Structural Design Report
for Girder Template

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1. Design Conditions

1) General Characteristics

(1) Project Name : Girder Template
(2) Design Code : EuroCode 2
(3) Unit : Kips.in
(4) Partial Safety Factors for Materials
Concrete : 1.50
Reinforcing and prestressing steel: 1.15
(5) Scope of Report
The purpose of this report is to design structural concrete member using strut-tie model. The design is performed according to the EuroCode 2 strut-tie model provisions.

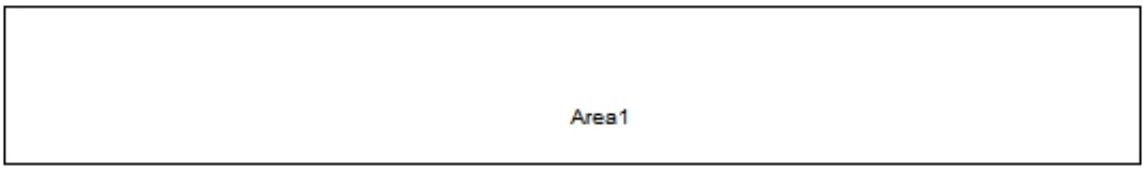
This report provides results of calculation for:
- check capacity of bearing plates
- design tie reinforcement
- check capacity of struts
- check capacity of nodal zones

2) Materials

(1) Concrete
- Mass : 147 lb/ft³
- Weight : 149.6 lb/ft³
- Poisson's ratio : 0.15
- Compressive Strength of Concrete, fck : 3480.9 lb/in²
- Tensile Strength of Concrete, fct : 348.1 lb/in²
- Elastic modulus of concrete, Ec : 4,039,177 lb/in²

(2) Steel1
- Mass : 490 lb/ft³
- Weight : 499.7 lb/ft³
- Poisson's ratio : 0.15
- Yield strength of steel, fy : 58015.4 lb/in²
- Elastic modulus of steel, Es : 29,007,699 lb/in²

3) Geometrical Shape

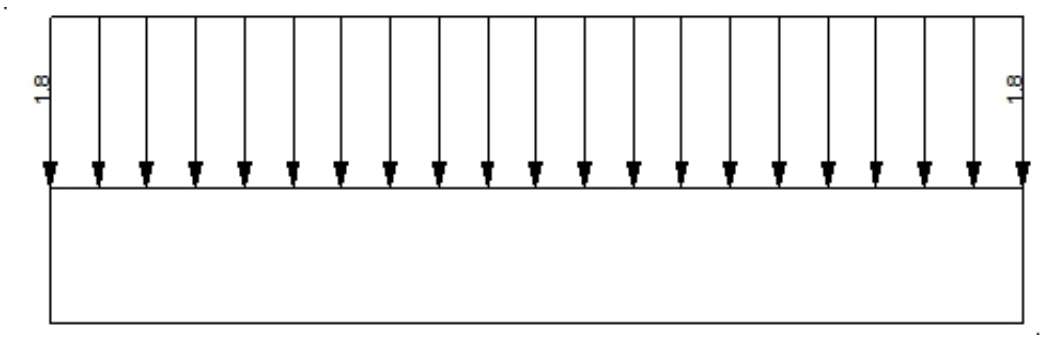


- Thickness : 40.00 in

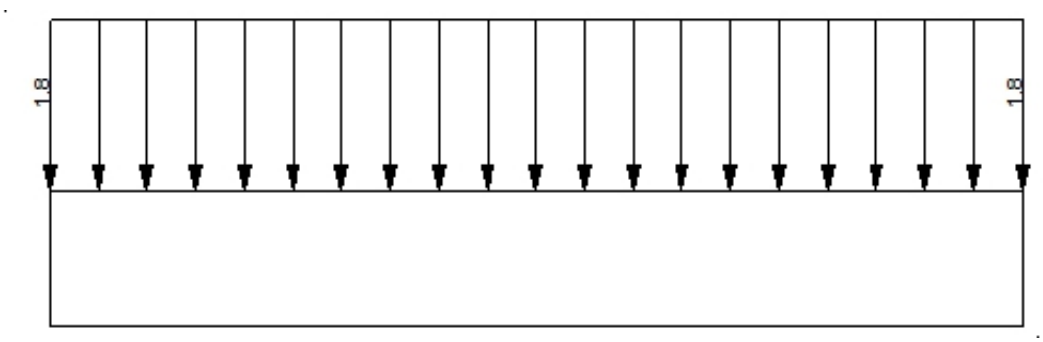
4) Loads and Load Combinations

(1) Loads

D (Uniform Load)



L (Uniform Load)



(2) Load Combinations

1) LC01 : 1.30D + 2.15L

5) Reference

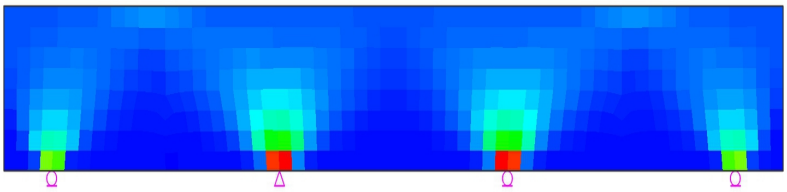
(1) Designer : Hangil IT
(2) Date : 2017-07-15
(3) Note : Design of Girder using Template (Eurocode 2)

2. Strut-Tie Model Design (Load Combination-1)

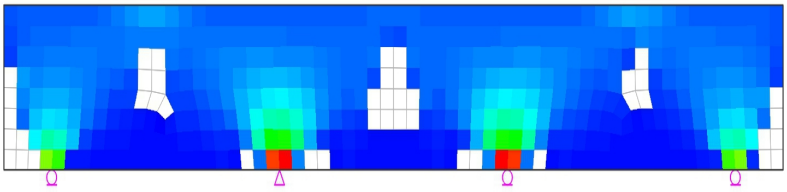
1) Construction of Strut-Tie Model

(1) ESO (Evolutionary Structural Optimization)

