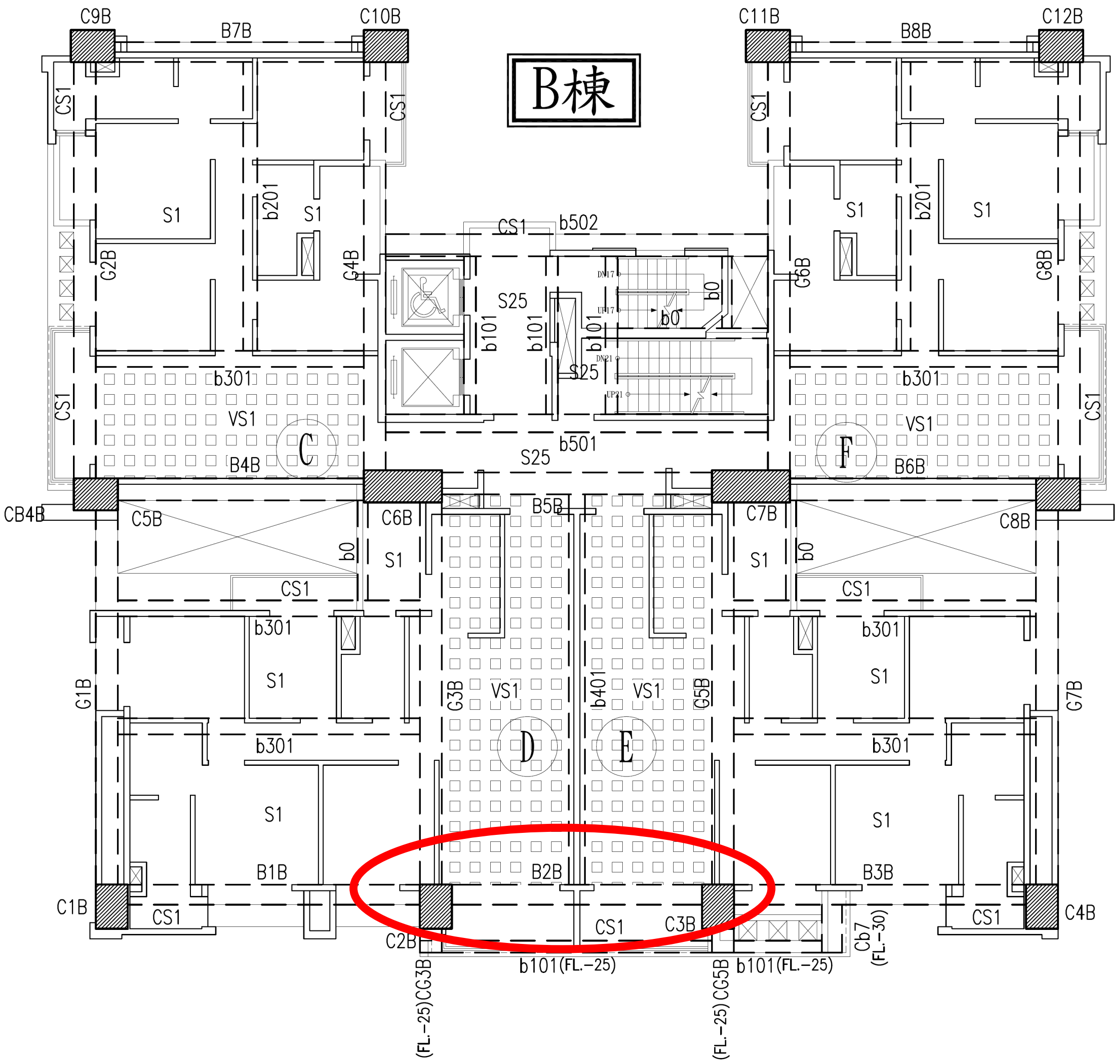
四、結構桿件設計說明

4-1 鋼筋混凝土梁韌性設計

鋼筋混凝土梁之韌性設計(附篇 B、C)

以 15FL (BAY NO.18),梁編號 B2B 為例



(一) 已知條件

Fy＝	4200	kg/cm^2	Fc'＝	245	kg/cm^2
F_{vy}＝	4200	kg/cm^2	Ln＝	7.1	m
B＝	50	cm	H＝	75	cm
d'＝	7	cm	d＝	68	cm

