1. Design conditions

1) General

(1) Project name : Project1

(2) Application standard : KCI

(3) System of unit : KN.m

(4) Strength reduction factor(Î¦)

Strut : 0.75

Tie : 0.85

Node : 0.75

2) Use material

(1) Concrete

- Mass : 2.35
- Weight : 23.5
- Temperature : 0
- Poisson's ratio : 0.15
- Coefficient of thermal expansion : 0.00001

(2) Reinforced concrete

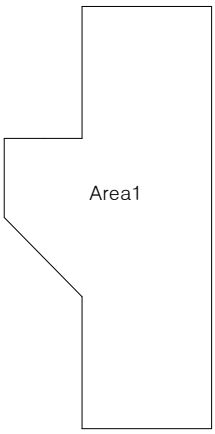
- Mass : 2.5
- Weight : 25
- Temperature : 0
- Poisson's ratio : 0.15
- Coefficient of thermal expansion : 0.00001

(3) Reinforcement

- Mass : 7.85
- Weight : 78.5
- Temperature : 0
- Poisson's ratio : 0.15
- Coefficient of thermal expansion : 0.00001

3) Dimension of structure

(1) Form



(2) Dimension of cross section

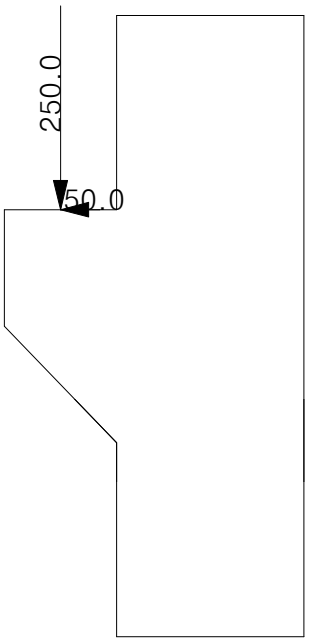
1) Area1

(A) Thickness	:	1	m
(B) Effectiveness factor	:	0.6	
(C) Concrete Compressive Strength, fck	:	24	Mpa
(D) Concrete Tensile Strength, fct	:	2.4	Mpa
(E) Concrete Effective Stiffness	:	14.4	Mpa
(F) Concrete Elastic Factor, Ec	:	27849	Mpa
(G) Steel Yield Strangth, fy	:	300	Mpa
(H) Steel Elastic Factor, Es	:	200000	Mpa

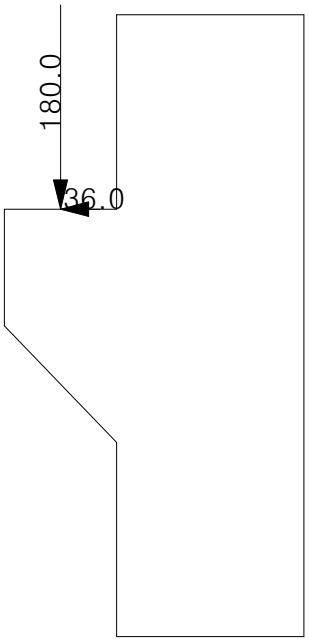
4) Load

(1) Load appliled to Structure

- D ; Dead load



- L ; Live load



(2) Load combination

1) LC01 : 1.30D + 2.15L

5) Reference

(1)Designer : Designer1

(2)Date : 2016-04-21

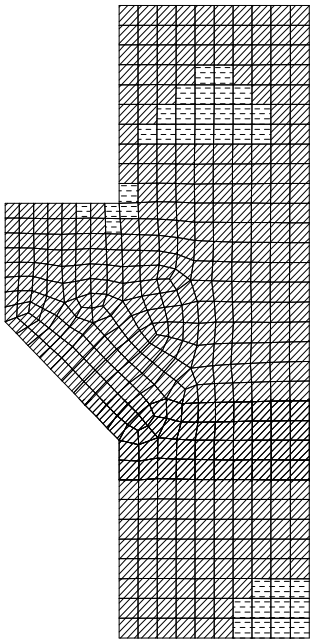
(3)Note :