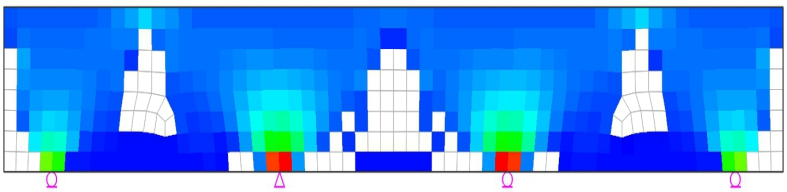
1. STAGE-01 (Initial shape)



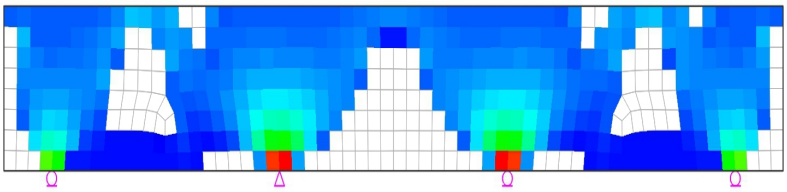
2. STAGE-02 (Elimination ratio = 9%)



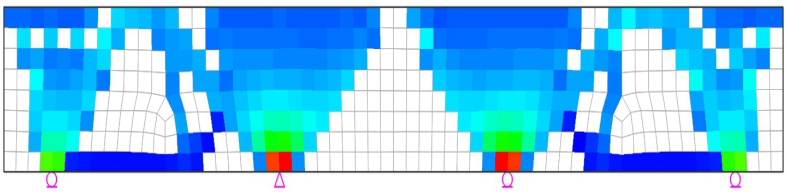
3. STAGE-03 (Elimination ratio = 17%)



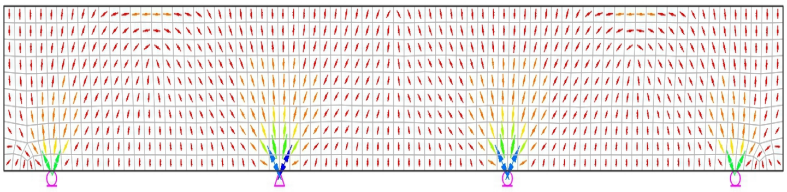
4. STAGE-04 (Elimination ratio = 25%)



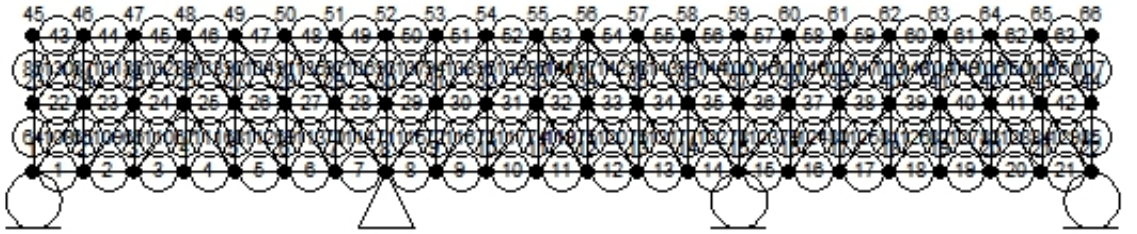
5. STAGE-06 (Elimination ratio = 39%)



(2) Compressive Principal Stress Flow



(3) Constructed Strut-Tie Model



(A) Nodal Coordinates

Node No.	X coordi.	Z coordi.	Node No.	X coordi.	Z coordi.
1	17.725	4.000	2	29.803	4.000
3	41.882	4.000	4	53.961	4.000
5	66.039	4.000	6	78.118	4.000
7	90.197	4.000	8	102.275	4.000
9	114.354	4.000	10	126.433	4.000
11	138.512	4.000	12	150.590	4.000
13	162.669	4.000	14	174.748	4.000
15	186.826	4.000	16	198.905	4.000
17	210.984	4.000	18	223.062	4.000
19	235.141	4.000	20	247.220	4.000
21	259.299	4.000	22	271.377	4.000
23	17.725	20.000	24	29.803	20.000
25	41.882	20.000	26	53.961	20.000
27	66.039	20.000	28	78.118	20.000
29	90.197	20.000	30	102.275	20.000
31	114.354	20.000	32	126.433	20.000
33	138.512	20.000	34	150.590	20.000
35	162.669	20.000	36	174.748	20.000
37	186.826	20.000	38	198.905	20.000
39	210.984	20.000	40	223.062	20.000
41	235.141	20.000	42	247.220	20.000
43	259.299	20.000	44	271.377	20.000
45	17.725	36.000	46	29.803	36.000
47	41.882	36.000	48	53.961	36.000
49	66.039	36.000	50	78.118	36.000
51	90.197	36.000	52	102.275	36.000
53	114.354	36.000	54	126.433	36.000

55	138.512	36.000	56	150.590	36.000
57	162.669	36.000	58	174.748	36.000
59	186.826	36.000	60	198.905	36.000
61	210.984	36.000	62	223.062	36.000
63	235.141	36.000	64	247.220	36.000
65	259.299	36.000	66	271.377	36.000

(B) Element Connectivity

Element No.	Start Node	End Node	Element No.	Start Node	End Node
1	1	2	2	2	3
3	3	4	4	4	5
5	5	6	6	6	7
7	7	8	8	8	9
9	9	10	10	10	11
11	11	12	12	12	13
13	13	14	14	14	15
15	15	16	16	16	17
17	17	18	18	18	19
19	19	20	20	20	21
21	21	22	22	23	24
23	24	25	24	25	26
25	26	27	26	27	28
27	28	29	28	29	30
29	30	31	30	31	32
31	32	33	32	33	34
33	34	35	34	35	36
35	36	37	36	37	38
37	38	39	38	39	40
39	40	41	40	41	42
41	42	43	42	43	44
43	45	46	44	46	47
45	47	48	46	48	49
47	49	50	48	50	51
49	51	52	50	52	53
51	53	54	52	54	55
53	55	56	54	56	57
55	57	58	56	58	59

