =  ------------  =  0.019  <  1.000  --->  O.K.
         Fvz           960.000
```


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12. รายการคำนวณ Base Plate

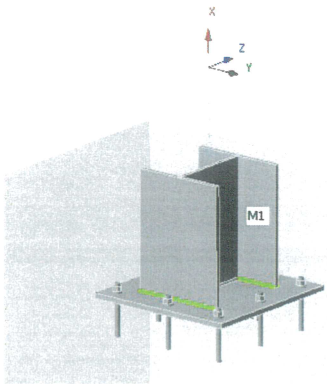
12.1 รายการคำนวณ Base Plate เสา H-Beam 300X300X15X10 mm.

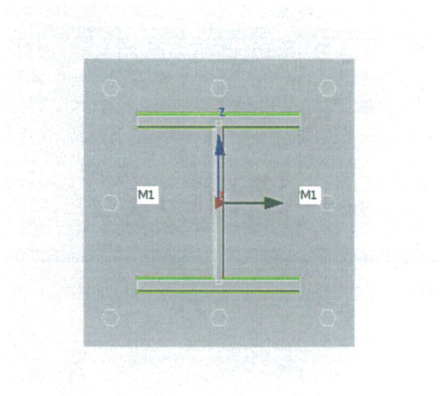
Material

Steel	A36	
Concrete	5000 psi	หรือ 35 Mpa.

Design

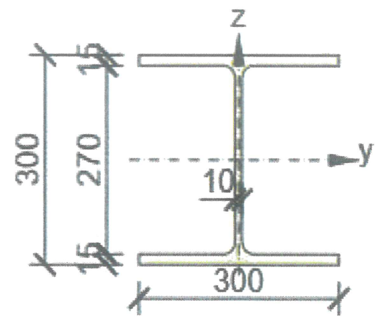
Name	Base Plat Column H300X300X15X10
Analysis	Joint design resistance
Design code	AISC - ASD 2016





Cross-sections H300X300X15X10 Material A36

Drawing



Anchors

Name	Bolt assembly	Diameter [mm]	Yield Strength [MPa]	Gross area [mm2]
Expansion Bolt M16	Expansion Bolt M16	16	400	198

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Spacing (C20/25Concrete)							
Spacing mm	Tensile Resistance per Pair of Anchors						
	M6	M8	M10	M12	M16	M20	M24
50	6.2						
60	6.7	7.2					
65	6.9	7.5	10.4				
70	7.2	7.7	10.7				
75		8.0	11.0	15.4			
85			11.6	16.1			
100			12.5	17.1	21.2		
105			12.8	17.5	21.6		
115				18.2	22.4		
130				19.3	23.6	29.0	
140				20.0	24.4	29.9	
150					25.2	30.8	37.1
165					26.4	32.1	38.5
175						33.0	39.4
185						33.9	40.4

Reduced Design Resistance (kN) • Divide Loads by 1.4 for Recommended Loads

Influence of Concrete Strength

Concrete Strength		C20/25	C25/30	C30/37	C40/50	C45/55	C50/60
Cylinder	N/mm²	20	25	30	40	45	50
Cube	N/mm²	25	30	37	50	55	60
Factor		1.0	1.1	1.22	1.41	1.48	1.55

When using concrete factors check all other information to ensure Steel Tensile and Shear Resistance is not exceeded

Use Workign Tensile / ตัว = (23.60/1.40) *1.48 = 24.95 kN

Use Workign Shear / ตัว = 18.6 kN

Load effects

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
Node 7 (LC1)	H300	-261.0	0.1	-0.1	0.0	0.0	0.0

Foundation block

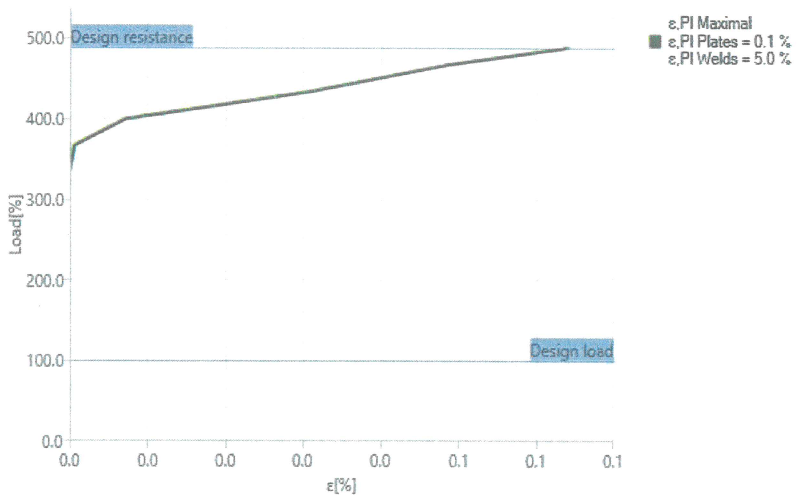
Dimensions	2500X2500	mm.
Depth	2000	mm.
Anchor	Expansion Bolt M16	
Anchoring length	120	mm.
Shear force transfer	Anchors	

Design Check

Joint design reistange

Joint design resistance

Loads	Resistance [%]
Node 7 (LC1)	488.5



Joint design resistance, Node 7 (LC1)

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Summary

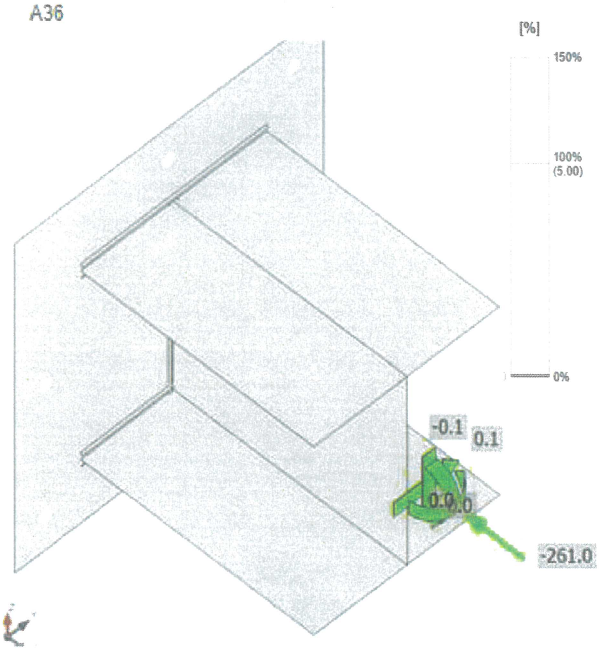
Name	Value	Check status
Plates	0.0 < 5.0%	OK
Anchors	Not calculated	
Welds	50.3 < 100%	OK
Concrete block	5.5 < 100%	OK

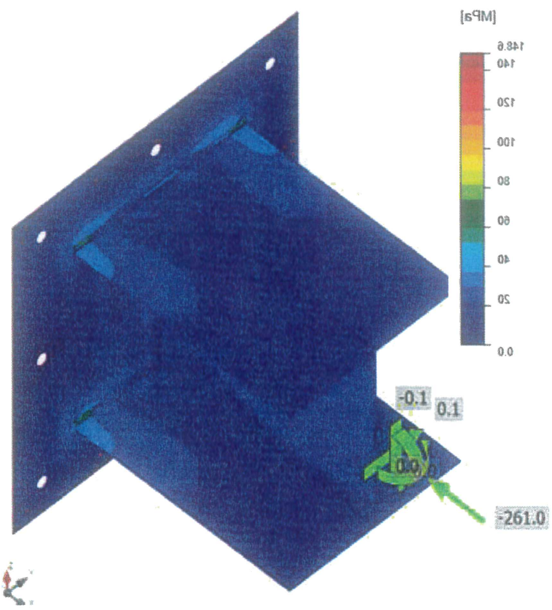
Plates

Name	f_y [MPa]	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	σc_{Ed} [MPa]	Check status
H300-bfl 1	248.2	15.0	Node 7 (LC1)	32.8	0.0	0.0	OK
H300-tfl 1	248.2	15.0	Node 7 (LC1)	32.8	0.0	0.0	OK
H300-w 1	248.2	10.0	Node 7 (LC1)	27.1	0.0	0.0	OK
SP1	248.2	15.0	Node 7 (LC1)	40.4	0.0	0.0	OK

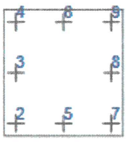
Design data

Material	f_y [MPa]	ε_{lim} [%]
A36	248.2	5.0





Anchors

Shape	Item	Loads	N_f [kN]	V [kN]	Status
	A2	Node 5(max)	0.5	0.0	OK
	A3	Node 5(max)	0.0	0.0	OK
	A4	Node 5(max)	0.5	0.1	OK
	A5	Node 5(max)	1.4	0.0	OK
	A6	Node 5(max)	1.5	0.0	OK
	A7	Node 5(max)	0.5	0.1	OK
	A8	Node 5(max)	0.0	0.0	OK
	A9	Node 5(max)	0.5	0.1	OK

Use Workign Tensile / ตัว = (23.60/1.40) *1.48 = 24.95 kN > Nf OK

Use Workign Shear / ตัว = 18.6 kN > V OK

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Weld sections

Item	Edge	Xu	T_h [mm]	L_s [mm]	L [mm]	L_c [mm]	Loads	F_n [kN]	R_n/Ω [kN]	Ut [%]	Status
SP1	H300-bfl 1	E60xx	◢4.2◣	◢6.0◣	300	30	Node 7 (LC1)	10.8	21.5	50.3	OK
		E60xx	◢4.2◣	◢6.0◣	300	30	Node 7 (LC1)	10.7	21.6	49.6	OK
SP1	H300-tfl 1	E60xx	◢4.2◣	◢6.0◣	300	30	Node 7 (LC1)	10.7	21.6	49.4	OK
		E60xx	◢4.2◣	◢6.0◣	300	30	Node 7 (LC1)	10.8	21.6	50.1	OK
SP1	H300-w 1	E60xx	◢4.2◣	◢6.0◣	284	32	Node 7 (LC1)	4.7	24.9	18.8	OK
		E60xx	◢4.2◣	◢6.0◣	284	32	Node 7 (LC1)	4.6	24.8	18.7	OK

Detailed result for SP1 / H300-bfl 1 - 1

Weld resistance check (AISC 360-16: J2-4)

$\frac{R_n}{\Omega} = \frac{F_{nw} \cdot A_{we}}{\Omega} =$ 21.5 kN ≥ $F_n =$ 10.8 kN

Where:

$F_{nw} = 339.2$ MPa – nominal stress of weld material:

- $F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot sin^{1.5}\theta)$, where:
  - $F_{EXX} =$ 413.7 MPa – electrode classification number, i.e. minimum specified tensile strength
  - $\theta =$ 54.4° – angle of loading measured from the weld longitudinal axis

$A_{we} = 127$ mm^2 – effective area of weld critical element

$\Omega = 2.0$ – safety factor for fillet welds

Concrete block

Item	Loads	A_1 [mm2]	A_2 [mm2]	σ [MPa]	Ut [%]	Status
CB 1	Node 7 (LC1)	191143	5306055	1.4	5.5	OK

Detailed result for CB 1

Concrete block compressive resistance check (AISC 360-16 Section J8)

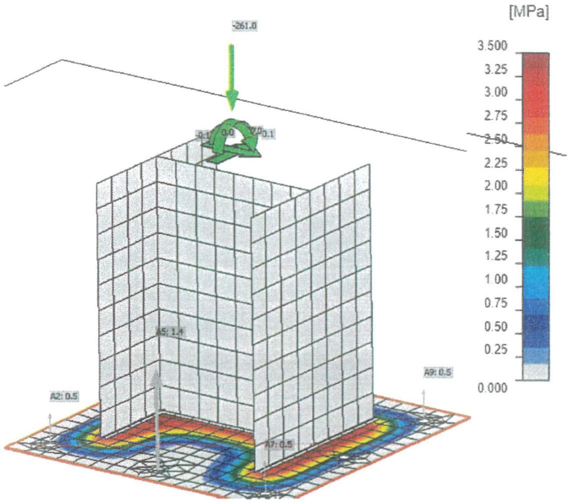
$\frac{f_{p,max}}{\Omega_c} =$ 25.4 MPa ≥ $\sigma =$ 1.4 MPa

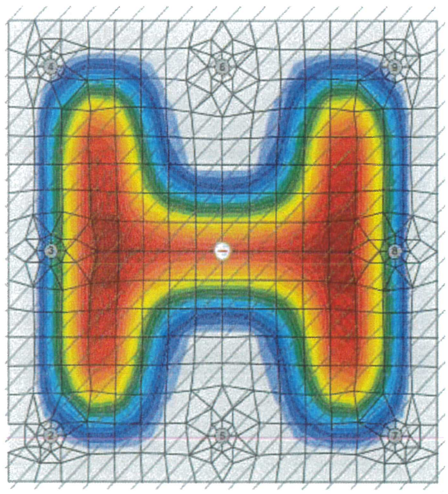
Where:

$f_{p,max} = 58.6$ MPa – concrete block design bearing strength:

- $f_{p,max} = 0.85 \cdot f_c' \cdot \sqrt{\frac{A_2}{A_1}} \leq 1.7 \cdot f_c'$, where:
  - $f_c' =$ 34.5 MPa – concrete compressive strength
  - $A_1 =$ 191143 mm^2 – base plate area in contact with concrete surface
  - $A_2 =$ 5306055 mm^2 – concrete supporting surface

$\Omega_c = 2.31$ – resistance factor for concrete





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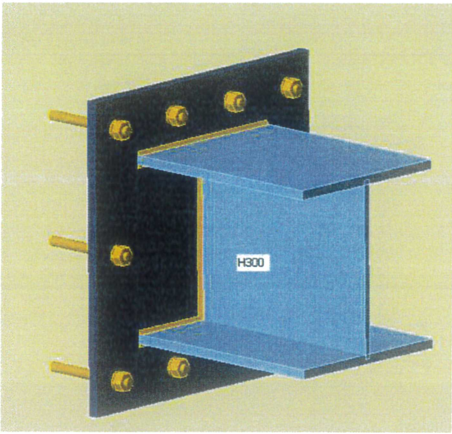
12.2 รายการคำนวณ Base Plate Beam Wall Type 1 H-Beam 300X300X15X10 mm.

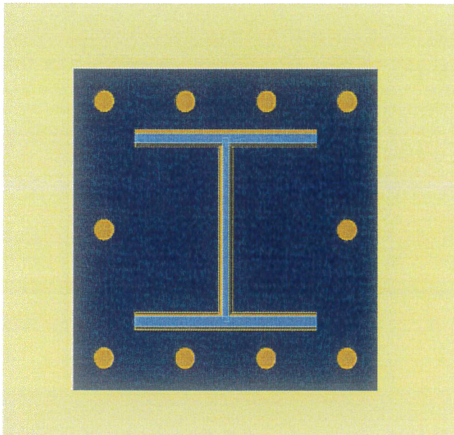
Material

Steel	A36
Concrete	5000 psi หรือ 35 Mpa.

Design

