

表 3.1 SRC 短柱軸壓試驗之試體規劃表

Column Cross-Section	Specimen Designation	Hoop/Spiral		Hoop/Spiral Spacing (mm)	Volume Ratio	Weight of Hoop/Spiral (N/m)	Reduction Factor	Design Guide
		Small Circle	Big Circle					
	SRC1-HC-ACI-60	#4		60	1.67%	616	1.00	ACI-318 Code
	SRC2-HC-TWN-75	#4		75	1.34%	494	0.79	Taiwan SRC Code
	SRC3-HC-WENG-90	#4		90	1.11%	410	0.65	Weng's Formula
	SRC4-HC-TWN-75	#4		75	1.34%	298	0.79	Taiwan SRC Code
	SRC5-HC-WENG-90	#4		90	1.11%	248	0.65	Weng's Formula
	SRC6-HB-TWN-75	#4		75	1.34%	494	0.79	Taiwan SRC Code
	SRC7-HB-WENG-85	#4		85	1.18%	433	0.68	Weng's Formula
	SRC8-YC-ACI-75	#3	#4	75	1.25%	360	1.00	ACI-318 Code
	SRC9-YC-TWN-95	#3	#4	95	0.99%	283	0.79	Taiwan SRC Code
	SRC10-YC-WENG-115	#3	#4	115	0.81%	235	0.65	Weng's Formula
	SRC11-YC-S1-60	#3	#4	60	1.56%	449	---	Spacing = SRC1
	SRC12-YC-S2-75	#3	#4	75	1.26%	360	---	Spacing = SRC2
	SRC13-YC-S3-90	#3	#4	90	1.04%	299	---	Spacing = SRC3
	SRC14-YB-TWN-95	#3	#4	95	0.99%	283	0.79	Taiwan SRC Code
	SRC15-YB-WENG-110	#3	#4	110	0.85%	245	0.68	Weng's Formula
	SRC16-YC-HS-TWN-105	#3	#4	105	0.88%	256	0.70	Taiwan SRC Code
	SRC17-YC-HS-WENG-130	#3	#4	130	0.71%	208	0.57	Weng's Formula
	SRC18-YC-HC-TWN-65	#3	#5	65	2.18%	557	0.87	Taiwan SRC Code
	SRC19-YC-HC-WENG-80	#3	#5	80	1.73%	453	0.69	Weng's Formula
	SRC20-YB-HC-TWN-65	#3	#5	65	2.18%	557	0.87	Taiwan SRC Code
	SRC21-YB-HC-WENG-80	#3	#5	80	1.83%	453	0.73	Weng's Formula
	RC-Y-ACI-75	#3	#4	75	1.25%	360	1.00	ACI-318 Code

Note :

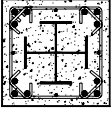
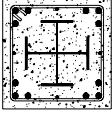
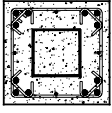
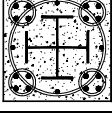
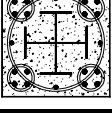
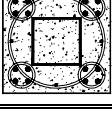
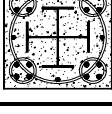
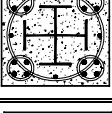
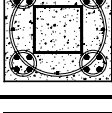
- (1) SRC Short column dimensions : Height : 1200 mm ; Cross-section : 600 × 600 mm
- (2) Steel section in SRC column : A572 Gr.50 ; $f_{ys} = 343 \text{ MPa}$
 Cross H : 2H350 × 175 × 6 × 9 ; $\rho_s = 2.91\%$
 Cross H : 2H350 × 200 × 9 × 14 ; $\rho_s = 4.72\%$ (SRC16 and SRC17 only)
 Box section : □275 × 275 × 10 × 10 ; $\rho_s = 2.94\%$
- (3) (A) Longitudinal bar in SRC hoop Column : 12 #9 (D29) ; $\rho_r = 2.15\%$; SD420 ; $f_{yr} = 412 \text{ MPa}$
 (B) Longitudinal bar in SRC spiral Column : 16 #8 (D25) ; $\rho_r = 2.25\%$; SD420 ; $f_{yr} = 412 \text{ MPa}^2$
 Supplementary longitudinal bar : 4 #4 (D13) ; Cut 50 mm short at each end.
- (4) Hoop (Spiral) : #3 (D10) 、 #4 (D13) and #5 (D16) ; SD420 ; $f_{yh} = 412 \text{ MPa}$
- (5) Longitudinal bar in RC column :
 RC : 16 # 8 (D25) and 12 # 9 (D29) ; $\rho_r = 4.40\%$; SD420 ; $f_{yh} = 412 \text{ MPa}$

表 3.2 SRC 短柱試體之材料強度表

Material Strength	Steel				Reinforcement				Concrete	
	Plate Thickness (mm)				#3	#4	#8	#9	Normal ⁽¹⁾ Strength Concrete	High ⁽²⁾ Strength Concrete
	6	9	10	14						
f_y (MPa)	437	454	419	429	494	472	451	439	f'_c (MPa)	f'_c (MPa)
f_u (MPa)	546	574	524	549	737	750	698	687	41.9	75.5

註：(1)本研究之試體除了試體 SRC18、19、20、21 之外，均採用一般常重混凝土，其 28 天之平均抗壓強度為 41.9 MPa。
 (2)本研究之試體 SRC18、19、20、21，採用高強度混凝土，其 28 天之平均抗壓強度為 75.5 MPa。

表 3.3 本研究 SRC 與 RC 短柱試體之軸向抗壓強度比較

Column Cross-Section	Specimen Designation	$(P_n)^{(1)}$ (kN)	$(P_u)_{squash}^{(2)}$ (kN)	$(P_u)_{test}^{(3)}$ (kN)	$\frac{(P_u)_{test}}{(P_n)}$	$\frac{(P_u)_{test}}{(P_u)_{squash}}$	Design Guide
	SRC1-HC-ACI-60	16765	16912	20856	1.24	1.23	ACI-318 Code
	SRC2-HC-TWN-75	16765	16912	19885	1.19	1.18	Taiwan SRC Code
	SRC3-HC-WENG-90	16765	16912	19110	1.14	1.13	Weng's Formula
	SRC4-HC-TWN-75	16765	16912	18188	1.08	1.08	Taiwan SRC Code
	SRC5-HC-WENG-90	16765	16912	17952	1.07	1.06	Weng's Formula
	SRC6-HB-TWN-75	16795	17040	18639	1.11	1.09	Taiwan SRC Code
	SRC7-HB-WENG-85	16795	17040	19522	1.16	1.15	Weng's Formula
	SRC8-YC-ACI-75	16903	17148	20964	1.24	1.22	ACI-318 Code
	SRC9-YC-TWN-95	16903	17148	20199	1.19	1.18	Taiwan SRC Code
	SRC10-YC-WENG-115	16903	17148	20630	1.22	1.20	Weng's Formula
	SRC11-YC-S1-60	16903	17148	23093	1.37	1.35	Spacing = SRC1
	SRC12-YC-S2-75	16903	17148	21337	1.26	1.24	Spacing = SRC2
	SRC13-YC-S3-90	16903	17148	20827	1.23	1.21	Spacing = SRC3
	SRC14-YB-TWN-95	16932	17275	20209	1.19	1.17	Taiwan SRC Code
	SRC15-YB-WENG-110	16932	17275	19228	1.14	1.11	Weng's Formula
	SRC16-YC-HS-TWN-105	18943	19846	21562	1.14	1.09	Taiwan SRC Code
	SRC17-YC-HS-WENG-130	18943	19846	19954	1.05	1.01	Weng's Formula
	SRC18-YC-HC-TWN-65	26860	24711	29253	1.09	1.18	Taiwan SRC Code
	SRC19-YC-HC-WENG-80	26860	24711	24859	0.93	1.01	Weng's Formula
	SRC20-YB-HC-TWN-65	26889	24839	30745	1.14	1.24	Taiwan SRC Code
	SRC21-YB-HC-WENG-80	26889	24839	28940	1.08	1.17	Weng's Formula
	RC-Y-ACI-75	16569	16324	18109	1.09	1.11	ACI-318 Code

NOTE : (1) Ultimate design compressive strength $(P_n) = 0.85 f'_c A_c + A_s F_{ys} + A_r F_{yr}$
(2) Ultimate squash compressive strength $(P_n)_{squash} = 0.85 (f'_c)_{test} A_{cc} + A_s (F_{ys})_{test} + A_r (F_{yr})_{test}$
(3) Test compressive strength

表 3.4 未受圍束與受圍束之混凝土抗壓強度的比較

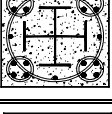
Column Cross-Section	Specimen Designation	f'_c ⁽¹⁾ (MPa)	f'_{cc} ⁽²⁾ (MPa)	$\frac{f'_{cc}}{0.85f'_c}$ ⁽³⁾	Weight of Hoop/Spiral (N/m)	Design Guide
	SRC1-HC-ACI-60	41.9	50.4	1.42	616	ACI-318 Code
	SRC2-HC-TWN-75	41.9	46.7	1.31	494	Taiwan SRC Code
	SRC3-HC-WENG-90	41.9	43.8	1.23	410	Weng's Formula
	SRC4-HC-TWN-75	41.9	40.4	1.13	298	Taiwan SRC Code
	SRC5-HC-WENG-90	41.9	39.5	1.11	248	Weng's Formula
	SRC6-HB-TWN-75	41.9	41.6	1.17	494	Taiwan SRC Code
	SRC7-HB-WENG-85	41.9	44.9	1.26	433	Weng's Formula
	SRC8-YC-ACI-75	41.9	50.0	1.41	360	ACI-318 Code
	SRC9-YC-TWN-95	41.9	47.1	1.32	283	Taiwan SRC Code
	SRC10-YC-WENG-115	41.9	48.7	1.37	235	Weng's Formula
	SRC11-YC-S1-60	41.9	58.0	1.63	449	Spacing = SRC1
	SRC12-YC-S2-75	41.9	51.4	1.45	360	Spacing = SRC2
	SRC13-YC-S3-90	41.9	49.5	1.39	299	Spacing = SRC3
	SRC14-YB-TWN-95	41.9	46.7	1.31	283	Taiwan SRC Code
	SRC15-YB-WENG-110	41.9	43.0	1.21	245	Weng's Formula
	SRC16-YC-HS-TWN-105	41.9	42.0	1.18	256	Taiwan SRC Code
	SRC17-YC-HS-WENG-130	41.9	36.0	1.01	208	Weng's Formula
	SRC18-YC-HC-TWN-65	75.5	81.3	1.27	557	Taiwan SRC Code
	SRC19-YC-HC-WENG-80	75.5	64.7	1.01	453	Weng's Formula
	SRC20-YB-HC-TWN-65	75.5	86.5	1.35	557	Taiwan SRC Code
	SRC21-YB-HC-WENG-80	75.5	79.6	1.24	453	Weng's Formula
	RC-Y-ACI-75	41.9	42.3	1.19	360	ACI-318 Code

Note : (1) Unconfined compressive strength of concrete from cylinder test at 28 days.

(2) Calculated compressive strength of confined concrete in the column : $f'_{cc} = [(P_u)_{test} - A_s(f_{ys})_{test} - A_r(f_{yr})_{test}] / A_{cc}$

(3) The unconfined concrete strength $0.85f'_c$ is used to account for the influence of size effect .

表 3.5 本研究之 RC 與 SRC 短柱之韌性比較

Column Cross-Section	Specimen Designation	$\epsilon_{P_u}^{(1)}$	$\epsilon_{0.7P_u}^{(2)}$	$\frac{\epsilon_{0.7P_u}}{\epsilon_{P_u}}$	Design Guide
	SRC1-HC-ACI-60	0.0094	0.0491	5.22	ACI-318 Code
	SRC2-HC-TWN-75	0.0090	0.0440	4.89	Taiwan SRC Code
	SRC3-HC-WENG-90	0.0079	0.0361	4.57	Weng's Formula
	SRC4-HC-TWN-75	0.0078	0.0255	3.27	Taiwan SRC Code
	SRC5-HC-WENG-90	0.0088	0.0317	3.60	Weng's Formula
	SRC6-HB-TWN-75	0.0073	0.0306	4.19	Taiwan SRC Code
	SRC7-HB-WENG-85	0.0067	0.0270	4.03	Weng's Formula
	SRC8-YC-ACI-75	0.0117	0.0509	4.35	ACI-318 Code
	SRC9-YC-TWN-95	0.0115	0.0546	4.75	Taiwan SRC Code
	SRC10-YC-WENG-115	0.0099	0.0446	4.51	Weng's Formula
	SRC11-YC-S1-60	0.0103	0.0496	4.82	Spacing = SRC1
	SRC12-YC-S2-75	0.0115	0.0581	5.05	Spacing = SRC2
	SRC13-YC-S3-90	0.0101	0.0433	4.29	Spacing = SRC3
	SRC14-YB-TWN-95	0.0076	0.0266	3.50	Taiwan SRC Code
	SRC15-YB-WENG-110	0.0075	0.0234	3.12	Weng's Formula
	SRC16-YC-HS-TWN-105	0.0125	0.0344	2.75	Taiwan SRC Code
	SRC17-YC-HS-WENG-130	0.0096	0.0417	4.34	Weng's Formula
	SRC18-YC-HC-TWN-65	0.0087	0.0563	6.47	Taiwan SRC Code
	SRC19-YC-HC-WENG-80	0.0107	0.0615	5.75	Weng's Formula
	SRC20-YB-HC-TWN-65	0.0096	0.0455	4.74	Taiwan SRC Code
	SRC21-YB-HC-WENG-80	0.0089	0.0232	2.61	Weng's Formula
	RC-Y-ACI-75	0.0099	0.0263	2.65	ACI-318 Code

Note : (1) Compressive strain of column at ultimate axial load.

(2) Compressive strain of column at 70% ultimate axial load after reaching maximum capacity.

(3) μ is the ductility index of the column, $\mu = \epsilon_{0.7P_u} / \epsilon_{P_u}$.

表 3.6 本研究之 RC 與 SRC 短柱之強度、韌性及箍筋用量經濟效益分析

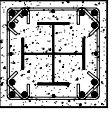
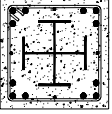
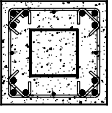
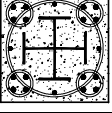
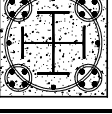
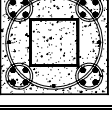
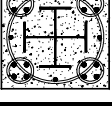
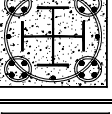
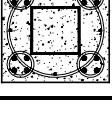

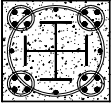
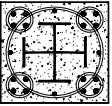
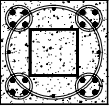
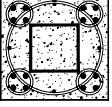
Column Cross-Section	Specimen Designation	$\frac{(P_u)_{test}}{(P_n)_{squash}}$	$\frac{\epsilon_{0.7P_u}}{\epsilon_{P_u}}$	Volumetric Ratio	Weight of Hoop/Spiral (N/m)	Reduction Factor	Design Guide
	SRC1-HC-ACI-60	1.23	5.22	1.67%	616	1.00	ACI-318 Code
	SRC2-HC-TWN-75	1.18	4.89	1.34%	494	0.79	Taiwan SRC Code
	SRC3-HC-WENG-90	1.13	4.57	1.11%	410	0.65	Weng's Formula
	SRC4-HC-TWN-75	1.08	3.27	1.34%	298	0.79	Taiwan SRC Code
	SRC5-HC-WENG-90	1.06	3.60	1.11%	248	0.65	Weng's Formula
	SRC6-HB-TWN-75	1.09	4.19	1.34%	494	0.79	Taiwan SRC Code
	SRC7-HB-WENG-85	1.15	4.03	1.18%	433	0.68	Weng's Formula
	SRC8-YC-ACI-75	1.22	4.35	1.25%	360	1.00	ACI-318 Code
	SRC9-YC-TWN-95	1.18	4.75	0.99%	283	0.79	Taiwan SRC Code
	SRC10-YC-WENG-115	1.20	4.51	0.81%	235	0.65	Weng's Formula
	SRC11-YC-S1-60	1.35	4.82	1.56%	449	---	Spacing = SRC1
	SRC12-YC-S2-75	1.24	5.05	1.26%	360	---	Spacing = SRC2
	SRC13-YC-S3-90	1.21	4.29	1.04%	299	---	Spacing = SRC3
	SRC14-YB-TWN-95	1.17	3.50	0.99%	283	0.79	Taiwan SRC Code
	SRC15-YB-WENG-110	1.11	3.12	0.85%	245	0.68	Weng's Formula
	SRC16-YC-HS-TWN-105	1.09	2.75	0.88%	256	0.70	Taiwan SRC Code
	SRC17-YC-HS-WENG-130	1.01	4.34	0.71%	208	0.57	Weng's Formula
	SRC18-YC-HC-TWN-65	1.18	6.47	2.18%	557	0.87	Taiwan SRC Code
	SRC19-YC-HC-WENG-80	1.01	5.75	1.73%	453	0.69	Weng's Formula
	SRC20-YB-HC-TWN-65	1.24	4.74	2.18%	557	0.87	Taiwan SRC Code
	SRC21-YB-HC-WENG-80	1.17	2.61	1.83%	453	0.73	Weng's Formula
	RC-Y-ACI-75	1.11	2.65	1.25%	360	1.00	ACI-318 Code

表 4.1 SRC 柱反覆載重試驗：試體規劃表

Column Cross-Section	Specimen Designation	Spiral Size		Spiral Spacing (mm)	Volume Ratio	Spiral Weight (N/m)	Spiral Reduction Factor	Design Guide
		Small Circle	Big Circle					
	C-SRC1-TWN-95	#3	#4	95	0.99%	283	0.79	Taiwan SRC Code
	C-SRC2-WENG-115	#3	#4	115	0.81%	235	0.65	Weng's Formula
	C-SRC3-TWN-95	#3	#4	95	0.99%	283	0.79	Taiwan SRC Code
	C-SRC4-WENG-110	#3	#4	110	0.85%	245	0.68	Weng's Formula

Note : (1) Total number of SRC column cyclic test specimens : 4
 (2) SRC column dimensions : Height : 3550 mm ; Cross-section : 600 × 600 mm
 RC foundation size : 2500 × 1800 × 750 mm
 Full height of the specimen including RC foundation : 4300 mm
 Top portion of SRC column is enlarged to 600× 600× 900 mm to connect the MTS actuator .
 (3) Steel section in SRC column : A572 Gr.50 ; $f_{ys} = 343 \text{ MPa}$
 Cross H in SRC1 and SRC2 : 2H350 × 175 × 6 × 9 ; $\rho_s = 2.91\%$
 Box section in SRC3 and SRC4 : □275 × 275 × 10 × 10 ; $\rho_s = 2.91\%$
 (4) Longitudinal reinforcements in SRC column : 16 #8 (D25) ; $\rho_r = 2.25\%$; SD420 ; $f_{yr} = 412 \text{ MPa}$
 Supplementary longitudinal reinforcements : 4 #4 (D13) as required in Taiwan SRC code.
 (5) Spiral : #3 (D10) 、 #4 (D13) ; SD420 ; $f_{yh} = 412 \text{ MPa}$
 (6) Normal weight concrete : $f'_c = 34.3 \text{ MPa}$

表 4.2 SRC 柱反覆載重試驗之材料強度

Material Strength	Steel			Reinforcement			Concrete	
	Plate Thickness (mm)			#3	#4	#8	f'_c (MPa)	
	6	9	10					
f_y (MPa)	365	457	422	414	444	453	37.3	40.0
f_u (MPa)	468	557	538	541	651	649	(C-SRC1、 C-SRC2)	(C-SRC3、 C-SRC4)

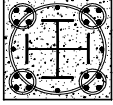
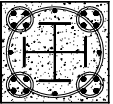
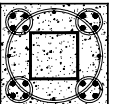
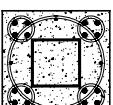
表 4.3 試體反覆載重加載歷程

Drift Angle (% rad.)	Displacement (mm)	Number of Cycle
0.25	8.1	2
0.5	16.3	2
0.75	24.4	2
1.0	32.5	2
1.5	48.8	2
2.0	65.0	2
3.0	97.5	2
4.0	130.0	2
5.0	162.5	2
6.0	195.0	2

表 4.4 試體混凝土彈性模數折減係數 β 及 γ

Specimen Designation	β			γ
	Drift Angle (rad.)			
	0.5%	0.75%	1.0%	
C-SRC1-TWN-95	0.48	0.41	0.37	0.35
C-SRC2-WENG-115	0.49	0.41	0.38	0.32
C-SRC3-TWN-95	0.43	0.36	0.32	0.31
C-SRC4-WENG-110	0.42	0.34	0.30	0.29

表 4.5 五螺箍 SRC 柱之強度分析與比較

Column Cross-Section	Specimen Designation	P_a (kN) (1)	$P_{P-\Delta}$ (kN) (2)	P_h (kN) (3)	$(P_h)_{test}$ (kN) (4)	$(M_n)_{SRC}$ (kN-m) (5)	$(M_n)_{test}$ (kN-m) (6)	$\frac{(M_n)_{test}}{(M_n)_{SRC}}$
	C-SRC1-TWN-95	1380	26	597	623	1414	1791	1.27
	C-SRC2-WENG-115	1380	26	626	652	1414	1875	1.33
	C-SRC3-TWN-95	1380	26	623	649	1483	1915	1.29
	C-SRC4-WENG-110	1380	26	602	628	1483	1853	1.25

Note: (1) P_a is the fixed axial load applied to the column, $P_a = 0.1 P_n$, where P_n is the nominal axial strength of the column calculated according to Taiwan SRC Code.

(2) $P_{P-\Delta}$ is the lateral load caused by the P- Δ effect, as given in equation (24).

(3) P_h is the recorded maximum lateral load applied to the column by the MTS actuator.

(4) $(P_h)_{test}$ is the total lateral load applied to the column including the P- Δ effect; (4) = (2) + (3).

(5) $(M_n)_{SRC}$ is the bending moment can be resisted by the column while subjected to the axial load P_a , calculated according to Taiwan SRC Code.

(6) $(M_n)_{test}$ is the total bending moment applied to the column including the P- Δ effect. The value of $(M_n)_{test}$ is equal to the product of $(P_h)_{test}$ and the distance between the loading point of the lateral force and the center of the plastic hinge of SRC column.