2. Load Combination-1

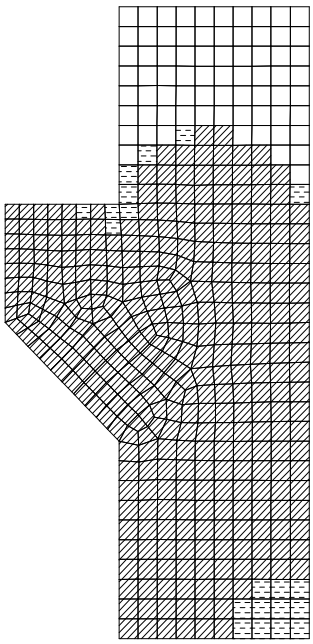
Factor : LC01 : 1.30D + 2.15L

1) ESO

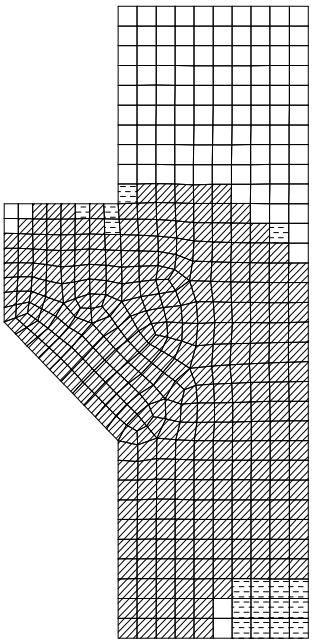
(1) STAGE-01 (Erasure rate 0%)



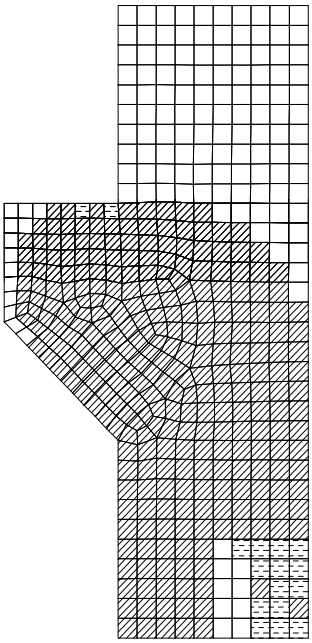
(2) STAGE-02 (Erasure rate 16%)



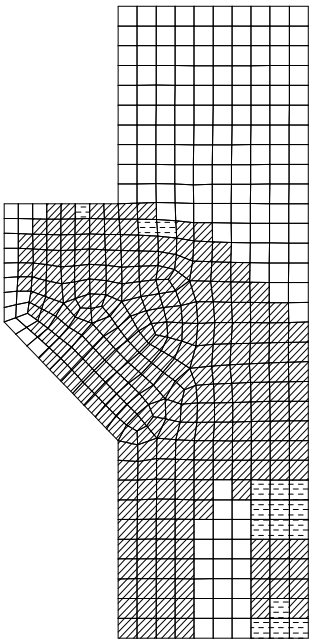
(3) STAGE-03 (Erasure rate 24%)



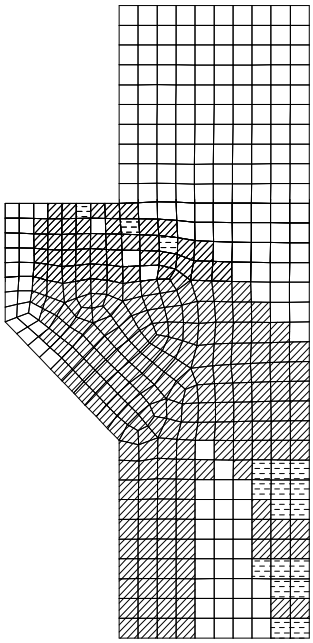
(4) STAGE-04 (Erasure rate 30%)