(二) 基本設計資料

m＝	20.17		ρ_b＝ 0.025
Fs'＝	4200	kg/cm^2	
AS_{max}＝	63.75	cm^2 ------------	(0.025×B×d,(f'c+100)/4fy×B×d)
AS_{min}＝	11.33	cm^2 ------------	(14/fy×B×d , 0.8$\sqrt{fc'}$/fy×B×d)
Vn_{max}＝	141.03	T -----------	(2.65$\sqrt{fc'}$×B×d)

(三) 梁分析後所得之應力

FORCE	Mi (T-m)	Vi (T)	Mj (T-m)	Vj (T)
DL	-21.23	-16.02	-21.06	15.96
LL	-3.54	-2.63	-3.56	2.63
AEQ	42.76	13.57	-42.72	13.57
BEQ	47.88	15.19	-47.84	15.19
DYN	49.54	15.72	49.51	15.72

(四) 計算梁設計彎矩Mu

載重組合：

1.4×MD+1.7×ML

0.75(1.4×MD+1.7×ML)±1.00×MEh±0.30×Mev

0.75(1.4×MD+1.7×ML)±0.30×MEh±1.00×Mev

0.9×MD±1.00×MEh±0.30×MEv

0.9×MD±0.30×MEh±1.00×MEv

NOTE： ME={AEQ；BEQ；DYN}取大值

	i端			j端	
－Mu＝	-79.80	T-M (36)	－Mu＝	-79.61	T-M (37)
＋Mu＝	33.88	T-M (47)	＋Mu＝	34.00	T-M (46)

(五)　計算樑AS

	i端			j端	
AST＝	34.59	cm^2 >Asmin OK	AST＝	34.5	cm^2 >Asmin OK
ASB＝	13.74	cm^2 >Asmin OK	ASB＝	13.79	cm^2 >Asmin OK

↓

(六)　樑主筋配筋(AST≧ASB/2；ASB≧AST/2)

	i端			j端	
TOP：	5 -#8		TOP：	5 -#8	
	2 -#8			2 -#8	
AST＝	35.49	cm^2 <Asmax OK	AST＝	35.49	cm^2 <Asmax OK
BOT：	0 -#8		BOT：	0 -#8	
	4 -#8			4 -#8	
ASB＝	20.28	cm^2 <Asmax OK	ASB＝	20.28	cm^2 <Asmax OK

↓

(七)　樑剪力筋設計

設計應力組合：
1.4×VD+1.7×VL
0.75(1.4×VD+1.7×VL)±1.00×Veh
0.75(1.4×VD+1.7×VL)±0.30×VEh±1.00×Vev
0.9×VD±1.00×VEh±0.30×VEv
0.9×VD±0.30×VEh±1.00×VEv

NOTE：
VE＝{AEQ；BEQ；DYN}取大值
VPi＝(MTi+MBj) / Ln
VPj＝(MBi+MTj) / Ln
Vei＝0.75(1.4×VDi+1.7×VLi)+VPi
Vej＝0.75(1.4×VDj+1.7×VLj)+VPj

↓

(八)　計算樑彎矩強度Mpr (Fs=1.25Fy　φ=1.0)

	i端			j端	
以AST＝	35.49	cm^2 爲張力筋	以AST＝	35.49	cm^2 爲張力筋
ASB＝	20.28	cm^2 爲壓力筋	ASB＝	20.28	cm^2 爲壓力筋
得MTi＝	-114.95	T-M	得MTj＝	-114.95	T-M
以AST＝	35.49	cm^2 爲壓力筋	以AST＝	35.49	cm^2 爲壓力筋
ASB＝	20.28	cm^2 爲張力筋	ASB＝	20.28	cm^2 爲張力筋
得MBi＝	67.50	T-M	得MBj＝	67.50	T-M