57	59	60	58	60	61
59	61	62	60	62	63
61	63	64	62	64	65
63	65	66	64	1	23
65	2	24	66	3	25
67	4	26	68	5	27
69	6	28	70	7	29
71	8	30	72	9	31
73	10	32	74	11	33
75	12	34	76	13	35
77	14	36	78	15	37
79	16	38	80	17	39
81	18	40	82	19	41
83	20	42	84	21	43
85	22	44	86	23	45
87	24	46	88	25	47
89	26	48	90	27	49
91	28	50	92	29	51
93	30	52	94	31	53
95	32	54	96	33	55
97	34	56	98	35	57
99	36	58	100	37	59
101	38	60	102	39	61
103	40	62	104	41	63
105	42	64	106	43	65
107	44	66	108	1	24
109	2	25	110	3	26
111	5	26	112	6	27
113	7	28	114	8	29
115	8	31	116	9	32
117	10	33	118	11	34
119	12	33	120	13	34
121	14	35	122	15	36
123	15	38	124	16	39
125	17	40	126	18	41
127	20	41	128	21	42
129	22	43	130	23	46
131	24	47	132	25	48

133	27	48	134	28	49
135	29	50	136	30	51
137	30	53	138	31	54
139	32	55	140	33	56
141	34	55	142	35	56
143	36	57	144	37	58
145	37	60	146	38	61
147	39	62	148	40	63
149	42	63	150	43	64
151	44	65			

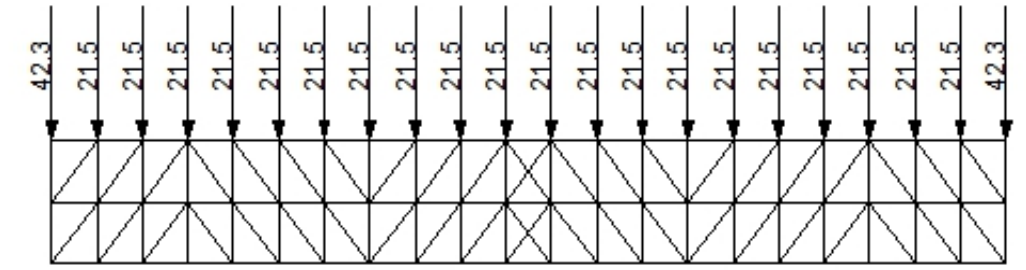
(C) Restraints

Node	Ux	Uy	Uz	Rx	Ry	Rz
1	-	-	O	-	-	-
8	O	O	O	O	-	O
15	-	-	O	-	-	-
22	-	-	O	-	-	-

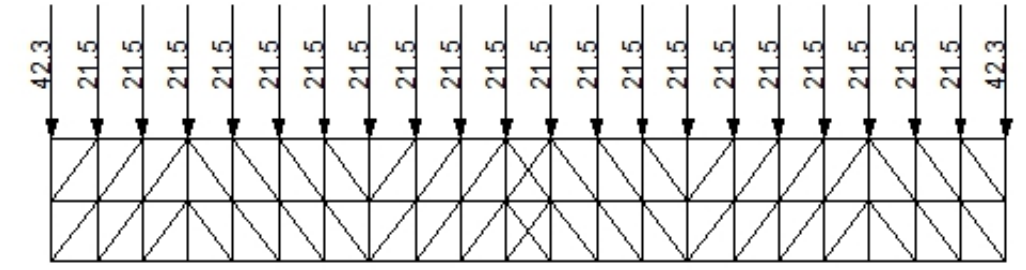
2) Analysis of Strut-Tie Model

(1) Loading Conditions

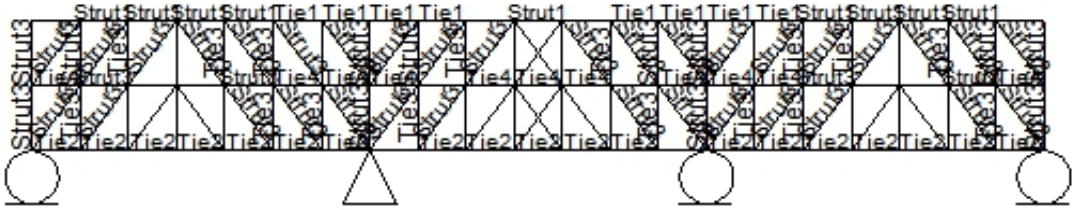
(1) (D)



(2) (L)

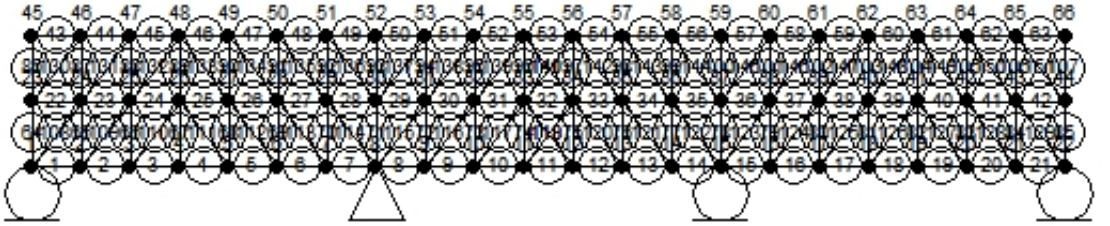


(2) Strut and Tie Types



- Strut1 : Strut without Transverse Tension
- Tie1 : Tie for top rebars
- Tie2 : Tie for bottom rebars
- Tie3 : Tie for intermediate vertical/horizontal rebars
- Tie4 : Tie for intermediate horizontal rebars

(3) Strut and Tie Forces



Elem. No.	Force (kip)	Elem. No.	Force (kip)	Elem. No.	Force (kip)	Elem. No.	Force (kip)
1	95.5	2	114.3	3	114.3	4	114.3
5	114.3	6	81.0	7	9.6	8	-0.0
9	31.3	10	31.3	11	31.3	12	31.3
13	31.3	14	-0.0	15	9.6	16	81.0
17	114.3	18	114.3	19	114.3	20	114.3
21	95.5	22	36.7	23	-1.3	24	0.3
25	0.3	26	-1.9	27	11.3	28	82.7
29	56.7	30	-0.5	31	24.2	32	24.2
33	24.2	34	-0.5	35	56.7	36	82.7
37	11.3	38	-1.9	39	0.3	40	0.3
41	-1.3	42	36.7	43	0.0	44	-36.7
45	-94.2	46	-79.1	47	-20.9	48	55.2
49	111.1	50	111.1	51	81.1	52	0.5
53	-55.5	54	0.5	55	81.1	56	111.1
57	111.1	58	55.2	59	-20.9	60	-79.1
61	-94.2	62	-36.7	63	0.0	64	-194.4
65	24.9	66	0.0	67	0.0	68	0.0
69	44.2	70	94.5	71	-187.9	72	41.4
73	0.0	74	-0.0	75	-0.0	76	0.0
77	41.4	78	-187.9	79	94.5	80	44.2
81	0.0	82	0.0	83	0.0	84	24.9
85	-194.4	86	-145.8	87	-25.5	88	2.1
89	-0.0	90	2.9	91	26.7	92	-0.0
93	-74.1	94	-34.3	95	32.7	96	-0.0
97	-0.0	98	32.7	99	-34.3	100	-74.1
101	-0.0	102	26.7	103	2.9	104	-0.0
105	2.1	106	-25.5	107	-145.8	108	-158.6