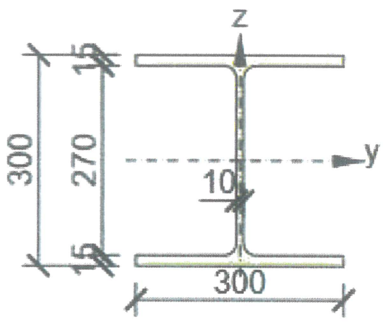
Name	Base Plat Beam H300X300X15X10
Analysis	Joint design resistance
Design code	AISC - ASD 2016





Cross-sections H300X300X15X10 Material A36

Drawing



Anchors

Name	Bolt assembly	Diameter [mm]	Yield Strength [MPa]	Gross area [mm2]
Expansion Bolt M16	Expansion Bolt M16	16	400	198

Use Workign Tensile / ตัว = (22.40/1.40) *1.48 = 23.68 kN

Use Workign Shear / ตัว = 18.6 kN

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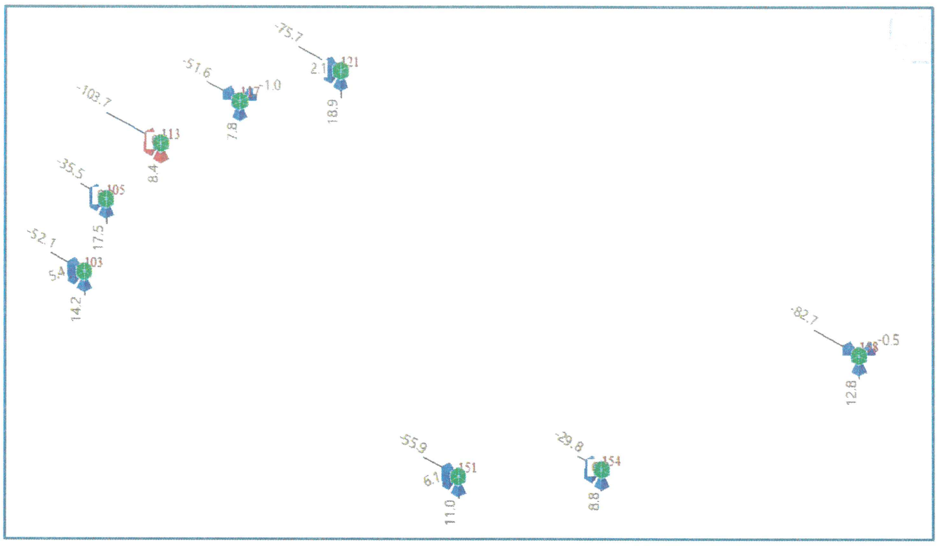
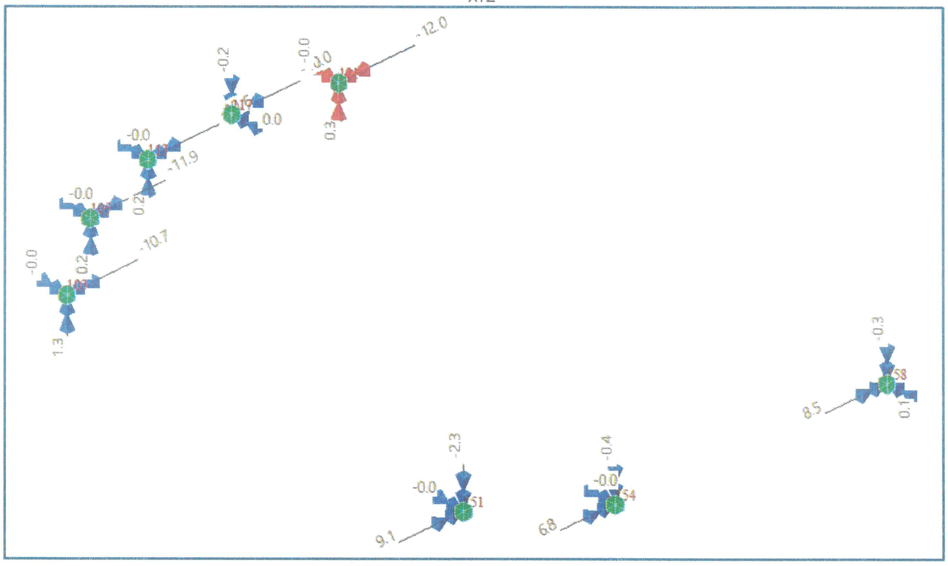


F_{XYZ}



M_{XYZ}

Load effects

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
103	H300	-52.1	5.4	-14.2	0.0	10.7	1.3
105	H300	-53.5	0.2	17.5	0.0	11.9	0.2
113	H300	-103.7	0.4	-8.4	0.0	10.6	0.2
117	H300	-51.6	-1.0	-7.8	0.0	10.0	0.2
121	H300	-75.7	-2.1	-18.9	0.0	12.0	0.3
151	H300	55.9	6.1	-11.0	0.0	9.1	2.3
154	H300	29.8	0.6	-8.9	0.0	6.8	-0.3
158	H300	82.7	-0.5	-12.8	0.0	8.5	-0.3

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Foundation block

Dimensions	2500X2500	mm.
Depth	1200	mm.
Anchor	Expansion Bolt M16	
Anchoring length	120	mm.
Shear force transfer	Anchors	

Check

Joint design resistance

Loads	Resistance [%]
103	704.7
117	879.4
105	744.0
113	670.6
121	706.0
151	272.4
154	449.0
158	233.6

Summary

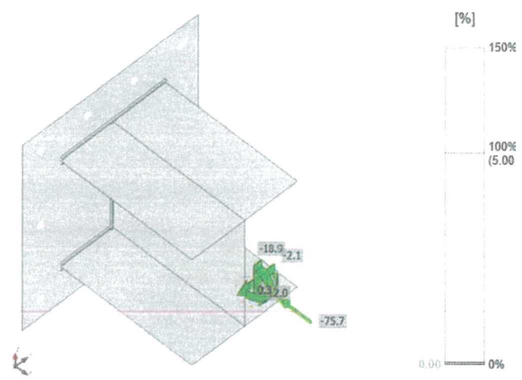
Name	Value	Check status
Plates	0.0 < 5.0%	OK
Anchors	Not calculated	
Welds	75.0 < 100%	OK
Concrete block	2.7 < 100%	OK

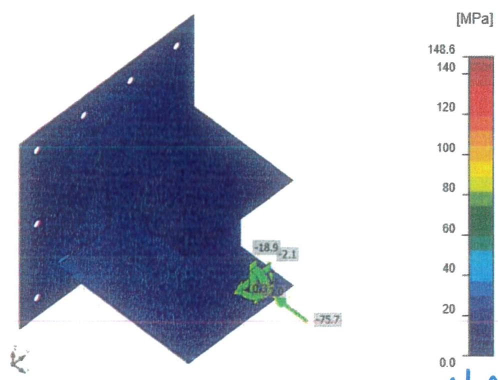
Plates

Name	f_y [MPa]	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	σc_{Ed} [MPa]	Check status
H300-bfl 1	248.2	15.0	121	27.9	0.0	0.0	OK
H300-tfl 1	248.2	15.0	158	62.9	0.0	0.0	OK
H300-w 1	248.2	10.0	158	46.4	0.0	0.0	OK
SP1	248.2	16.0	158	94.7	0.0	0.0	OK

Design data

Material	f_y [MPa]	ε_{lim} [%]
A36	248.2	5.0





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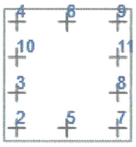
Strain check 121

Equivalent stress 121

Anchors



Shape	Item	Loads	N_f [kN]	V [kN]	Status
	A2	158	10.2	1.3	OK
	A3	158	22.6	1.4	OK
	A4	158	10.7	1.3	OK
	A5	158	8.6	1.2	OK
	A6	158	9.0	1.2	OK
	A7	158	2.6	1.2	OK
	A8	158	5.5	1.3	OK
	A9	158	3.0	1.2	OK
	A10	158	22.9	1.4	OK
	A11	158	5.9	1.3	OK

Use Workign Tensile / ตัว = (23.60/1.40) *1.48 = 23.68 kN > Nf OK

Use Workign Shear / ตัว = 18.6 kN > V OK

Weld sections

Item	Edge	Xu	T_h [mm]	L_s [mm]	L [mm]	L_c [mm]	Loads	F_n [kN]	R_n/Ω [kN]	Ut [%]	Status
SP1	H300-bfl 1	E60xx	◢4.2◣	◢6.0◣	300	30	113	7.7	21.3	36.1	OK
		E60xx	◢4.2◣	◢6.0◣	300	30	113	8.1	21.5	37.6	OK
SP1	H300-tfl 1	E60xx	◢4.2◣	◢6.0◣	299	30	158	17.4	23.2	75.0	OK
		E60xx	◢4.2◣	◢6.0◣	300	30	158	12.2	19.4	62.9	OK
SP1	H300-w 1	E60xx	◢4.2◣	◢6.0◣	285	32	158	11.7	24.9	46.8	OK
		E60xx	◢4.2◣	◢6.0◣	285	32	158	11.5	24.9	46.3	OK

Detailed result for SP1 / H300-tfl 1 - 1

Weld resistance check (AISC 360-16: J2-4)

$$\frac{R_n}{\Omega} = \frac{F_{nw} \cdot A_{we}}{\Omega} = \quad 23.2 \text{ kN} \geq F_n = \quad 17.4 \text{ kN}$$

Where:

F_{nw} = 366.3 MPa – nominal stress of weld material:

- $F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot sin^{1.5}\theta)$, where:
  - F_{EXX} = 413.7 MPa – electrode classification number, i.e. minimum specified tensile strength
  - θ = 75.3° – angle of loading measured from the weld longitudinal axis

A_{we} = 127 mm² – effective area of weld critical element

$\Omega = 2.0$ – safety factor for fillet welds

Concrete block

Item	Loads	A_1 [mm2]	A_2 [mm2]	σ [MPa]	Ut [%]	Status
CB 1	121	125204	4822298	0.7	2.7	OK

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Detailed result for CB 1

Concrete block compressive resistance check (AISC 360-16 Section J8)

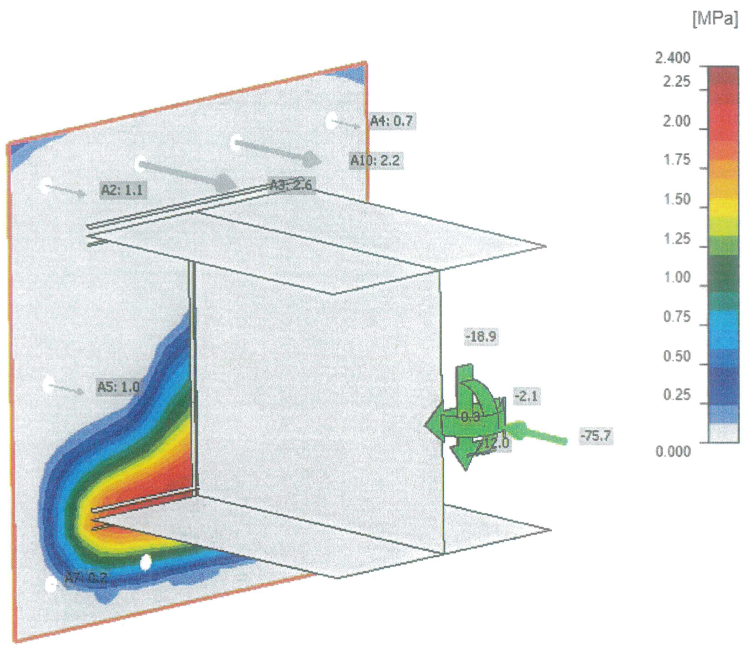
$\frac{f_{p,max}}{\Omega_c} = 25.4$ MPa ≥ $\sigma = 0.7$ MPa

Where:

$f_{p,max} = 58.6$ MPa – concrete block design bearing strength:

- $f_{p,max} = 0.85 \cdot f'_c \cdot \sqrt{\frac{A_2}{A_1}} \leq 1.7 \cdot f'_c$, where:
  - $f'_c = 34.5$ MPa – concrete compressive strength
  - $A_1 = 125204$ mm^2 – base plate area in contact with concrete surface
  - $A_2 = 4822298$ mm^2 – concrete supporting surface

$\Omega_c = 2.31$ – resistance factor for concrete



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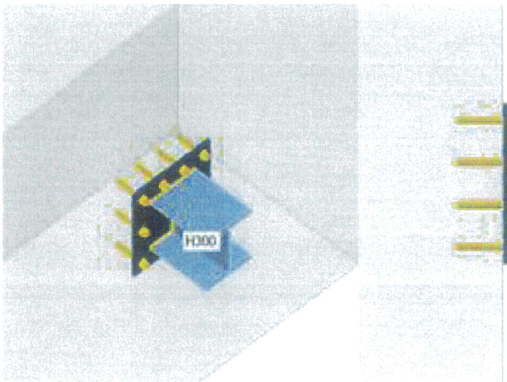
12.3 รายการคำนวณ Base Plate Beam Wall Type 2 H-Beam 300X300X15X10 mm.

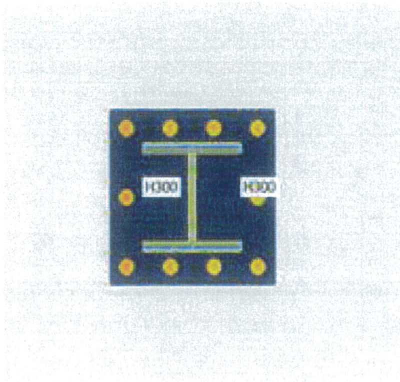
Material

Steel	A36	
Concrete	5000 psi	หรือ 35 Mpa.

Design

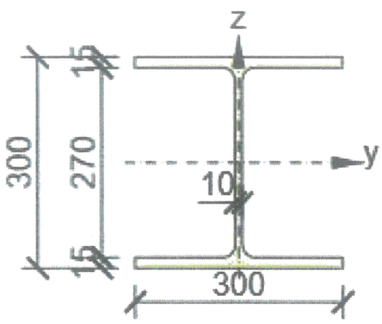
Name	Base Plat Beam H300X300X15X10	
Analysis	Stress, strain/ simplified loading	
Design code	AISC - ASD 2016	For Only Anchor bolt AISC - LRFD 2016





Cross-sections   H300X300X15X10   Material   A36

Drawing



Anchors

Name	Bolt assembly	Diameter [mm]	Yield Strength [MPa]	Gross area [mm2]
Bolt M16	Bolt M16(A325M)	16	640	201

Loads

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
132	H300	45.6	4.6	-58.5	0.0	4.1	1.3
133	H300	61.2	4.0	-65.5	0.0	34.1	-2.4
163	H300	-220.0	24.8	-108.0	0.0	54.9	7.6
164	H300	-177.9	21.3	-76.6	0.0	29.7	7.7

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Foundation block

Dimensions	2500X2500 mm.
Depth	1200 mm.
Anchor	Chemical Bolt M16
Anchoring length	150 mm.
Shear force transfer	Anchors

Sammary

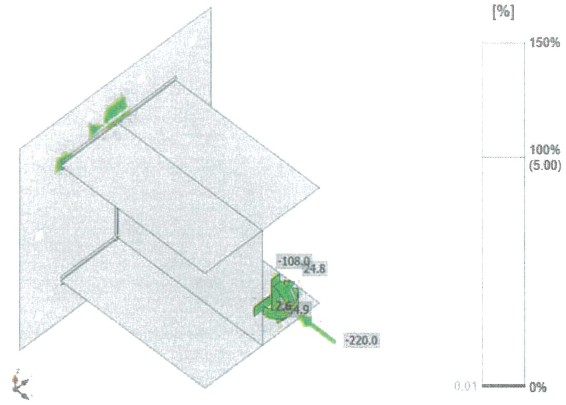
Name	Value	Check status
Analysis	100.0%	OK
Plates	0.1 < 5.0%	OK
Anchors	63.7 < 100%	OK
Welds	81.6 < 100%	OK