↓

(九)　計算樑設計剪力Vu

i端			j端		
Vpi＝	(MTi+MBj) / Ln		Vpj＝	(MTj+MBi) / Ln	
＝	25.7	T	＝	25.7	T
Vvi＝	0.75(1.4*VDi+1.7VLi)		Vvj＝	0.75(1.4*VDj+1.7VLj)	
＝	20.17	T	＝	20.11	T
Vei＝	Vpi+Vvi		Vej＝	Vpj+Vvj	
＝	45.87	T	＝	45.81	T

(十)　計算剪力鋼筋量及配筋

i端			j端		
Vn＝	45.87	÷0.85	Vn＝	45.81	÷0.85
	53.96	t<Vmax　ok		53.89	t<Vmax　ok
Vc＝	0	(Vpi>0.5Vei)	Vc＝	0	(Vpi>0.5Vei)
AV/S＝	(Vn - Vc)÷(fy × d)		AV/S＝	(Vn - Vc)÷(fy × d)	
＝	0.189	cm^2/cm	＝	0.189	cm^2/cm

STIR：	1-#4@12		STIR：	1-#4@12	
Avt/S＝	0.212	cm^2/cm	Avt/S＝	0.212	cm^2/cm

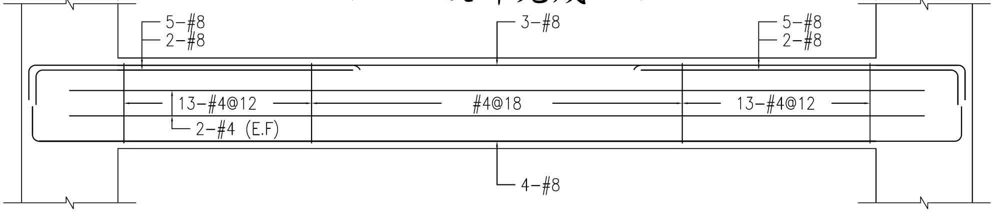
(十一)　樑(中央)分析後所得之應力及設計彎矩、剪力

FORCE	Mc (T-m)	Vc (T)				
DL	18.59	-9.26		－Mu＝	0.00	T-M (0)
LL	3.24	1.68	→	＋Mu＝	31.53	T-M (1)
AEQ	0.02	13.57		Vu＝	25.25	T (44)
BEQ	0.02	15.19				
DYN	0.02	15.72				

(十二)　計算樑(中央)斷面鋼筋量及配筋

AS計算				配筋	
AST＝	0	cm^2		AST＝	15.21 cm^2 (3-#8)
ASB＝	12.75	cm^2	→	ASB＝	20.28 cm^2 (4-#8)
AV/S＝	(Vu/ ϕ - Vc)÷(fy × d)			STIR：	1-#4@18
＝	0.104	cm^2/cm		Avt/S＝	0.141 cm^2/cm