109	-31.2	110	-0.0	111	-0.0	112	-55.3
113	-118.4	114	-244.7	115	-228.7	116	-51.9
117	-0.0	118	0.0	119	0.0	120	-0.0
121	-51.9	122	-228.7	123	-244.7	124	-118.4
125	-55.3	126	-0.0	127	-0.0	128	-31.2
129	-158.6	130	-60.9	131	-95.5	132	-33.8
133	-59.0	134	-96.5	135	-126.2	136	-92.8
137	-49.8	138	-133.8	139	-92.8	140	0.0
141	0.0	142	-92.8	143	-133.8	144	-49.8
145	-92.8	146	-126.2	147	-96.5	148	-59.0
149	-33.8	150	-95.5	151	-60.9		

3) Strength Verification and Required Rebars

(1) Required Area of Rebars

1) Main Rebars

(A) Horizontal Rebars

As.req = (Fu/cos theta) / (fy/gamma_s) < As.used
where,
Fu = member force of steel tie
gamma_s = partial safety factor for steel tie : 1.15
fy = yield strength of steel : 58015.4 lb/in²
theta = angle of steel tie measured from positive horizontal axis
(+: counterclockwise)

Tie No.	Types	Fu (kip)	theta (deg.)	Rebars	As.req (in²)	As.used (in²)	Note
1	Bottom	21.48	0.0	8-#9	2	8	O.K
2	Bottom	25.70	0.0	8-#9	2	8	O.K
6	Bottom	18.21	0.0	8-#9	2	8	O.K
7	Bottom	2.16	0.0	8-#9	0	8	O.K
9	Bottom	7.03	0.0	8-#9	1	8	O.K
48	Top	12.40	0.0	8-#9	1	8	O.K
49	Top	24.97	0.0	8-#9	2	8	O.K
51	Top	18.23	0.0	8-#9	2	8	O.K

2) Transverse Rebars

(A) Horizontal Rebars

Tie No.	Fu (kip)	theta (deg.)	Rebars	Weff,tie (in)	Sh (in)	phi Fn (kip)	Note
22	8.25	0.0	4-#9	0.6	0.5	60.4	O.K
27	2.54	0.0	4-#9	0.6	0.5	60.4	O.K
28	18.58	0.0	4-#9	0.6	0.5	60.4	O.K
29	12.75	0.0	4-#9	0.6	0.5	60.4	O.K
31	5.44	0.0	4-#9	0.6	0.5	60.4	O.K

phi·Fn = Avh·(fy/gamma_s)·Weff,tie·cos theta / Sh > Fu
where,
Fu = member force of steel tie
gamma_s = partial safety factor for steel tie : 1.15
fy = yield strength of steel : 58015.4 lb/in²
theta = angle of steel tie measured from positive horizontal axis
(+: counterclockwise)
Sh = spacing of horizontal rebars

Weff,tie = effective width of tie

(C) Horizontal-Vertical Rebars

Tie No.	Fu (kip)	theta (deg.)	Rebars	Weff,tie (in)	Sprov (in)	phi Fn (kip)	Note
65	5.60	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
69	9.93	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
70	21.25	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
72	9.31	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
88	0.47	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
90	0.66	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
91	5.99	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
95	7.35	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K

phi·Fn = (Avh·(fy/gamma_s)·Weff,tie·cos theta / Sh) + (Av·(fy/gamma_s)·Weff,tie·sin theta / Sv) > Fu

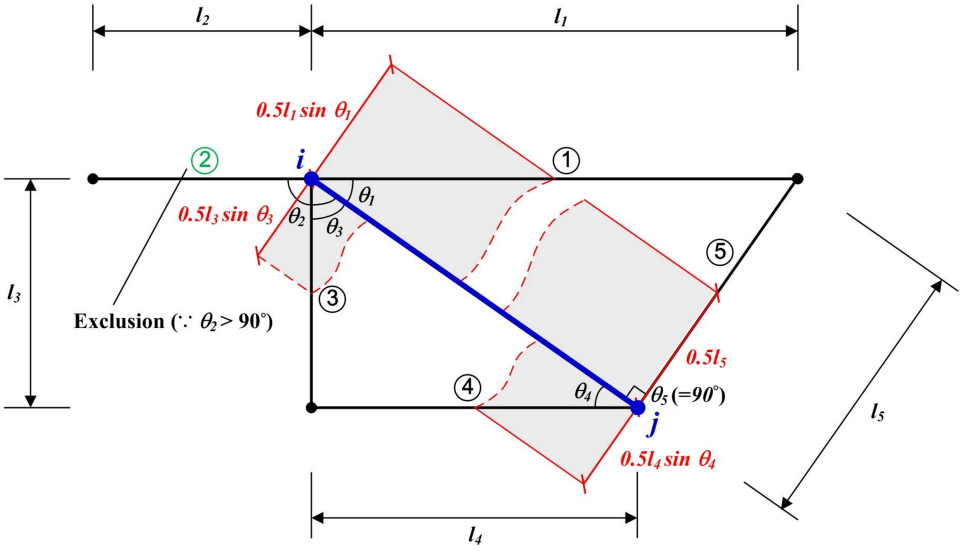
where,

Fu = member force of steel tie
gamma_s = partial safety factor for steel tie : 1.15
fy = yield strength of steel : 58015.4 lb/in²
theta = angle of steel tie measured from positive horizontal axis (+: counterclockwise)
Sprov = spacing of vertical and horizontal rebars
Weff,tie = effective width of tie

(2) Available Widths of Struts and Nodal Zones

The available widths of a strut at both ends and nodal zone faces are determined by taking the minimum ones from the values calculated below for three cases.

