設計柱名: 2F C7 (ETABS: 3F C7)

unit: ton-m for MOMENT, TORSION and SHEAR(such as Mu Vu Tu,...)
kg-cm for else

(1) 已知條件

fc' = 350 kg/cm2
fy = 4200 kg/cm2
fys = 4200 kg/cm2
Dmaj = 70 cm
Dmin = 110 cm
H = 320 cm
Hn = 240 cm

(2) 柱彈性分析所得之應力

COLUMN FORCES AT LEVEL 2F IN FRAME SPACE FRAME

COL ID	OUTPUT ID	OUTPUT POINT	(T-m) MAJOR MOMENT	(T) MAJOR SHEAR	(T-m) MINOR MOMENT	(T) MINOR SHEAR	(T) AXIAL FORCE
C7	DL	Bottom	-14.89	-11.79	1.41	2.91	-430.42
C7	DL	Top	13.44	-11.79	-5.43	2.91	-425.99
C7	EXP	Bottom	121.31	90.04	1.31	1.19	34.33
C7	EXP	Top	-97.74	90.04	-1.53	1.19	34.33
C7	EXN	Bottom	120.33	89.31	-8.49	-5.90	34.70
C7	EXN	Top	-96.96	89.31	5.87	-5.90	34.70
C7	EQV	Bottom	-2.08	-1.65	0.20	0.41	-60.09
C7	EQV	Top	1.88	-1.65	-0.76	0.41	-59.47
C7	LL	Bottom	-1.90	-1.51	-0.05	0.12	-53.18
C7	LL	Top	1.73	-1.51	-0.34	0.12	-53.18
C7	LL1	Bottom	-0.01	-0.05	-0.22	-0.05	-0.12
C7	LL1	Top	0.12	-0.05	-0.10	-0.05	-0.12
C7	LL500	Bottom	-0.51	-0.36	1.11	0.54	4.01
C7	LL500	Top	0.36	-0.36	-0.18	0.54	4.01
C7	SPX Max	Bottom	121.81	90.84	25.24	18.27	31.60
C7	SPX Max	Top	99.25	90.84	19.11	18.27	31.60
C7	AutoSeq Max	Bottom	0.00	0.00	0.30	2.68	0.00
C7	AutoSeq Max	Top	15.44	0.00	0.00	2.68	0.00
C7	AutoSeq Min	Bottom	-14.36	-12.42	-1.47	-0.48	-499.74
C7	AutoSeq Min	Top	0.00	-12.42	-6.13	-0.48	-495.31

(3) 柱主筋彈性設計結果

由 COMB1 載重組合控制

	Pu(T)	Mumaj(T-m)	Vumaj(T)	Mumin(T-m)	Vumin(T)
Top	-596.38	18.82	-16.51	-7.61	4.08
Bottom	-602.59	-20.85	-16.51	1.98	4.08

As,req = 77.00 cm2

(4) 求梁彎矩強度和 Σ φb x Mbn

考慮 T 型梁 (雙翼板) = min(Ln/8, 8*ts, (Ls1)/2) = min(63.13, 96.00, 162.50) = 63.13 cm
版配筋 #3@15(fy=2800)
T 型梁內版筋總量 = 3.00 cm2 (等值梁 fy = 2.00 cm2)

X 方向 柱頂
3F GB4(55x80)
B = 55cm
D = 80cm
AST = 12-#8 + 2.00 cm2
ASB = 12-#8
φb x Mbpc_clock = 177.82 (t-m)
φb x Mbpc_cntclock = 172.35 (t-m)
φb x Mbnc_clock = 160.02 (t-m)
φb x Mbnc_cntclock = 155.11 (t-m)

考慮 T 型梁 (雙翼板) = min(Ln/8, 8*ts, (Ls1)/2) = min(72.88, 96.00, 100.00) = 72.88 cm
版配筋 #3@15(fy=2800)
T 型梁內版筋總量 = 3.46 cm2 (等值梁 fy = 2.31 cm2)

X 方向 柱頂
3F GB5(55x80)
B = 55cm
D = 80cm
AST = 13-#8 + 2.31 cm2
ASB = 11-#8
φb x Mbpc_clock = 158.44 (t-m)
φb x Mbpc_cntclock = 192.41 (t-m)
φb x Mbnc_clock = 142.57 (t-m)
φb x Mbnc_cntclock = 173.16 (t-m)

考慮 T 型梁 (雙翼板) = min(Ln/8, 8*ts, (Ls1)/2) = min(63.13, 96.00, 325.00) = 63.13 cm
版配筋 #3@15(fy=2800)
T 型梁內版筋總量 = 3.00 cm2 (等值梁 fy = 2.00 cm2)

X 方向 柱底
2F GB4(55x80)
B = 55cm

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  D    = 80cm
  AST = 11-#8 + 2.00 cm2
  ASB = 11-#8
  φb x Mbpc_clock     = 163.85 (t-m)
  φb x Mbpc_cntclock = 158.37 (t-m)
  φb x Mbnc_clock     = 147.47 (t-m)
  φb x Mbnc_cntclock = 142.54 (t-m)
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考慮 T 型梁 (雙翼板) = min(Ln/8, 8*ts, (Ls1)/2) = min(72.88, 96.00, 325.00) = 72.88 cm
版配筋 #3@15(fy=2800)
T 型梁內版筋總量 = 3.46 cm2 (等值梁 fy = 2.31 cm2)