設計完成

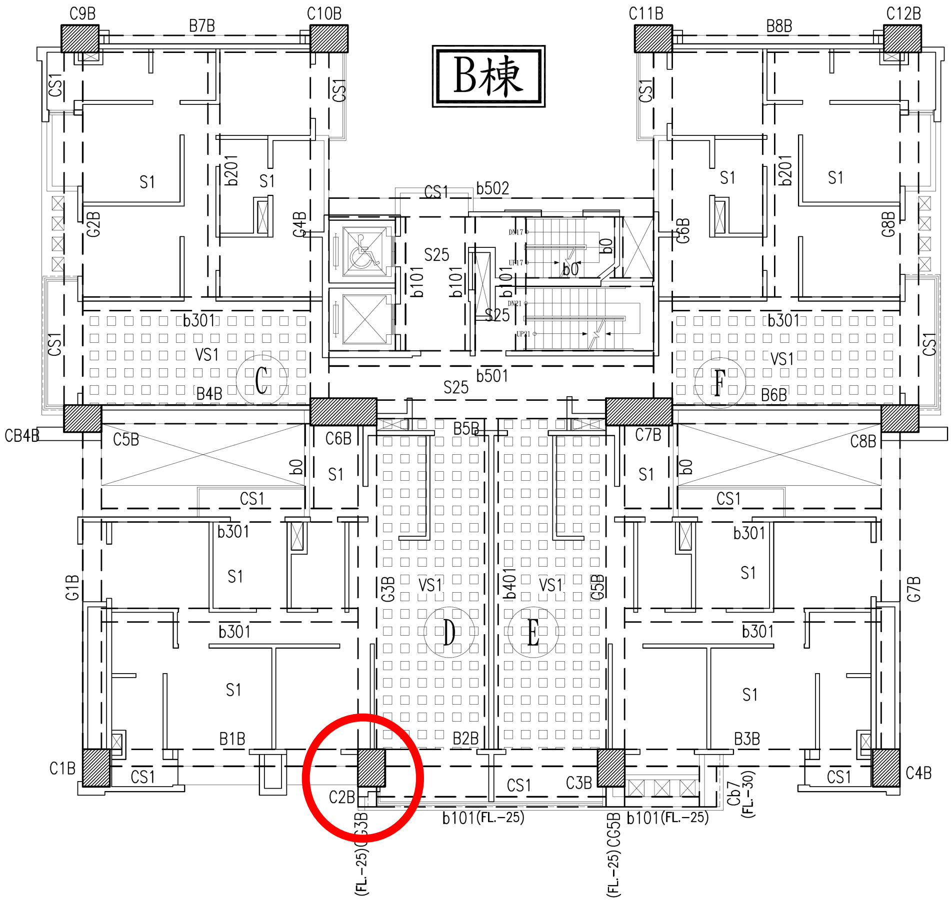


15F B2B (50x75)

4-2 鋼筋混凝土柱韌性設計

鋼筋混凝土柱之韌性設計(附篇 B、C)

以 5FL (COL. NO.15),柱編號 C2B 為例 (CHECK X 向)



(一) 已知條件

Fc'＝	245	kg/cm^2	Fy＝	4200	kg/cm^2
D_{maj}＝	80	cm	D_{min}＝	110	cm
Hn＝	230	cm	F_{vy}＝	4200	kg/cm^2

(二) 柱彈性分析所得之應力

COLUMN FORCES AT LEVEL 6F 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	(T-m) TORSIONAL MOMENT
15	CASE 1	TOP	9.98	-8.80	23.06	-19.97	-682.69	0.06
		BOTTOM	-10.27		-22.95			
15	CASE 2	TOP	1.94	-1.73	3.84	-3.30	-106.83	0.01
		BOTTOM	-2.03		-3.77			
15	CASE 3	TOP	-78.10	69.34	3.69	-2.44	64.51	-3.61
		BOTTOM	81.39		-1.94			
15	CASE 4	TOP	-93.73	82.68	5.97	-5.00	65.32	0.85
		BOTTOM	96.43		-5.55			
15	CASE 5	TOP	91.42	80.06	13.74	12.28	52.59	3.80
		BOTTOM	93.89		15.82			

(三) 柱主筋彈性設計結果

由第1組載重組合控制

	Pu(T)	Mumaj(T-m)	Vumaj(T)	Mumin(T-m)	Vumin(T)	Tu(T-m)
TOP	-1101.05	43.21	-14.67	53.11	-32.45	0.1
BOTTOM		43.21		53.11		