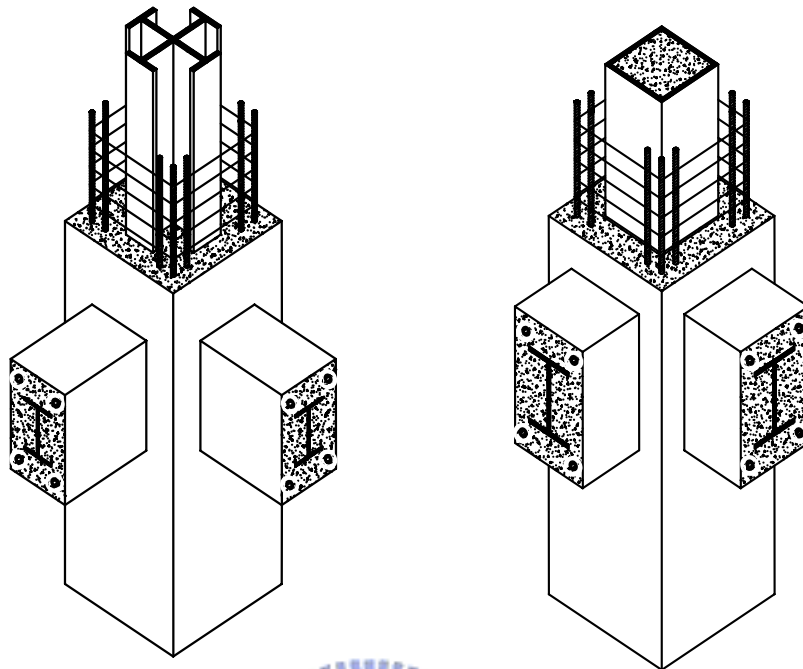


圖 1.1 配置傳統水平閉合箍筋之矩形 SRC 柱示意圖

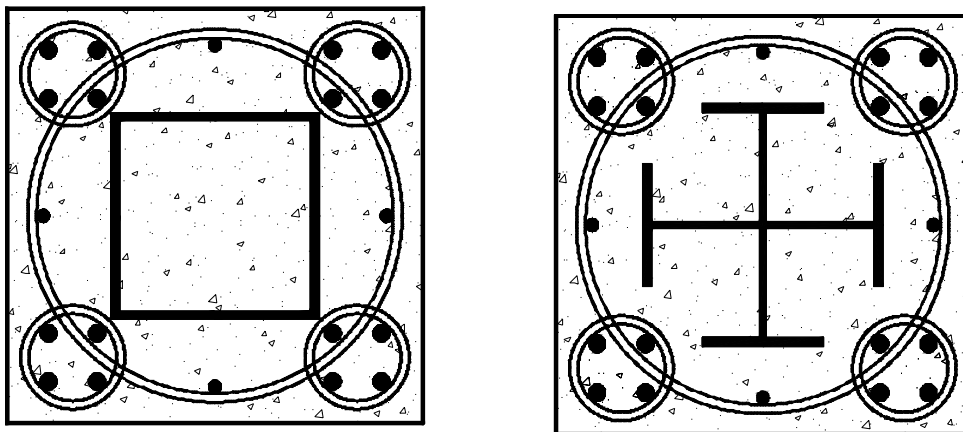


圖 1.2 配置新型「五螺箍」之矩形 SRC 柱斷面示意圖

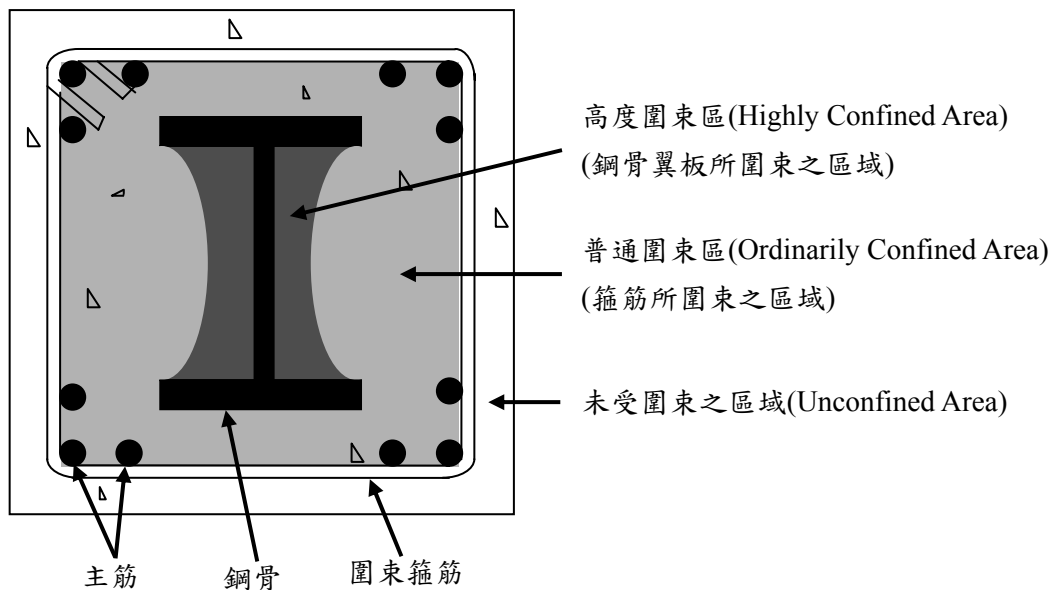


圖 2.1 包覆 H 型 SRC 柱中混凝土受圍束之情形

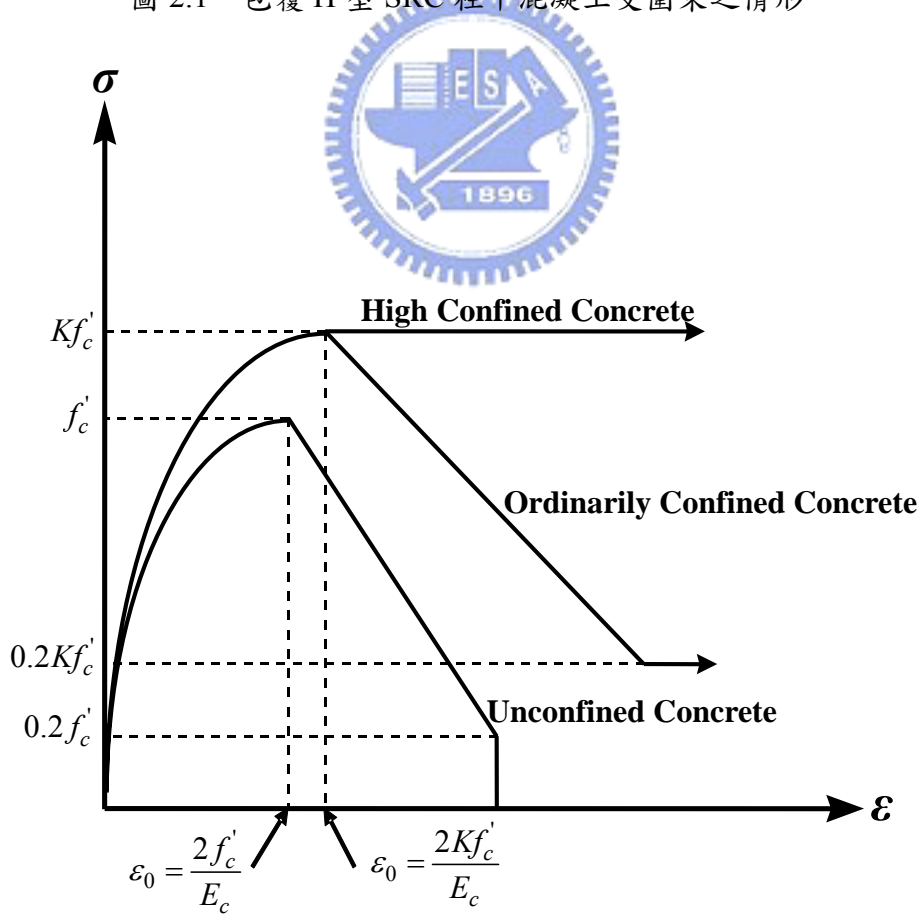


圖 2.2 包覆 H 型 SRC 柱中混凝土之應力-應變曲線

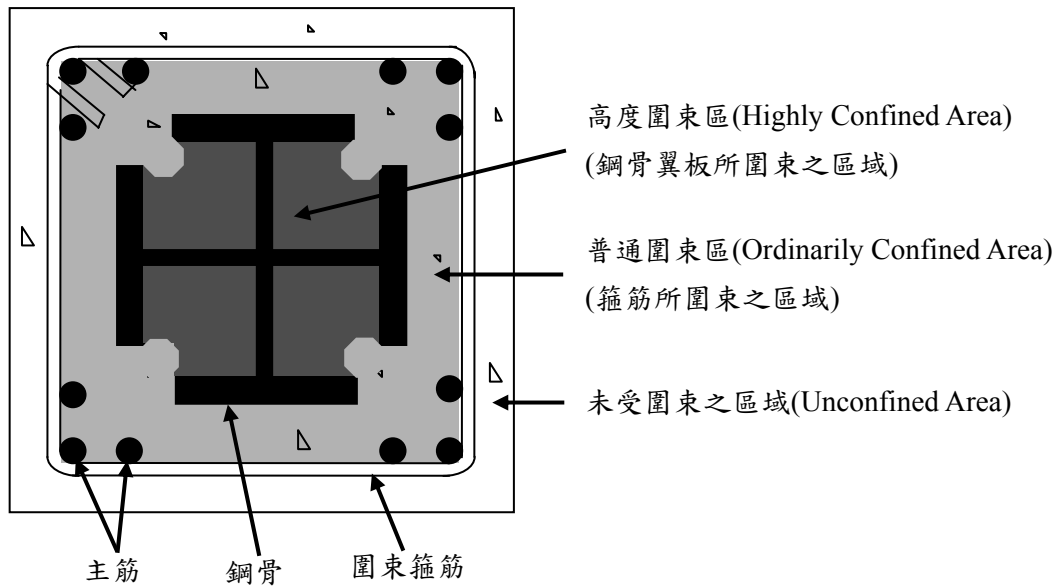


圖 2.3 包覆十字型 SRC 柱中混凝土受圍束之情形

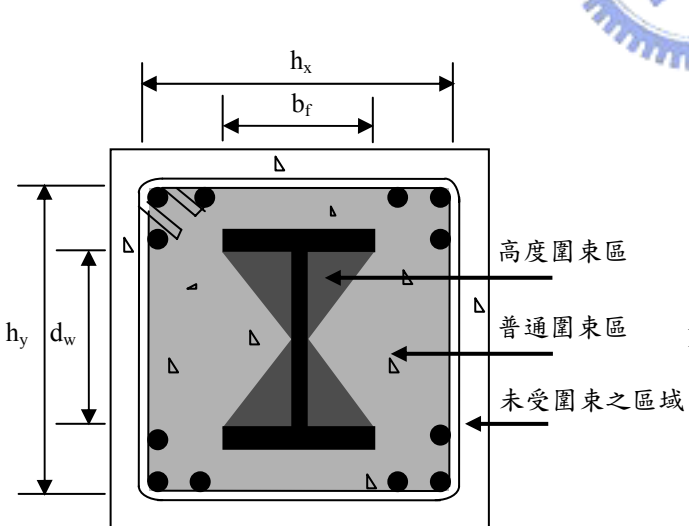


圖 2.4 三角形圍束模式

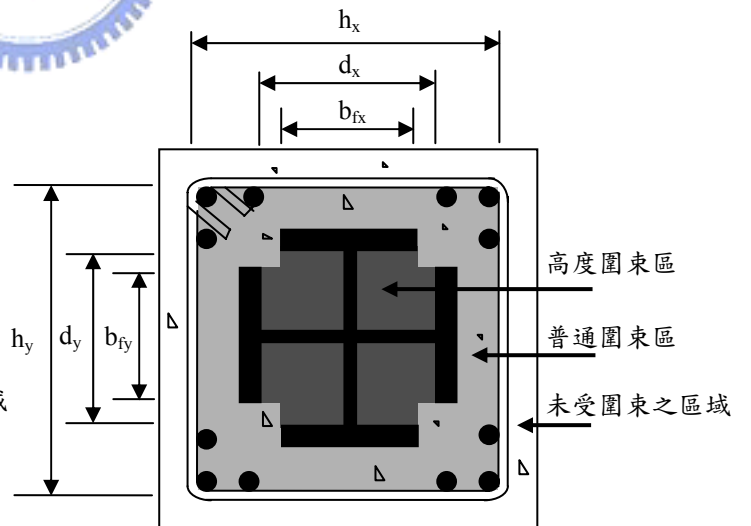
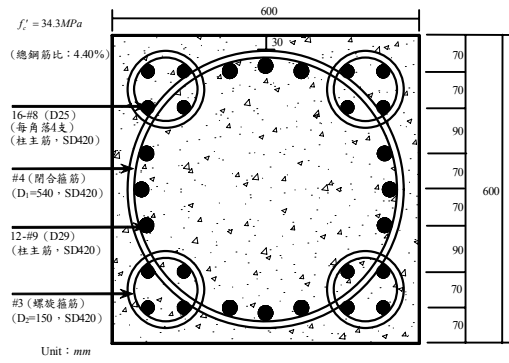
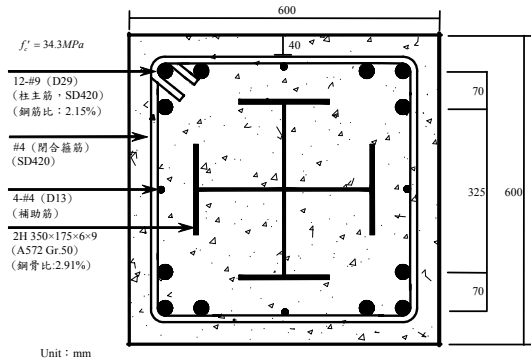


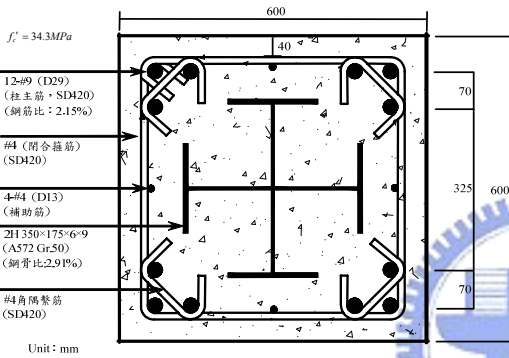
圖 2.5 矩形圍束模式



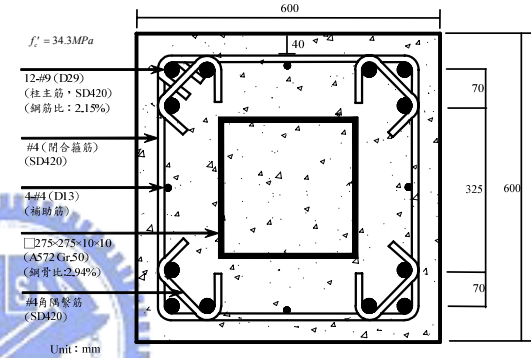
(a) 五螺箍 RC 柱斷面



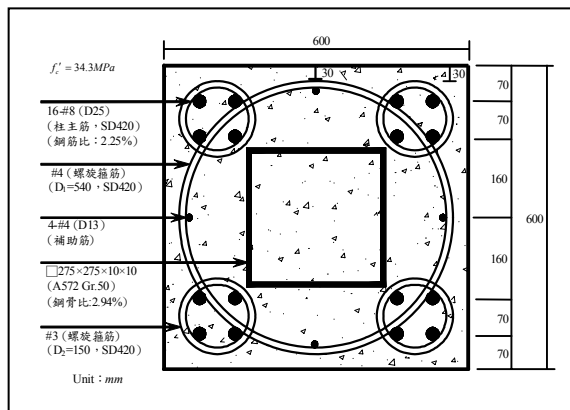
(b) 傳統橫箍包覆十字型 SRC 柱斷面
(無角隅繫筋)



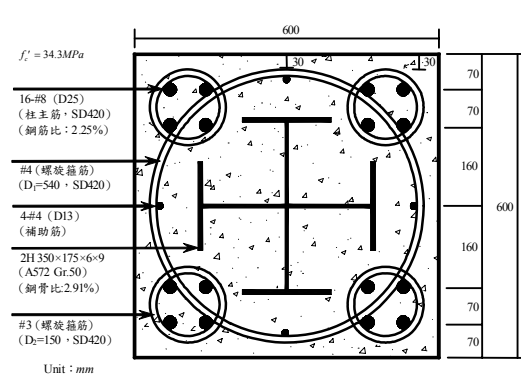
(c) 傳統橫箍包覆十字型 SRC 柱斷面
(有角隅繫筋)



(d) 傳統橫箍包覆箱型 SRC 柱斷面
(有角隅繫筋)



(e) 五螺箍包覆箱型 SRC 柱斷面



(f) 五螺箍包覆十字型 SRC 柱斷面

圖 3.1 本研究各系列短柱試體之斷面配置圖

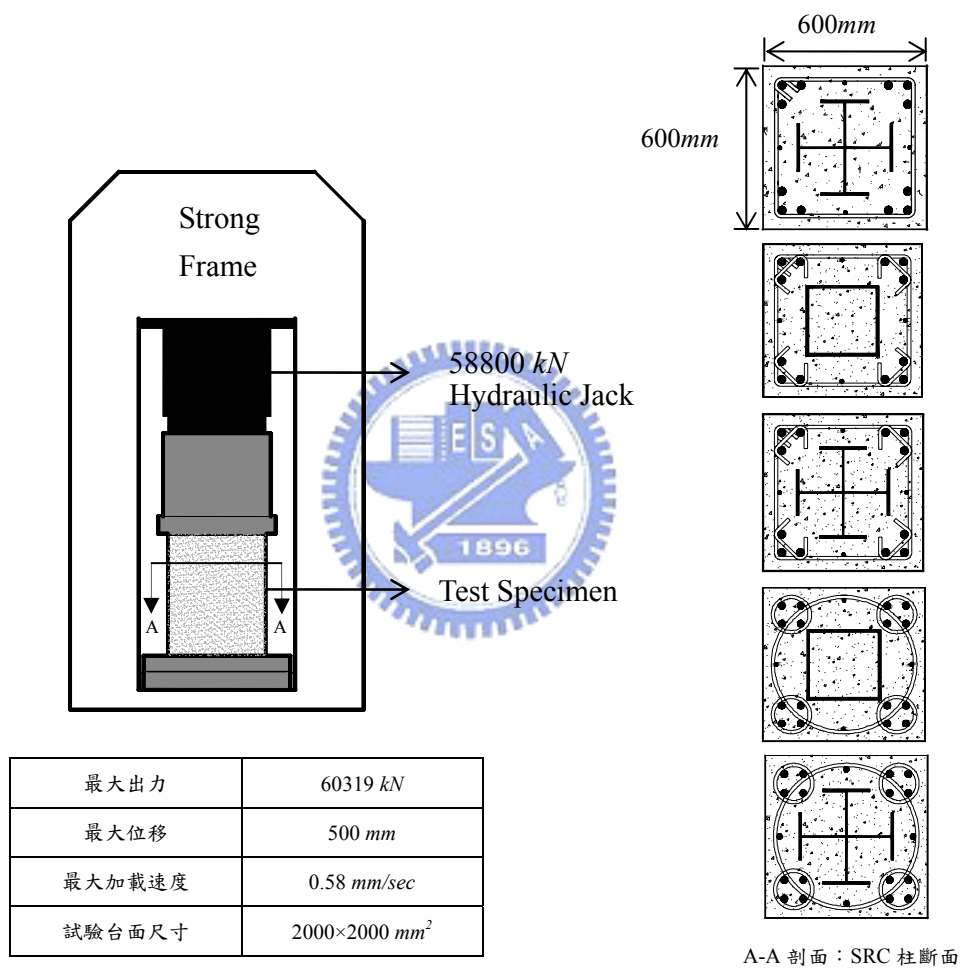
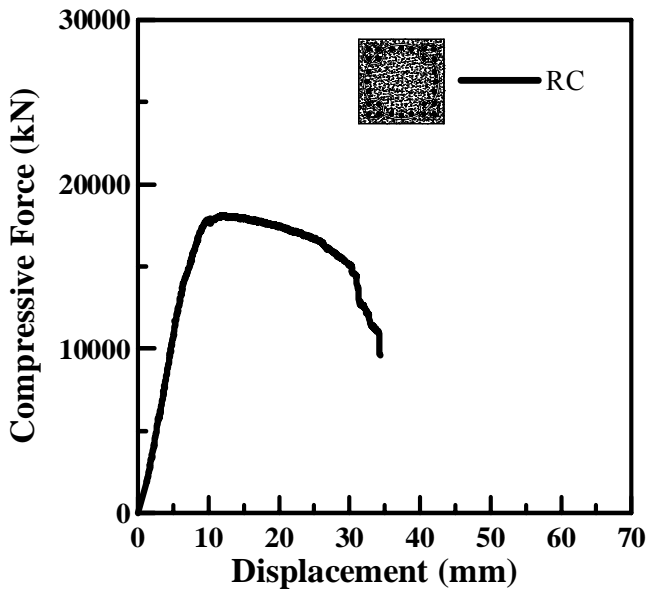
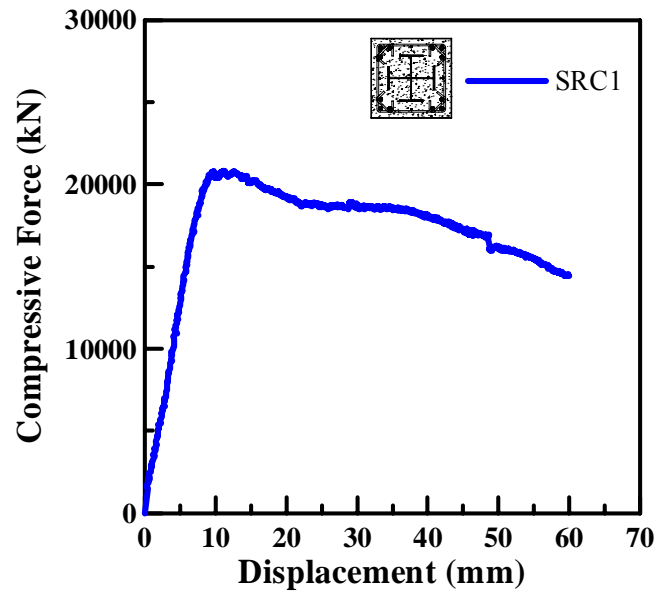