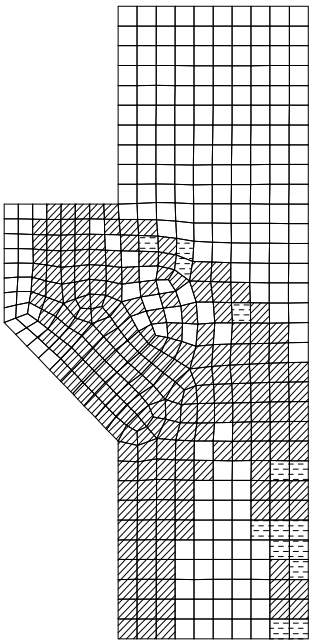
(5) STAGE-05 (Erasure rate 37%)



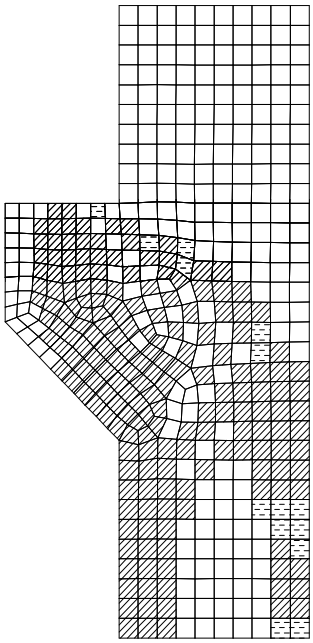
(6) STAGE-06 (Erasure rate 43%)



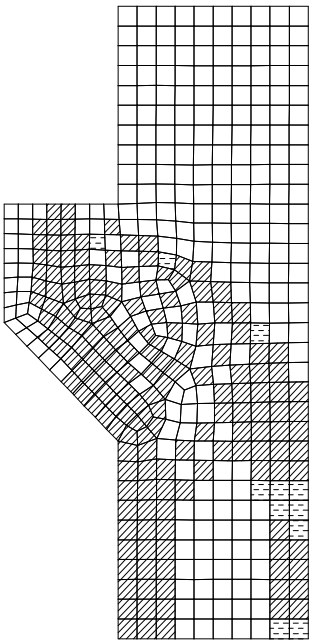
(7) STAGE-07 (Erasure rate 48%)



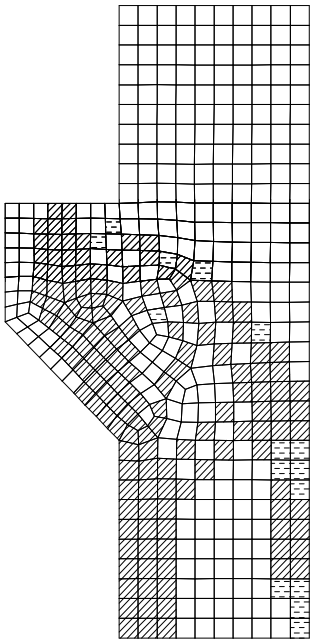
(8) STAGE-08 (Erasure rate 53%)



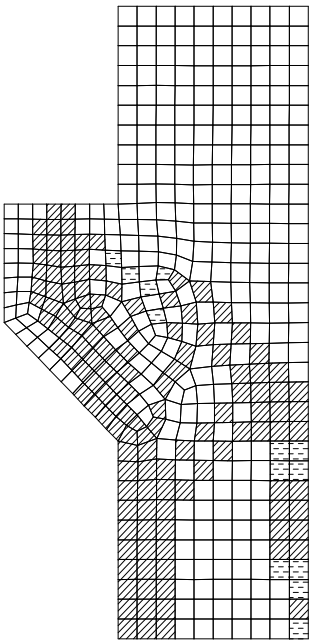
(9) STAGE-09 (Erasure rate 57%)