Concrete block	11.7 < 100%	OK

Plate

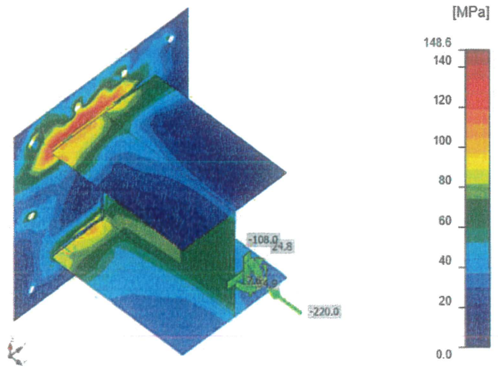
Name	f_y [MPa]	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	σc_{Ed} [MPa]	Check status
H300-bfl 1	248.2	15.0	163	100.2	0.0	0.0	OK
H300-tfl 1	248.2	15.0	133	142.9	0.0	0.0	OK
H300-w 1	248.2	10.0	133	98.7	0.0	0.0	OK
SP1	248.2	15.0	133	148.8	0.1	0.0	OK

Design data

Material	f_y [MPa]	ε_{lim} [%]
A36	248.2	5.0



Strain check, 163



Equivalent stress, 163

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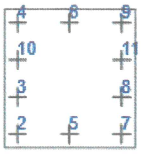
Anchors Bolts

Anchors

Shape	Item	Loads	N_f [kN]	V [kN]	ΦN_{cbg} [kN]	ΦV_{cbg} [kN]	ΦV_{cp} [kN]	Ut_t [%]	Ut_s [%]	Ut_{ts} [%]	Status
	A2	133	20.0	6.5	261.8	-	500.3	63.7	13.1	50.6	OK
	A3	133	46.9	7.0	261.8	-	500.3	63.7	13.8	50.9	OK
	A4	133	22.7	6.4	261.8	576.5	500.3	63.7	13.1	50.6	OK
	A5	133	12.5	6.3	261.8	-	500.3	63.7	13.1	50.6	OK
	A6	133	14.3	6.3	261.8	576.5	500.3	63.7	13.1	50.6	OK
	A7	133	0.3	6.3	261.8	305.3	500.3	63.7	21.5	54.9	OK
	A8	163	0.0	11.4	-	306.2	500.3	0.0	35.4	17.7	OK
	A9	133	0.2	6.4	261.8	305.3	500.3	63.7	21.5	54.9	OK
	A10	133	50.0	7.0	261.8	-	500.3	63.7	13.7	50.8	OK
	A11	163	0.0	11.6	-	306.2	500.3	0.0	35.4	17.7	OK

Design data

Grade	ΦN_{sa} [kN]	ΦV_{sa} [kN]
16 A325M - 1	91.2	50.8

Detailed result for A10

Anchor tensile resistance (ACI 318-14 – 17.4.1)

$\phi N_{sa} = \phi \cdot A_{se,N} \cdot f_{uta} =$ 91.2 kN ≥ $N_f =$ 50.0 kN

Where:

$\phi = 0.70$ – resistance factor

$A_{se,N} =$ 157 mm^2 – tensile stress area

$f_{uta} =$ 830.0 MPa – specified tensile strength of anchor steel:

- $f_{uta} = \min(860\ \mathrm{MPa}, 1.9 \cdot f_{ya},\ f_u)$, where:
  - $f_{ya} =$ 660.0 MPa – specified yield strength of anchor steel
  - $f_u =$ 830.0 MPa – specified ultimate strength of anchor steel

Concrete breakout resistance of anchor in tension (ACI 318-14 – 17.4.2)

The check is performed for group of anchors that form common tension breakout cone: A2, A3, A4, A5, A6, A7, A9, A10

$\phi N_{cbg} = \phi \cdot \frac{A_{Nc}}{A_{Nc0}} \cdot \Psi_{ed,N} \cdot \Psi_{ec,N} \cdot \Psi_{c,N} \cdot N_b =$ 261.8 kN ≥ $N_{fg} =$ 166.9 kN

Where:

$N_{fg} =$ 166.9 kN – sum of tension forces of anchors with common concrete breakout cone area

$\phi = 0.70$ – resistance factor

$A_{Nc} =$ 722500 mm^2 – concrete breakout cone area for group of anchors

$A_{Nc0} =$ 202500 mm^2 – concrete breakout cone area for single anchor not influenced by edges

$\Psi_{ed,N} = 1.00$ – modification factor for edge distance:

- $\Psi_{ed,N} = \min(0.7 + \frac{0.3 \cdot c_{a,min}}{1.5 \cdot h_{ef}}, 1)$, where:
  - $c_{a,min} =$ 1050 mm – minimum distance from the anchor to the edge
  - $h_{ef} = \min(h_{emb}, \max(\frac{c_{a,max}}{1.5}, \frac{s}{3})) =$ 150 mm – depth of embedment, where:
    - $h_{emb} =$ 150 mm – anchor length
    - $c_{a,max} =$ 1050 mm – maximum distance from the anchor to one of the three closest edges
    - $s =$ 133 mm – maximum spacing between anchors

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$\Psi_{ec,N} = 0.97$ – modification factor for eccentrically loaded group of anchors

- $\Psi_{ec,N} = \Psi_{ecx,N} \cdot \Psi_{ecy,N}$, where:
  - $\Psi_{ecx,N} = \frac{1}{1+\frac{2 e_{x,N}}{3 h_{ef}}} =$ 1.00 – modification factor that depends on eccentricity in x-direction
  - $e_{x,N} =$ 0 mm – tension load eccentricity in x-direction
  - $\Psi_{ecy,N} = \frac{1}{1+\frac{2 e_{y,N}}{3 h_{ef}}} =$ 0.97 – modification factor that depends on eccentricity in y-direction
  - $e_{y,N} =$ 7 mm – tension load eccentricity in y-direction
  - $h_{ef} =$ 150 mm – depth of embedment

$\Psi_{c,N} = 1.00$ – modification factor for concrete conditions

$N_b = 107.9$ kN – basic concrete breakout strength of a single anchor in tension:

- $N_b = k_c \cdot \lambda_a \cdot \sqrt{f'_c} \cdot h_{ef}^{1.5}$, where:
  - $k_c =$ 10.0 – coefficient for cast-in anchors
  - $\lambda_a =$ 1.00 – modification factor for lightweight concrete
  - $f'_c =$ 34.5 MPa – concrete compressive strength
  - $h_{ef} =$ 150 mm – depth of embedment

Shear resistance (ACI 318-14 – 17.5.1)

$\phi V_{sa} = \phi \cdot 0.6 \cdot A_{se,V} \cdot f_{uta} =$ 50.8 kN ≥ $V =$ 7.0 kN

Where:

$\phi = 0.65$ – resistance factor

$A_{se,V} = 157$ mm² – tensile stress area

$f_{uta} = 830.0$ MPa – specified tensile strength of anchor steel:

- $f_{uta} = \min(860\ \mathrm{MPa}, 1.9 \cdot f_{ya}, f_u)$, where:
  - $f_{ya} =$ 660.0 MPa – specified yield strength of anchor steel
  - $f_u =$ 830.0 MPa – specified ultimate strength of anchor steel

Concrete pryout resistance (ACI 318-14 – 17.5.3)

The check is performed for group of anchors on common base plate

$\phi V_{cp} = \phi \cdot k_{cp} \cdot N_{cp} =$ 500.3 kN ≥ $V_g =$ 65.6 kN

Where:

$\phi = 0.65$ – resistance factor

$k_{cp} = 2.00$ – concrete pry-out factor

$N_{cp} = 384.9$ kN – concrete cone tension break-out resistance in case all anchors are in tension

$V_g = 65.6$ kN – sum of shear forces of anchors on common base plate

Interaction of tensile and shear forces (ACI 318-14 – R17.6)

$U_{tt}^{5/3} + U_{ts}^{5/3} =$ 0.51 ≤ 1.0

Where:

$U_{tt} = 0.64$ – maximum ratio of factored tensile force and tensile resistance determined from all appropriate failure modes

$U_{ts} = 0.14$ – maximum ratio of factored shear force and shear resistance determined from all appropriate failure modes