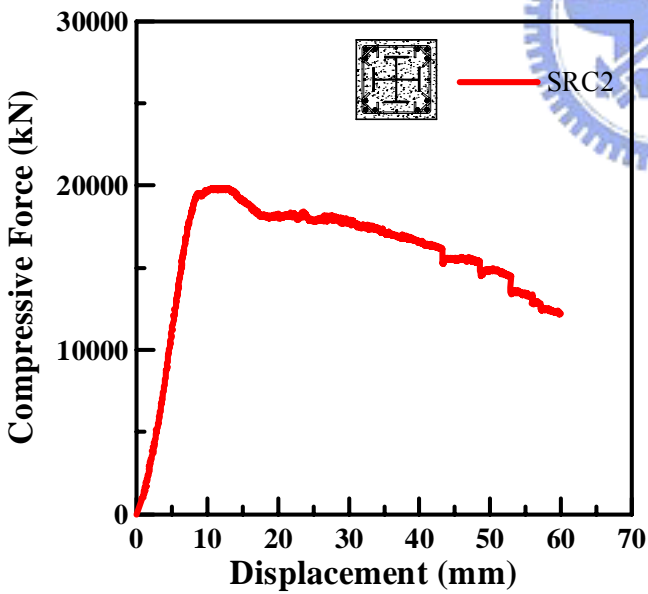
圖 3.2 SRC 短柱抗壓試驗構架與 SRC 柱斷面示意圖



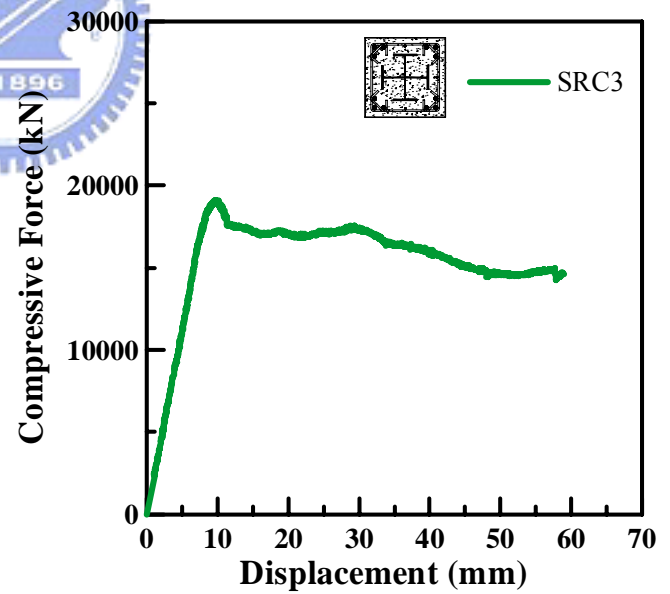
(a) 試體 RC



(b) 試體 SRC1

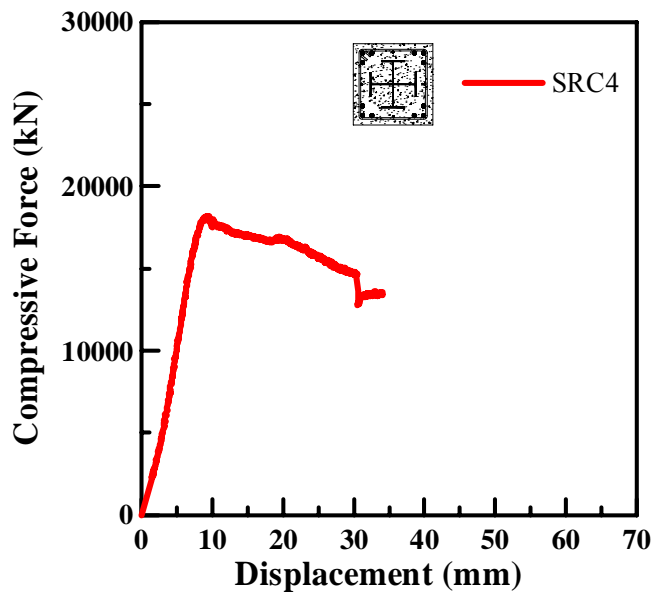


(c) 試體 SRC2

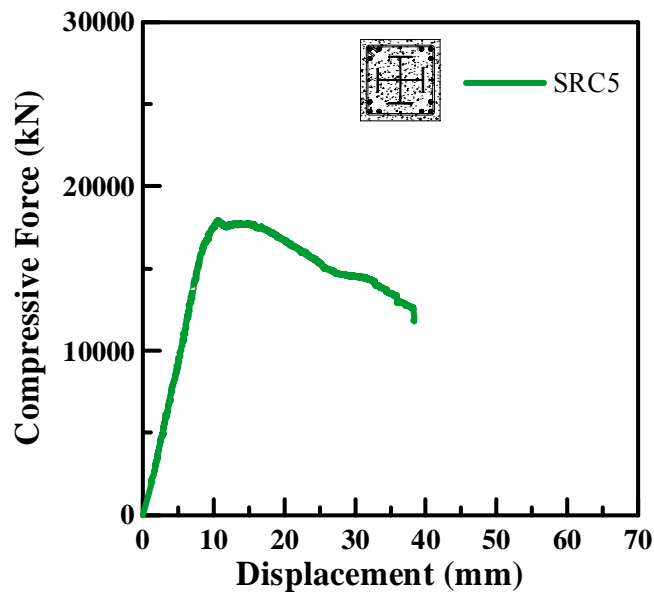


(d) 試體 SRC3

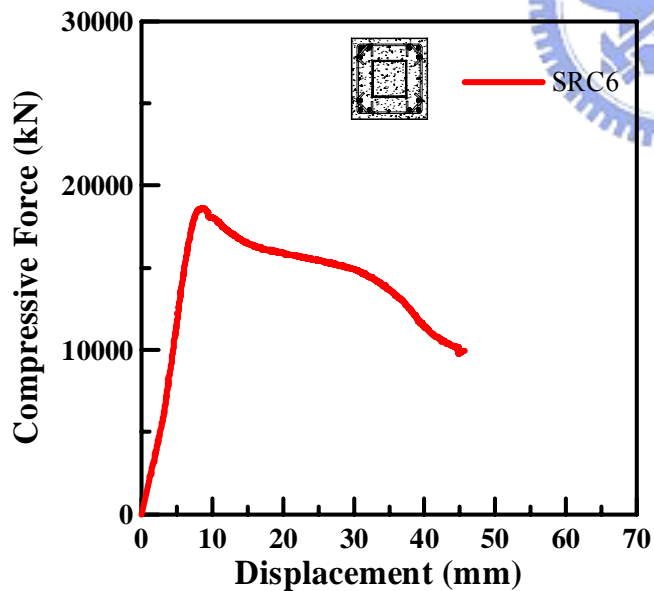
圖 3.3 本研究短柱試體之軸力-位移曲線圖



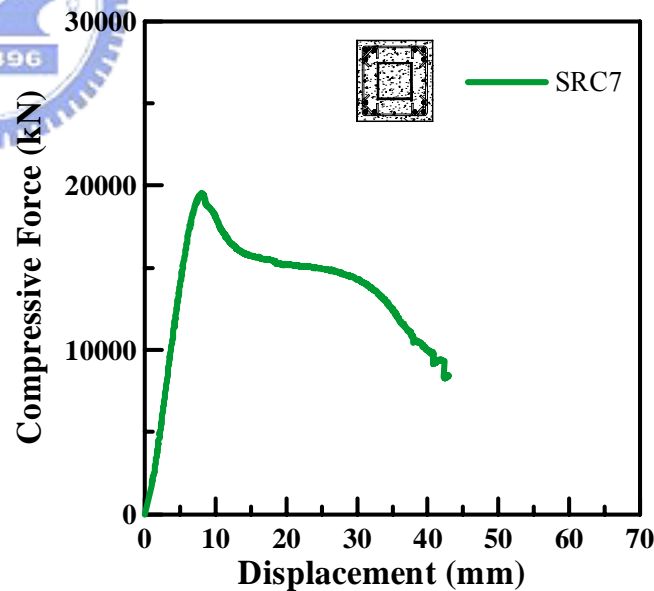
(e) 試體 SRC4



(f) 試體 SRC5

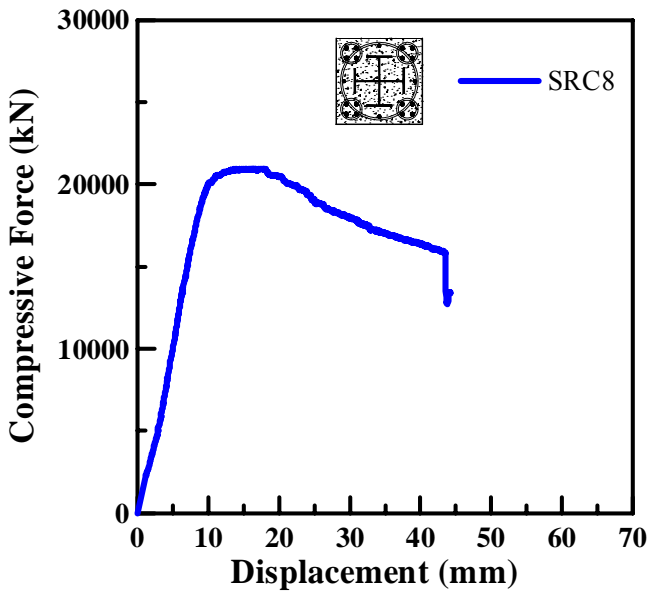


(g) 試體 SRC6

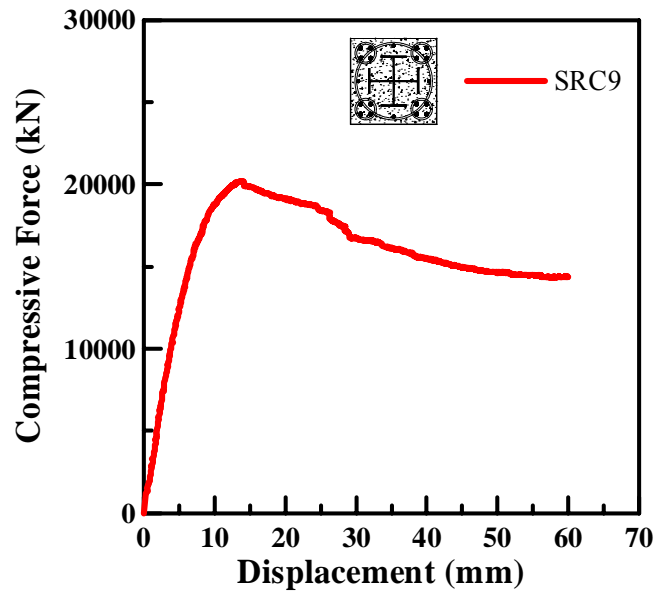


(h) 試體 SRC7

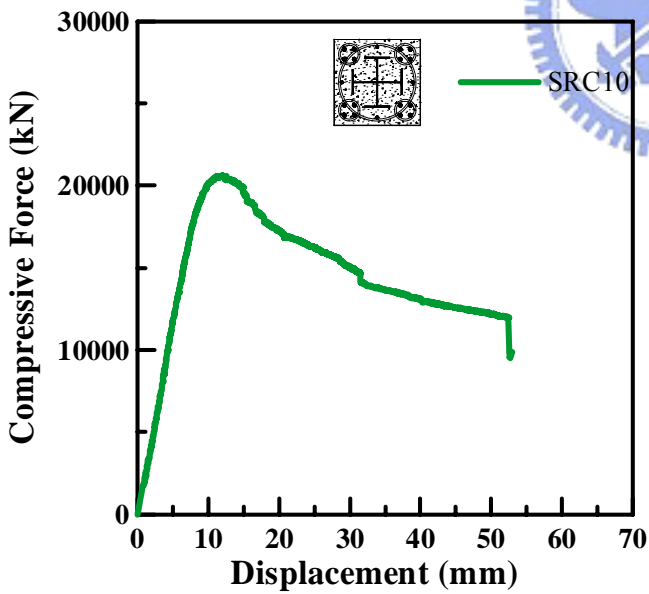
圖 3.3 本研究短柱試體之軸力-位移曲線圖 (續)



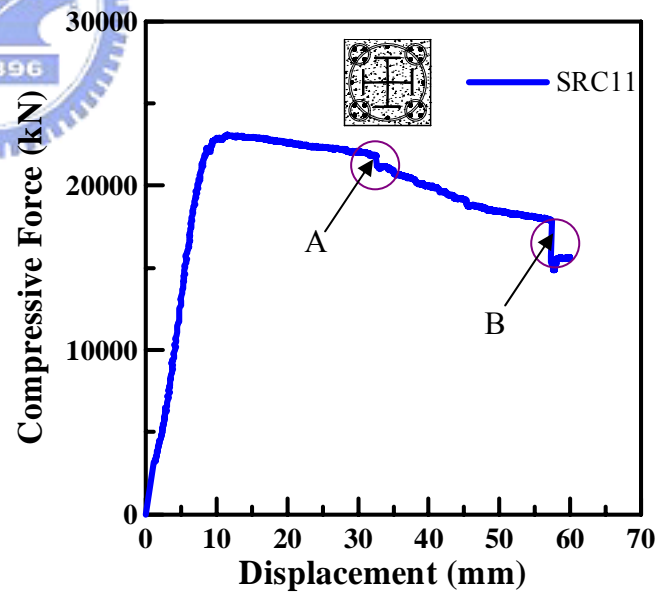
(i) 試體 SRC8



(j) 試體 SRC9

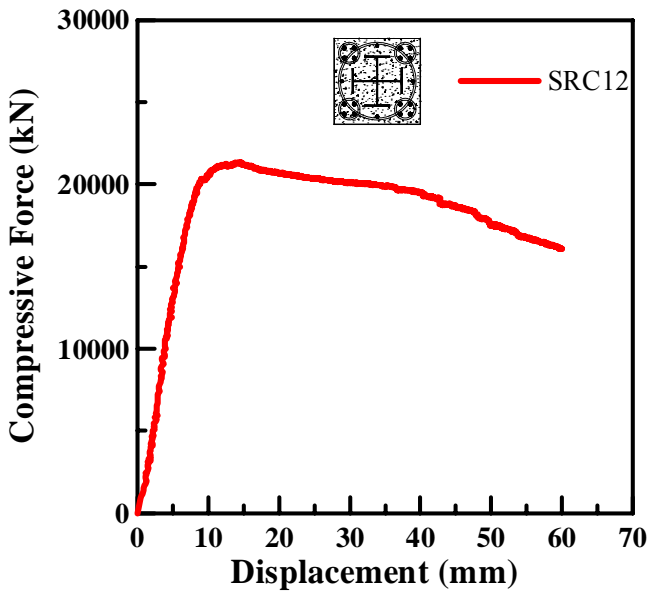


(k) 試體 SRC10

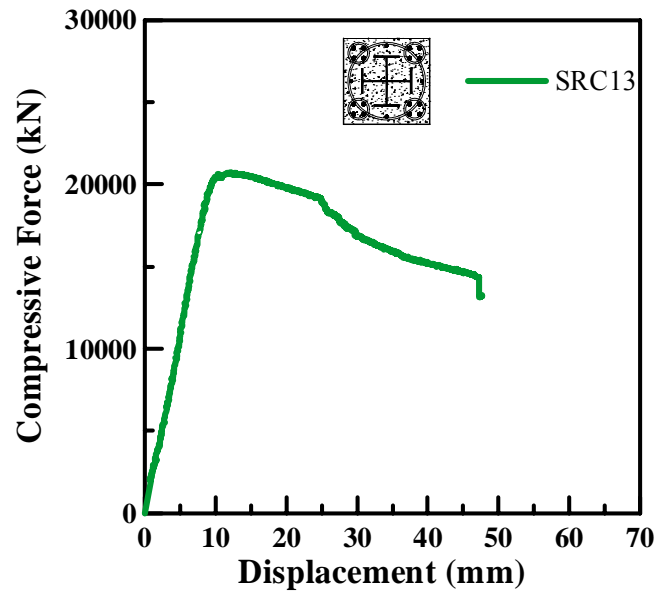


(l) 試體 SRC11

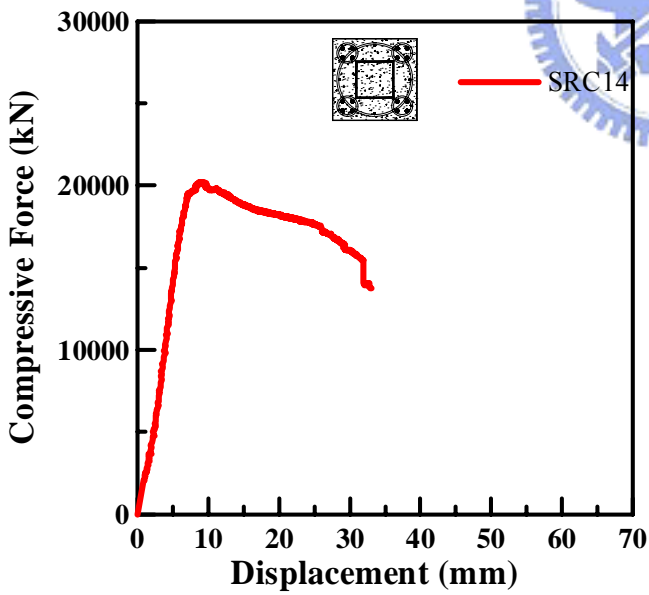
圖 3.3 本研究短柱試體之軸力-位移曲線圖 (續)



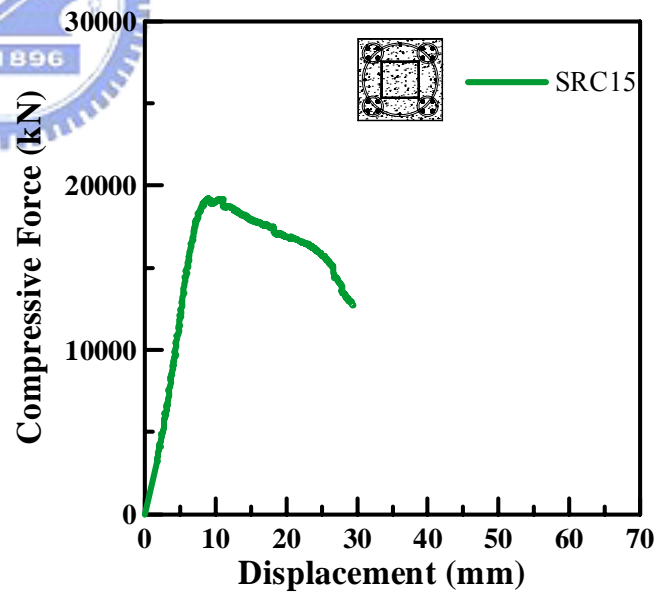
(m) 試體 SRC12



(n) 試體 SRC13

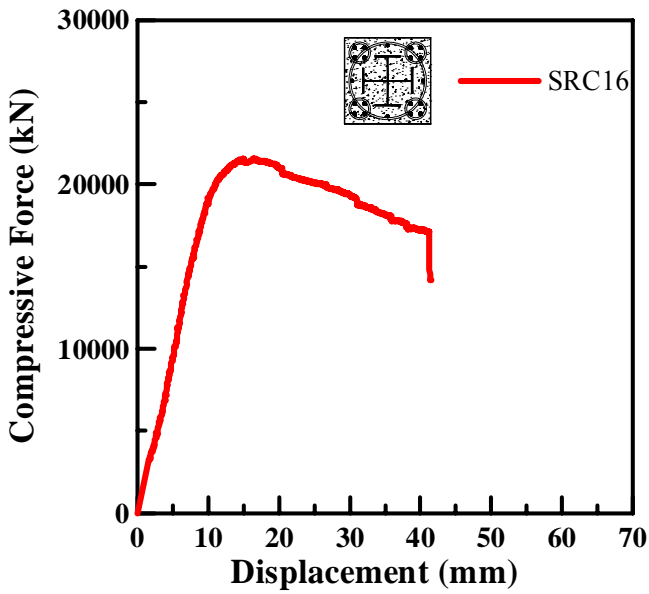


(o) 試體 SRC14

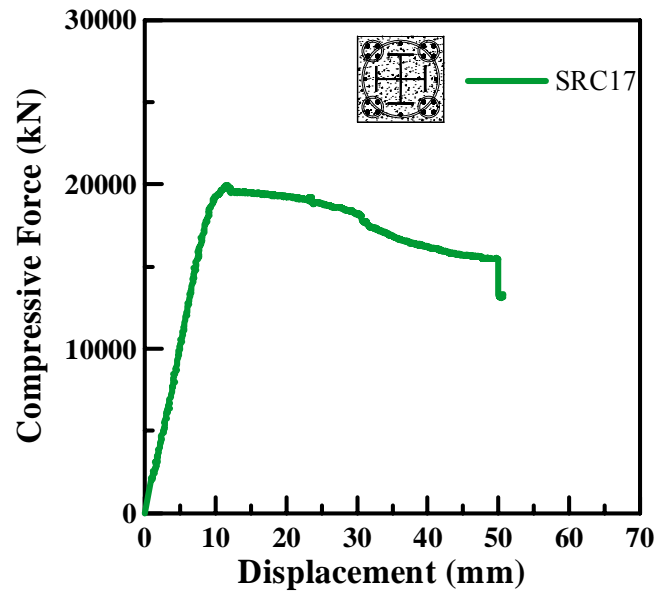


(p) 試體 SRC15

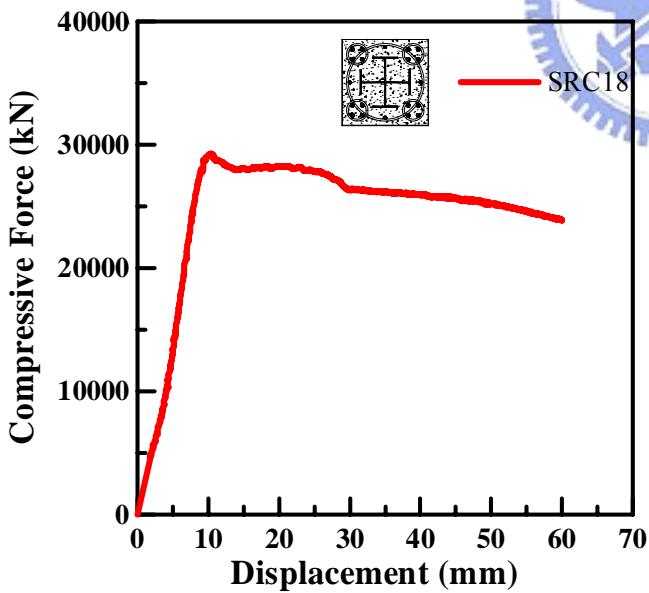
圖 3.3 本研究短柱試體之軸力-位移曲線圖 (續)



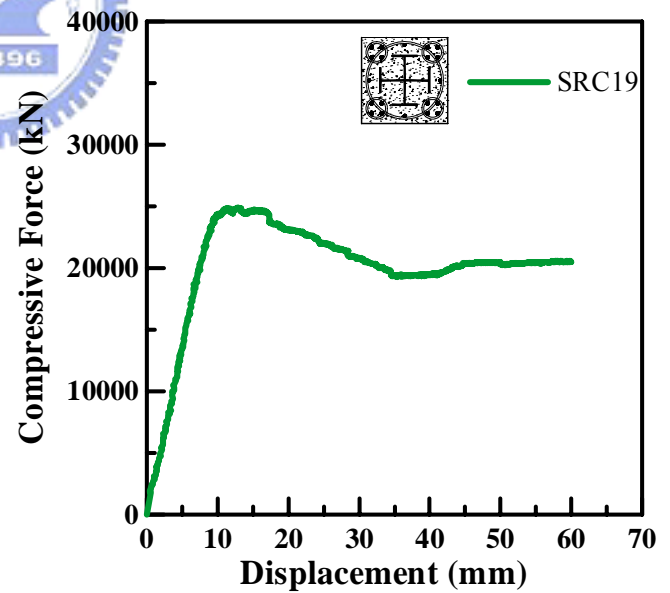
(q) 試體 SRC16



(r) 試體 SRC17

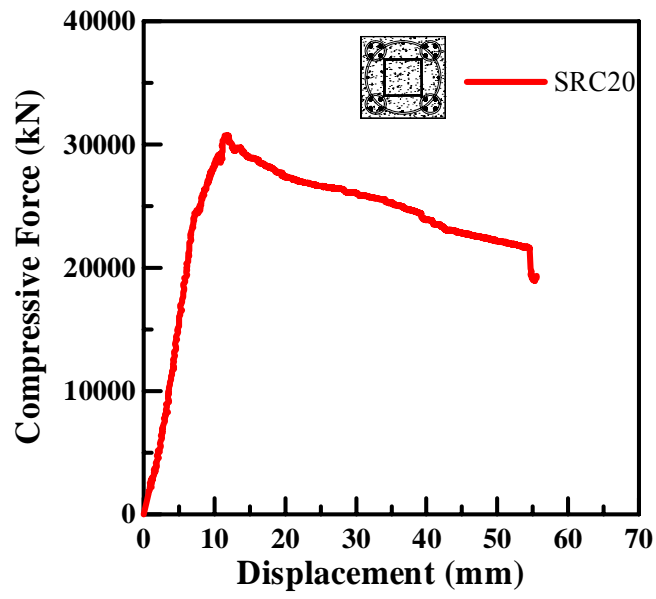


(s) 試體 SRC18

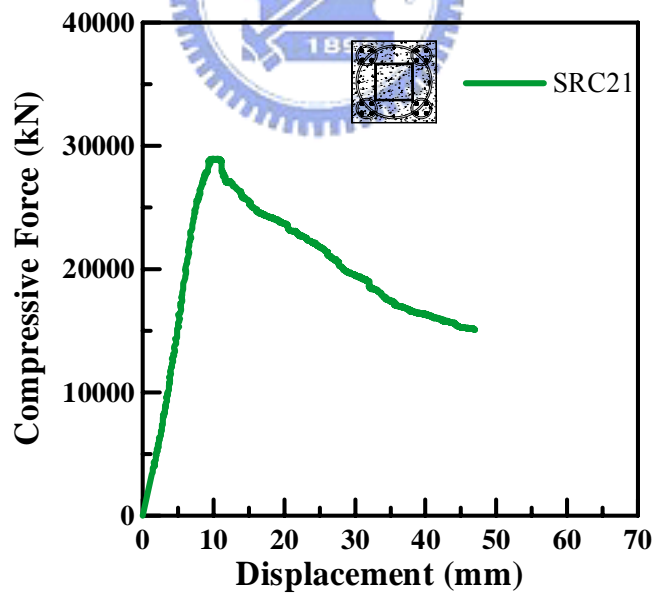


(t) 試體 SRC19

圖 3.3 本研究短柱試體之軸力-位移曲線圖 (續)