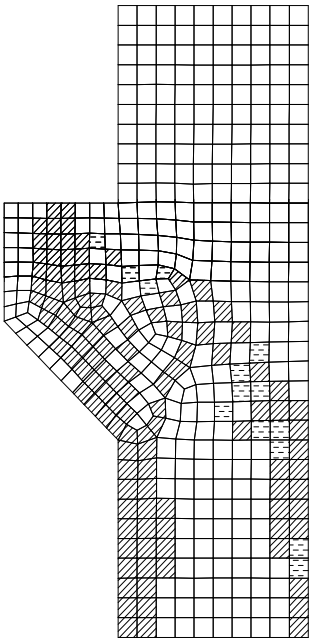
(10) STAGE-10 (Erasure rate 61%)



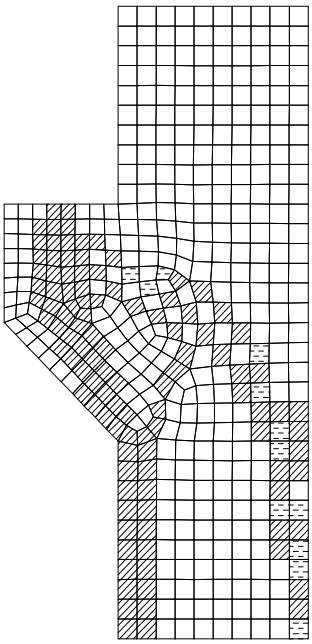
(11) STAGE-11 (Erasure rate 65%)



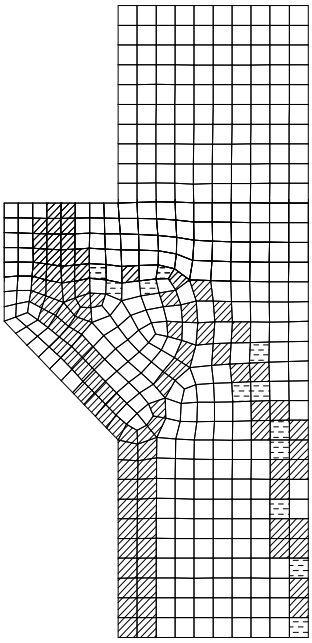
(12) STAGE-12 (Erasure rate 69%)



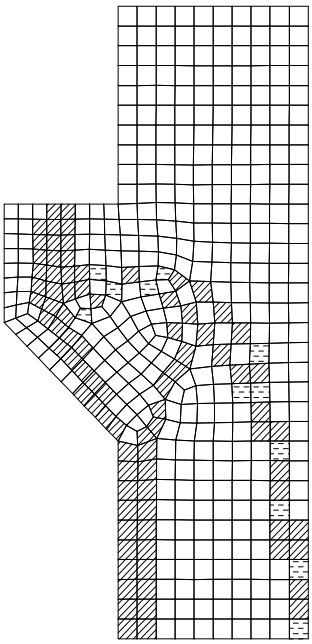
(13) STAGE-13 (Erasure rate 72%)



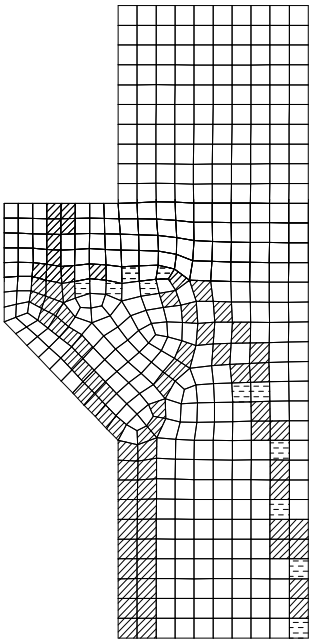
(14) STAGE-14 (Erasure rate 75%)



(15) STAGE-15 (Erasure rate 77%)

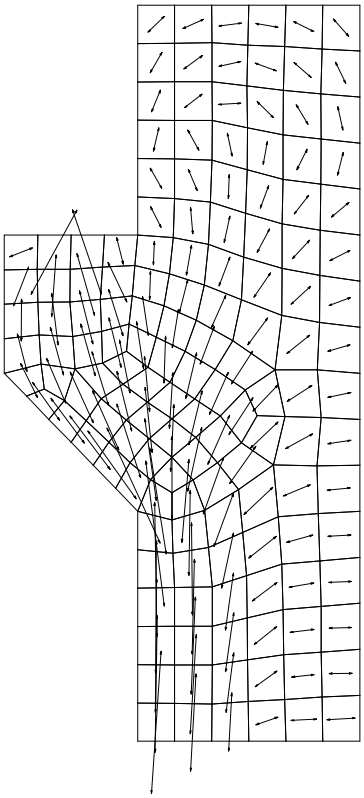


(16) STAGE-16 (Erasure rate 79%)