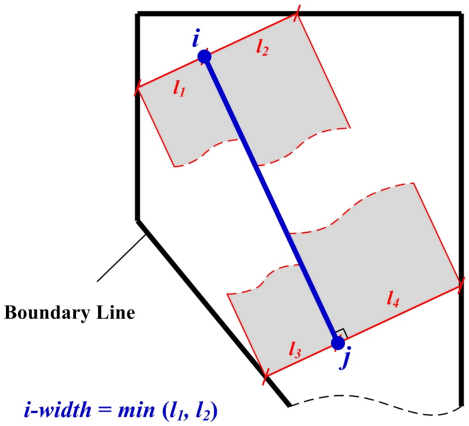
[CASE 1]



i-width = min ($l_1 \sin\theta_1$, $l_3 \sin\theta_3$)

j-width = min ($l_4 \sin\theta_4$, l_5)

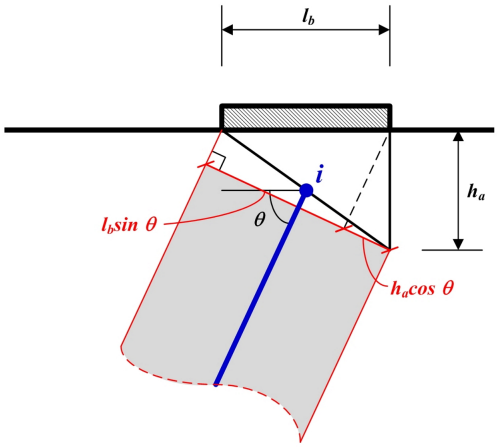
[CASE 2]



i-width = min (l_1, l_2)

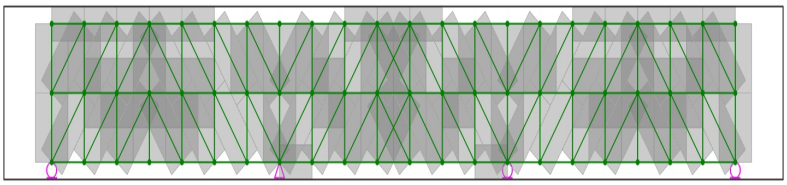
j-width = min (l_3, l_4)

[CASE 3]



i-width = $l_b \sin\theta + h_a \cos\theta$

The available widths of struts and ties determined by the methods introduced above are shown below



Elem. No.	i-width	j-width	Available Width	Elem. No.	i-width	j-width	Available Width
23	16.0	16.0	16.0	26	16.0	16.0	16.0
38	16.0	16.0	16.0	41	16.0	16.0	16.0
44	8.0	8.0	8.0	45	8.0	8.0	8.0
46	8.0	8.0	8.0	47	8.0	8.0	8.0
53	8.0	8.0	8.0	59	8.0	8.0	8.0
60	8.0	8.0	8.0	61	8.0	8.0	8.0
62	8.0	8.0	8.0	64	12.0	12.0	12.0
71	12.0	12.0	12.0	78	12.0	12.0	12.0
85	12.0	12.0	12.0	86	12.0	12.0	12.0
87	12.0	12.0	12.0	93	12.0	12.0	12.0
94	12.0	12.0	12.0	99	12.0	12.0	12.0
100	12.0	12.0	12.0	106	12.0	12.0	12.0
107	12.0	12.0	12.0	108	9.6	9.6	9.6
109	9.6	9.6	9.6	112	9.6	9.6	9.6
113	9.6	9.6	9.6	114	9.6	9.6	9.6
115	9.6	9.6	9.6	116	9.6	9.6	9.6
121	9.6	9.6	9.6	122	9.6	9.6	9.6
123	9.6	9.6	9.6	124	9.6	9.6	9.6
125	9.6	9.6	9.6	128	9.6	9.6	9.6
129	9.6	9.6	9.6	130	9.6	9.6	9.6
131	9.6	9.6	9.6	132	9.6	9.6	9.6
133	9.6	9.6	9.6	134	9.6	9.6	9.6

135	9.6	9.6	9.6	136	9.6	9.6	9.6
137	9.6	9.6	9.6	138	9.6	9.6	9.6
139	9.6	9.6	9.6	142	9.6	9.6	9.6
143	9.6	9.6	9.6	144	9.6	9.6	9.6
145	9.6	9.6	9.6	146	9.6	9.6	9.6
147	9.6	9.6	9.6	148	9.6	9.6	9.6
149	9.6	9.6	9.6	150	9.6	9.6	9.6
151	9.6	9.6	9.6				

(3) Strength of Struts

- Design strength of concrete strut without transverse tension (Type 1)
  Wreq = Fu / ((alpha_cc·fck/gamma_c)·b) < Wprov (See Eurocode 2 Section 6.5.2(1))
- Design strength of concrete strut with transverse tension (Type 2)
  Wreq = Fu / (0.6·(1-fck/36,260)·(alpha_cc·fck/gamma_c)·b) < Wprov (See Eurocode 2 Section 6.5.2(2))

gamma_c = partial safety factor for concrete = 1.50
alpha_cc = coefficient of long term effects = 1.00

Strut No.	Type	theta	Fu (kip)	b (in)	Wreq (in)	Wprov (in)	Note
23	3	0.0	1.3	40.0	0.0	16.0	O.K
26	3	0.0	1.9	40.0	0.0	16.0	O.K
38	3	0.0	1.9	40.0	0.0	16.0	O.K
41	3	0.0	1.3	40.0	0.0	16.0	O.K
44	1	0.0	36.7	40.0	0.4	8.0	O.K
45	1	0.0	94.2	40.0	1.0	8.0	O.K
46	1	0.0	79.1	40.0	0.9	8.0	O.K
47	1	0.0	20.9	40.0	0.2	8.0	O.K
53	1	0.0	55.5	40.0	0.6	8.0	O.K
59	1	0.0	20.9	40.0	0.2	8.0	O.K
60	1	0.0	79.1	40.0	0.9	8.0	O.K
61	1	0.0	94.2	40.0	1.0	8.0	O.K
62	1	0.0	36.7	40.0	0.4	8.0	O.K
64	3	90.0	194.4	40.0	3.9	12.1	O.K
71	3	90.0	187.9	40.0	3.7	12.1	O.K
78	3	90.0	187.9	40.0	3.7	12.1	O.K
85	3	90.0	194.4	40.0	3.9	12.1	O.K
86	3	90.0	145.8	40.0	2.9	12.1	O.K
87	3	90.0	25.5	40.0	0.5	12.1	O.K