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Weld sections

Item	Edge	Xu	T_h [mm]	L_s [mm]	L [mm]	L_c [mm]	Loads	F_n [kN]	R_n/Ω [kN]	Ut [%]	Status
SP1	H300-bfl 1	E60xx	◢4.2◣	◢6.0◣	300	30	163	18.2	22.9	79.3	OK
		E60xx	◢4.2◣	◢6.0◣	300	30	163	19.0	23.3	81.6	OK
SP1	H300-tfl 1	E60xx	◢4.2◣	◢6.0◣	299	30	133	18.1	23.5	76.9	OK
		E60xx	◢4.2◣	◢6.0◣	300	30	133	16.4	21.3	77.1	OK
SP1	H300-w 1	E60xx	◢4.2◣	◢6.0◣	285	32	133	13.8	23.5	58.6	OK
		E60xx	◢4.2◣	◢6.0◣	285	32	133	13.6	23.6	57.8	OK

Detailed result for SP1 / H300-bfl 1 - 2

Weld resistance check (AISC 360-16: J2-4)

$\frac{R_n}{\Omega} = \frac{F_{nw} \cdot A_{we}}{\Omega} =$ 23.3 kN ≥ $F_n =$ 19.0 kN

Where:

$F_{nw} =$ 366.8 MPa – nominal stress of weld material:

- $F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot sin^{1.5}\theta)$, where:
  - $F_{EXX} =$ 413.7 MPa – electrode classification number, i.e. minimum specified tensile strength
  - $\theta =$ 76.0° – angle of loading measured from the weld longitudinal axis

$A_{we} =$ 127 mm^2 – effective area of weld critical element

$\Omega = 2.0$ – safety factor for fillet welds

Concrete block

Item	Loads	A_1 [mm2]	A_2 [mm2]	σ [MPa]	Ut [%]	Status
CB 1	163	110998	4869644	3.0	11.7	OK

Detailed result for CB 1

Concrete block compressive resistance check (AISC 360-16 Section J8)

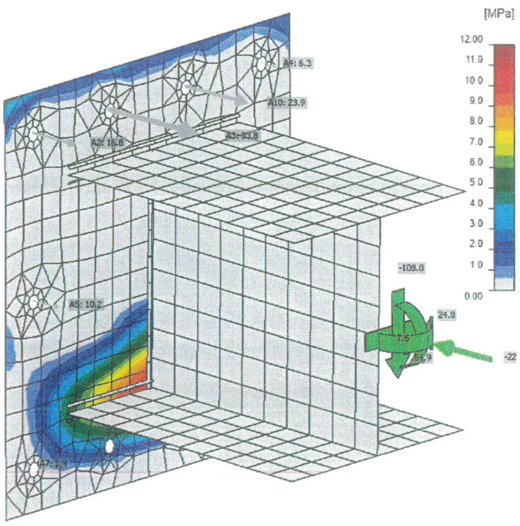
$\frac{f_{p,max}}{\Omega_c} =$ 25.4 MPa ≥ $\sigma =$ 3.0 MPa

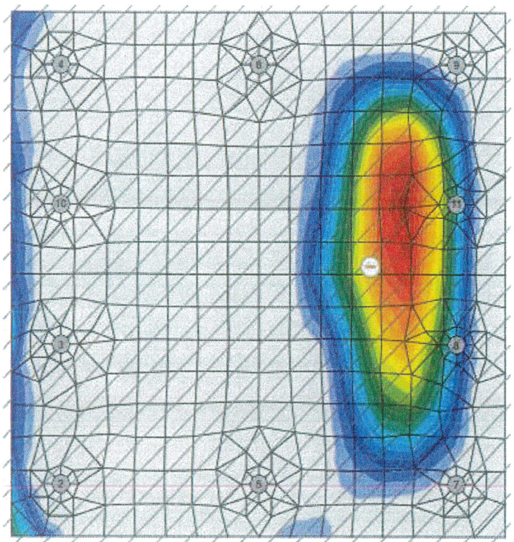
Where:

$f_{p,max} =$ 58.6 MPa – concrete block design bearing strength:

- $f_{p,max} = 0.85 \cdot f'_c \cdot \sqrt{\frac{A_2}{A_1}} \leq 1.7 \cdot f'_c$, where:
  - $f'_c =$ 34.5 MPa – concrete compressive strength
  - $A_1 =$ 110998 mm^2 – base plate area in contact with concrete surface
  - $A_2 =$ 4869644 mm^2 – concrete supporting surface

$\Omega_c =$ 2.31 – resistance factor for concrete





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13 รายการคำนวณ Reaction Frame

13.1 propertry

13.1.1 Material property

ID	Name	Type	Standard	DB
1	A36	Steel	ASTM(S)	A36

Steel

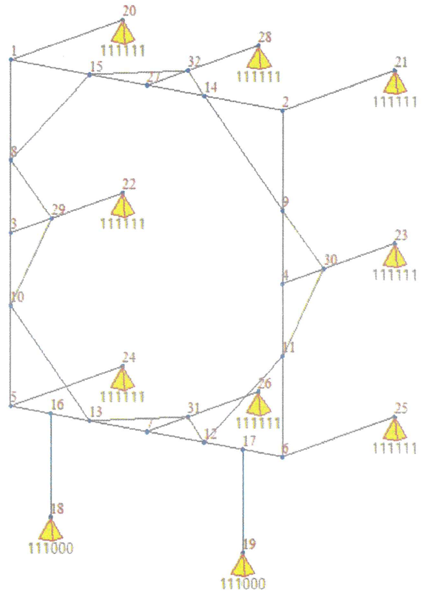
Modulus of Elasticity :	1.9995e+08	kN/m^2
Poisson's Ratio :	0.3	
Thermal Coefficient :	6.5000e-06	1/[F]
Weight Density :	77.09	kN/m^3
☐ Use Mass Density:	7.861	kN/m^3/g

13.1.2 Section property

ID	Name	Type	Shape
1	H 350x350x12/19	DB	I
2	H 300x300x10/15	DB	I
3	H 200x200x8/12	DB	I

13.1.3 Boundary Support

Node	Dx	Dy	Dz	Rx	Ry	Rz	Rw(
18	1	1	1	0	0	0	0
19	1	1	1	0	0	0	0
20	1	1	1	1	1	1	0
21	1	1	1	1	1	1	0
22	1	1	1	1	1	1	0
23	1	1	1	1	1	1	0
24	1	1	1	1	1	1	0
25	1	1	1	1	1	1	0
26	1	1	1	1	1	1	0
28	1	1	1	1	1	1	0



13.1.4 Static Load

No	Name	Type	Description
1	Load Self	Dead Load (D)	
2	Advance Trust Force	Live Load (L)	

13.1.5 Static Load Calculation

* ช่วงเจาะ concrete Pile Wall ใช้ Advance Trust Force 8000 kN.

ความยาว Beam ที่รองรับ Load = (1.5*4)+(1.462*4) = 11.848 m.

Beam Load = 8000/11.848 =675.2 kN/m.

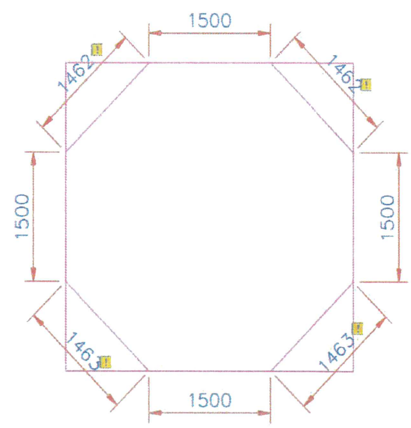
ใช้ Load Factor = 1.20

Beam Load = 675.2*1.20 =810.24 kN/m.

หรือ Advance Trust Force 9600 kN.

หลังจากเจาะทะลุ Pile Wall แล้ว ใช้ Face Pressure 1.33 bar.

หรือ Advance Trust Force ประมาณไม่เกิน 4000 kN.



13.1.6 Load Combination

1	LC1	Strengt	Add
2	LC2	Strengt	Add

▶	Load Self(ST)	1.0000
	Advance Trust Force(ST)	1.2000
*		

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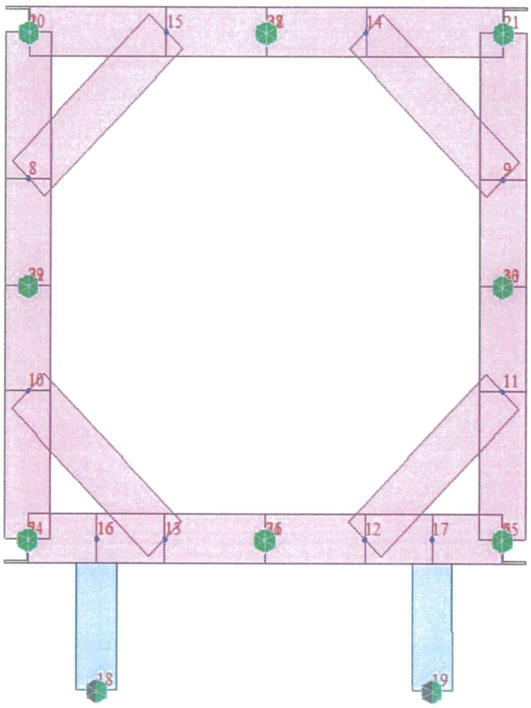
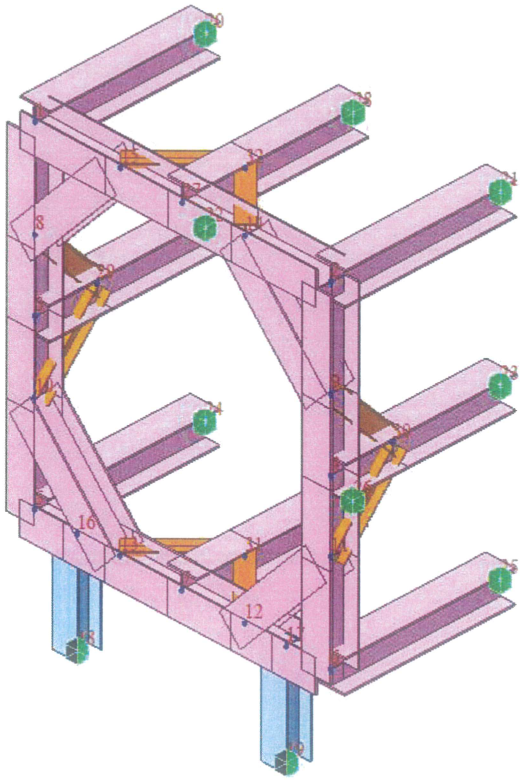
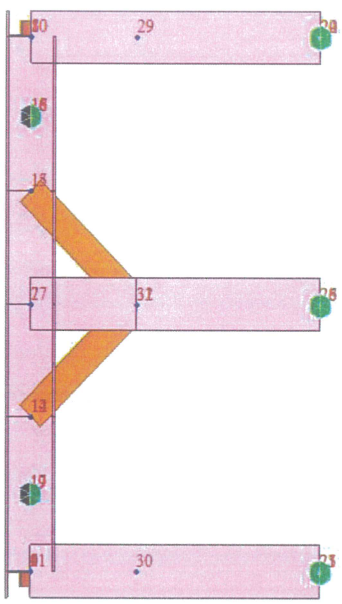
13.1.7 Geometry ของการป้อนข้อมูล



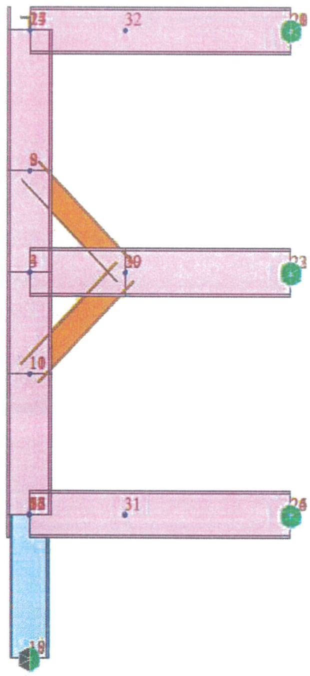
รูป Geometry ของรูปหน้า



รูป Geometry ของรูปสามมิติ



รูป Geometry ของรูปด้านบน



รูป Geometry ของรูปด้านข้าง

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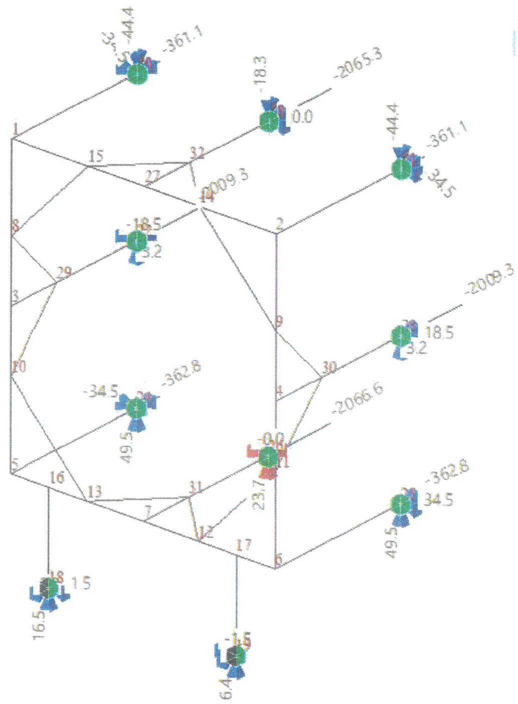
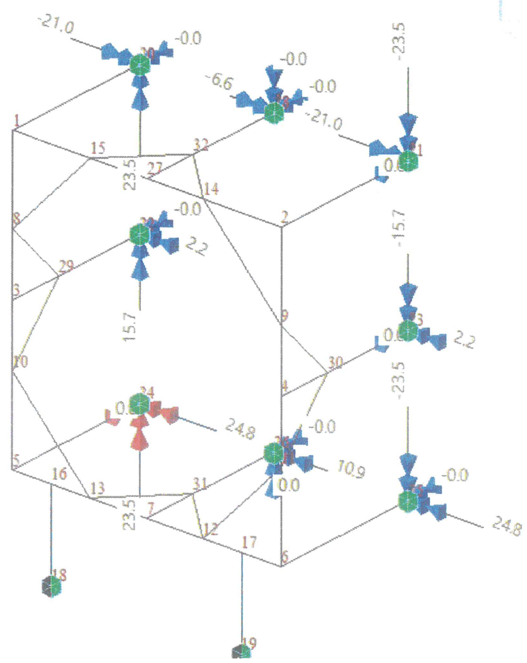
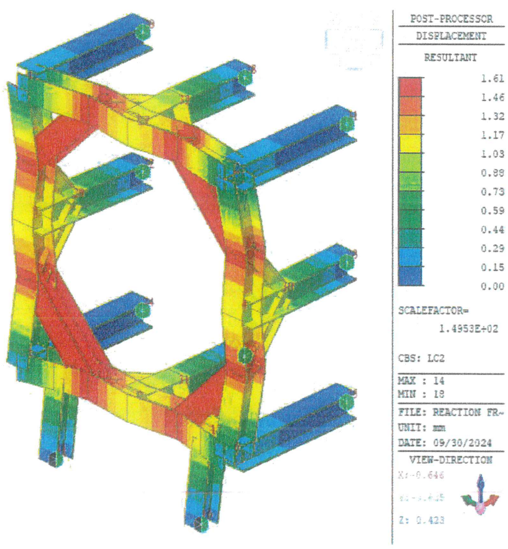
13.1.8 Reaction Force

Node	Load	FX (kN)	FY (kN)	FZ (kN)	MX (kN*m)	MY (kN*m)	MZ (kN*m)
18	LC2	0.2	1.5	16.5	0.0	0.0	0.0
19	LC2	0.2	-1.5	16.4	0.0	0.0	0.0
20	LC2	-361.1	-34.5	-44.4	0.0	-21.0	23.5
21	LC2	-361.1	34.5	-44.4	0.0	-21.0	-23.5
22	LC2	-2,009.3	-18.5	3.2	0.0	2.2	15.7
23	LC2	-2,009.3	18.5	3.2	0.0	2.2	-15.7
24	LC2	-362.8	-34.5	49.5	0.0	24.8	23.5
25	LC2	-362.8	34.5	49.5	0.0	24.8	-23.5
26	LC2	-2,066.6	0.0	23.7	0.0	10.9	0.0
28	LC2	-2,065.3	0.0	-18.3	0.0	-6.6	0.0
SUMMATION OF REACTION FORCES PRINTOUT							
	Load	FX (kN)	FY (kN)	FZ (kN)			
	LC2	-9,597.9	0.0	55.1			





13.1.9 Graphic Deflection



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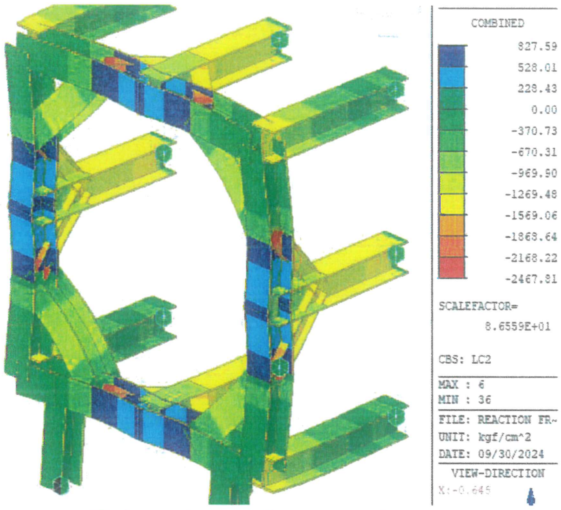
13.1.10 Graphic Stress



13.1.11 Check Result

CHK	MEMB / COM	SECT / SHR	SEL	Section		LCB	Len / Lb	Ly / Lz	Cb	Ky / Kz	B1y / B1z	B2y / B2z	Pr / Pc	Mry / Mcy	Mrz / Mcz	Vry / Vcy	Vrz / Vcz	Tr / Tc	Def / Defa
				Material	Fy														
OK	21	1	┌	H 350x350x12/19		2	146.302	146.302	1.000	1.000	1.000	1.000	-2535.3	-2.0E+6	19096.1	365.120	-61020	0.00000	-
	0.355	0.957		A36	2531.05		146.302	146.302		1.000	1.000	1.000	390464	5808763	2687977	181780	63782.5	0.00000	-
OK	36	3	┌	H 200x200x8/12		2	106.066	106.066	1.000	1.000	1.007	1.000	-61878	-250431	-158158	-1986.6	-4166.4	0.00000	-
	0.876	0.171		A36	2531.05		106.066	106.066		1.000	1.022	1.000	141357	1198200	555819	65604.8	24298.1	0.00000	-

13.1.12 Steel Member Applicable Code Checking Ba: AISC(14th) LRFD

* Code check member ที่ มีหน่วยแรงสูงสุดในแต่ละชนิดโครงสร้าง H350X350X19X12