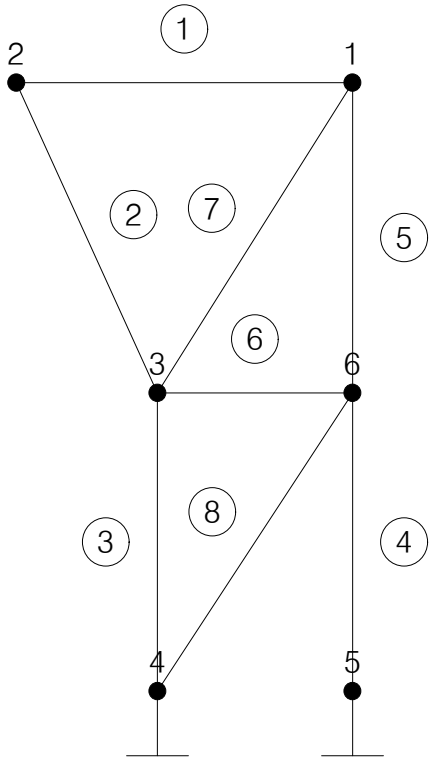
2) StressFlow

1) Principal stress flow chart



3) Truss

(1) Modeling



(1) Nodal coordinates

Item	X	Z	Node	Item	X	Z	Node
1	-0.080	1.02	1.000	2	-0.666	1.02	2.000
3	-0.420	0.5	3.000	4	-0.420	0	4.000
5	-0.080	0	5.000	6	-0.080	0.5	6.000

(2) Member specifications

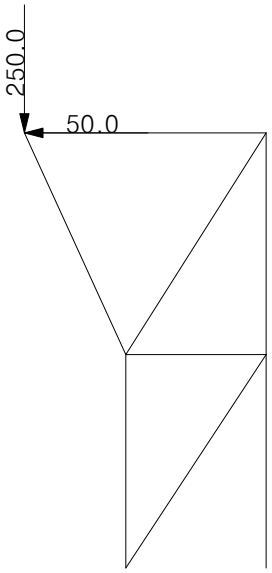
Item	START	END	Member	Area Type	Item	START	END	Member	Area Type
1	1	2	1	Area1	2	2	3	2	Area1
3	3	4	3	Area1	4	5	6	4	Area1
5	6	1	5	Area1	6	3	6	6	Area1
7	1	3	7	Area1	8	6	4	8	Area1

(3) Restraints

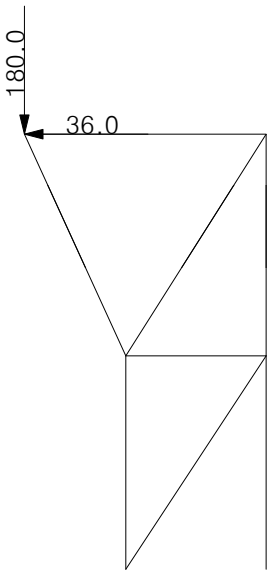
Node	Ux	Uy	Uz	Rx	Ry	Rz
4	0	0	0	0	0	0
5	0	0	0	0	0	0

(2) Load

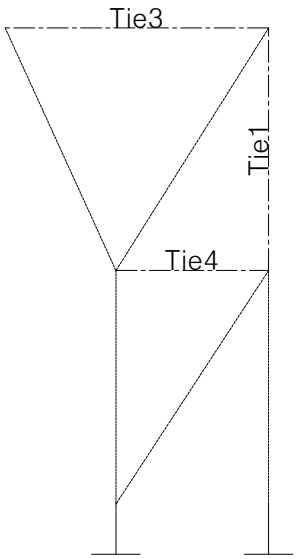
(1) Dead load (D)