As,req= 33.5 cm^2

(四) 求樑彎矩強度和ΣMbn Ln=7.30m Ls1=3.75m ts=18cm

```
考慮T型梁(僅一側翼板)=min(Ln/12,6×ts,(Ls1)/2)=min(60.83,108,187.5)=60.83cm
版配筋#3@15(fy=2800)
T型梁內版筋總量=1×60.83/15×0.71=     2.88cm2
[ 柱  頂 ]

B1B(50x80)          (6F bay 17 )
                B=      50     cm                          AST=     6- #10   + 2.88cm2
                D=      80     cm                          ASB=     6- #10
 ----------------------------------------------
 [Mbpc_clock     =Mpj_bottom-Vp_cntclock*col_wide*0.01=  191.42 (t-m)]
 [Mbpc_cntclock =Mpj_top    -Vp_clock    *col_wide*0.01= -187.27 (t-m)]
 [Mbnc_clock     =Mnj_bottom-Vn_cntclock*col_wide*0.01=  154.38 (t-m)]
 [Mbnc_cntclock =Mnj_top    -Vn_clock    *col_wide*0.01= -150.93 (t-m)]
-------------------------------------------------------------------------------
B2B(50x80)          (6F bay 18 )
                B=      50     cm                          AST=     8- #10
                D=      80     cm                          ASB=     6- #10
 ----------------------------------------------
 [Mbpc_clock     =Mpi_top    +Vp_cntclock*col_wide*0.01= -249.29 (t-m)]
 [Mbpc_cntclock =Mpi_bottom+Vp_clock    *col_wide*0.01=  196.44 (t-m)]
 [Mbnc_clock     =Mni_top    +Vn_cntclock*col_wide*0.01= -201.92 (t-m)]
 [Mbnc_cntclock =Mni_bottom+Vn_clock    *col_wide*0.01=  158.11 (t-m)]
-------------------------------------------------------------------------------

[ 柱  底 ]

B1B(50x80)          (5F bay 17 )
                B=      50     cm                          AST=     6- #10   + 2.88cm2
                D=      80     cm                          ASB=     6- #10
-------------------------------------------------------------------------------
 [Mbpc_clock     =Mpj_bottom-Vp_cntclock*col_wide*0.01=  191.42 (t-m)]
 [Mbpc_cntclock =Mpj_top    -Vp_clock    *col_wide*0.01= -187.27 (t-m)]
 [Mbnc_clock     =Mnj_bottom-Vn_cntclock*col_wide*0.01=  154.38 (t-m)]
 [Mbnc_cntclock =Mnj_top    -Vn_clock    *col_wide*0.01= -150.93 (t-m)]
-------------------------------------------------------------------------------
B2B(50x80)          (5F bay 18 )
                B=      50     cm                          AST=     8- #10
                D=      80     cm                          ASB=     6- #10
-------------------------------------------------------------------------------
 [Mbpc_clock     =Mpi_top    +Vp_cntclock*col_wide*0.01= -249.29 (t-m)]
 [Mbpc_cntclock =Mpi_bottom+Vp_clock    *col_wide*0.01=  196.44 (t-m)]
 [Mbnc_clock     =Mni_top    +Vn_cntclock*col_wide*0.01= -201.92 (t-m)]
 [Mbnc_cntclock =Mni_bottom+Vn_clock    *col_wide*0.01=  158.11 (t-m)]
-------------------------------------------------------------------------------
```

↓

(五) 強柱弱樑設計分配彎矩

```
5F上半層柱分配彎矩
[R_top=Mc/fabs(Mc_up-Mc)=          0.56
-------------------------------------------------------------------------------
[Mcu_top_clock    =R_top * 1.2Σ(φbxMbn_sum_clock)    = -203.24(t-m)]
[Mcu_top_cntclock=R_top * 1.2Σ(φbxMbn_sum_cntclock)= -179.59(t-m)]
Mcu_top_clock(face)       =fabs(Mcu_top_clock)    -fabs(Vcu_clock)*D*0.01    =  109.58
Mcu_top_cntclock(face)    =fabs(Mcu_top_cntclock)-fabs(Vcu_cntclock)*D*0.01=  96.83
-------------------------------------------------------------------------------
                                                          [ Mcu  =109.58]

5F下半層柱分配彎矩
[R_bottom=Mc/fabs(Mc-Mc_down)=          0.44
-------------------------------------------------------------------------------
[Mcu_bottom_clock    =R_bottom * 1.2Σ(φbxMbn_sum_clock)    =  159.69(t-m)]
[Mcu_bottom_cntclock=R_bottom * 1.2Σ(φbxMbn_sum_cntclock)=  141.11(t-m)]
Mcu_bottom_clock(face)    =fabs(Mcu_bottom_clock)    =  159.69
Mcu_bottom_cntclock(face)=fabs(Mcu_bottom_cntclock)=  141.11
-------------------------------------------------------------------------------
                                                         [ Mcu  = 159.69]
```

(六) 柱主筋配筋

彈性分析鋼筋設計 (第1組載重組合控制)

Pu＝	-1101.05	T	Mu_{maj}＝	43.21	T-M
Mu_{min}＝	53.11	T-M	As＝	33.5	cm^2

強柱弱樑分析鋼筋設計 (柱底控制)

Pu＝	-1101.05	T	Mu_{maj}＝	159.4	T-M
Mu_{min}＝	0	T-M	As＝	139.6	cm^2
			As(req)＝	139.6	cm^2
主筋：	30- #8		As(pro)＝	152.1	cm^2