```
*. MEMBER NO    =      21,  ELEMENT TYPE = Beam
*. LOADCOMB NO =        2,  MATERIAL NO  =     1,   SECTION NO =     1
*. UNIT SYSTEM : kgf, cm

*. SECTION PROPERTIES : Designation = H 350x350x12/19
   Shape       = I - Section. (Rolled)
   Depth       =     35.000,  Top F Width =     35.000,  Bot.F Width =     35.000
   Web Thick =        1.200,  Top F Thick =      1.900,  Bot.F Thick =      1.900

   Area = 1.73900e+02,  Asy  = 8.86666e+01,  Asz  = 4.20000e+01
   Ybar = 1.75000e+01,  Zbar = 1.75000e+01,  Qyb  = 1.03883e+03,  Qzb  = 1.53125e+02
   Syy  = 2.30000e+03,  Szz  = 7.76000e+02,  Zyy  = 2.55000e+03,  Zzz  = 1.18000e+03
   Iyy  = 4.03000e+04,  Izz  = 1.36000e+04,  Iyz  = 0.00000e+00
   ry   = 1.52000e+01,  rz   = 8.84000e+00
   J    = 1.78000e+02,  Cwp  = 3.72507e+06

*. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
   Ly   = 1.46302e+02,  Lz   = 1.46302e+02,  Lu   = 1.46302e+02
   Ky   = 1.00000e+00,  Kz   = 1.00000e+00

*. MATERIAL PROPERTIES :
   Fy   = 2.53105e+03,  Es   = 2.03890e+06,  MATERIAL NAME  = A36

===================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
===================================================================================

    ( ). Factored force/moments caused by unit load case.
         *.Load combination ID =   2
         ------------------------------------------------------------------------------
          Load Case              Pa          Myi          Myj          Mzi          Mzj
         ------------------------------------------------------------------------------
          DL                 -87.51      2091.60     -2070.05      8159.55    -16040.72
          LL               -2447.75    161091.67    252905.49     29916.55     10999.20
          DL+LL            -2535.26    163183.27    250835.44     38076.09     -5041.52
          OTHER CASES          0.00         0.00         0.00         0.00         0.00
         ------------------------------------------------------------------------------
          TOTAL            -2535.26    163183.27    250835.44     38076.09     -5041.52
         ------------------------------------------------------------------------------
         *.Member end moments caused by gravity load(DL+LL).
           My1G =     163183.27,    My2G =     250835.44
           Mz1G =       5041.52,    Mz2G =      38076.09