(2) Live load (L)

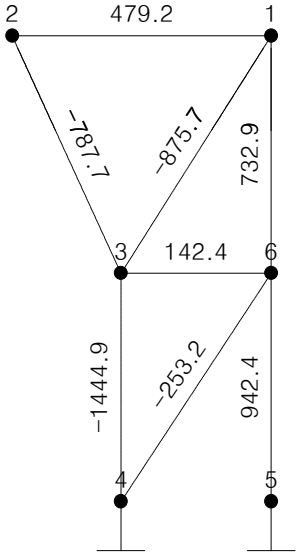


(3) Apply strut/tie



- Tie1 : Outer Rebar
- Tie3 : Main Rebar
- Tie4 : Shear Rebar

(4) Section force strut/tie



Member	ºÎÀç·Â(kN)	Member	ºÎÀç·Â(kN)	Member	ºÎÀç·Â(kN)	Member	ºÎÀç·Â(kN)
1	479.2	2	-787.7	3	-1444.9	4	942.4
5	732.9	6	142.4	7	-875.7	8	-253.2

(5) Review of bearing Plate

The bearing plate is examined through compareing maximum action force and required bearing stress and maximum bearing stress .

Φfce = Φ·0.85·βn·fck ≤ Fu/A

Î²n : Supporting plate, Strut or
Nodal area of supporting plate 1.00
Nodal area connected a tie 0.80
Nodal area connected more than 0.60

Node	βn	fce	Fu(kN)	B(mm)	W(mm)	Fu/A	Note
2	0.8	15.3	430	1000	268	1.604	O.K

(6) Placement of reinforcement

1) Selection of main reinforcement

(A) Quantity of required reinforcement

· Tie 1 : $Ast = \frac{Fu}{\Phi \cdot fy} = \frac{479.231 \times 10^3}{0.90 \times 300} = 1774.9\ mm^2$

· Tie 5 : $Ast = \frac{Fu}{\Phi \cdot fy} = \frac{732.941 \times 10^3}{0.90 \times 300} = 2714.6\ mm^2$

(B) Quantity of used reinforcement

· Section 1~2 : D19 - 4.0 EA (= 1146.0 mm²) ∴ N.G

· Section 6~1 : D19 - 4.0 EA (= 1146.0 mm²) ∴ N.G

2) Selection of shear reinforcement

(A) Calculation of shear reinforcement

· Tie 6 : $\eta req = \frac{Fu}{\Phi Ast \cdot fvy} = \frac{142.400 \times 10^3}{0.90 \times 198.60 \times 2.5 \times 300} = 1.1$

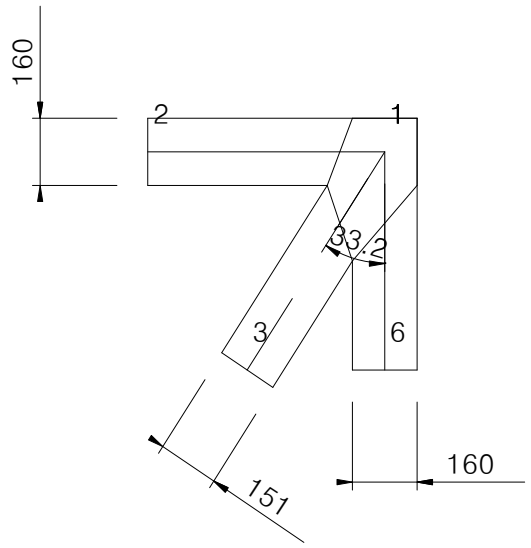
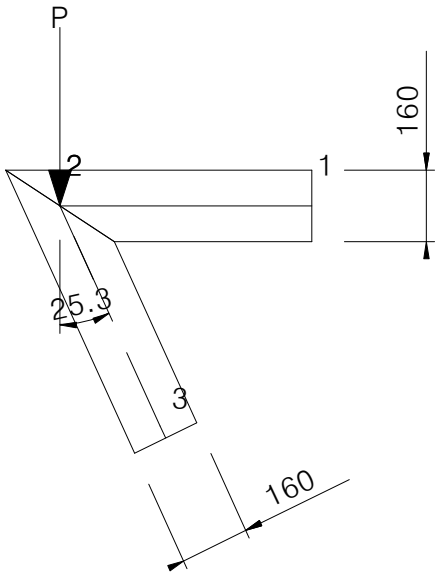
(B) Interval review of shear reinforcementInterval review of shear reinforcement