93	3	90.0	74.1	40.0	1.5	12.1	O.K
94	3	90.0	34.3	40.0	0.7	12.1	O.K
99	3	90.0	34.3	40.0	0.7	12.1	O.K
100	3	90.0	74.1	40.0	1.5	12.1	O.K
106	3	90.0	25.5	40.0	0.5	12.1	O.K
107	3	90.0	145.8	40.0	2.9	12.1	O.K
108	3	53.0	158.6	40.0	3.1	9.6	O.K
109	3	53.0	31.2	40.0	0.6	9.6	O.K
112	3	53.0	55.3	40.0	1.1	9.6	O.K
113	3	53.0	118.4	40.0	2.4	9.6	O.K
114	3	53.0	244.7	40.0	4.9	9.6	O.K
115	3	53.0	228.7	40.0	4.5	9.6	O.K
116	3	53.0	51.9	40.0	1.0	9.6	O.K
121	3	53.0	51.9	40.0	1.0	9.6	O.K
122	3	53.0	228.7	40.0	4.5	9.6	O.K
123	3	53.0	244.7	40.0	4.9	9.6	O.K
124	3	53.0	118.4	40.0	2.4	9.6	O.K
125	3	53.0	55.3	40.0	1.1	9.6	O.K
128	3	53.0	31.2	40.0	0.6	9.6	O.K
129	3	53.0	158.6	40.0	3.1	9.6	O.K
130	3	53.0	60.9	40.0	1.2	9.6	O.K
131	3	53.0	95.5	40.0	1.9	9.6	O.K
132	3	53.0	33.8	40.0	0.7	9.6	O.K
133	3	53.0	59.0	40.0	1.2	9.6	O.K
134	3	53.0	96.5	40.0	1.9	9.6	O.K
135	3	53.0	126.2	40.0	2.5	9.6	O.K
136	3	53.0	92.8	40.0	1.8	9.6	O.K
137	3	53.0	49.8	40.0	1.0	9.6	O.K
138	3	53.0	133.8	40.0	2.7	9.6	O.K
139	3	53.0	92.8	40.0	1.8	9.6	O.K
142	3	53.0	92.8	40.0	1.8	9.6	O.K
143	3	53.0	133.8	40.0	2.7	9.6	O.K
144	3	53.0	49.8	40.0	1.0	9.6	O.K
145	3	53.0	92.8	40.0	1.8	9.6	O.K
146	3	53.0	126.2	40.0	2.5	9.6	O.K
147	3	53.0	96.5	40.0	1.9	9.6	O.K
148	3	53.0	59.0	40.0	1.2	9.6	O.K
149	3	53.0	33.8	40.0	0.7	9.6	O.K

150	3	53.0	95.5	40.0	1.9	9.6	O.K
151	3	53.0	60.9	40.0	1.2	9.6	O.K

(4) Strength of Nodal Zones

The verification of the nodal zone strength should be done through comparing the available nodal zone area with that required. In this report, if the thickness of the structural concrete is consistent, the verification will be done by comparing the available nodal zone width, Wprov, with that required, Wreq

Wreq = Fu / (k·(1-fck/36,260)·(alpha_cc·fck/gamma_c)·b) < Wprov (See Eurocode 2 Section 6.5.4(4))

k = 1.00 (compression nodes where no ties are anchored at the node)
0.85 (compression-tension nodes with anchored ties provided in one direction)
0.75 (compression-tension nodes with anchored ties provided in more than one direction)

Under the conditions listed below, the design compressive stress values given in 6.5.4(4) may be increased by up to 10 percent where at least one of the following applies:

- triaxial compression is assured
- all angles between struts and ties are > 55
- the stresses applied at supports or at point loads are uniform, and the node is confined by stirrups
- the reinforcement is arranged in multiple layers
- the node is reliably confined by means of bearing arrangement or friction

Node No.	k	Type	Element	Fu (kip)	Wreq (in)	Wprov (in)	Note
1	0.85	CCT	T-1	95.5	1.3	8.0	O.K
			C-64	194.4	2.7	12.1	O.K
			C-108	158.6	2.2	9.6	O.K
2	0.75	CTT	T-1	-	-	-	-
			T-2	18.8	0.3	8.0	O.K
			T-65	24.9	0.4	12.1	O.K
			C-109	31.2	0.5	9.6	O.K
6	0.75	CTT	T-5	33.3	0.5	8.0	O.K
			T-6	-	-	-	-
6	0.75	CTT	T-69	44.2	0.7	12.1	O.K
			C-112	55.3	0.9	9.6	O.K
7	0.75	CTT	T-6	71.4	1.1	8.0	O.K
			T-7	-	-	-	-

7	0.75	CTT	T-70	94.5	1.5	12.1	O.K
			C-113	118.4	1.9	9.6	O.K
			T-7	9.6	0.1	8.0	O.K
			C-71	187.9	2.6	12.1	O.K
8	0.85	CCT	C-114	244.7	3.4	9.6	O.K
			C-115	228.7	3.2	9.6	O.K
			T-9	31.3	0.5	8.0	O.K
			T-72	41.4	0.7	12.1	O.K
9	0.75	CTT	C-116	51.9	0.8	9.6	O.K
			T-13	31.3	0.5	8.0	O.K
			T-77	41.4	0.7	12.1	O.K
			C-121	51.9	0.8	9.6	O.K
15	0.85	CCT	T-15	9.6	0.1	8.0	O.K
			C-78	187.9	2.6	12.1	O.K
			C-122	228.7	3.2	9.6	O.K
15	0.85	CCT	C-123	244.7	3.4	9.6	O.K
			T-15	-	-	-	-
16	0.75	CTT	T-16	71.4	1.1	8.0	O.K
			T-79	94.5	1.5	12.1	O.K
16	0.75	CTT	C-124	118.4	1.9	9.6	O.K
			T-16	-	-	-	-
17	0.75	CTT	T-17	33.3	0.5	8.0	O.K
			T-80	44.2	0.7	12.1	O.K
17	0.75	CTT	C-125	55.3	0.9	9.6	O.K
			T-20	18.8	0.3	8.0	O.K
			T-21	-	-	-	-
21	0.75	CTT	T-84	24.9	0.4	12.1	O.K
			C-128	31.2	0.5	9.6	O.K
			T-21	95.5	1.3	8.0	O.K
			C-85	194.4	2.7	12.1	O.K
22	0.85	CCT	C-129	158.6	2.2	9.6	O.K
			T-22	36.7	0.5	16.0	O.K
			C-64	194.4	2.7	12.1	O.K
			C-86	145.8	2.0	12.1	O.K
23	0.85	CCT	C-130	60.9	0.9	9.6	O.K
			T-22	36.7	0.6	16.0	O.K
			C-23	1.3	0.0	16.0	O.K
			T-65	24.9	0.4	12.1	O.K