    ( ). Compute coefficient assuming no lateral translation of the frame (Cmy, Cmz)
         [ AISC(14th) Specification C2.1.1b. (C2-4) ]
         -. Cmy  =  1.000 (User defined or default value)
         -. Cmz  =  1.000 (User defined or default value)
```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```
( ). Compute moment magnification factors(B1y,B1z).
     -. Pu      =  Pu(DL+LL) + Pu(WL(EL))    =     2535.26 kgf.
     -. About major(Local-y) axis.
        SLENy  =  Ky*Ly/ry                   =        9.63
        Lambda =  (SLENy/pi)*SQRT(Fy/Es)     =      0.1079
        Pey    =  (Area*Fy)/Lambda^2         = 37773196.72 kgf.
        B1y    =  Cmy / (1-Pu/Pey)           =        1.00
     -. About minor(Local-z) axis.
        SLENz  =  Kz*Lz/rz                   =       16.55
        Lambda =  (SLENz/pi)*SQRT(Fy/Es)     =      0.1856
        Pez    =  (Area*Fy)/Lambda^2         = 12776182.14 kgf.
        B1z    =  Cmz / (1-Pu/Pez)           =        1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
     -. B2y   =  1.00 (Default value)
     -. B2z   =  1.00 (Default value)

( ). Given factored axial forces and moments at <1/2>.
     -----------------------------------------------------------------
      Load Case               Pa                   My                Mz
     -----------------------------------------------------------------
      DL                    -87.51              10.77          -1365.57
      LL                  -2447.75         -2002906.18         20457.87
      DL+LL               -2535.26         -2002895.41         19092.30
      OTHER CASES             0.00                0.00              0.00
     -----------------------------------------------------------------
      TOTAL               -2535.26         -2002895.41         19092.30
     -----------------------------------------------------------------

( ). Compute magnified moments.
     -. Muy   =  B1y*My(DL+LL) + B2y*My(OTHERS) = -2003029.85 kgf-cm.
     -. Muz   =  B1z*Mz(DL+LL) + B2z*Mz(OTHERS) =    19096.09 kgf-cm.

=========================================================================================
   [[[*]]]   CHECK AXIAL STRENGTH.
=========================================================================================

( ). Check slenderness ratio of axial compression member (KL/r).
     [ AISC(14th) Specification E2. ]
     -. KL/r  =     16.5   <    200.0   ---> O.K.

( ). Check width-thickness ratio of flange (BTR).
     [ AISC(14th) Specification B4. <Table B4.1a> ]
     -. Lambda_r  =  0.56*SQRT[Es/Fy]   =   15.89
     -. BTR  =  bf/2tf   =      9.21  <  Lambda_r  --->  NON-SLENDER SECTION !

( ). Check depth-thickness ratio of web (DTR).
     [ AISC(14th) Specification B4. <Table B4.1a> ]
     -. Lambda_r  =  1.49*SQRT[Es/Fy]   =   42.29
     -. Dweb =  H-tf1-tf2   =    27.20 cm.
     -. DTR  =  Dweb/tw     =    22.67  <  Lambda_r  --->  NON-SLENDER SECTION !

( ). Calculate Flexural Buckling Stress (Fcr1).
     [AISC(14th) Specification E3]
               pi^2 * E
     -. Fe   = -----------  =    73468.5574 kgf/cm^2.
                (KL/r)^2
     -. KL/r =   16.550 < 4.71 * SQRT[Es/Fy]  =  133.681
     -. Fcr1 = (0.658)^(Fy/Fe) * Fy =     2494.8169 kgf/cm^2.

( ). Calculate axial compressive strength (phiPn).
     [ AISC(14th) Specification E1. ]
     -. Fcr      =     2494.8169 kgf/cm^2.
     -. Resistance factor for compression   :  phi = 0.90
     -. phiPn  =  phi*Area*Fcr   =       390463.79 kgf.

( ). Check ratio of axial strength (Pu/phiPn).
          Pu                2535.26
     -. -------   =   ---------------   =  0.006  <  1.000  --->  O.K.
         phiPn            390463.79

=========================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
=========================================================================================

( ). Elastic section modulus refered to tension and compression flanges.
     -. Syc =       2302.8571 cm^3.
     -. Syt =       2302.8571 cm^3.

( ). Calculate limiting width-thickness ratio of flange for flexure.
     [ AISC(14th) Specification B4. <Table B4.1b> ]
     -. Lambda_p = 0.38*SQRT[Es/Fy]  =    10.79
     -. Lambda_r = 1.00*SQRT[Es/Fy]  =    28.38
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```
 ( ). Calculate limiting width-thickness ratio of web for flexure.
      [ AISC(14th) Specification B4. <Table B4.1b> ]
      -. Lambda_p = 3.76*SQRT[Es/Fy] =    106.72
      -. Lambda_r = 5.70*SQRT[Es/Fy] =    161.78

 ( ). Check width-thickness ratio of flange (BTR).
      [ AISC(14th) Specification B4. <Table B4.1b> ]
      -. BTR =      9.21 < Lambda_p =     10.79 ---> COMPACT.

 ( ). Check width-thickness ratio of web (DTR).
      [ AISC(14th) Specification B4. <Table B4.1b> ]
      -. DTR =     22.67 < Lambda_p =    106.72 ---> COMPACT.

( ). Calculate lateral-torsional buckling modification factor (Cb).
     [ AISC(14th) Specification F1.(2) (F1-1) ]
     -. Cb      =  1.000 (User defined or default value)

---------------------------------------------------------------------------
[*]   Check Yielding (Y).
---------------------------------------------------------------------------

( ). Calculate nominal flexural strength for Yielding (Y).
     [ AISC(14th) Specification F2.1 (F2-1) ]
     -. Mn.Y = Mp = Fy*Zyy =      6454180.75 kgf-cm.

---------------------------------------------------------------------------
[*]   Check Lateral-Torsional Buckling (LTB).
---------------------------------------------------------------------------

( ). Compute limiting laterally unbraced length for the limit state of yielding (Lp).
     [ AISC(14th) Specification F2.2 (F2-5) ]
     -. Lp = 1.76*rz*SQRT[Es/Fy] =    441.58 cm.

( ). Calculate nominal flexural strength for Lateral-torsional buckling (LTB).
     -. Lb < Lp ---> Lateral-torsional buckling is not applied.

---------------------------------------------------------------------------
[*]   Check Final Flexural Strength.
---------------------------------------------------------------------------

( ). Compute flexural strength about major axis (phiMny).
     -. Mny = Mn.Y =      6454180.75 kgf-cm.
     -. Resistance factor for flexure   :  phi = 0.90
     -. phiMny =  phi*Mny =      5808762.68 kgf-cm.

( ). Check ratio of flexural strength (Muy/phiMny).
          Muy               2003029.85
     -. --------   =   ---------------   =  0.345  <  1.000  --->  O.K.
         phiMny             5808762.68

=========================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
=========================================================================================

( ). Elastic section modulus refered to tension and compression flanges.
     -. Syc =       2302.8571 cm^3.
     -. Syt =       2302.8571 cm^3.

( ). Calculate limiting width-thickness ratio of flange for flexure.
     [ AISC(14th) Specification B4. <Table B4.1b> ]
     -. Lambda_p = 0.38*SQRT[Es/Fy] =    10.79
     -. Lambda_r = 1.00*SQRT[Es/Fy] =    28.38

( ). Check width-thickness ratio of flange (BTR).
     [ AISC(14th) Specification B4. <Table B4.1b> ]
     -. BTR =      9.21 < Lambda_p =     10.79 ---> COMPACT.

---------------------------------------------------------------------------
[*]   Check Yielding (Y).
---------------------------------------------------------------------------

( ). Calculate nominal flexural strength for Yielding (Y).
     [ AISC(14th) Specification F6.1 (F6-1) ]
     -. Mn.Y = Mp = MIN[ Fy*Zzz, 1.6*Fy*Szz ] =    2986640.50 kgf-cm.

---------------------------------------------------------------------------
[*]   Check Flange Local Buckling (FLB).
---------------------------------------------------------------------------

( ). Calculate nominal flexural strength for Flange local buckling (FLB).
     -. COMPACT flange ---> the limit state of flange local buckling is not applied.
```


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```
---------------------------------------------------------------------------
[*]   Check Final Flexural Strength.
---------------------------------------------------------------------------

( ). Compute flexural strength about minor axis (phiMnz).
     -. Mnz = Mn.Y =       2986640.50 kgf-cm.
     -. Resistance factor for flexure   :  phi = 0.90
     -. phiMnz =  phi*Mnz =     2687976.45 kgf-cm.

( ). Check ratio of flexural strength (Muz/phiMnz).
          Muz                19096.09
     -. --------  =  ---------------  =  0.007  <  1.000  ---> O.K.
         phiMnz            2687976.45

=========================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
=========================================================================================

( ). Check interaction ratio of combined strength.
     [ AISC(14th) Specification H1.1(b) ]
     -. Pr/Pc <  0.20  ---> Formula(H1-1b)
                      Pr      [  Mry      Mrz  ]
     -. ComRat  =  ------ + [ ----- + ----- ]
                     2*Pc     [  Mcy      Mcz  ]
                =  0.003 + [  0.345 +  0.007 ]
                =  0.355  <  1.000  --->  O.K.

=========================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
=========================================================================================

( ). Calculate the web plate buckling coefficient (kv).
     [ AISC(14th) Specification G2. ]
     -. for singly and doubly symmetric shapes loaded in the weak axis.
     -. kv =      1.20

( ). Calculate the web shear coefficient (Cv).
     [ AISC(14th) Specification G2.1 (G2-3) ]
     -. for webs of all other doubly/singly symmetric shapes and channels.
     -. h/tw =    9.211< 1.10*SQRT[kv*Es/Fy] =  34.200
     -. Cv =      1.00

( ). Calculate shear strength in local-y direction (phiVny).
     -. Aw =          133.00 cm^2.
     -. Vn = 0.6*Fy*Aw*Cv =  201977.8917 kgf.
     -. Resistance factor for shear   :  phi = 0.90
     -. phiVny  =  phi*Vn =    181780.10 kgf.

( ). Check ratio of shear strength (Vu/phiVn).
     ( LCB =     2, POS =     J )
     -. Applied shear force : Vuy =       365.12 kgf.
           Vuy                365.12
     -. --------  =  ---------------  =  0.002  <  1.000  --->  O.K.
         phiVny           181780.10

( ). Calculate the web plate buckling coefficient (kv).
     [ AISC(14th) Specification G2.1(ii) ]
     -. for stiffened webs.
     -. kv =      5.00

( ). Calculate the web shear coefficient (Cv).
     [ AISC(14th) Specification G2.1 (G2-2) ]
     -. for Rolled H-Shape Members.
     -. h/tw =  22.667 < 2.24*SQRT[Es/Fy]  =  63.576
     -. Cv =      1.00

( ). Calculate shear strength in local-z direction (phiVnz).
     -. Aw =            42.00 cm^2.
     -. Vn = 0.6*Fy*Aw*Cv =   63782.4921 kgf.

     -. for webs of rolled H-shape members with h/tw < 2.24*SQRT[Es/Fy].
     -. Resistance factor for shear   :  phi = 1.00
     -. phiVnz  =  phi*Vn =     63782.49 kgf.

( ). Check ratio of shear strength (Vu/phiVn).
     ( LCB =     2, POS =     J )
     -. Applied shear force : Vuz =     61019.57 kgf.
           Vuz               61019.57
     -. --------  =  ---------------  =  0.957  <  1.000  --->  O.K.
         phiVnz               63782.49
```


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* Code check member ที่ มีหน่วยแรงสูงสุดในแต่ละชนิดโครงสร้าง H200X200X12X8

```
*. MEMBER NO    =      36,  ELEMENT TYPE = Beam
*. LOADCOMB NO =       2,  MATERIAL NO  =     1,  SECTION NO =     3
*. UNIT SYSTEM : kgf, cm

*. SECTION PROPERTIES : Designation = H 200x200x8/12
   Shape      = I - Section. (Rolled)
   Depth      =    20.000,  Top F Width =     20.000,  Bot.F Width =     20.000
   Web Thick =      0.800,  Top F Thick =      1.200,  Bot.F Thick =      1.200

   Area = 6.35300e+01,  Asy  = 3.20000e+01,  Asz  = 1.60000e+01
   Ybar = 1.00000e+01,  Zbar = 1.00000e+01,  Qyb  = 3.20720e+02,  Qzb  = 5.00000e+01
   Syy  = 4.72000e+02,  Szz  = 1.60000e+02,  Zyy  = 5.26000e+02,  Zzz  = 2.44000e+02
   Iyy  = 4.72000e+03,  Izz  = 1.60000e+03,  Iyz  = 0.00000e+00
   ry   = 8.62000e+00,  rz   = 5.02000e+00
   J    = 2.60000e+01,  Cwp  = 1.41376e+05

*. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
   Ly   = 1.06066e+02,  Lz   = 1.06066e+02,  Lu   = 1.06066e+02
   Ky   = 1.00000e+00,  Kz   = 1.00000e+00

*. MATERIAL PROPERTIES :
   Fy   = 2.53105e+03,  Es   = 2.03890e+06,  MATERIAL NAME  = A36
```

```
================================================================================
 [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID = 2

Load Case	Pa	Myi	Myj	Mzi	Mzj
DL	-238.92	114.09	1194.74	-2516.22	367.32
LL	-61638.72	-248709.77	190132.53	-152224.56	55603.67
DL+LL	-61877.64	-248595.68	191327.27	-154740.78	55971.00
OTHER CASES	0.00	0.00	0.00	0.00	0.00
TOTAL	-61877.64	-248595.68	191327.27	-154740.78	55971.00

```
*.Member end moments caused by gravity load(DL+LL).
  My1G =     191327.27,   My2G =     248595.68
  Mz1G =      55971.00,   Mz2G =     154740.78

( ). Compute coefficient assuming no lateral translation of the frame (Cmy, Cmz)
     [ AISC(14th) Specification C2.1.1b. (C2-4) ]
     -. Cmy  =  1.000 (User defined or default value)
     -. Cmz  =  1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
     -. Pu      =  Pu(DL+LL) + Pu(WL(EL))     =    61877.64 kgf.
     -. About major(Local-y) axis.
        SLENy  =  Ky*Ly/ry                    =       12.30
        Lambda =  (SLENy/pi)*SQRT(Fy/Es)      =      0.1380
        Pey    =  (Area*Fy)/Lambda^2          =  8443782.74 kgf.
        B1y    =  Cmy / (1-Pu/Pey)            =        1.01
     -. About minor(Local-z) axis.
        SLENz  =  Kz*Lz/rz                    =       21.13
        Lambda =  (SLENz/pi)*SQRT(Fy/Es)      =      0.2370
        Pez    =  (Area*Fy)/Lambda^2          =  2863716.05 kgf.
        B1z    =  Cmz / (1-Pu/Pez)            =        1.02

( ). Magnification factors for sidesway moments(B2y,B2z).
     -. B2y   =  1.00 (Default value)
     -. B2z   =  1.00 (Default value)

( ). Given factored axial forces and moments at &lt;I&gt;.
```

Load Case	Pa	My	Mz
DL	-238.92	114.09	-2516.22
LL	-61638.72	-248709.77	-152224.56
DL+LL	-61877.64	-248595.68	-154740.78
OTHER CASES	0.00	0.00	0.00
TOTAL	-61877.64	-248595.68	-154740.78

```
( ). Compute magnified moments.
     -. Muy   =  B1y*My(DL+LL) + B2y*My(OTHERS) =  -250430.88 kgf-cm.
     -. Muz   =  B1z*Mz(DL+LL) + B2z*Mz(OTHERS) =  -158158.18 kgf-cm.
```


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```
==================================================================================
  [[[*]]]   CHECK AXIAL STRENGTH.
==================================================================================

      ( ). Check slenderness ratio of axial compression member (KL/r).
           [ AISC(14th) Specification E2. ]
           -. KL/r  =     21.1  <    200.0  --->  O.K.

      ( ). Check width-thickness ratio of flange (BTR).
           [ AISC(14th) Specification B4. <Table B4.1a> ]
           -. Lambda_r  =  0.56*SQRT[Es/Fy]  =   15.89
           -. BTR  =  bf/2tf  =     8.33  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check depth-thickness ratio of web (DTR).
           [ AISC(14th) Specification B4. <Table B4.1a> ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   42.29
           -. Dweb =  H-tf1-tf2  =    15.00 cm.
           -. DTR  =  Dweb/tw    =    18.75  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate Flexural Buckling Stress (Fcr1).
           [AISC(14th) Specification E3]
                     pi^2 * E
           -. Fe  = -----------  =   45076.5945 kgf/cm^2.
                     (KL/r)^2
           -. KL/r =    21.129 < 4.71 * SQRT[Es/Fy] =  133.681
           -. Fcr1 = (0.658)^(Fy/Fe) * Fy =     2472.2610 kgf/cm^2.