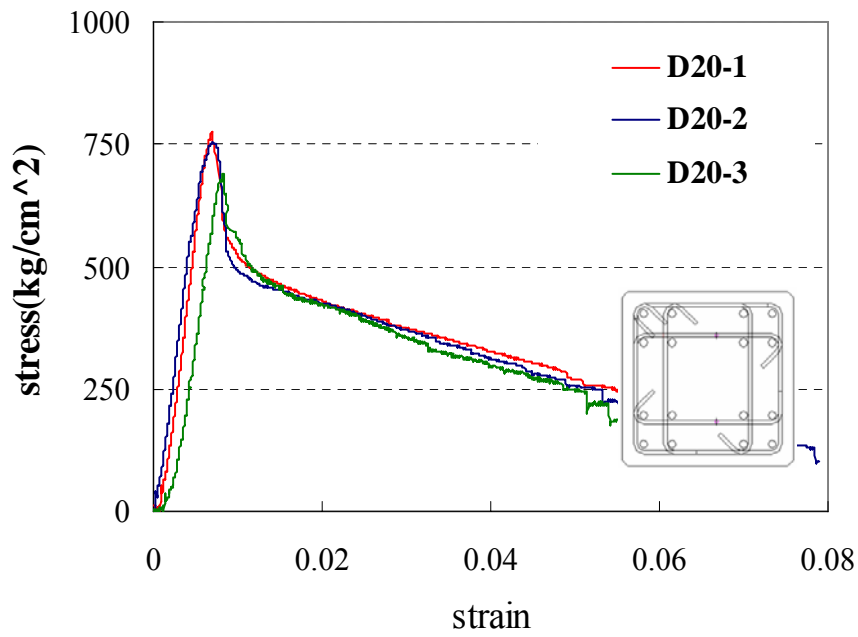


(u) 試體 SRC20

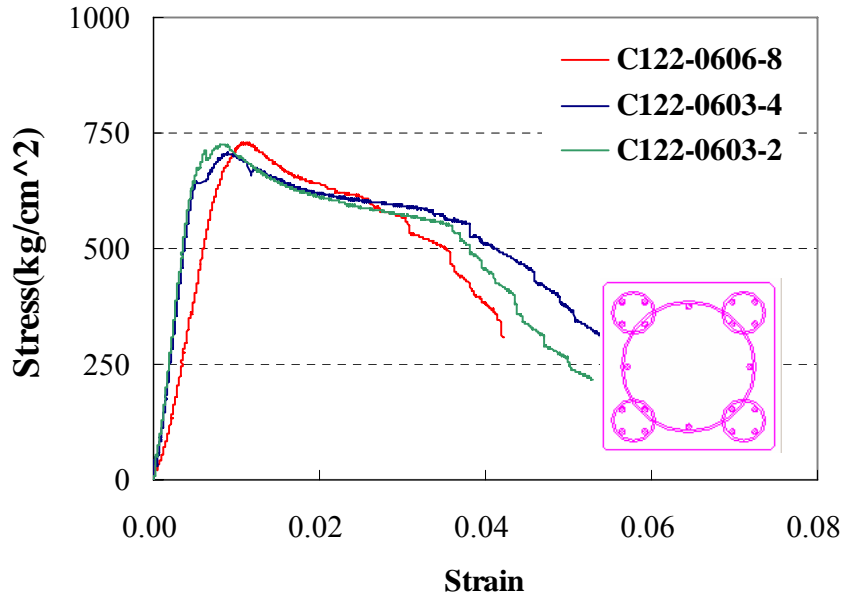


(v) 試體 SRC21

圖 3.3 本研究短柱試體之軸力-位移曲線圖 (續)

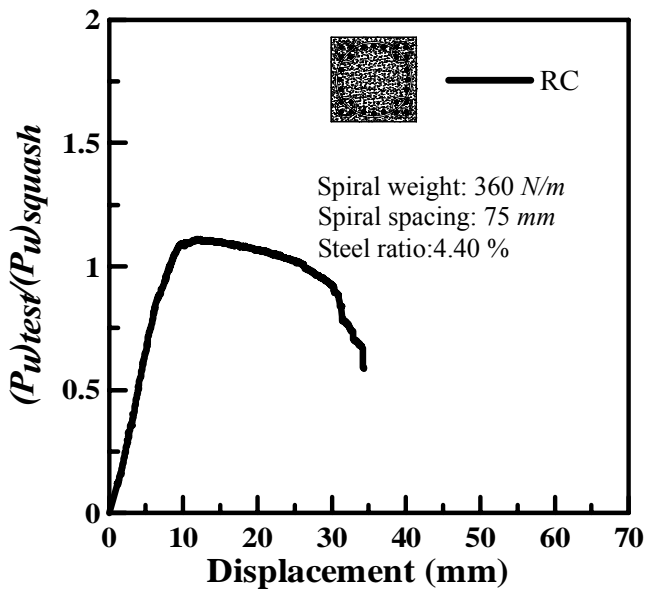


(a) 傳統橫箍 RC 柱受軸壓之應力-應變曲線

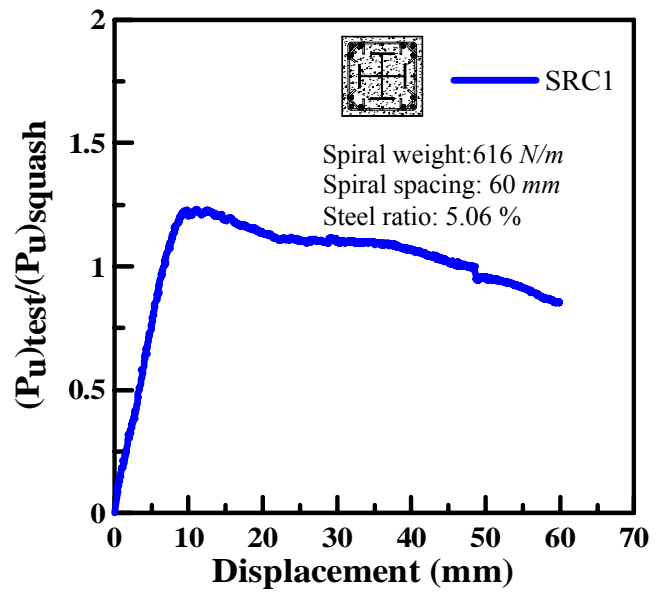


(b) 五螺箍 RC 柱受軸壓之應力-應變曲線

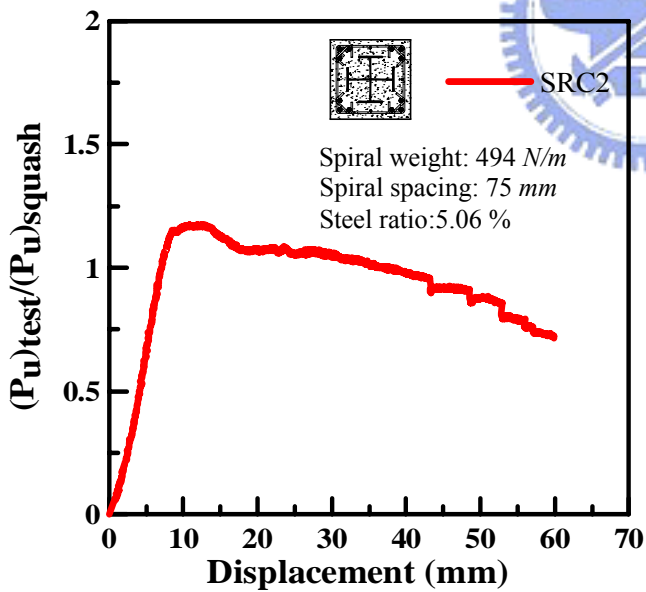
圖 3.4 傳統橫箍 RC 柱與新型五螺箍 RC 柱之應力-應變曲線比較
(張國鎮等，2005)



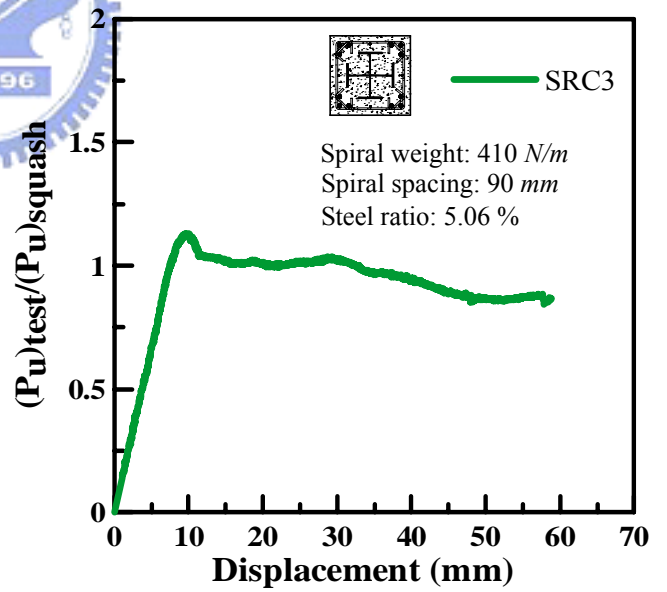
(a) 試體 RC



(b) 試體 SRC1

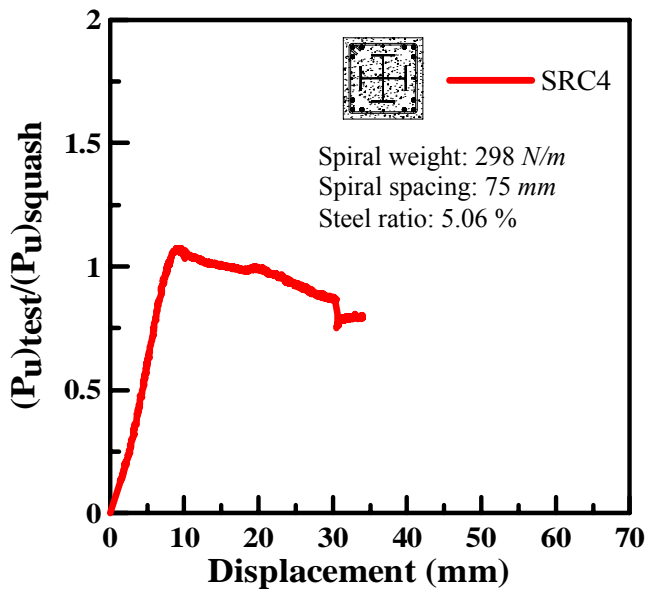


(c) 試體 SRC2

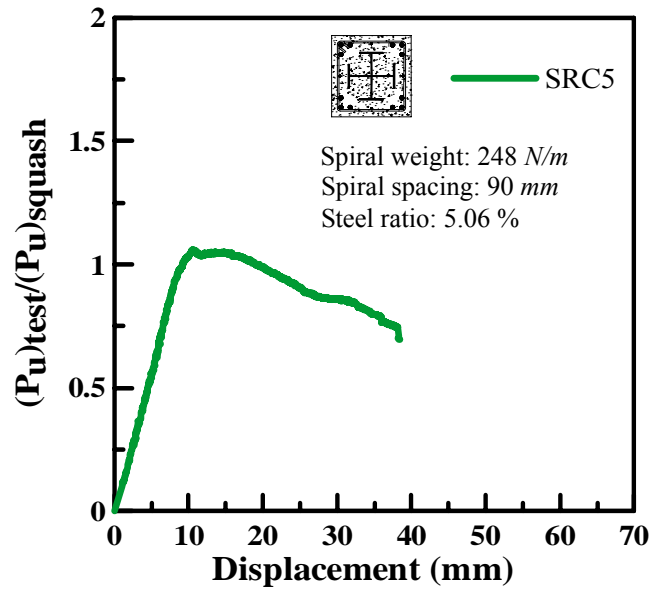


(d) 試體 SRC3

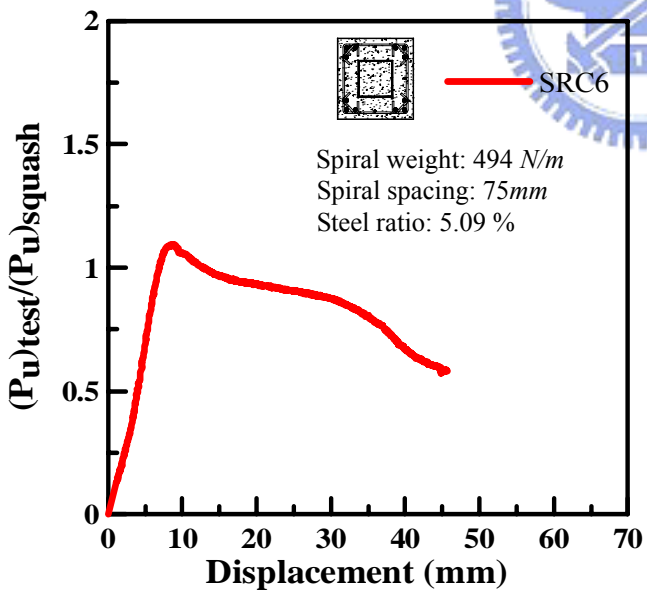
圖 3.5 本研究短柱試體之試驗軸壓強度與壓碎軸壓強度之比值-位移曲線圖



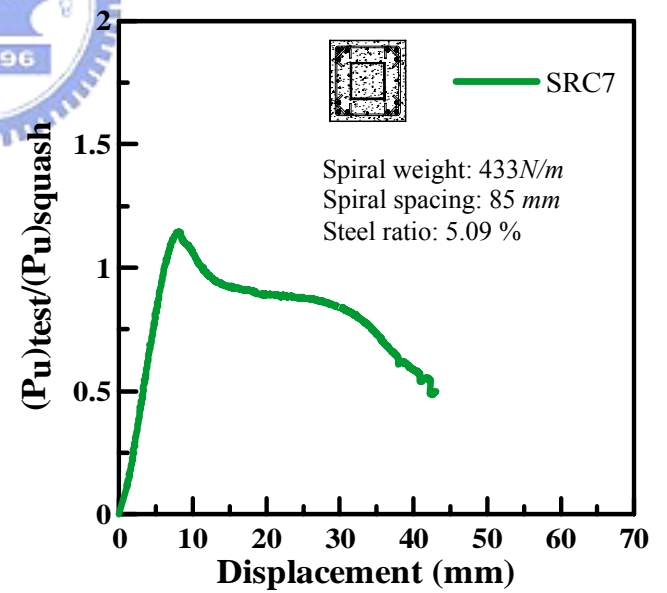
(e) 試體 SRC4



(f) 試體 SRC5

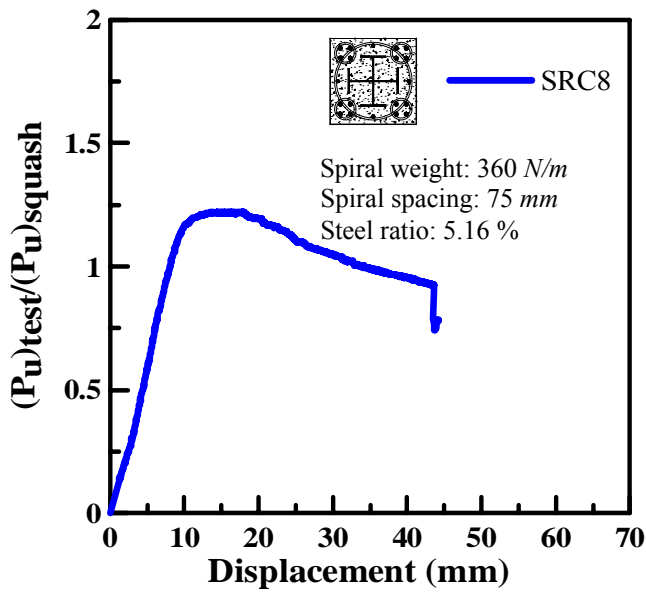


(g) 試體 SRC6

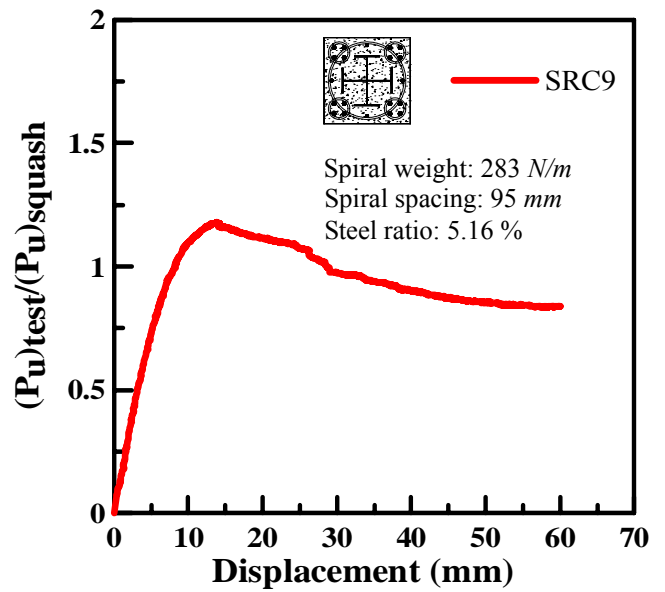


(h) 試體 SRC7

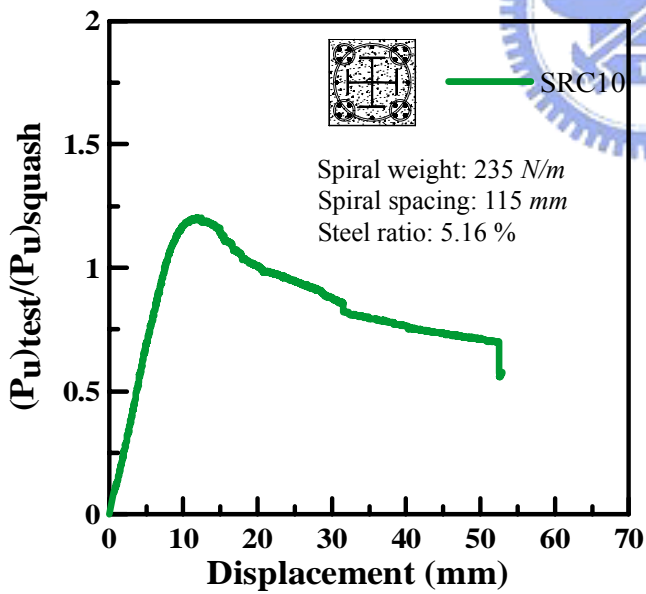
圖 3.5 本研究短柱試體之試驗軸壓強度與壓碎軸壓強度之比值-位移曲線圖(續)



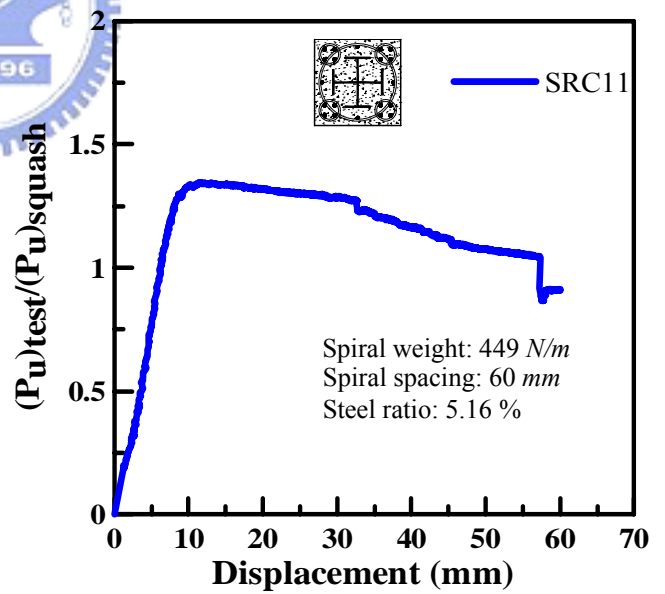
(u) 試體 SRC8



(j) 試體 SRC9



(k) 試體 SRC10



(l) 試體 SRC11

圖 3.5 本研究短柱試體之試驗軸壓強度與壓碎軸壓強度之比值-位移曲線圖(續)