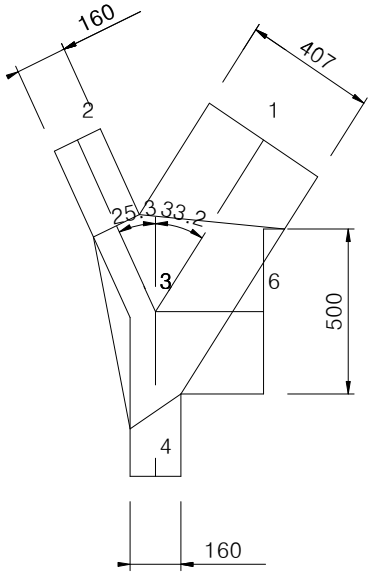
The requred rebar spacing in the maximum effective width is calculated by strut number placed on tie location and is as following.

· Tie 6 : Sreq = 500.0 / 1.1 = 470.7 mm ≥ 300.0 mm ∴ O.K

(7) Maximum effective width decision of strut nodal area

Member	ective widt	ective widt	m effective	Member	ective widt	ective widt	m effective
2	160	160	160.0	3	160	160	160.0
7	150	406	150.0	8	0	0	0.0

Node : 1	Node : 2
 Tie 1 : 160 mm Tie 5 : 160 mm Strut 7 : 151 mm	 Width of load plate : 268 mm Tie 1 : 160 mm Strut 2 : 160 mm

Node : 3
 Tie 6 : 500 mm Strut 3 : 160 mm Strut 7 : 407 mm Strut 2 : 160 mm

(8) Strength review of strut

The strut is examined whether required effective width
delivering section force of strut exceeds maximum effective width.

$$Wreq = \frac{Fu}{\Phi \cdot 0.85 \cdot \beta s \cdot fck \cdot b}$$

βs : Uniform section 1.00
Bottle type(rebar) 0.75
Bottle type 0.60(λ = 1.00)
Tensile element 0.40
All other cases 0.60

Member	βs	θ	Fu(kN)	Φ	Wreq(mm)	Wprov(mm)	Note
2	1.00	64.70	787.70	0.75	51.50	160.00	O.K
3	1.00	90.00	1444.90	0.75	94.40	160.00	O.K
7	1.00	56.80	875.70	0.75	57.20	150.70	O.K

(9) Strength review of nodal area

The strength of nodal area is examined through compareing required effective width
delivering section force of strut or tie and maximum effective width of nodal boundary.

$$Wreq = \frac{Fu}{\Phi \cdot 0.85 \cdot \beta n \cdot fck \cdot b}$$

βn : Supporting plate, Strut or
Nodal area of supporting plate and stru 1.00
Nodal area connected a tie 0.80
Nodal area connected more than two ties 0.60

Node	βn	Type	ection forc	Fu(kN)	Wreq(mm)	Wprov(mm)	Note
1	0.6	CTT	T-1	479.2	52.2	160	O.K
			T-5	732.9	79.8	160	O.K
			C-7	875.7	95.4	150.7	O.K
2	0.8	CCT	H	50	4.1	268	O.K
			V	250	20.4	268	O.K
			T-1	479.2	39.2	160	O.K
			C-2	787.7	64.4	160	O.K
3	0.8	CCT	C-2	787.7	64.4	160	O.K
			C-3	1444.9	118.1	160	O.K
			T-6	142.4	11.6	500	O.K
			C-7	875.7	71.5	406.9	O.K