      ( ). Calculate axial compressive strength (phiPn).
           [ AISC(14th) Specification E1. ]
           -. Fcr     =     2472.2610 kgf/cm^2.
           -. Resistance factor for compression   :  phi = 0.90
           -. phiPn   =  phi*Area*Fcr   =      141356.47 kgf.

      ( ). Check ratio of axial strength (Pu/phiPn).
                  Pu              61877.64
           -. -------  =  ---------------  =  0.438  <  1.000  --->  O.K.
                phiPn            141356.47

==================================================================================
  [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
==================================================================================

      ( ). Elastic section modulus refered to tension and compression flanges.
           -. Syc =       472.0000 cm^3.
           -. Syt =       472.0000 cm^3.

      ( ). Calculate limiting width-thickness ratio of flange for flexure.
           [ AISC(14th) Specification B4. <Table B4.1b> ]
           -. Lambda_p = 0.38*SQRT[Es/Fy] =    10.79
           -. Lambda_r = 1.00*SQRT[Es/Fy] =    28.38

      ( ). Calculate limiting width-thickness ratio of web for flexure.
           [ AISC(14th) Specification B4. <Table B4.1b> ]
           -. Lambda_p = 3.76*SQRT[Es/Fy] =    106.72
           -. Lambda_r = 5.70*SQRT[Es/Fy] =    161.78

      ( ). Check width-thickness ratio of flange (BTR).
           [ AISC(14th) Specification B4. <Table B4.1b> ]
           -. BTR =      8.33 < Lambda_p =     10.79 ---> COMPACT.

      ( ). Check width-thickness ratio of web (DTR).
           [ AISC(14th) Specification B4. <Table B4.1b> ]
           -. DTR =     18.75 < Lambda_p =     106.72 ---> COMPACT.
      ( ). Calculate lateral-torsional buckling modification factor (Cb).
           [ AISC(14th) Specification F1.(2) (F1-1) ]
           -. Cb      =  1.000 (User defined or default value)

      --------------------------------------------------------------------------
      [*]   Check Yielding (Y).
      --------------------------------------------------------------------------

      ( ). Calculate nominal flexural strength for Yielding (Y).
           [ AISC(14th) Specification F2.1 (F2-1) ]
           -. Mn.Y = Mp = Fy*Zyy =      1331332.97 kgf-cm.

      --------------------------------------------------------------------------
      [*]   Check Lateral-Torsional Buckling (LTB).
      --------------------------------------------------------------------------

      ( ). Compute limiting laterally unbraced length for the limit state of yielding (Lp).
           [ AISC(14th) Specification F2.2 (F2-5) ]
           -. Lp = 1.76*rz*SQRT[Es/Fy] =    250.76 cm.

      ( ). Calculate nominal flexural strength for Lateral-torsional buckling (LTB).
           -. Lb < Lp ---> Lateral-torsional buckling is not applied.
```


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```
    ---------------------------------------------------------------------------
    [*]   Check Final Flexural Strength.
    ---------------------------------------------------------------------------

    ( ). Compute flexural strength about major axis (phiMny).
         -. Mny = Mn.Y =      1331332.97 kgf-cm.
         -. Resistance factor for flexure  :  phi = 0.90
         -. phiMny =  phi*Mny =     1198199.67 kgf-cm.

    ( ). Check ratio of flexural strength (Muy/phiMny).
              Muy               250430.88
         -. --------  =  ---------------  =  0.209  <  1.000  ---> O.K.
             phiMny           1198199.67

=======================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
=======================================================================================

    ( ). Elastic section modulus refered to tension and compression flanges.
         -. Syc =        472.0000 cm^3.
         -. Syt =        472.0000 cm^3.

    ( ). Calculate limiting width-thickness ratio of flange for flexure.
         [ AISC(14th) Specification B4. <Table B4.1b> ]
         -. Lambda_p = 0.38*SQRT[Es/Fy] =   10.79
         -. Lambda_r = 1.00*SQRT[Es/Fy] =   28.38

    ( ). Check width-thickness ratio of flange (BTR).
         [ AISC(14th) Specification B4. <Table B4.1b> ]
         -. BTR =      8.33 < Lambda_p =    10.79 ---> COMPACT.

    ---------------------------------------------------------------------------
    [*]   Check Yielding (Y).
    ---------------------------------------------------------------------------

    ( ). Calculate nominal flexural strength for Yielding (Y).
         [ AISC(14th) Specification F6.1 (F6-1) ]
         -. Mn.Y = Mp = MIN[ Fy*Zzz, 1.6*Fy*Szz ] =     617576.51 kgf-cm.

    ---------------------------------------------------------------------------
    [*]   Check Flange Local Buckling (FLB).
    ---------------------------------------------------------------------------

    ( ). Calculate nominal flexural strength for Flange local buckling (FLB).
         -. COMPACT flange ---> the limit state of flange local buckling is not applied.

    ---------------------------------------------------------------------------
    [*]   Check Final Flexural Strength.
    ---------------------------------------------------------------------------

    ( ). Compute flexural strength about minor axis (phiMnz).
         -. Mnz = Mn.Y =      617576.51 kgf-cm.
         -. Resistance factor for flexure  :  phi = 0.90
         -. phiMnz =  phi*Mnz =      555818.86 kgf-cm.

    ( ). Check ratio of flexural strength (Muz/phiMnz).
              Muz               158158.18
         -. --------  =  ---------------  =  0.285  <  1.000  ---> O.K.
             phiMnz            555818.86

=======================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
=======================================================================================

    ( ). Check interaction ratio of combined strength.
         [ AISC(14th) Specification H1.1(a) ]
         -. Pr/Pc >  0.20  ---> Formula(H1-1a)
                           Pr      8  [  Mry      Mrz  ]
         -. ComRat  =   ---- + --- [ ----- + ----- ]
                           Pc      9  [  Mcy      Mcz  ]
                    =   0.438 + (8/9)*[  0.209 +  0.285 ]
                    =   0.876  <  1.000  ---> O.K.

=======================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
=======================================================================================


    ( ). Calculate the web plate buckling coefficient (kv).
         [ AISC(14th) Specification G2. ]
         -. for singly and doubly symmetric shapes loaded in the weak axis.
         -. kv =      1.20
```


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```
( ). Calculate the web shear coefficient (Cv).
     [ AISC(14th) Specification G2.1 (G2-3) ]
     -. for webs of all other doubly/singly symmetric shapes and channels.
     -. h/tw =   8.333< 1.10*SQRT[kv*Es/Fy] =  34.200
     -. Cv =     1.00

( ). Calculate shear strength in local-y direction (phiVny).
     -. Aw =          48.00 cm^2.
     -. Vn = 0.6*Fy*Aw*Cv =   72894.2767 kgf.
     -. Resistance factor for shear  :  phi = 0.90
     -. phiVny  =  phi*Vn =    65604.85 kgf.

( ). Check ratio of shear strength (Vu/phiVn).
     ( LCB =    2, POS =    J )
     -. Applied shear force : Vuy =     1986.61 kgf.
           Vuy             1986.61
     -. --------  =  ---------------  =  0.030  <  1.000  ---> O.K.
         phiVny          65604.85

( ). Calculate the web plate buckling coefficient (kv).
     [ AISC(14th) Specification G2.1(ii) ]
     -. for stiffened webs.
     -. kv =     5.00

( ). Calculate the web shear coefficient (Cv).
     [ AISC(14th) Specification G2.1 (G2-2) ]
     -. for Rolled H-Shape Members.
     -. h/tw =  18.750 < 2.24*SQRT[Es/Fy] =  63.576
     -. Cv =     1.00

( ). Calculate shear strength in local-z direction (phiVnz).
     -. Aw =          16.00 cm^2.
     -. Vn = 0.6*Fy*Aw*Cv =   24298.0922 kgf.

     -. for webs of rolled H-shape members with h/tw < 2.24*SQRT[Es/Fy].
     -. Resistance factor for shear  :  phi = 1.00
     -. phiVnz  =  phi*Vn =    24298.09 kgf.