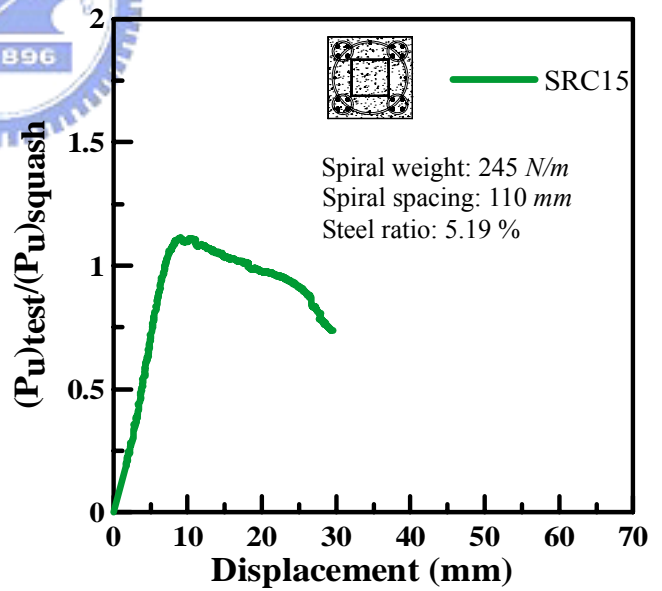
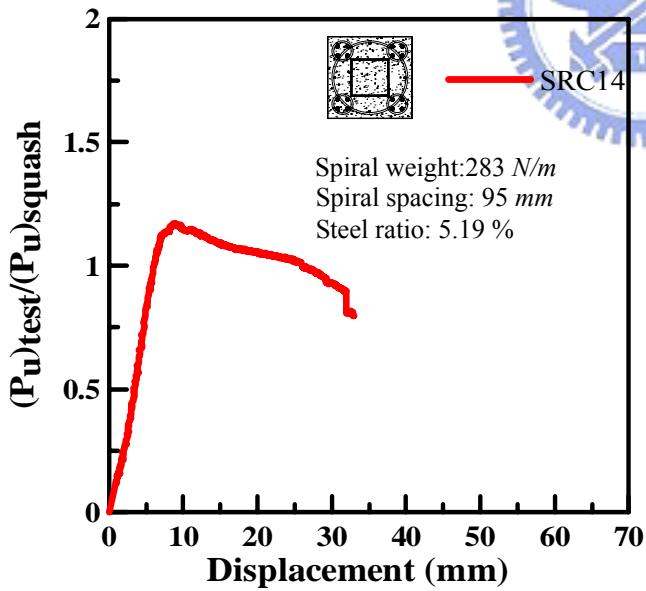
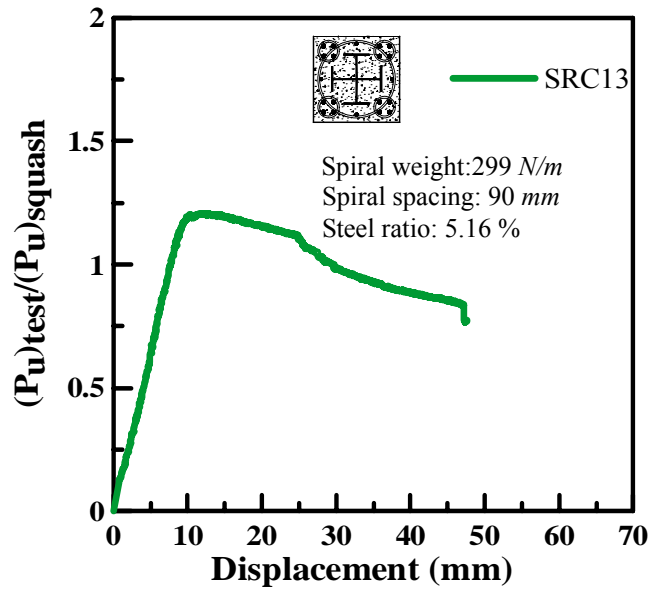
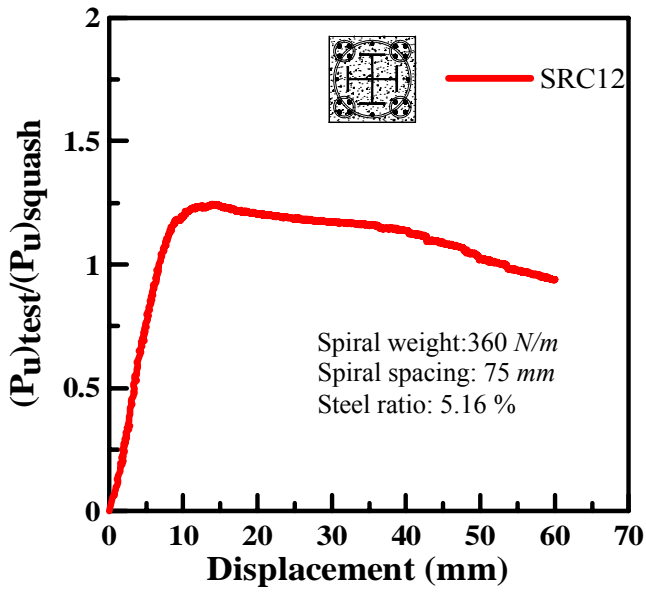
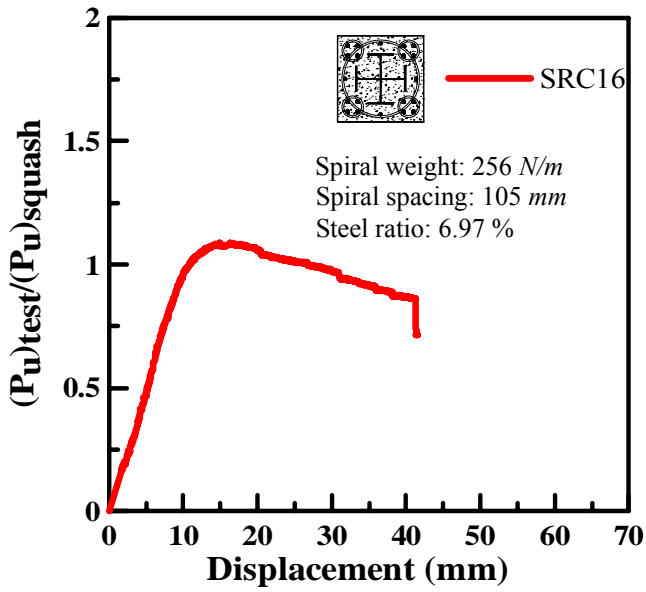
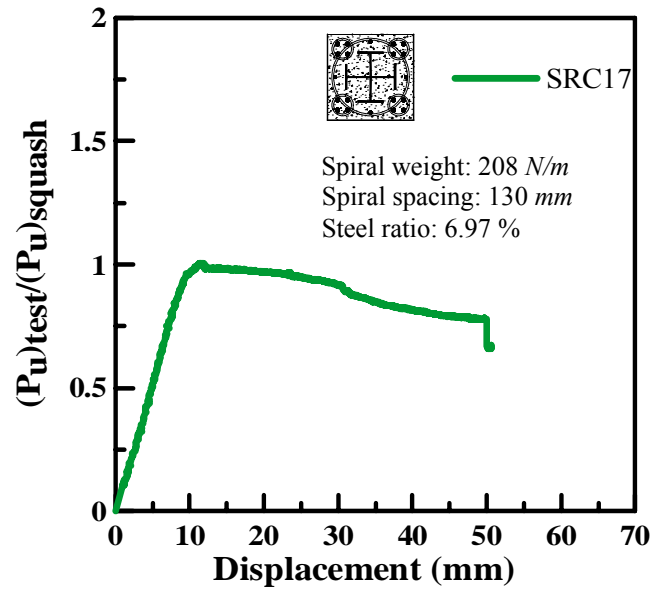


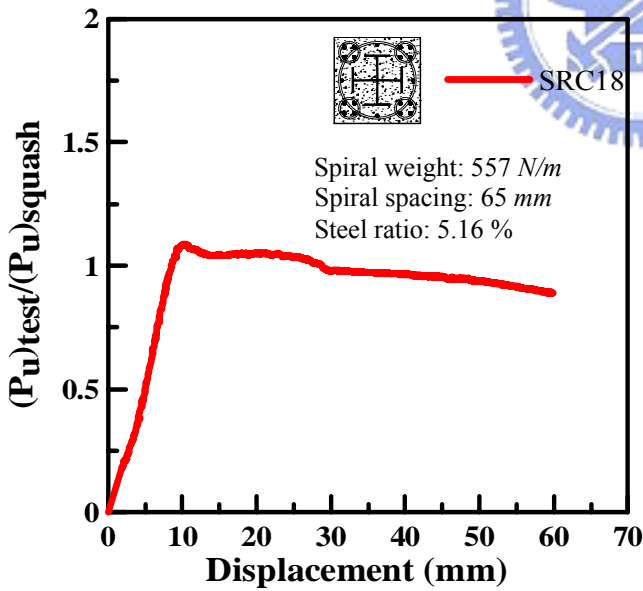
圖 3.5 本研究短柱試體之試驗軸壓強度與壓碎軸壓強度之比值-位移曲線圖(續)



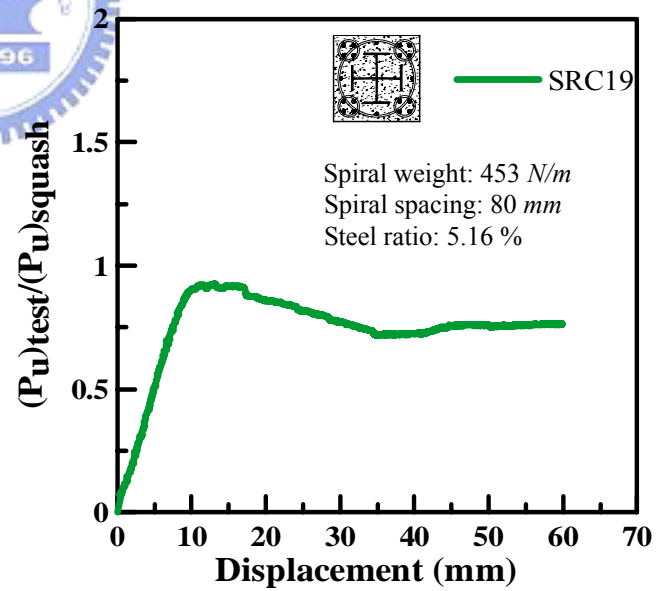
(q) 試體 SRC16



(r) 試體 SRC17

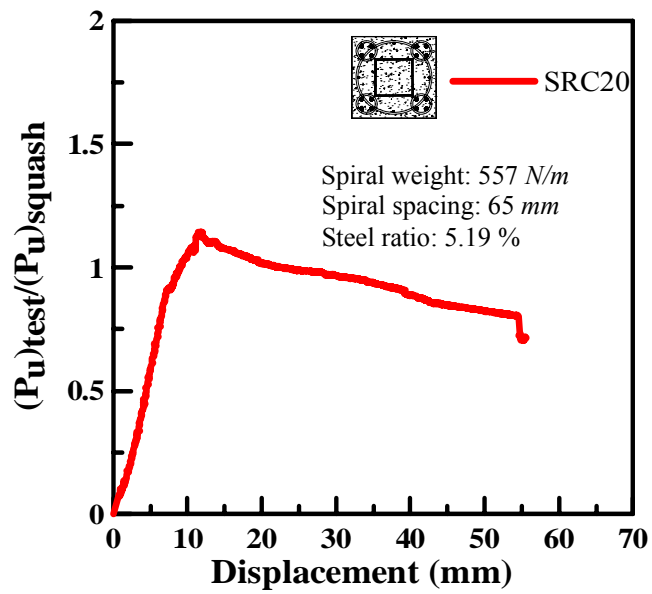


(s) 試體 SRC18

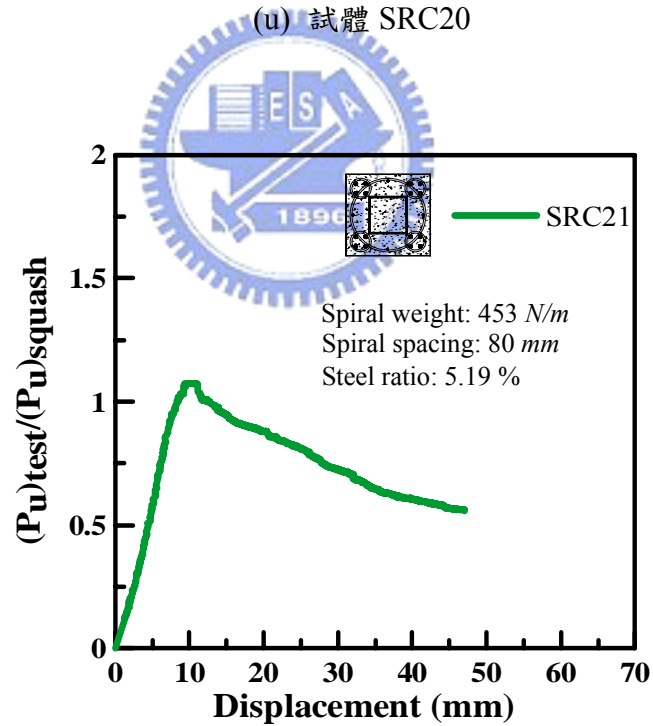


(t) 試體 SRC19

圖 3.5 本研究短柱試體之試驗軸壓強度與壓碎軸壓強度之比值-位移曲線圖(續)



(u) 試體 SRC20



(v) 試體 SRC21

圖 3.5 本研究短柱試體之試驗軸壓強度與壓碎軸壓強度之比值-位移曲線圖(續)

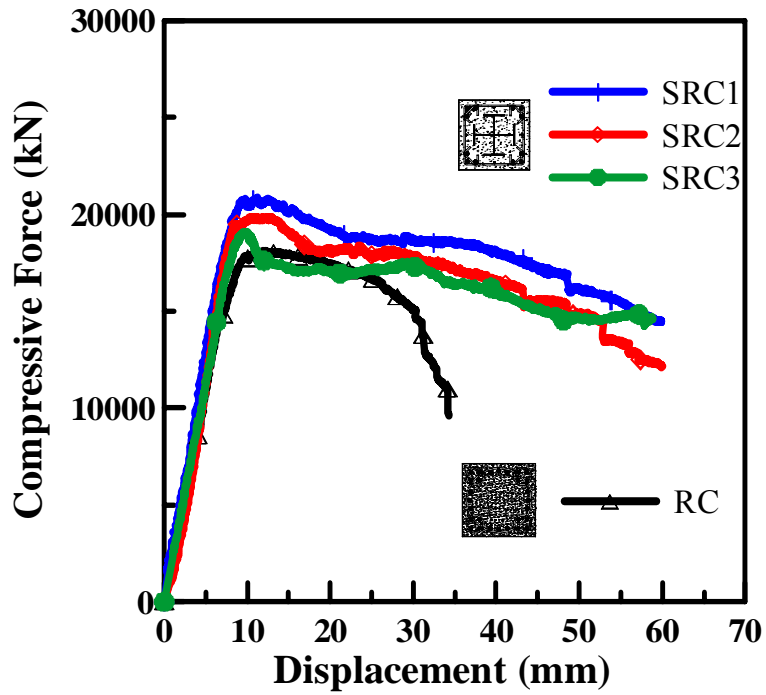


圖 3.6 五螺箍 RC 柱、具有角隅繫筋之傳統橫箍 SRC 柱與傳統橫箍 RC 柱之

軸力-位移曲線比較

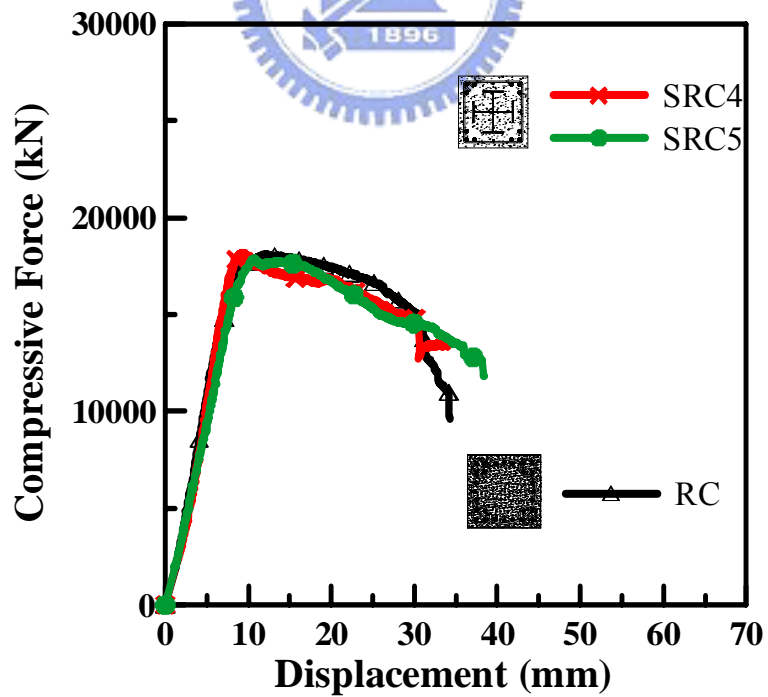
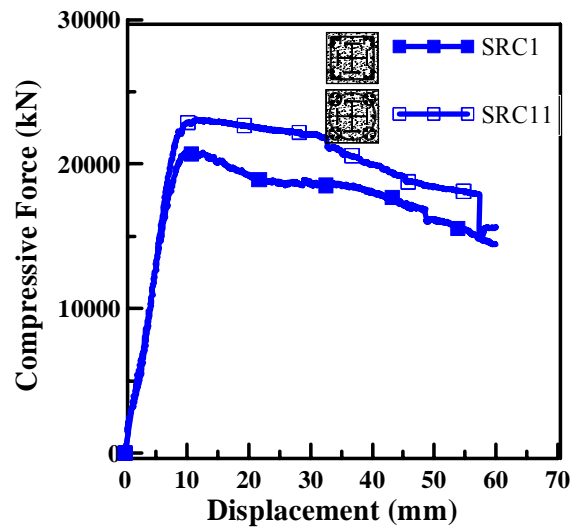
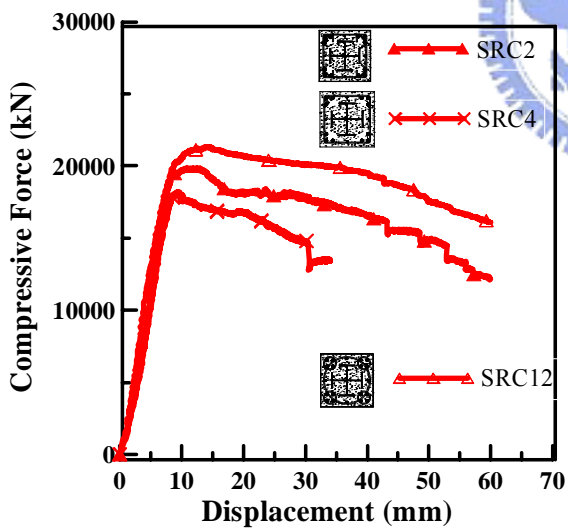