24	0.75	CTT	C-87	25.5	0.4	12.1	O.K
			C-108	158.6	2.5	9.6	O.K
24	0.75	CTT	C-131	95.5	1.5	9.6	O.K
			C-23	1.3	0.0	16.0	O.K
25	0.85	CCT	T-88	2.1	0.0	12.1	O.K
			C-109	31.2	0.4	9.6	O.K
25	0.85	CCT	C-132	33.8	0.5	9.6	O.K
			C-26	1.9	0.0	16.0	O.K
			T-90	2.9	0.0	12.1	O.K
			C-112	55.3	0.8	9.6	O.K
27	0.85	CCT	C-133	59.0	0.8	9.6	O.K
			C-26	1.9	0.0	16.0	O.K
			T-27	11.3	0.2	16.0	O.K
28	0.75	CTT	T-69	17.5	0.3	12.1	O.K
			T-91	-	-	-	-
			C-113	118.4	1.9	9.6	O.K
			C-134	96.5	1.5	9.6	O.K
29	0.75	CTT	T-27	-	-	-	-
			T-28	71.4	1.1	16.0	O.K
			T-70	94.5	1.5	12.1	O.K
			C-114	244.7	3.9	9.6	O.K
			C-135	126.2	2.0	9.6	O.K
			T-28	25.9	0.4	16.0	O.K
30	0.75	CTT	T-29	-	-	-	-
			C-71	187.9	3.0	12.1	O.K
			C-93	74.1	1.2	12.1	O.K
			C-136	92.8	1.5	9.6	O.K
30	0.75	CTT	C-137	49.8	0.8	9.6	O.K
			T-29	56.7	0.9	16.0	O.K
			T-72	41.4	0.7	12.1	O.K
			C-94	34.3	0.5	12.1	O.K
31	0.75	CTT	C-115	228.7	3.6	9.6	O.K
			C-138	133.8	2.1	9.6	O.K
			T-31	24.2	0.4	16.0	O.K
			T-95	32.7	0.5	12.1	O.K
			C-116	51.9	0.8	9.6	O.K
			C-139	92.8	1.5	9.6	O.K
35	0.75	CTT	T-33	24.2	0.4	16.0	O.K

35	0.75	CTT	T-98	32.7	0.5	12.1	O.K
			C-121	51.9	0.8	9.6	O.K
			C-142	92.8	1.5	9.6	O.K
			T-35	56.7	0.9	16.0	O.K
36	0.75	CTT	T-77	41.4	0.7	12.1	O.K
			C-99	34.3	0.5	12.1	O.K
			C-122	228.7	3.6	9.6	O.K
			C-143	133.8	2.1	9.6	O.K
			T-35	-	-	-	-
			T-36	25.9	0.4	16.0	O.K
37	0.75	CTT	C-78	187.9	3.0	12.1	O.K
			C-100	74.1	1.2	12.1	O.K
			C-144	49.8	0.8	9.6	O.K
			C-145	92.8	1.5	9.6	O.K
			T-36	71.4	1.1	16.0	O.K
38	0.75	CTT	T-37	-	-	-	-
			T-79	94.5	1.5	12.1	O.K
			C-123	244.7	3.9	9.6	O.K
			C-146	126.2	2.0	9.6	O.K
39	0.75	CTT	T-37	11.3	0.2	16.0	O.K
			C-38	1.9	0.0	16.0	O.K
39	0.75	CTT	T-80	17.5	0.3	12.1	O.K
			T-102	-	-	-	-
39	0.75	CTT	C-124	118.4	1.9	9.6	O.K
			C-147	96.5	1.5	9.6	O.K
			C-38	1.9	0.0	16.0	O.K
			T-103	2.9	0.0	12.1	O.K
40	0.85	CCT	C-125	55.3	0.8	9.6	O.K
			C-148	59.0	0.8	9.6	O.K
			C-41	1.3	0.0	16.0	O.K
			T-105	2.1	0.0	12.1	O.K
			C-128	31.2	0.4	9.6	O.K
42	0.85	CCT	C-149	33.8	0.5	9.6	O.K
			C-41	1.3	0.0	16.0	O.K
			T-42	36.7	0.6	16.0	O.K
			T-84	24.9	0.4	12.1	O.K
			C-106	25.5	0.4	12.1	O.K
			C-129	158.6	2.5	9.6	O.K