X 方向 柱底
  2F GB5(55x80)
  B    = 55cm
  D    = 80cm
  AST = 11-#8 + 2.31 cm2
  ASB = 9-#8
  φb x Mbpc_clock     = 130.41 (t-m)
  φb x Mbpc_cntclock = 164.54 (t-m)
  φb x Mbnc_clock     = 117.38 (t-m)
  φb x Mbnc_cntclock = 148.10 (t-m)
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(5) 強柱弱梁設計分配彎矩
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柱頂分配彎矩
R_top = Mc / fabs (Mc_up - Mc) = 0.45
Mcu_top_clock     = R_top * 1.2Σ(φb x Mbn_sum_clock)     = 161.68 (t-m)
Mcu_top_cntclock = R_top * 1.2Σ(φb x Mbn_sum_cntclock) = 175.40 (t-m)

柱底分配彎矩
R_bottom = Mc / fabs (Mc + Mc_down) = 0.57
Mcu_bottom_clock     = R_bottom * 1.2Σ(φb x Mbn_sum_clock)     = 181.20 (t-m)
Mcu_bottom_cntclock = R_bottom * 1.2Σ(φb x Mbn_sum_cntclock) = 198.84 (t-m)

(6) 柱主筋配筋
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彈性分析鋼筋設計 (COMB1 載重組合控制)
Pu      = -602.59 T
Mu,maj = -20.85 T-M
Mu,min = 1.98 T-M
As      = 77.00 cm2

強柱弱梁分析鋼筋設計 (柱底控制)
Pu      = -588.84 T
Mu,maj = -22.62 T-M
Mu,min = -198.84 T-M
As      = 117.82 cm2

As,req = 117.82 cm2
主筋: 16-#10  (As,pro = 130.29 cm2)

(7) 求柱設計剪力(梁 Mpr: Fs = 1.25Fy, φ = 1.0 , 韌性分析剪力)
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柱頂分配彎矩
R_top = Mc / fabs (Mc_up - Mc) = 0.45
Mcp_top_clock     = R_top * fabs(Mpb_sum_clock)     = 182.79 (t-m)
Mcp_top_cntclock = R_top * fabs(Mpb_sum_cntclock) = 197.89 (t-m)

柱底分配彎矩
R_bottom = Mc / fabs (Mc + Mc_down) = 0.57
Mcp_bottom_clock     = R_bottom * fabs(Mpb_sum_clock)     = 204.28 (t-m)
Mcp_bottom_cntclock = R_bottom * fabs(Mpb_sum_cntclock) = 223.79 (t-m)

Vp = (Mtop - Mbot) / H
Hn            = 240 (cm)
Vcp_clock     = 161.28 (t)
Vcp_cntclock = 175.70 (t)
Vp            = 175.70 (t)

(8) 計算柱橫向鋼筋
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柱圍束區箍筋量之公式:
Ash / S = 0.30 x hc x (Ag / Ac - 1) x (fc' / fy)-----eq.(1)
Ash / S = 0.09 x hc x (fc' / fy)---------------------eq.(2)
Av / S  = (Vu,max / φ - Vc) / (fy x d)---------------eq.(3)
Av / S  = (Vp / φ - Vc) / (fy x d)-------------------eq.(4)

柱中央區剪力筋之公式:
Av / S  = (Vu,max / φ - Vc) / (fy x d)---------------eq.(3)
Av / S  = (Vp / φ - Vc) / (fy x d)-------------------eq.(4)

(major)
IF Pu < 0.05Agfc', Vc = 0
Vu(max) =      80.72 T
Vp      =     175.70 T
hc      =      60.73 cm
Ag      =    7700.00 cm2
Ac      =    6324.00 cm2

Ash / S =       0.755 cm2 / cm (圍束區) <--- 由 eq.(2) 控制
Avh / S =       0.548 cm2 / cm (中央區) <--- 由 eq.(4) 控制

(minor)
Ash / S =       0.455 cm2 / cm (圍束區) <--- 由 eq.(2) 控制
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Avh / S = 0.396 cm2 / cm (中央區) <--- 由 eq.(4) 控制

(9) 柱圍束區及中央區之箍筋量配置

(major)
圍束區: (Hoop: 1-#4 + Ties: 2-#4) @ 10 Ash / S = 0.51 cm2 / cm
中央區: (Hoop: 1-#4 + Ties: 2-#4) @ 12 Ash / S = 0.42 cm2 / cm

(minor)
圍束區: (Hoop: 1-#4 + Ties: 4-#4) @ 10 Ash / S = 0.76 cm2 / cm
中央區: (Hoop: 1-#4 + Ties: 4-#4) @ 12 Ash / S = 0.63 cm2 / cm

(10) 柱設計及配筋完成

(COL. LINE : C7)

FL:2F (70.0)x (110.0)	Fc'=350	Fy=4200 Fyh=4200	RECT
As= 117.8 <COMB35 Min-XB> 1.53 %[C7]		o 16-#10 [130.3] o 0-#0 X- 4(0) Y- 6(0)	
Maj.Av/S= 0.755<15-4>[C7] 0.548<Mpr>[C7]		Hoop: 1-#4	
Min.Av/S= 0.455<15-4>[C7] 0.396<Mpr>[C7]		Ties: 2-#4 @ 10 - 12 4-#4	