圖 3.7 五螺箍 RC 柱、無角隅繫筋之傳統橫箍 SRC 柱與傳統橫箍 RC 柱之

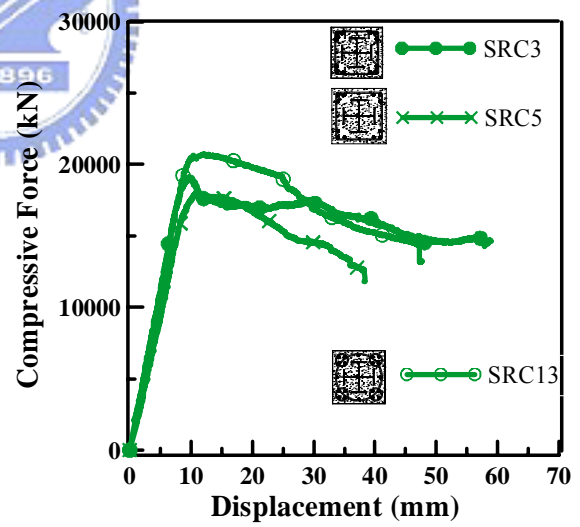
軸力-位移曲線比較



(a) 兩支試體之箍筋間距均為 60mm

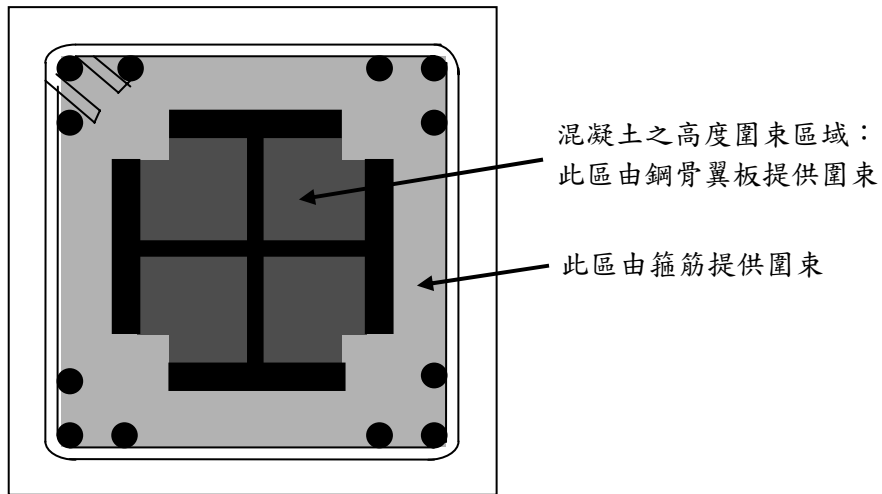


(b) 兩支試體之箍筋間距均為 75mm

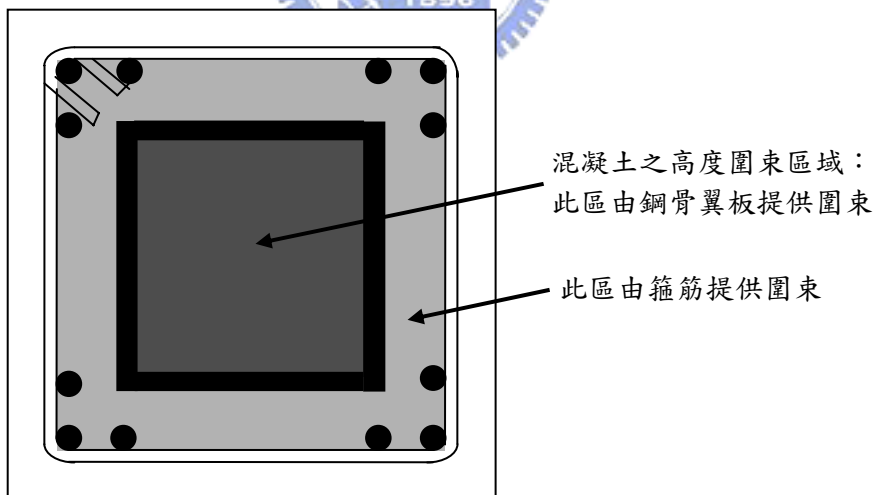


(c) 兩支試體之箍筋間距均為 90mm

圖 3.8 相同縱向總用鋼量與箍筋間距之五螺箍 SRC 柱與傳統橫箍 SRC 柱之軸力-位移曲線的比較

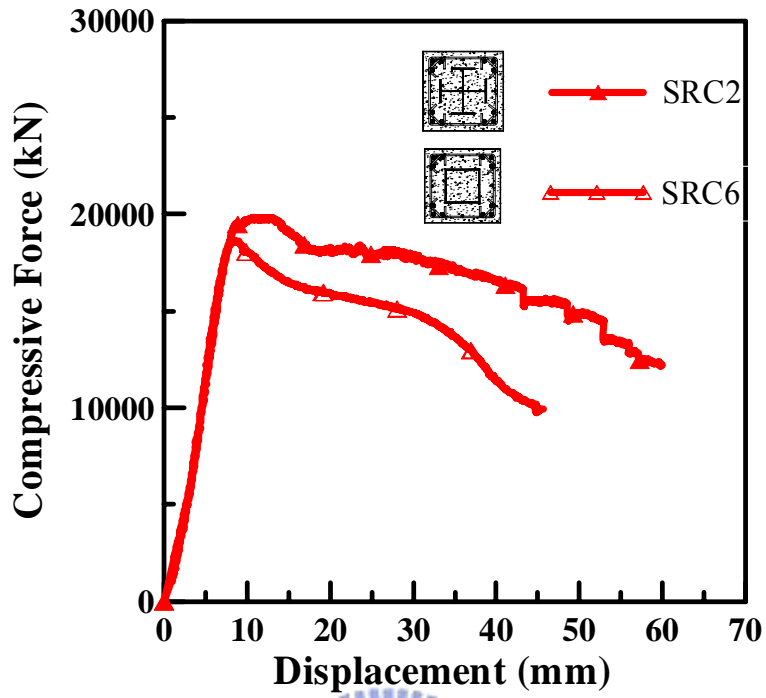


(a) 十字型鋼骨圍束模式

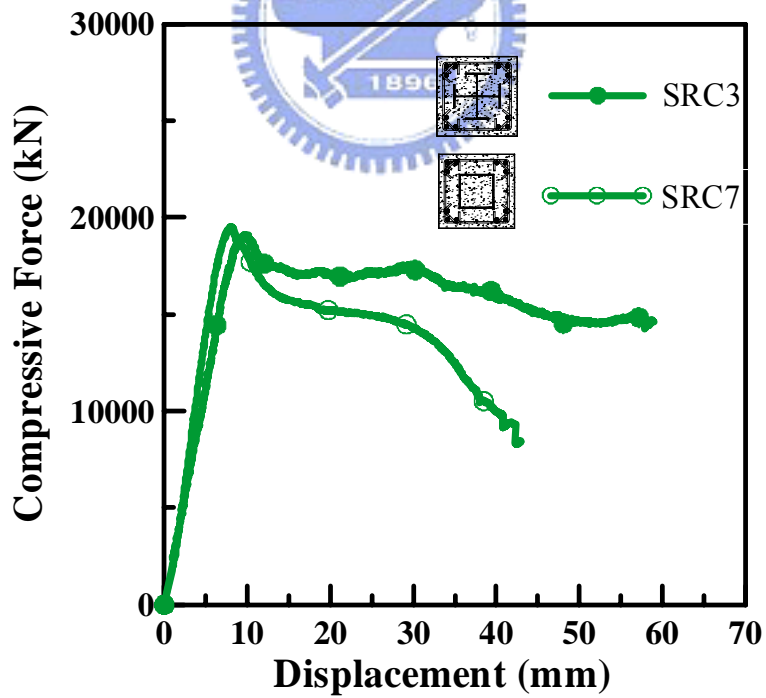


(b) 箱型鋼骨圍束模式

圖 3.9 包覆型 SRC 柱之鋼骨圍束混凝土區域示意圖

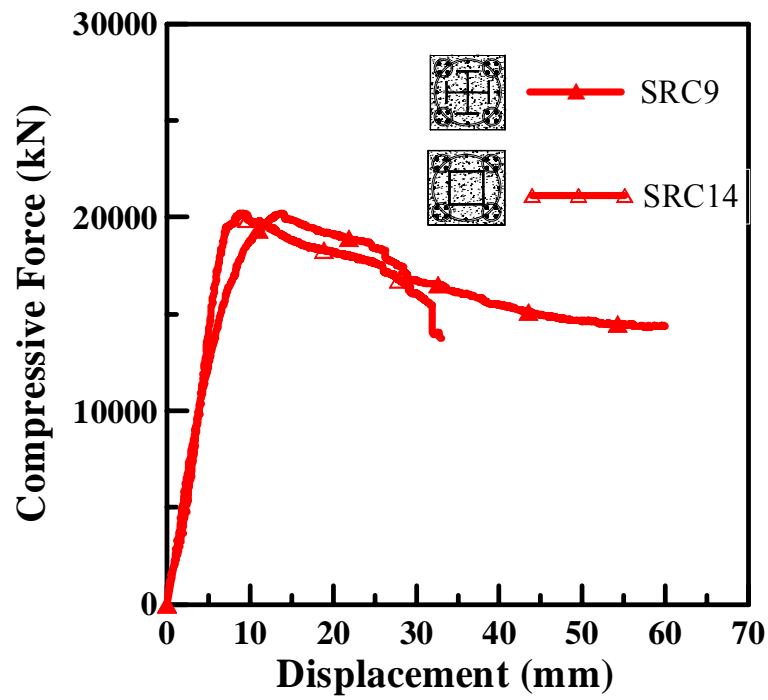


(a) 採用 Taiwan SRC Code 設計之傳統橫箍 SRC 柱

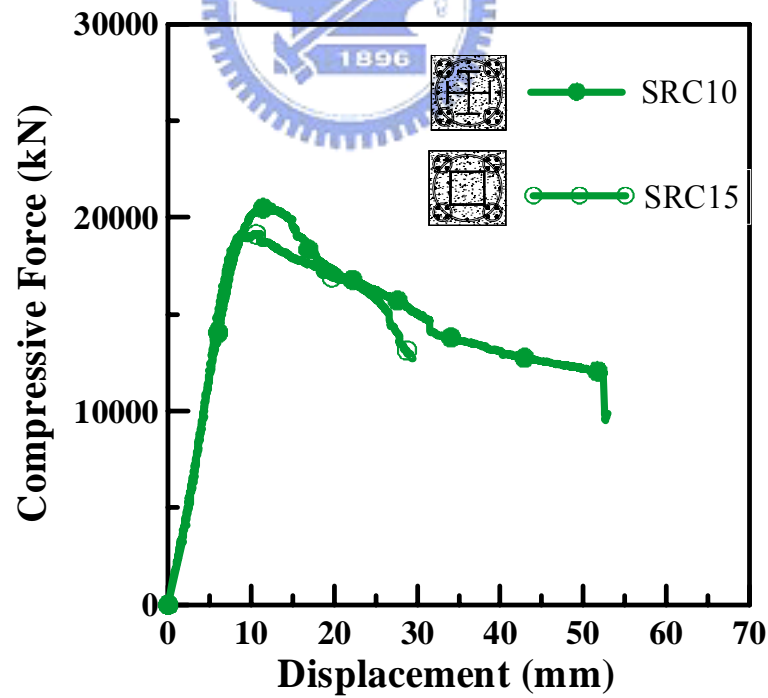


(b) 採用 Weng's Formula 設計之傳統橫箍 SRC 柱

圖 3.10 傳統橫箍 SRC 柱十字型鋼骨斷面與箱型鋼骨斷面之軸力 - 位移曲線比較



(a) 採用 Taiwan SRC Code 設計之五螺箍 SRC 柱



(b) 採用 Weng's Formula 設計之五螺箍 SRC 柱

圖 3.11 五螺箍 SRC 柱十字型鋼骨斷面與箱型鋼骨斷面之軸力 - 位移曲線比較

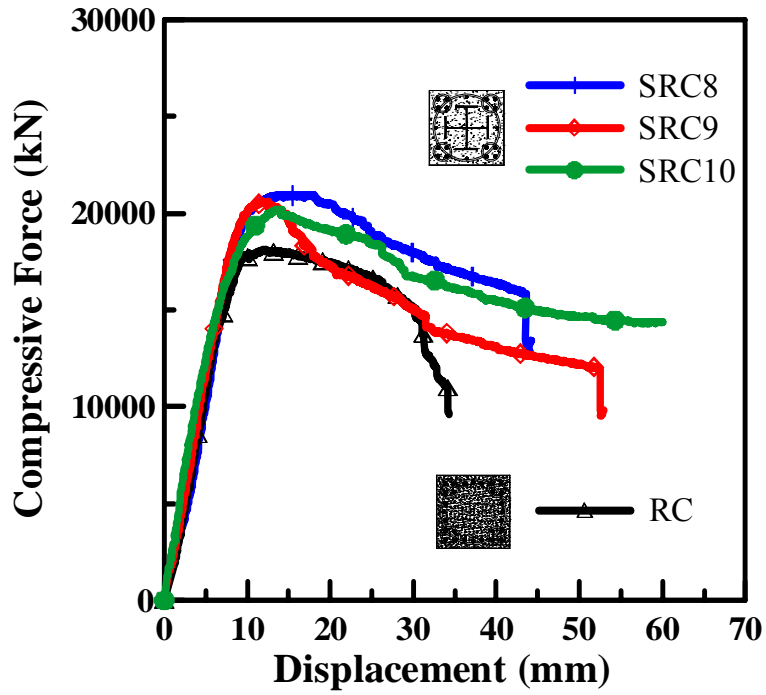


圖 3.12 五螺箍 SRC 柱、五螺箍 RC 柱與五螺箍 RC 柱之軸力-位移曲線的比較

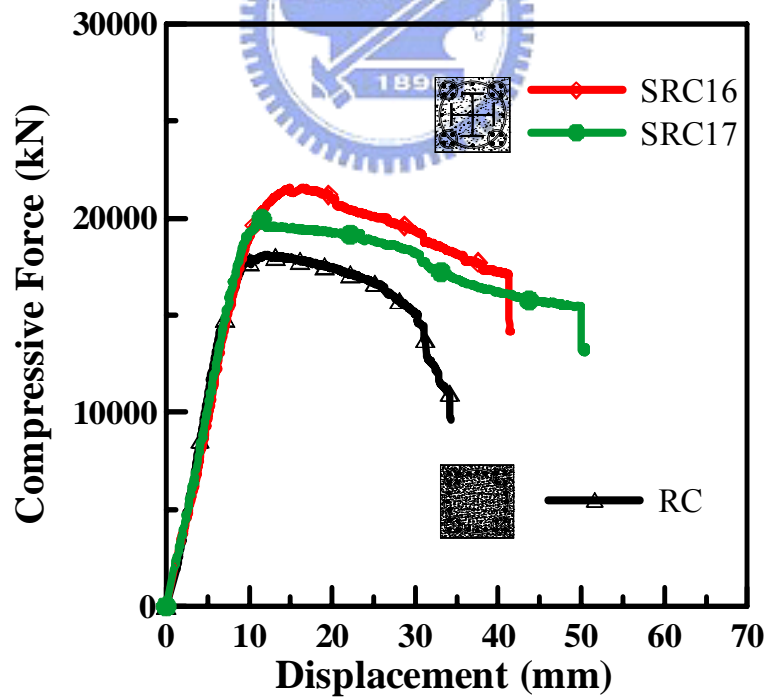
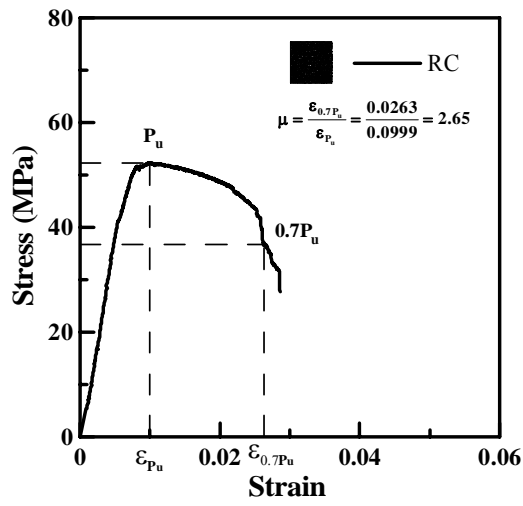
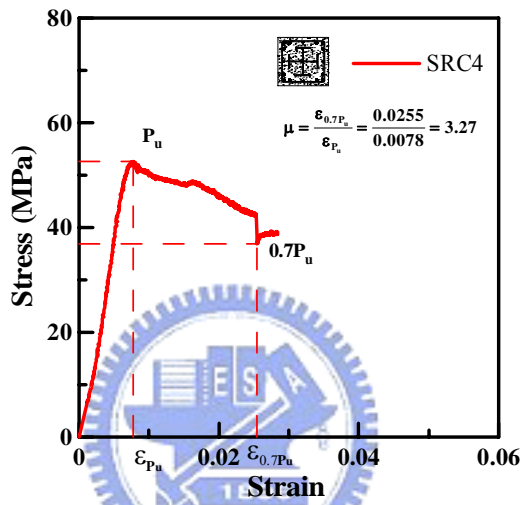


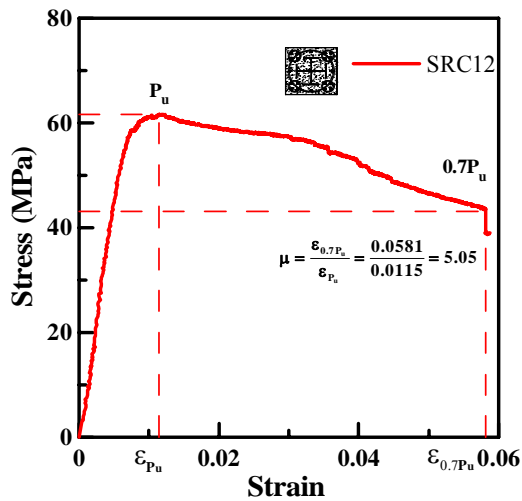
圖 3.13 高鋼骨量五螺箍 SRC 柱、五螺箍 RC 柱與傳統橫箍 RC 柱之軸力-位移曲線的比較



(a) 五螺箍 RC 柱 (RC)：箍筋間距 75mm

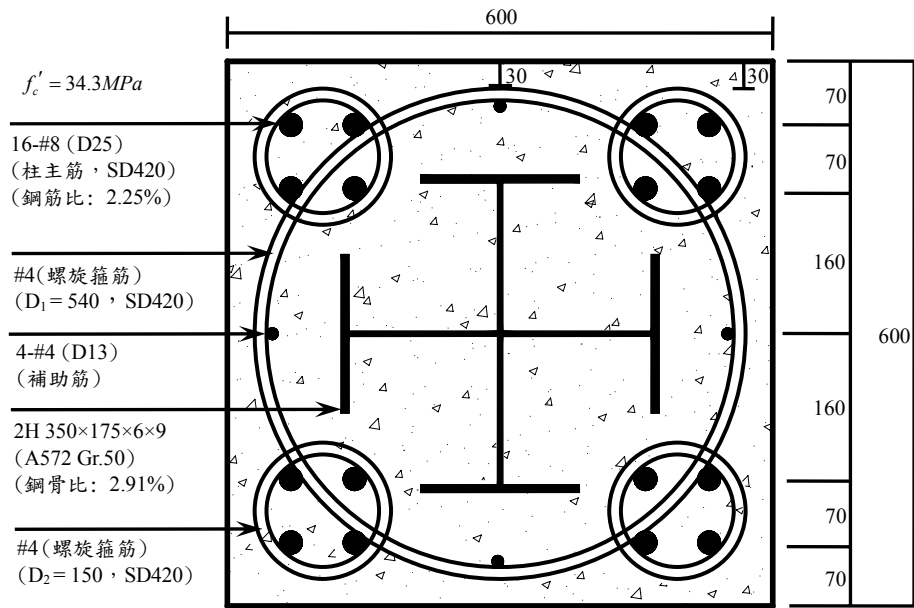


(b) 傳統橫箍 SRC 柱 (SRC4)：箍筋間距 75mm



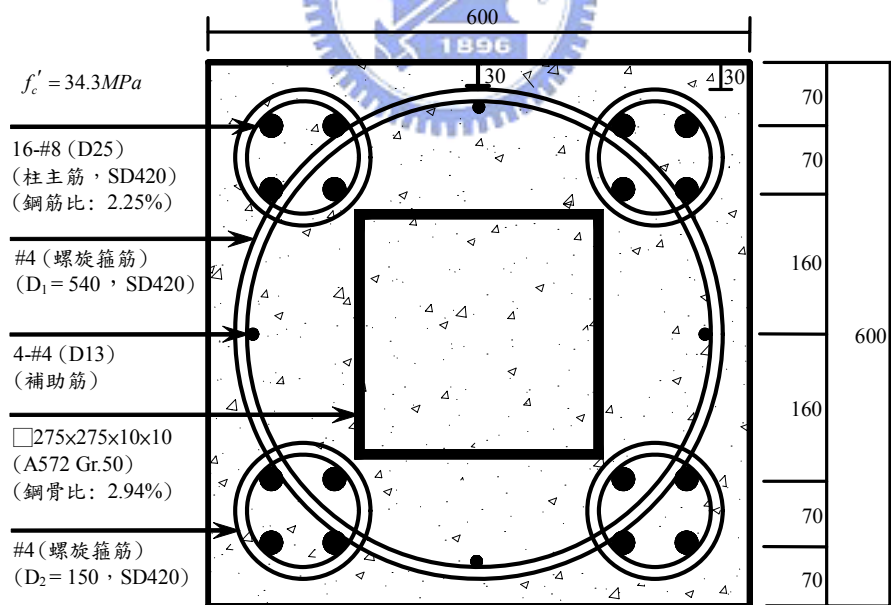
(c) 五螺箍 SRC 柱 (SRC12)：箍筋間距 75mm

圖 3.14 五螺箍 SRC 柱、傳統橫箍 SRC 柱與五螺箍 RC 柱之韌性指標比較圖



(Unit : mm)

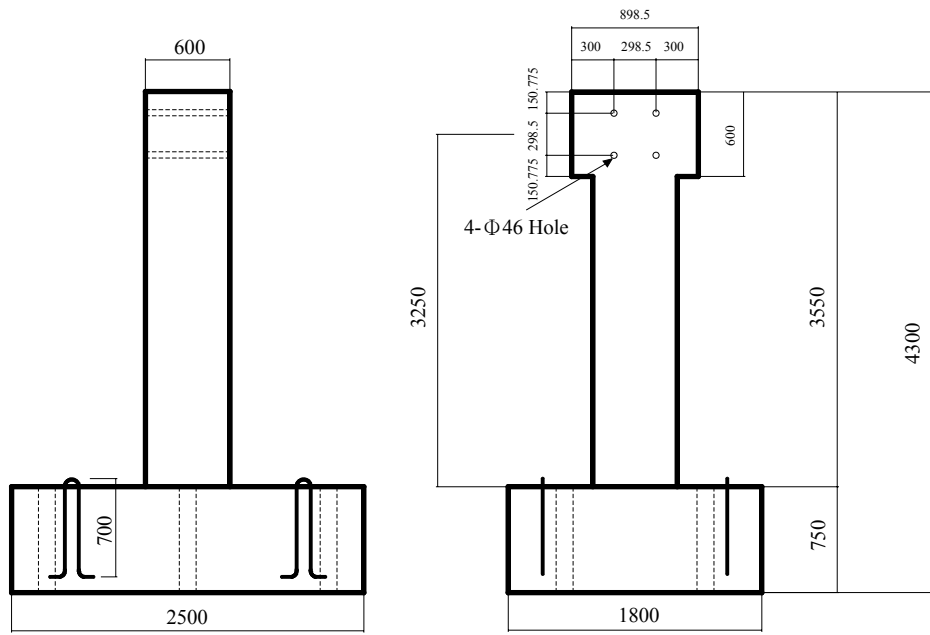
(a) 十字型鋼骨試體(C-SRC1、C-SRC2)



(Unit : mm)

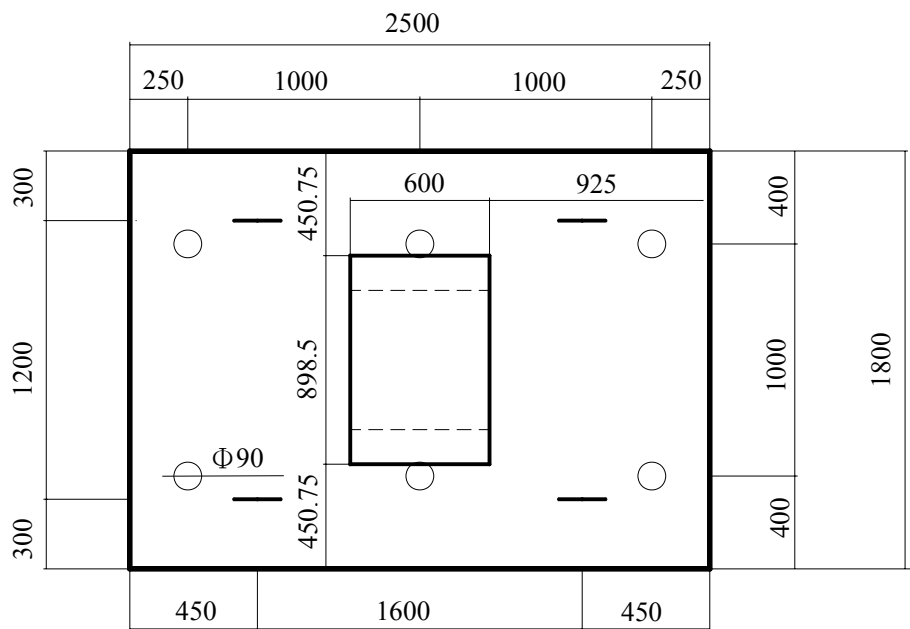
(b) 箱型鋼骨試體(C-SRC3、C-SRC4)

圖 4.1 本研究之五螺箍 SRC 柱斷面圖



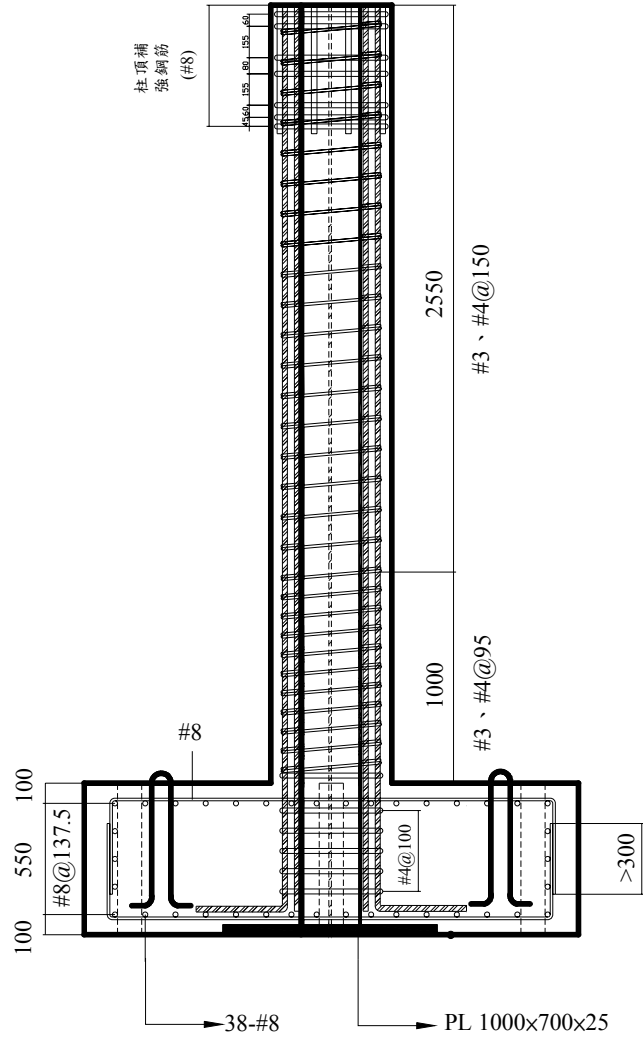
(Unit : mm)

圖 4.2 本研究 SRC 柱反覆載重試驗之試體立面圖



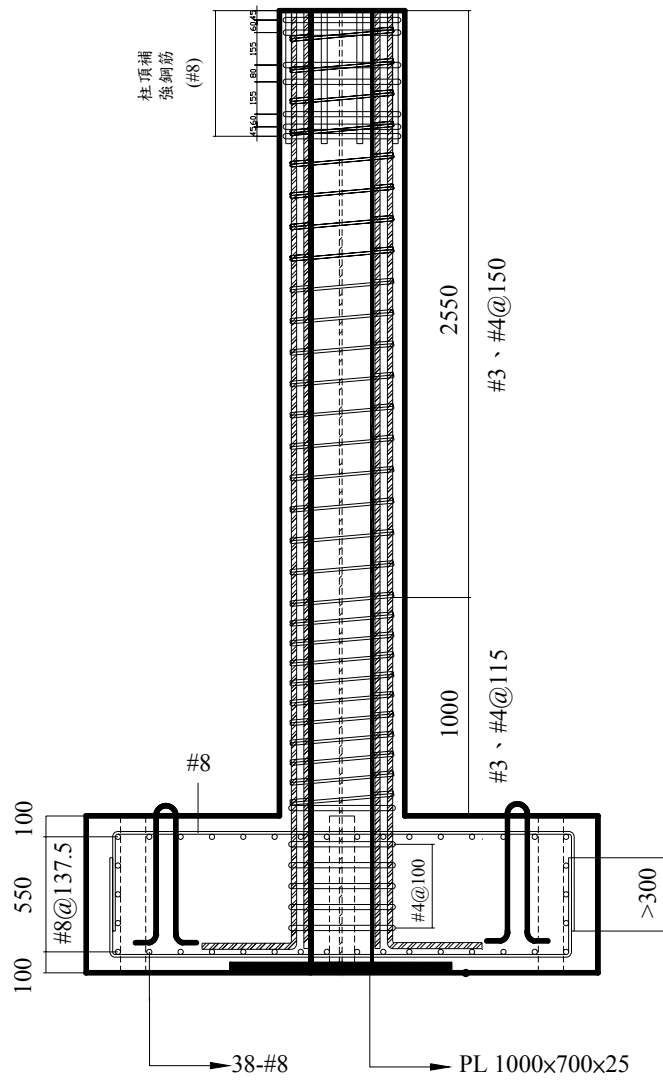
(Unit : mm)

圖 4.3 本研究 SRC 柱反覆載重試驗之試體平面圖



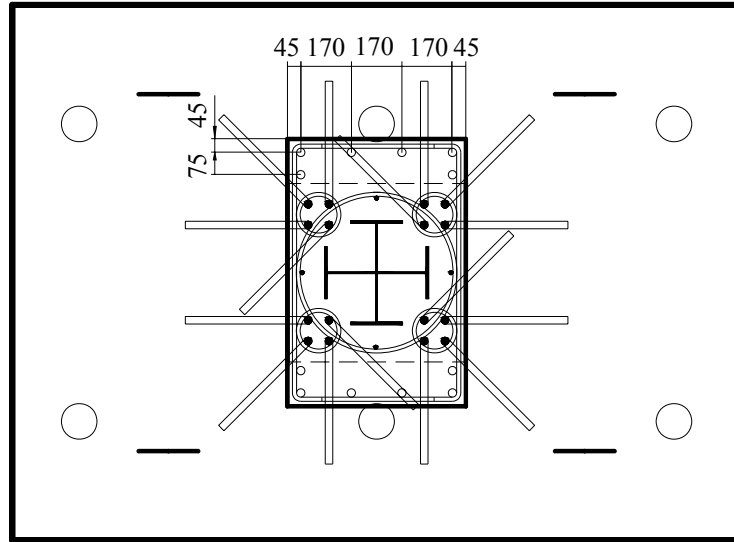
(Unit : mm)