43	0.75	CTT	C-150	95.5	1.5	9.6	O.K
			T-42	36.7	0.5	16.0	O.K
			C-85	194.4	2.7	12.1	O.K
			C-107	145.8	2.0	12.1	O.K
			C-151	60.9	0.9	9.6	O.K
45	1.00	CCC	C-86	145.8	1.7	12.1	O.K
			C-44	36.7	0.4	8.0	O.K
			C-87	25.5	0.3	12.1	O.K
			C-130	60.9	0.7	9.6	O.K
			C-44	36.7	0.5	8.0	O.K
			C-45	94.2	1.3	8.0	O.K
47	0.85	CCT	T-88	2.1	0.0	12.1	O.K
			C-131	95.5	1.3	9.6	O.K
			C-45	94.2	1.1	8.0	O.K
			C-46	79.1	0.9	8.0	O.K
48	1.00	CCC	C-132	33.8	0.4	9.6	O.K
			C-133	59.0	0.7	9.6	O.K
			C-46	79.1	1.1	8.0	O.K
			C-47	20.9	0.3	8.0	O.K
49	0.85	CCT	T-90	2.9	0.0	12.1	O.K
			C-134	96.5	1.4	9.6	O.K
			C-47	20.9	0.3	8.0	O.K
			T-48	55.2	0.9	8.0	O.K
			T-91	26.7	0.4	12.1	O.K
			C-135	126.2	2.0	9.6	O.K
51	0.75	CTT	T-48	-	-	-	-
			T-49	55.9	0.9	8.0	O.K
			C-136	92.8	1.5	9.6	O.K
			T-49	-	-	-	-
52	0.75	CTT	T-50	-	-	-	-
52	0.75	CTT	C-93	74.1	1.2	12.1	O.K
			T-50	30.0	0.5	8.0	O.K
			T-51	-	-	-	-
53	0.75	CTT	C-94	34.3	0.5	12.1	O.K
			C-137	49.8	0.8	9.6	O.K
			T-51	81.1	1.3	8.0	O.K
			T-95	32.7	0.5	12.1	O.K
54	0.75	CTT	C-138	133.8	2.1	9.6	O.K

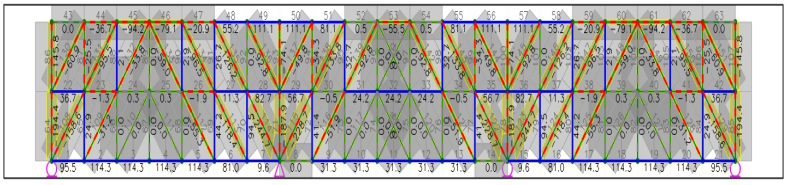
55	1.00	CCC	C-53	55.5	0.7	8.0	O.K
			C-139	92.8	1.1	9.6	O.K
			C-53	55.5	0.7	8.0	O.K
56	1.00	CCC	C-142	92.8	1.1	9.6	O.K
			T-55	81.1	1.3	8.0	O.K
			T-98	32.7	0.5	12.1	O.K
			C-143	133.8	2.1	9.6	O.K
58	0.75	CTT	T-55	-	-	-	-
			T-56	30.0	0.5	8.0	O.K
			C-99	34.3	0.5	12.1	O.K
			C-144	49.8	0.8	9.6	O.K
59	0.75	CTT	T-56	-	-	-	-
			T-57	-	-	-	-
			C-100	74.1	1.2	12.1	O.K
60	0.75	CTT	T-57	55.9	0.9	8.0	O.K
			T-58	-	-	-	-
			C-145	92.8	1.5	9.6	O.K
61	0.75	CTT	T-58	55.2	0.9	8.0	O.K
			C-59	20.9	0.3	8.0	O.K
			T-102	26.7	0.4	12.1	O.K
			C-146	126.2	2.0	9.6	O.K
62	0.85	CCT	C-59	20.9	0.3	8.0	O.K
			C-60	79.1	1.1	8.0	O.K
			T-103	2.9	0.0	12.1	O.K
62	0.85	CCT	C-147	96.5	1.4	9.6	O.K
			C-60	79.1	0.9	8.0	O.K
63	1.00	CCC	C-61	94.2	1.1	8.0	O.K
			C-148	59.0	0.7	9.6	O.K
63	1.00	CCC	C-149	33.8	0.4	9.6	O.K
			C-61	94.2	1.3	8.0	O.K
			C-62	36.7	0.5	8.0	O.K
64	0.85	CCT	T-105	2.1	0.0	12.1	O.K
			C-150	95.5	1.3	9.6	O.K
			C-62	36.7	0.4	8.0	O.K
			C-106	25.5	0.3	12.1	O.K
65	1.00	CCC	C-151	60.9	0.7	9.6	O.K
			C-107	145.8	1.7	12.1	O.K

C: compression; T: tension; V: vertical force; H: horizontal force

3. Summary

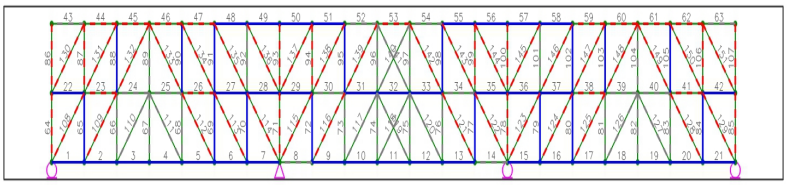
1) Dimensioned Shape

1) Load Combination - 1



2) Required and Used Areas of Rebars

1) Load Combination - 1



(A) Main Rebars

Tie No.	Types	Fu (kip)	theta (deg.)	Rebars	As.req (in²)	As.used (in²)	Note
1	Bottom	21.48	0.0	8-#9	2	8	O.K

2	Bottom	25.70	0.0	8-#9	2	8	O.K
6	Bottom	18.21	0.0	8-#9	2	8	O.K
7	Bottom	2.16	0.0	8-#9	0	8	O.K
9	Bottom	7.03	0.0	8-#9	1	8	O.K
48	Top	12.40	0.0	8-#9	1	8	O.K
49	Top	24.97	0.0	8-#9	2	8	O.K
51	Top	18.23	0.0	8-#9	2	8	O.K

(B) Transverse Rebars

Tie No.	Fu (kip)	theta (deg.)	Rebars	Weff,tie (in)	Sh (in)	phi Fn (kip)	Note
22	8.25	0.0	4-#9	0.6	0.5	60.4	O.K
27	2.54	0.0	4-#9	0.6	0.5	60.4	O.K
28	18.58	0.0	4-#9	0.6	0.5	60.4	O.K
29	12.75	0.0	4-#9	0.6	0.5	60.4	O.K
31	5.44	0.0	4-#9	0.6	0.5	60.4	O.K

- Horizontal-Vertical Rebars

Tie No.	Fu (kip)	theta (deg.)	Rebars	Weff,tie (in)	Sprov (in)	phi Fn (kip)	Note
65	5.60	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
69	9.93	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
70	21.25	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
72	9.31	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
88	0.47	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
90	0.66	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
91	5.99	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K
95	7.35	90.0	4-#9 4-#9	0.5 0.5	0.5 0.5	45.6	O.K