↓

(七) 求柱設計剪力(梁 Mpr ： Fs=1.25Fy φ=1.0 ，韌性分析剪力)

柱頂分配彎矩

```
[R_top=Mc/fabs(Mc_up-Mc)=      0.56
--------------------------------------------------------------------------------
[Mcp_top_clock    =R_top * fabs(Mbp_sum_clock)      = -233.09(t-m)]
[Mcp_top_cntclock=R_top * fabs(Mbp_sum_cntclock)    = -206.48(t-m)]
```

柱底分配彎矩

```
[R_bottom=Mc/fabs(Mc-Mc_down)=          0.44
--------------------------------------------------------------------------------
[Mcp_bottom_clock    =R_bottom * fabs(Mbp_sum_clock)       =  183.14(t-m)]
[Mcp_bottom_cntclock=R_bottom * fabs(Mbp_sum_cntclock)    =  162.23(t-m)]
--------------------------------------------------------------------------------

 Vp=(Mtop-Mbot)/H
 [H=     3.1 m]
 [Vcp_clock    =fabs((Mcp_top_clock    -Mcp_bottom_clock    )/H)=  134.27]
 [Vcp_cntclock=fabs((Mcp_top_cntclock-Mcp_bottom_cntclock)/H)=  118.94]
 [Vcu_clock    =fabs((Mcu_top_clock    -Mcu_bottom_clock    )/H)=  117.08]
 [Vcu_cntclock=fabs((Mcu_top_cntclock-Mcu_bottom_cntclock)/H)=  103.45]
--------------------------------------------------------------------------------
                                               [  Vp   =        134.27 ]
```

} 梁產生塑角之對應剪力 (Vcp)

} 強柱弱梁之對應剪力 (Vcu)

↓

(八) 計算柱橫向鋼筋

柱圍束區箍筋量之公式：

Ash/S=0.30 × hc × (Ag/Ac-1)×(fc' / fy)------- eq.(1)

Ash/S=0.09 × hc × (fc' / fy)------------------ eq.(2)

柱中央區剪力筋之公式：

Av/S=(Vmax/ ϕ -Vc) / (fy×d)-------------------- eq.(3)

(major)

(IF Pu<0.05Agfc',Vc=0)

Vu(max)＝ 134.27 T

hc＝ 100.73cm

Ag＝ 8800cm2

Ac＝ 7344cm2

Ash/S= 0.529 cm^2/cm (圍束區) <--- 由 eq.(2) 控制

Avh/S= 0.210 cm^2/cm (中央區)

(minor)

Ash/S= 0.371 cm^2/cm (圍束區) <--- 由 eq.(2) 控制

Avh/S= 0.079 cm^2/cm (中央區)

(九) 柱圍束區及中央區之箍筋量配置

(major)

圍束區：	(Hoop：1-#4+Ties：4-#4) @ 10	Ash/S=	0.762	cm^2/cm
中央區：	(Hoop：1-#4+Ties：4-#4) @ 15	Avh/S=	0.508	cm^2/cm

(minor)

圍束區：	(Hoop：1-#4+Ties：2-#4) @ 10	Ash/S=	0.508	cm^2/cm
中央區：	(Hoop：1-#4+Ties：2-#4) @ 15	Avh/S=	0.339	cm^2/cm

柱設計及配筋完成

```
C2B   (COL. LINE :15)
+----------------------------------------------------------------------------+
| FL:5F      ( 80.0)x(110.0)    Fc'=245   Fy=4200   Fyh=4200                 |
|                                  +-------------+                           |
| As( 1)= 139.6<  A>               |             |     o 30-#8  [ 152.1]     |
|          1.6%[ 15]               |             |       X- 7( 0)            |
|                                  |             |       Y-10( 0)            |
| Maj.Av/S=  0.529                 |             |     Hoop: 1-#4            |
|            0.210<  B>[ 15]       |             |     Ties: 4-#4 @ 10 - 15|
| Min.Av/S=  0.371                 |             |           2-#4            |
|            0.079<  B>[ 15]       +-------------+                           |
+----------------------------------------------------------------------------+
```