圖 4.4 試體 C-SRC1 之正立面圖



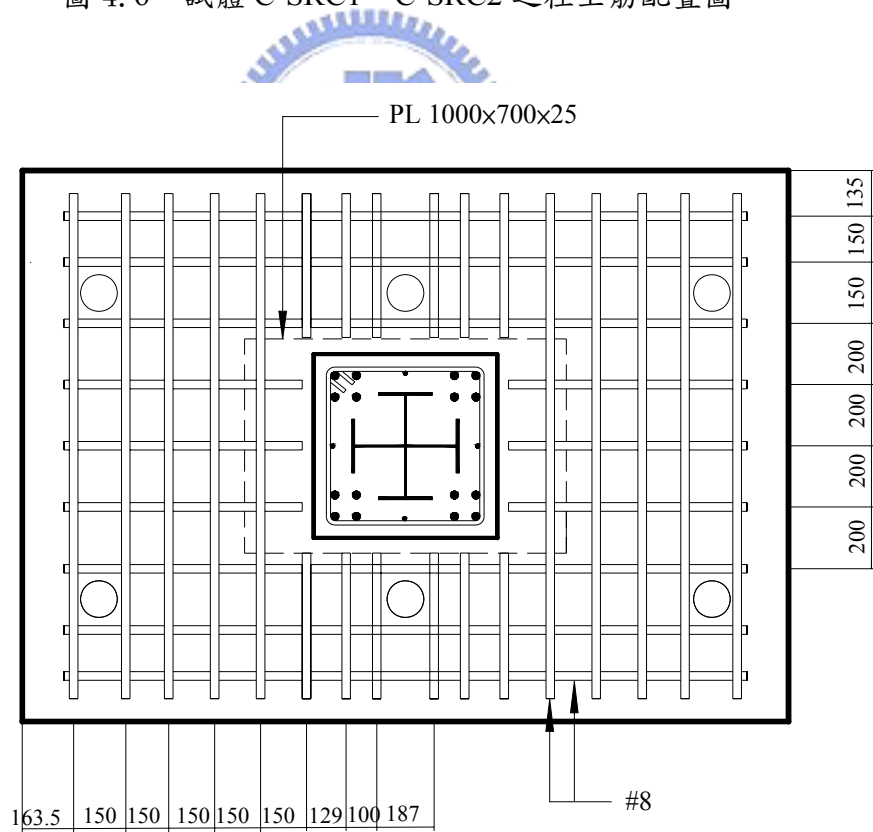
(Unit : mm)

圖 4.5 試體 C-SRC2 之正立面圖



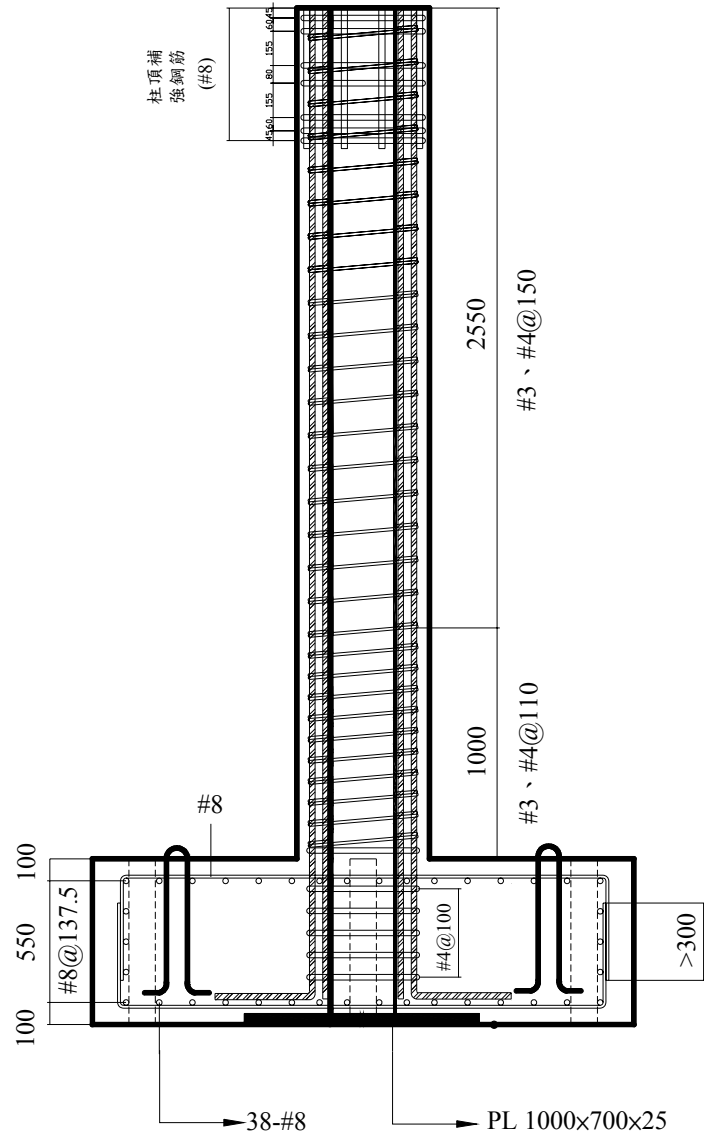
(Unit : mm)

圖 4.6 試體 C-SRC1、C-SRC2 之柱主筋配置圖



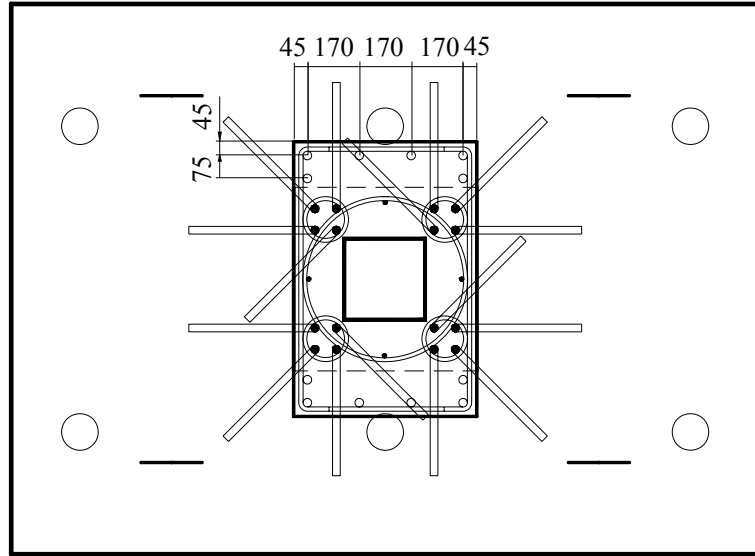
(Unit : mm)

圖 4.7 試體 C-SRC1、C-SRC2 之基礎主筋配置圖



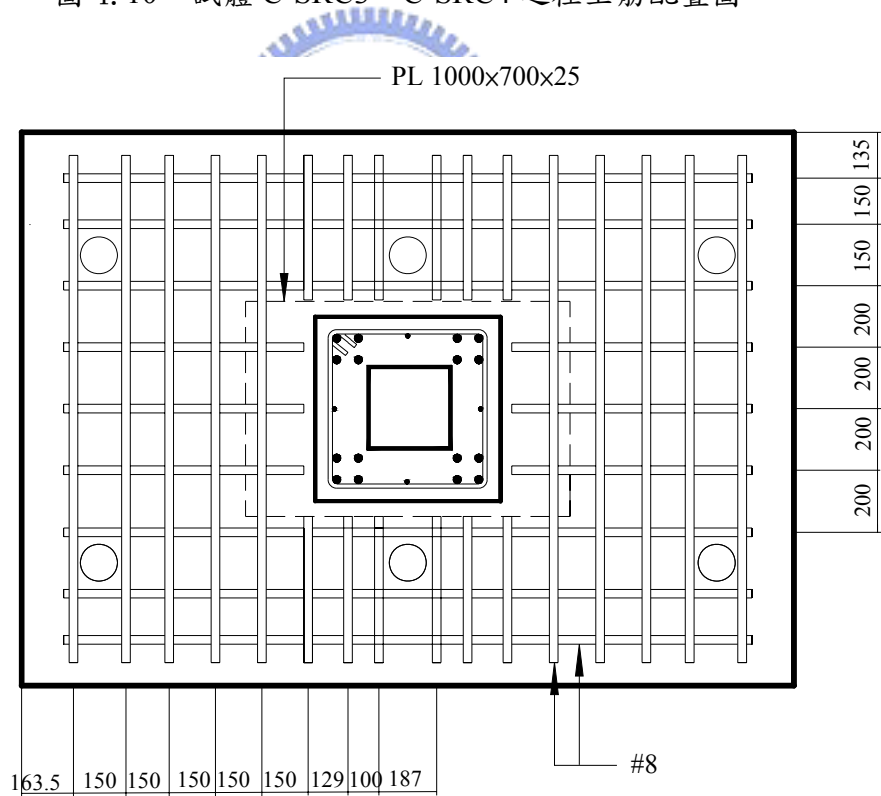
(Unit : mm)

圖 4.9 試體 C-SRC4 之正立面圖



(Unit : mm)

圖 4.10 試體 C-SRC3、C-SRC4 之柱主筋配置圖



(Unit : mm)