( ). Check ratio of shear strength (Vu/phiVn).
     ( LCB =    2, POS =    I )
     -. Applied shear force : Vuz =     4166.36 kgf.
           Vuz             4166.36
     -. --------  =  ---------------  =  0.171  <  1.000  ---> O.K.
         phiVnz          24298.09
```


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13.2 รายการคำนวณ Base Plate Beam Reaction Frame Wall Support H-Beam 350X350X19X12 mm.

Material

Steel A36

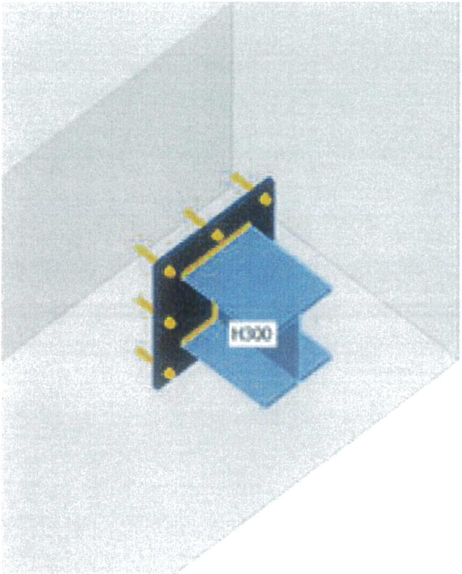
Concrete 5000 psi หรือ 35 Mpa.

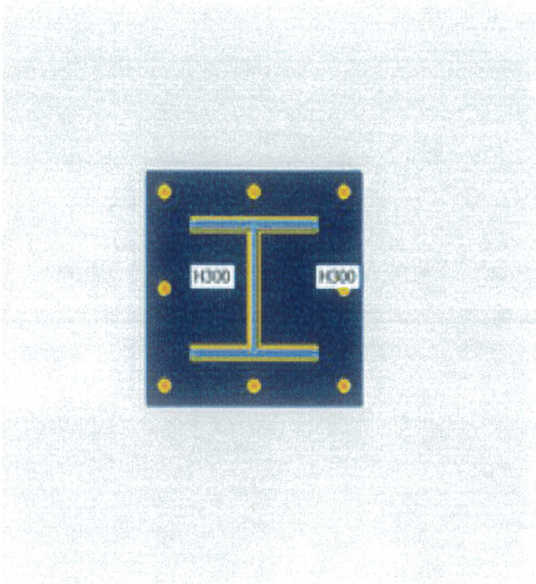
Design

Name Base Plat Beam H350X350X19X12

Analysis Joint Desing Resistance

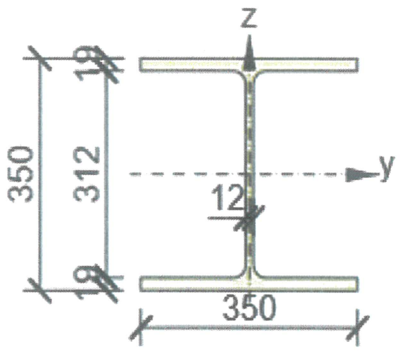
Design code AISC - ASD 2016





Cross-sections H350X350X19X12 Material A36

Drawing



Anchors

Name	Bolt assembly	Diameter [mm]	Yield [MPa]	Gross area [mm2]
Bolt M16	Expansion Bolt M16	16	640	201

Loads

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
26	H350	-2009.0	18.5	-3.2	0.0	2.2	15.7

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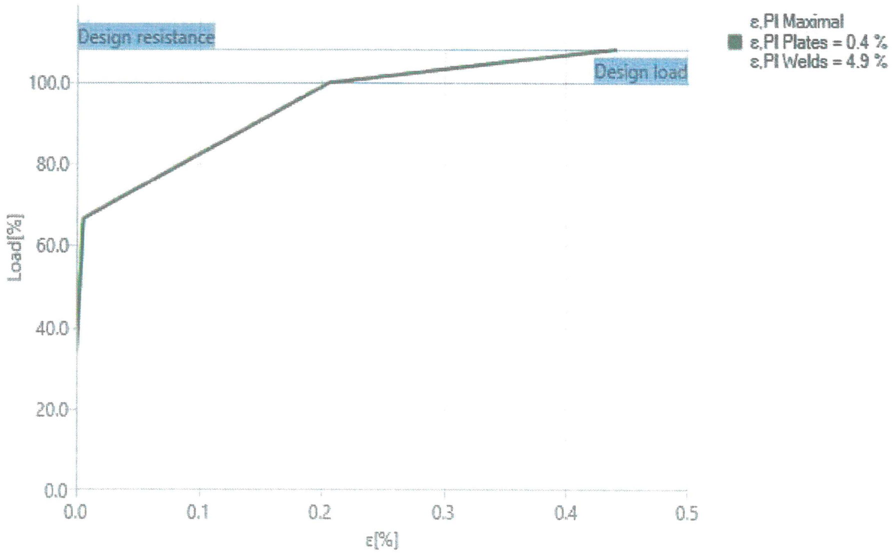
Foundation block

Item	Value	Unit
CB 1		
Dimensions	1800 x 1800	mm
Depth	1200	mm
Anchor	16 A325M	
Anchoring length	130	mm
Shear force transfer	Anchors	

Joint design resistance



Joint design resistance, 26

Summary

Name	Value	Check status
Plates	0.2 < 5.0%	OK
Anchors	Not calculated	
Welds	92.2 < 100%	OK
Concrete block	32.4 < 100%	OK

Plates

Name	f_y [MPa]	Thickness [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	σc_{Ed} [MPa]	Check status
H350-bfl 1	248.2	19.0	26	148.9	0.2	0.0	OK
H350-tfl 1	248.2	19.0	26	147.4	0.2	0.0	OK
H350-w 1	248.2	12.0	26	148.8	0.1	0.0	OK
SP1	248.2	20.0	26	148.7	0.1	0.0	OK

Design data

Material	f_y [MPa]	ε_{lim} [%]
A36	248.2	5.0

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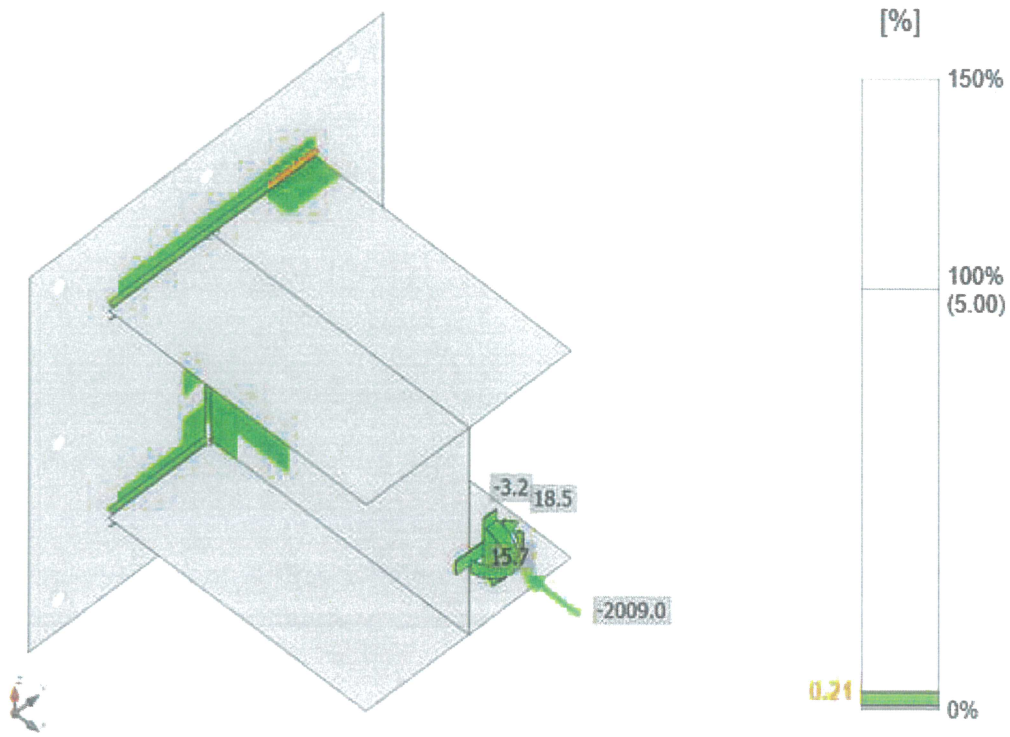
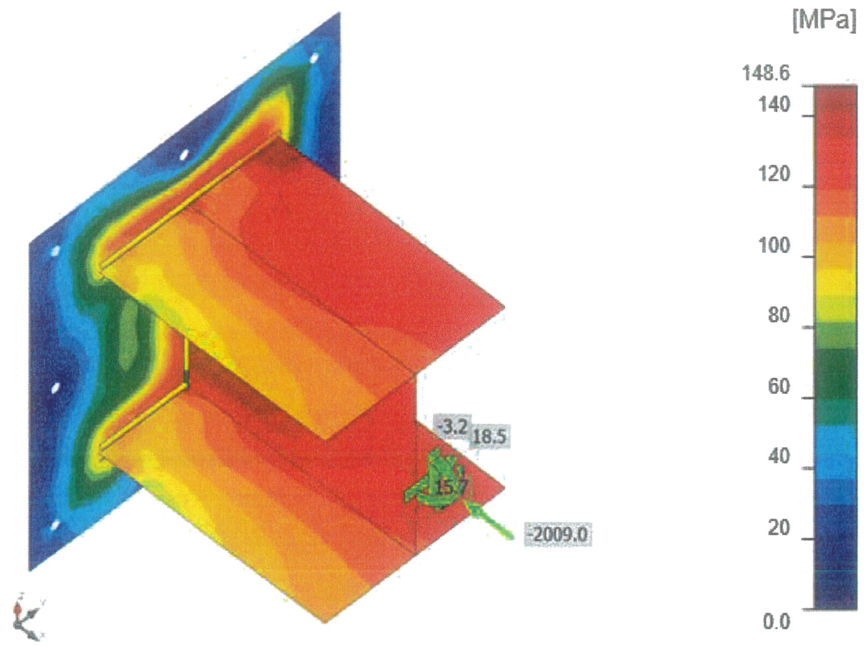


Strain check, 26



Equivalent stress, 26

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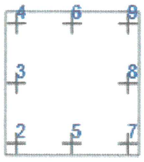
Anchors

Shape	Item	Loads	N_f [kN]	V [kN]	Status
	A2	26	5.0	2.0	OK
	A3	26	0.0	2.3	OK
	A4	26	6.2	2.6	OK
	A5	26	9.1	2.2	OK
	A6	26	10.8	2.6	OK
	A7	26	5.1	2.0	OK
	A8	26	0.0	2.4	OK
	A9	26	6.3	2.7	OK

Spacing (C20/25Concrete)

Spacing mm	Tensile Resistance per Pair of Anchors M6	M8	M10	M12	M16	M20	M24
50	6.2						
60	6.7	7.2					
65	6.9	7.5	10.4				
70	7.2	7.7	10.7				
75		8.0	11.0	15.4			
85			11.6	16.1			
100			12.5	17.1	21.2		
105			12.8	17.5	21.6		
115				18.2	22.4		
130				19.3	23.6	29.0	
140				20.0	24.4	29.9	
150					25.2	30.8	37.1
165					26.4	32.1	38.5
175						33.0	39.4

Reduced Design Resistance (kN) • Divide Loads by 1.4 for Recommended Loads

Influence of Concrete Strength

Concrete Strength		C20/25	C25/30	C30/37	C40/50	C45/55	C50/60
Cylinder	N/mm²	20	25	30	40	45	50
Cube	N/mm²	25	30	37	50	55	60
Factor		1.0	1.1	1.22	1.41	1.48	1.55

When using concrete factors check all other information to ensure Steel Tensile and Shear Resistance is not exceeded

Use Workign Tensile / ตัว = (23.60/1.40) *1.48 = 24.95 kN

Use Workign Shear / ตัว = 18.6 kN

Weld sections

Item	Edge	Xu	T_h [mm]	L_s [mm]	L [mm]	L_c [mm]	Loads	F_n [kN]	R_n/Ω [kN]	Ut [%]	Status
SP1	H350-bfl 1	E60xx	◢7.1◣	◢10.0◣	350	39	26	46.3	50.2	92.2	OK
		E60xx	◢7.1◣	◢10.0◣	349	39	26	46.5	51.0	91.2	OK
SP1	H350-tfl 1	E60xx	◢7.1◣	◢10.0◣	350	39	26	46.2	50.3	91.9	OK
		E60xx	◢7.1◣	◢10.0◣	350	39	26	46.1	50.2	91.7	OK
SP1	H350-w 1	E60xx	◢7.1◣	◢10.0◣	330	37	26	37.7	48.3	78.0	OK
		E60xx	◢7.1◣	◢10.0◣	330	37	26	37.5	48.3	77.6	OK

Detailed result for SP1 / H350-bfl 1 - 1

Weld resistance check (AISC 360-16: J2-4)

$\frac{R_n}{\Omega} = \frac{F_{nw} \cdot A_{we}}{\Omega} = 50.2$ kN $\geq F_n = 46.3$ kN

Where:

$F_{nw} = 365.5$ MPa – nominal stress of weld material:

- $F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot sin^{1.5}\theta)$, where:
  - $F_{EXX} = 413.7$ MPa – electrode classification number, i.e. minimum specified tensile strength
  - $\theta = 74.4°$ – angle of loading measured from the weld longitudinal axis

$A_{we} = 275$ mm^2 – effective area of weld critical element

$\Omega = 2.0$ – safety factor for fillet welds

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Concrete block

Item	Loads	A_1 [mm2]	A_2 [mm2]	σ [MPa]	Ut [%]	Status
CB 1	26	250797	2705303	8.2	32.4	OK

Detailed result for CB 1

Concrete block compressive resistance check (AISC 360-16 Section J8)

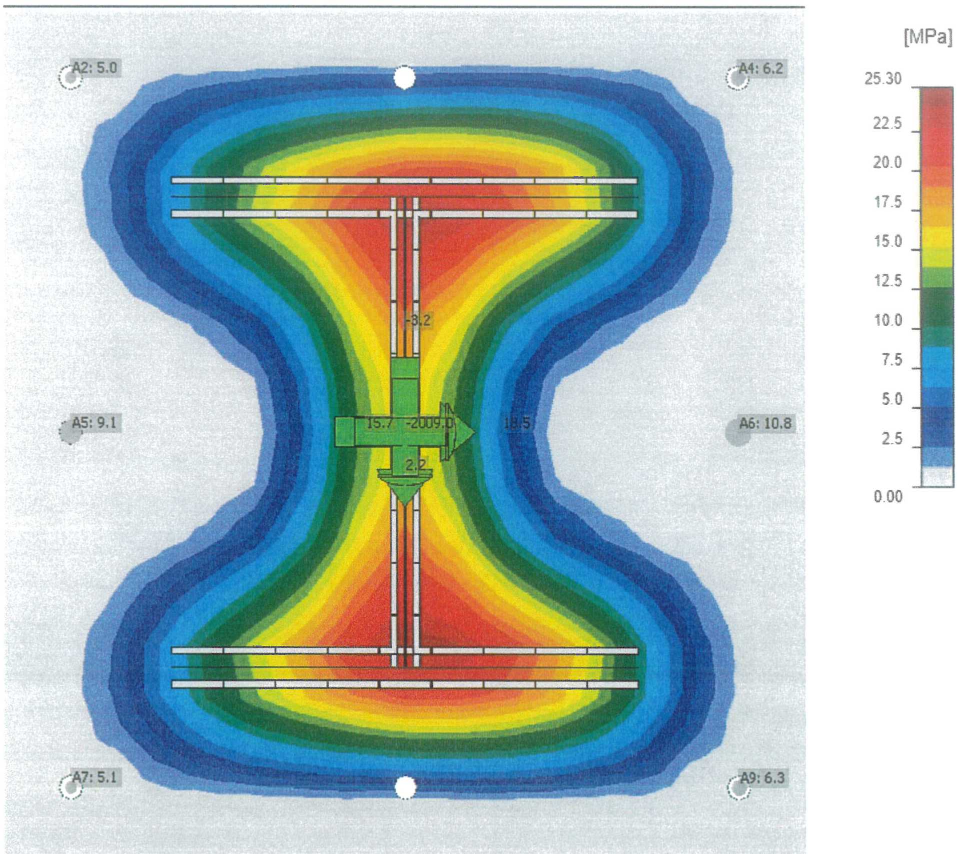
$\frac{f_{p.max}}{\Omega_c} =$ 25.4 MPa ≥ $\sigma =$ 8.2 MPa

Where:

$f_{p.max} = 58.6$ MPa – concrete block design bearing strength:

- $f_{p.max} = 0.85 \cdot f'_c \cdot \sqrt{\frac{A_2}{A_1}} \le 1.7 \cdot f'_c$, where:
  - $f'_c =$ 34.5 MPa – concrete compressive strength
  - $A_1 =$ 250797 mm^2 – base plate area in contact with concrete surface
  - $A_2 =$ 2705303 mm^2 – concrete supporting surface

$\Omega_c = 2.31$ – resistance factor for concrete



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รายการคำนวณ platform สำหรับงาน Luanch TBM5 บ่อก่อสร้าง 9C-3 เท่านั้น

สุวิทย์ กมลวานนท์

ส.ย.13272