圖 4.11 試體 C-SRC3、C-SRC4 之基礎主筋配置圖

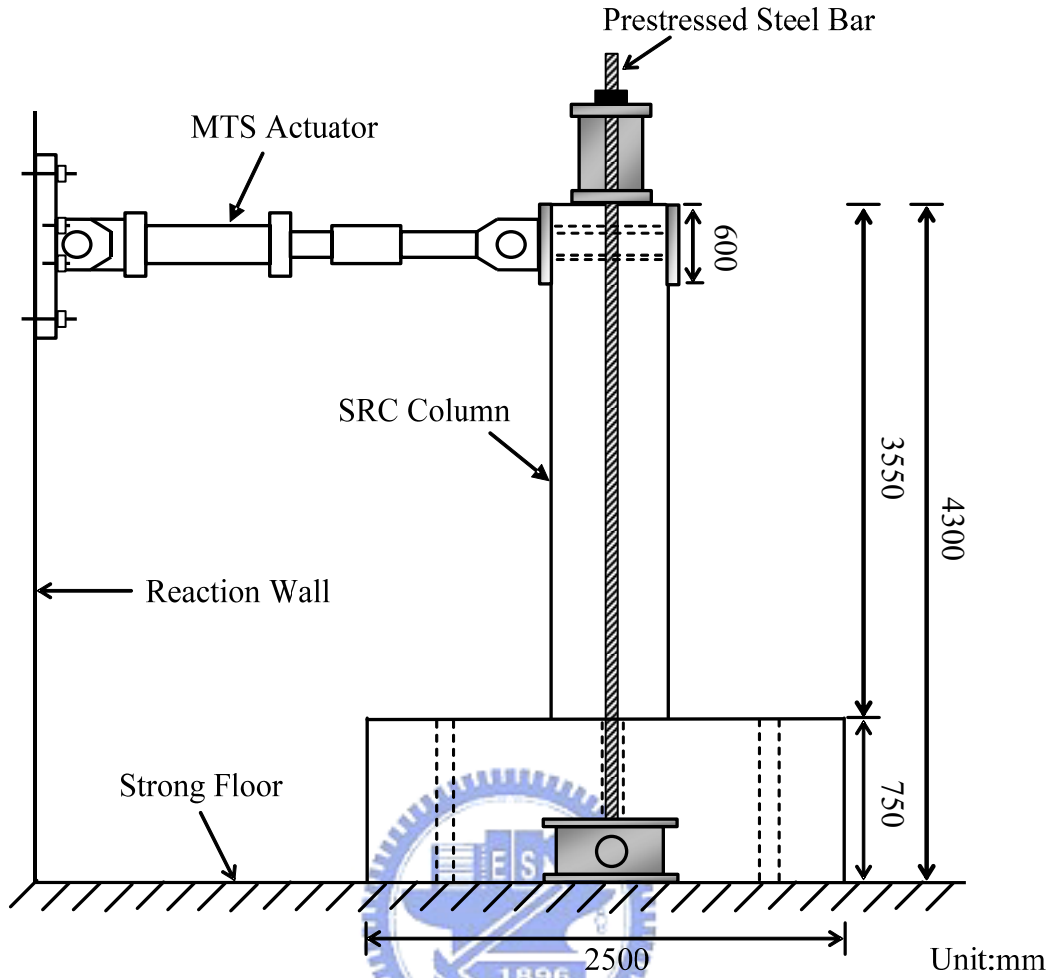


圖 4.12 本研究 SRC 柱反復載重試驗構架示意圖

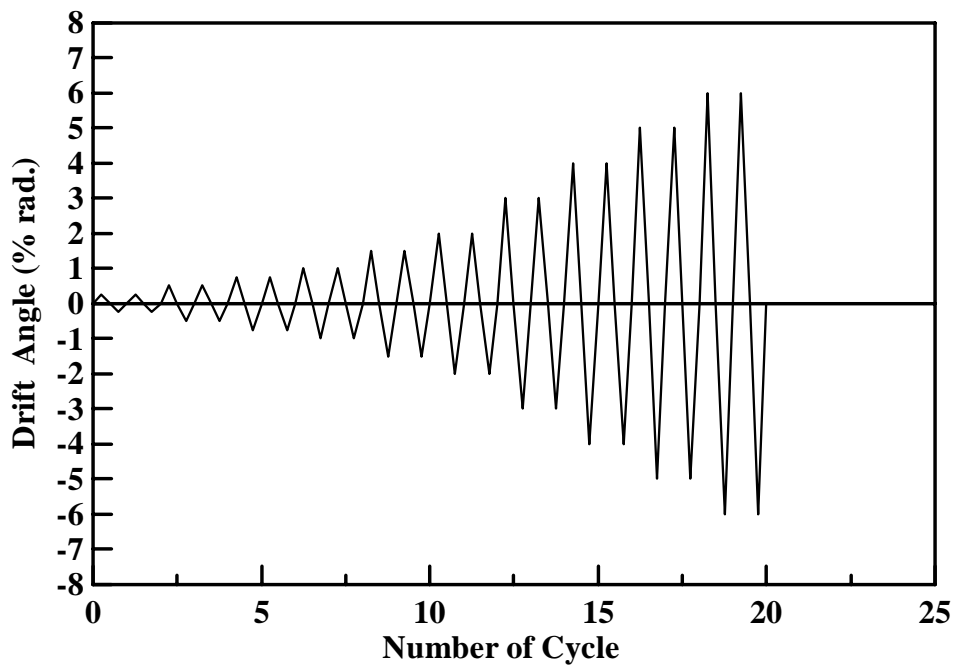


圖 4.13 本研究反復載重加載歷程圖

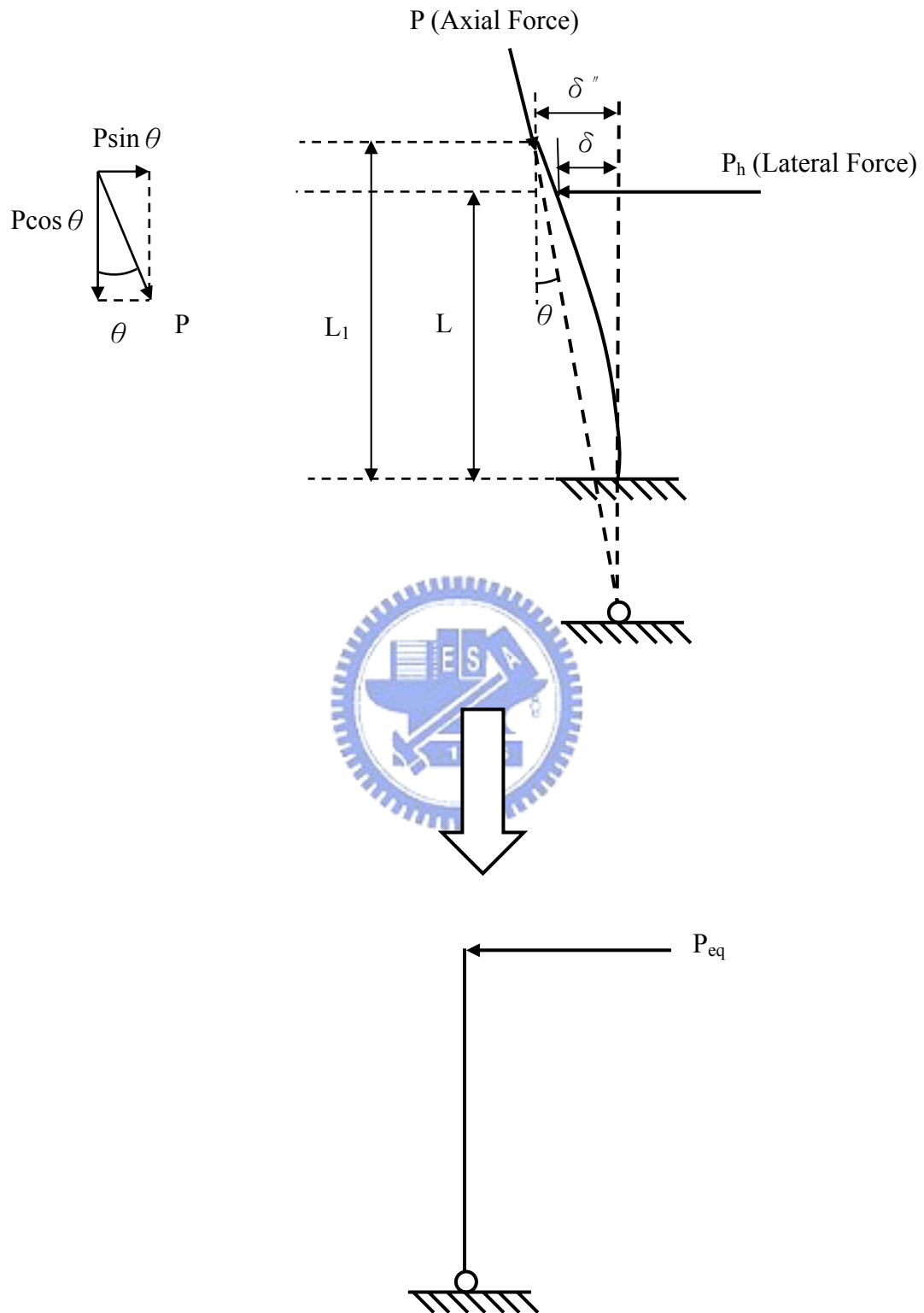


圖 4.14 P- Δ 效應修正示意圖

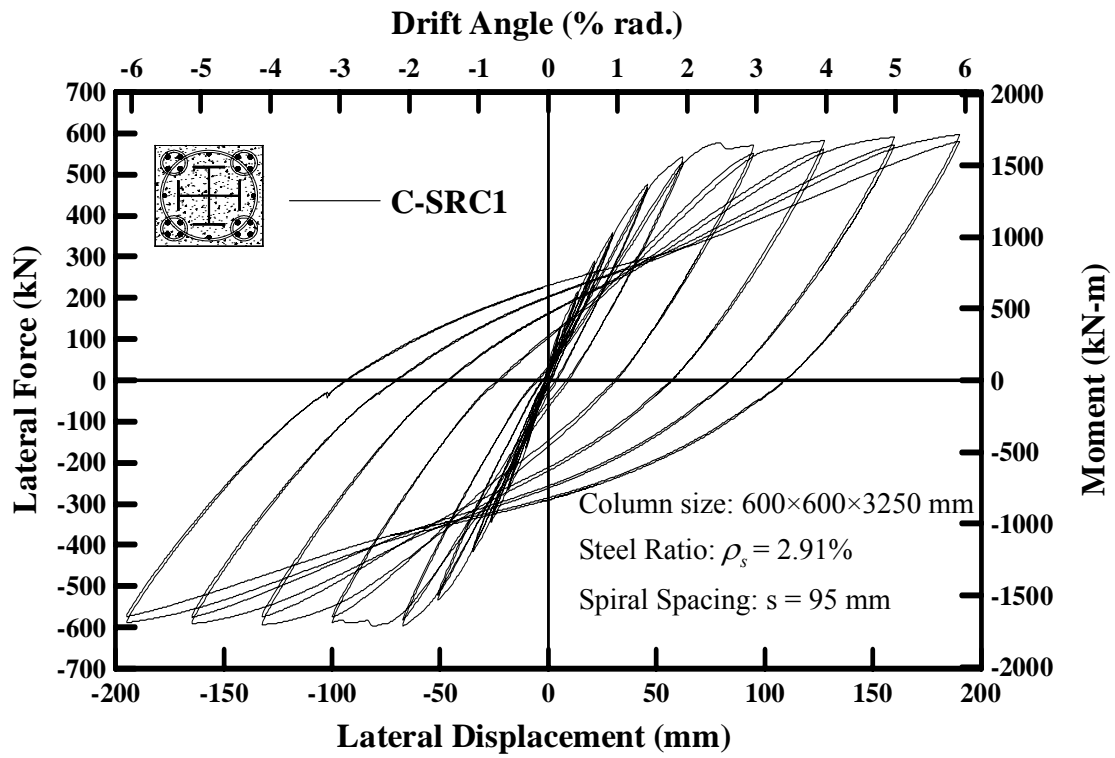


圖 4.15 SRC 柱受往復載重作用之遲滯迴圈：試體 C-SRC1

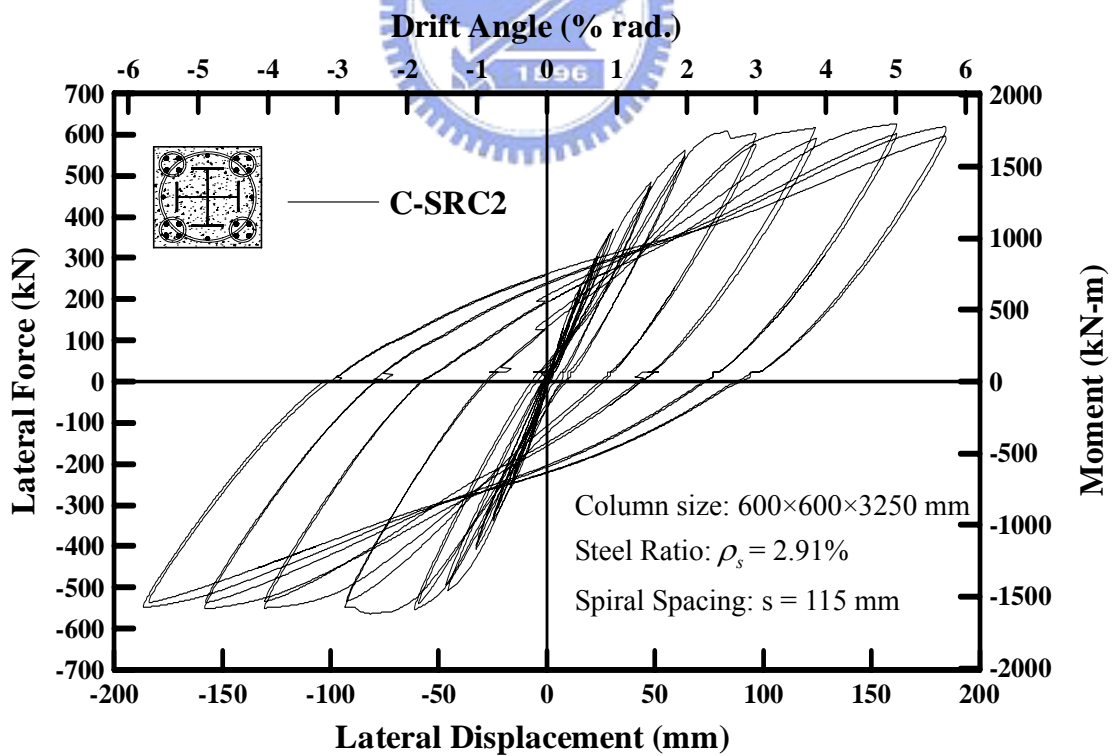


圖 4.16 SRC 柱受往復載重作用之遲滯迴圈：試體 C-SRC2

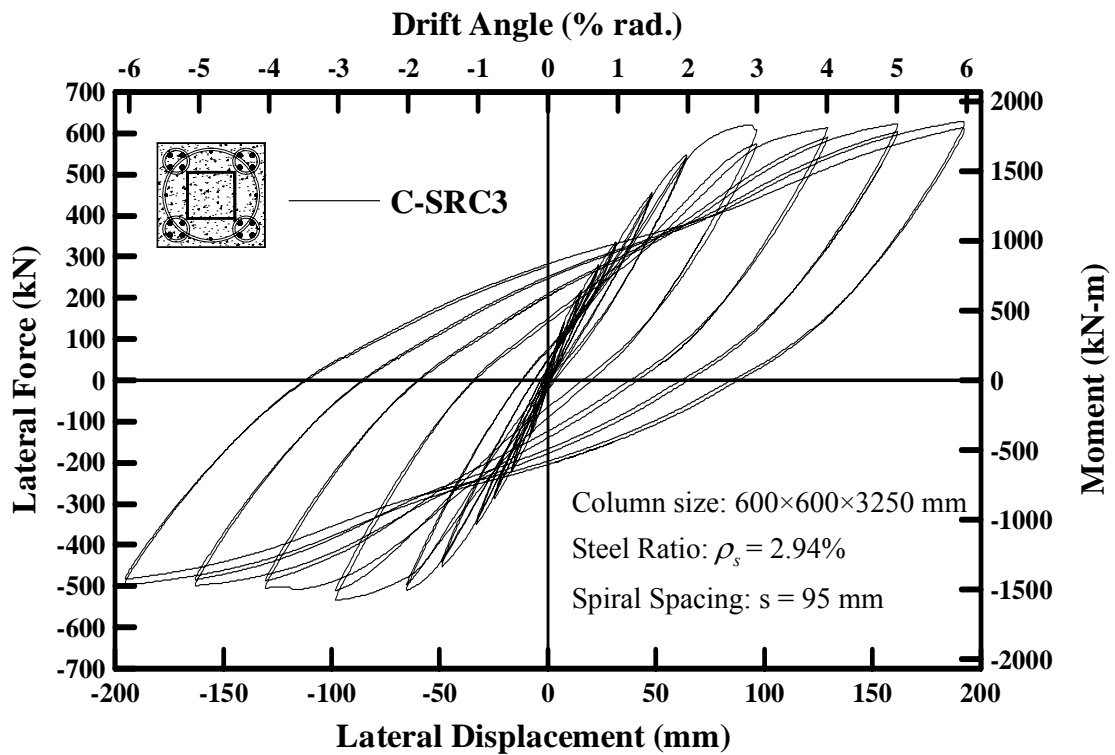


圖 4.17 SRC 柱受往復載重作用之遲滯迴圈：試體 C-SRC3

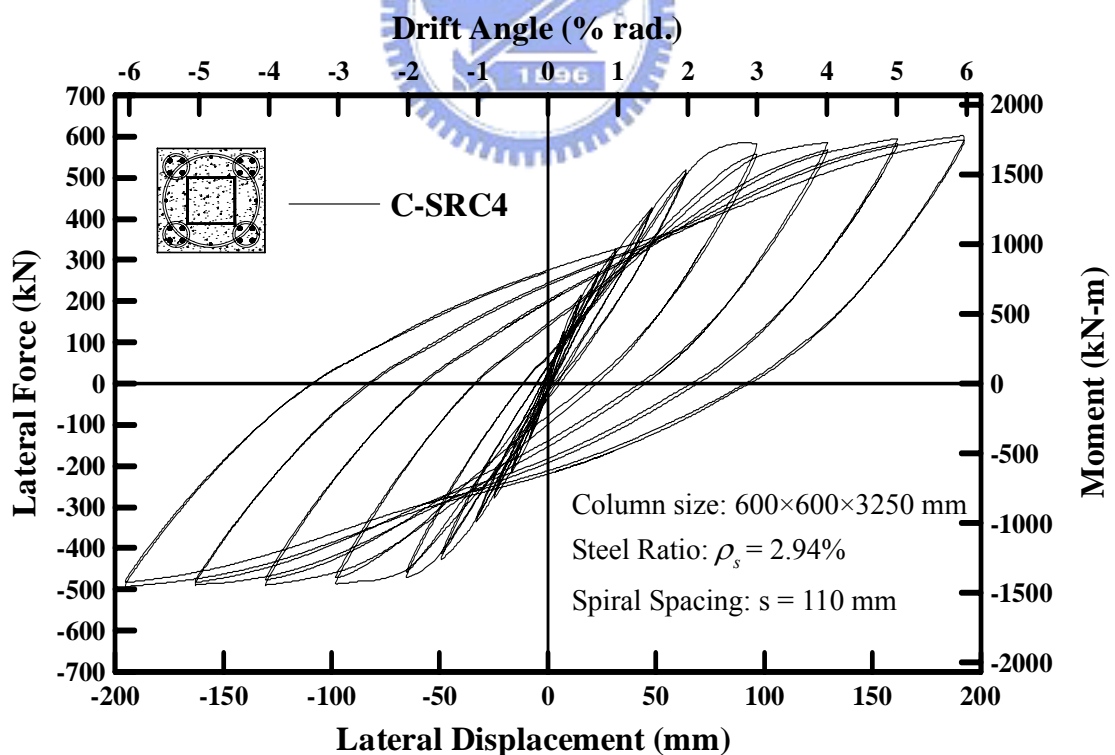


圖 4.18 SRC 柱受往復載重作用之遲滯迴圈：試體 C-SRC4

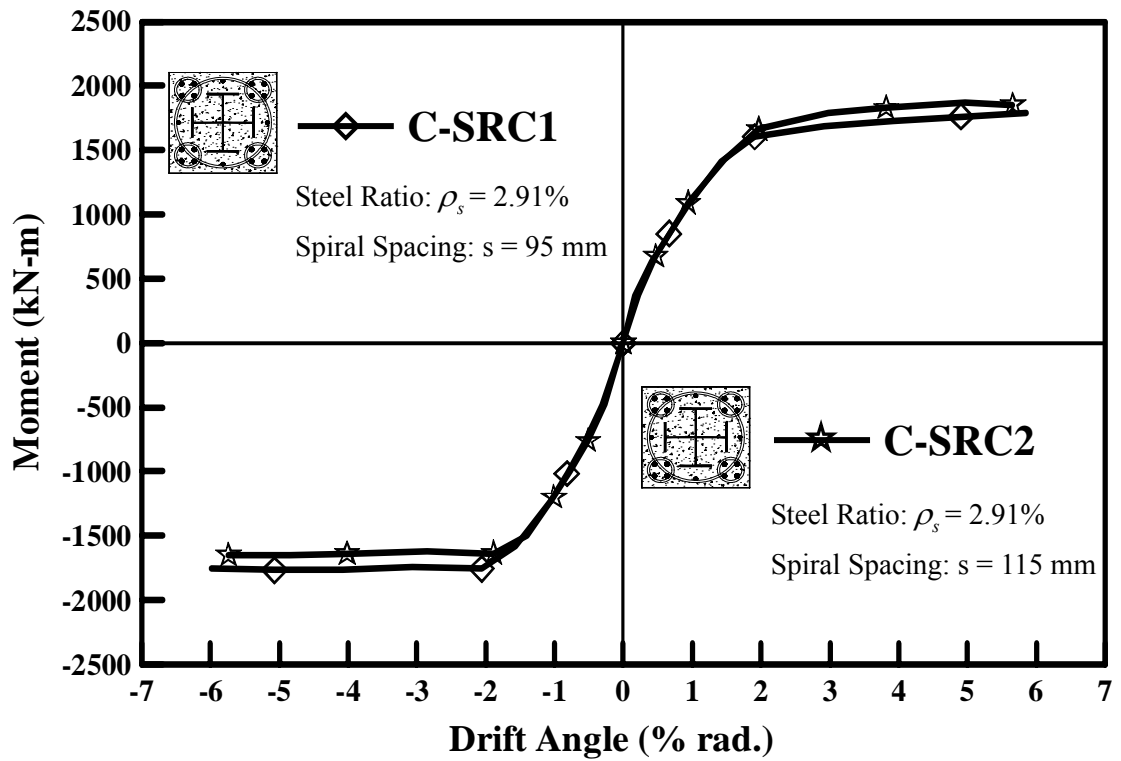


圖 4.19 SRC 柱受往復載重作用之遲滯迴圈包絡線：試體 C-SRC1 與 C-SRC2

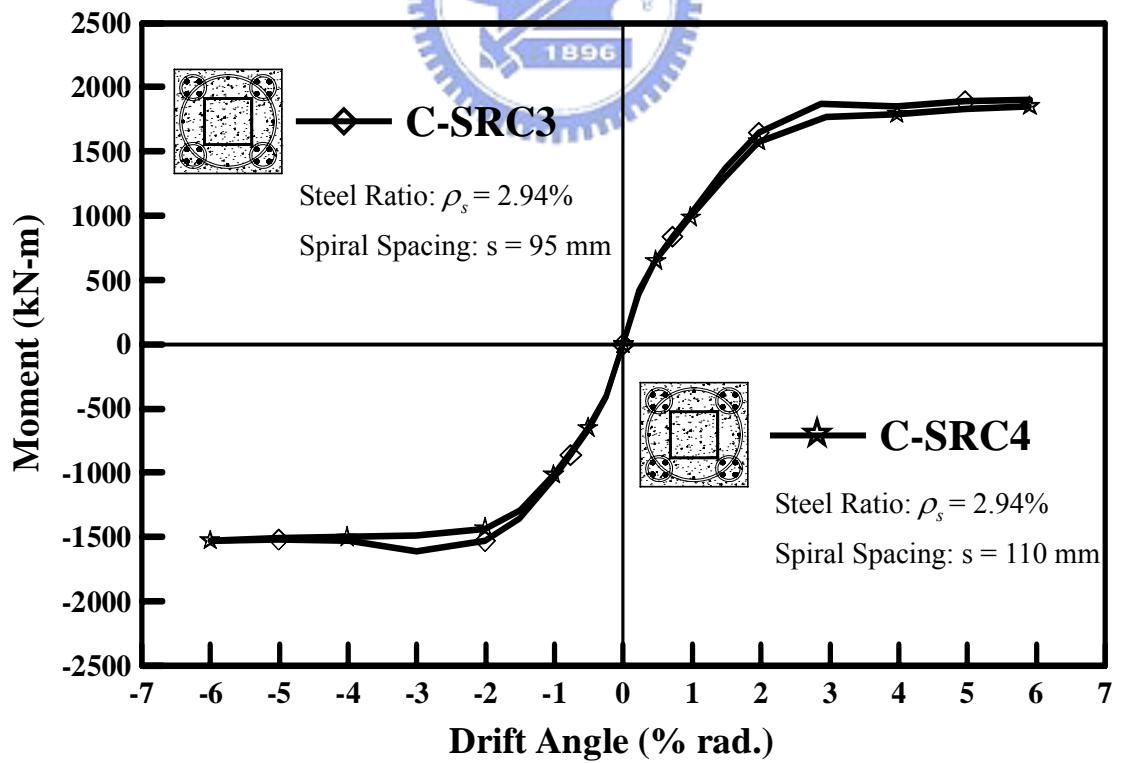


圖 4.20 SRC 柱受往復載重作用之遲滯迴圈包絡線：試體 C-SRC3 與 C-SRC4

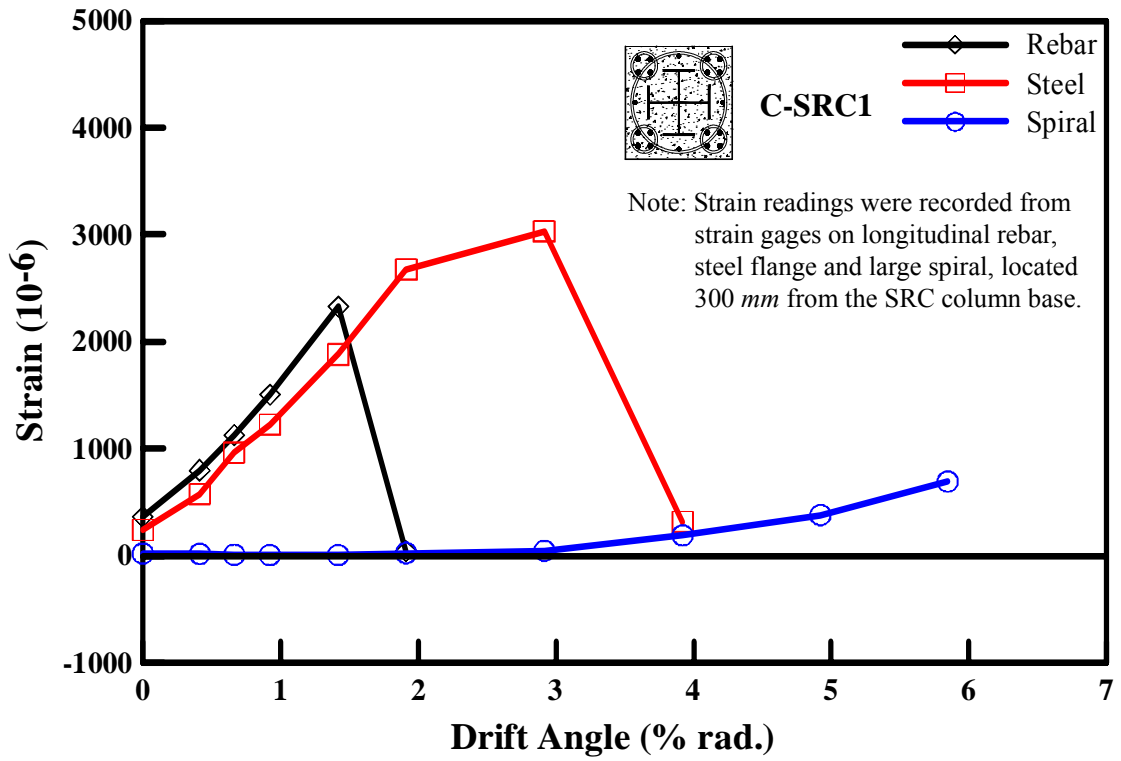


圖 4.21 試體 C-SRC1 之柱底部鋼骨翼板、主筋及箍筋的應變計讀數變化

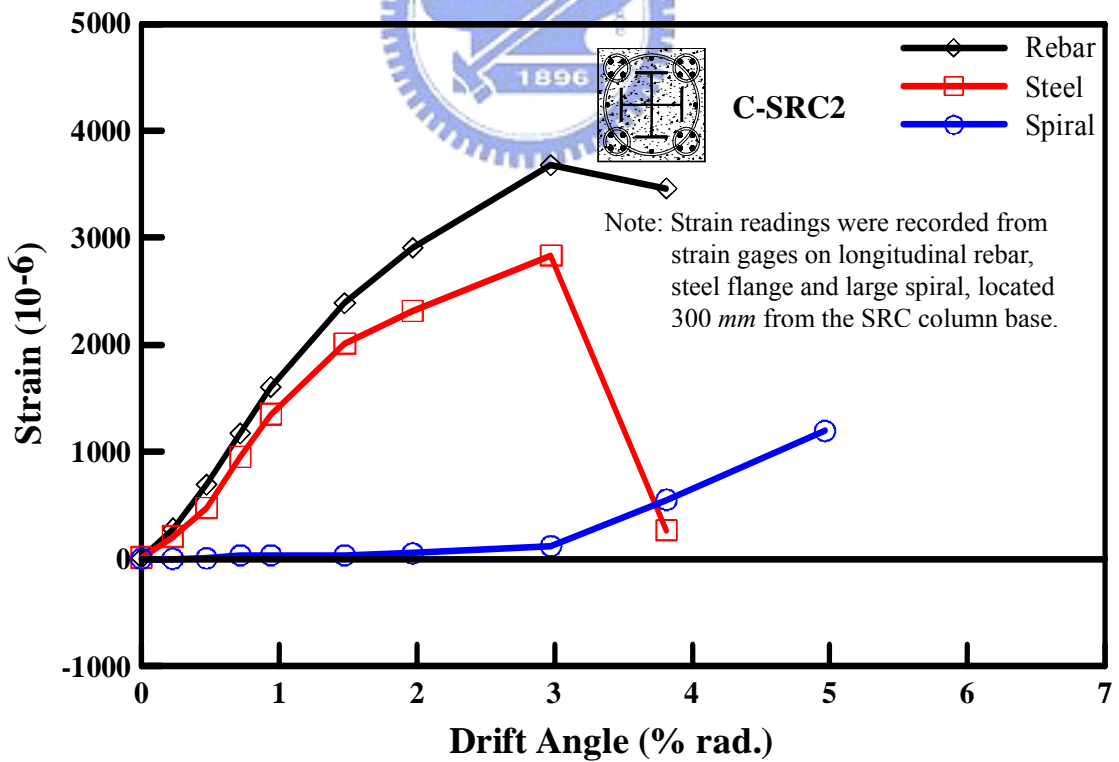


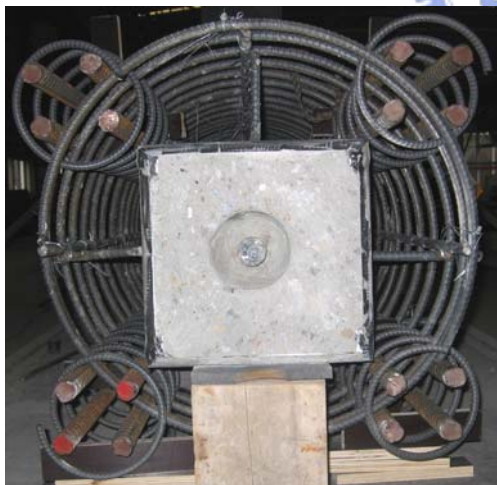
圖 4.22 試體 C-SRC2 之柱底部鋼骨翼板、主筋及箍筋的應變計讀數變化



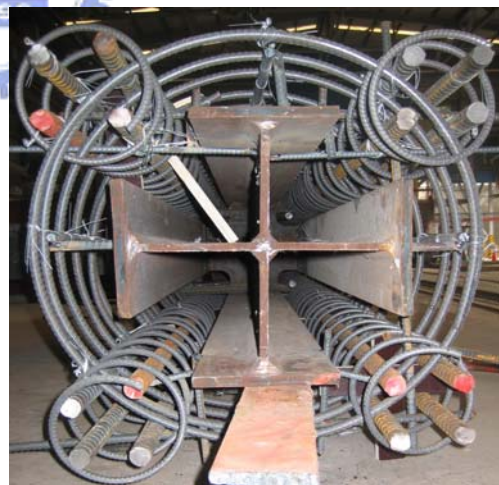
(a) 箍筋及主筋組立完成



(b) 鋼骨組立完成



(a) 五螺箍包覆箱型 SRC 柱



(b) 五螺箍包覆十字型 SRC 柱

照片 3.1 SRC 柱灌漿前之情形



照片 3.2 SRC 柱試體灌漿並搗實



照片 3.3 在 SRC 柱試體灌漿時同時製作 $150 \times 300 \text{ mm}$ 的標準混凝土圓柱試體



(a) 58800 kN 萬能試驗機



(b) 試體架設於試驗機平台上之情形

照片 3.4 58800 kN 萬能試驗機與 SRC 短柱試體之架設情形



(a) 主筋輕微挫屈

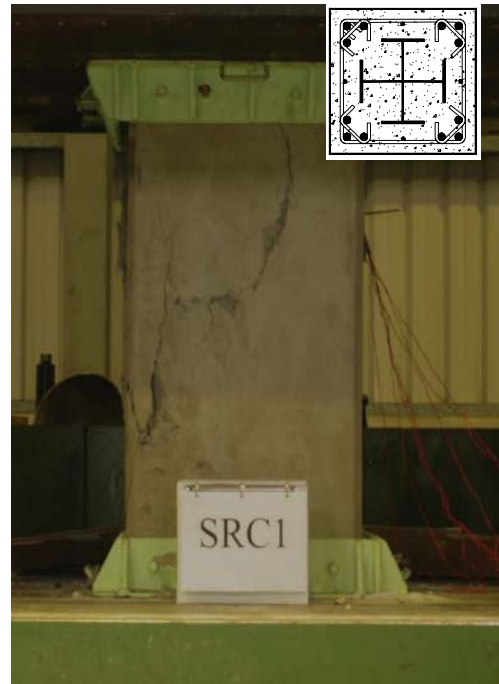


(b) 箍筋輕微彎曲

照片 3.5 五螺箍 SRC 柱於試驗結束後剝除碎裂混凝土後之情況



(a) 採用 ACI-318 Code 設計
(箍筋間距 75 mm)



(b) 採用 ACI-318 Code 設計
(箍筋間距 60 mm)

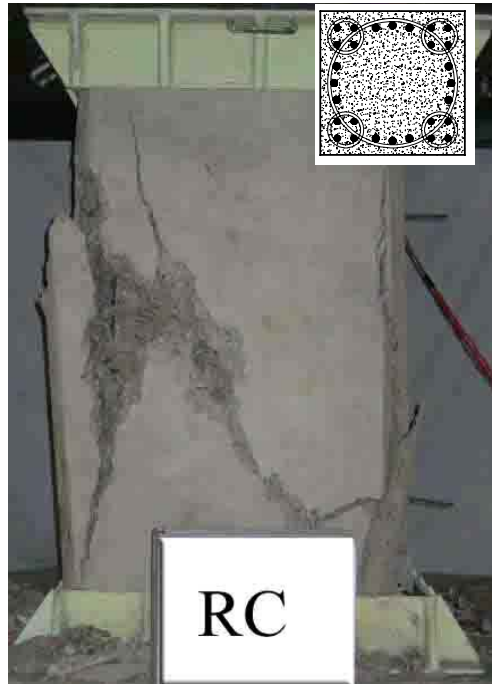


(c) 採用 Taiwan SRC Code 設計
(箍筋間距 75 mm)



(d) 採用 Weng's Formula 設計
(箍筋間距 90 mm)

照片 3.6 五螺箍 RC 柱 (試體 RC) 與有角隅繫筋之傳統橫箍 SRC 柱 (試體 SRC1、SRC2、SRC3) 達極限載重 P_u 時之破壞情形



(a) 採用 ACI-318 Code 設計
(箍筋間距 75 mm)



(b) 採用 Taiwan SRC Code 設計
(箍筋間距 75 mm)



(c) 採用 Weng's Formula 設計
(箍筋間距 90 mm)

照片 3.7 五螺箍 RC 柱 (試體 RC) 與無角隅繫筋之傳統橫箍 SRC 柱 (試體 SRC4、SRC5) 達極限載重 P_u 時之破壞情形



(a) 採用 ACI 318 Code 設計 (箍筋間距 60 mm)



(b) 採用 ACI 318 Code 設計 (箍筋間距 60 mm)

照片 3.8 五螺箍 SRC 柱 (試體 SRC11 至 SRC13) 與傳統橫箍 SRC 柱 (試體 SRC1 至 SRC5) 達極限載重 P_u 時之破壞情形



(c) 採用 Taiwan SRC Code 設計

(箍筋間距 75 mm)



(d) 採用 Taiwan SRC Code 設計

(箍筋間距 75 mm)



(e) 採用 Taiwan SRC Code 設計

(箍筋間距 75 mm)

照片 3.8 五螺箍 SRC 柱 (試體 SRC11 至 SRC13) 與傳統橫箍 SRC 柱

(試體 SRC1 至 SRC5) 達極限載重 P_u 時之破壞情形 (續)



(f) 採用 Weng's Formula 設計

(箍筋間距 90 mm)



(g) 採用 Weng's Formula 設計

(箍筋間距 90 mm)



(h) 採用 Weng's Formula 設計

(箍筋間距 90 mm)

照片 3.8 五螺箍 SRC 柱 (試體 SRC11 至 SRC13) 與傳統橫箍 SRC 柱 (試體 SRC1 至 SRC5) 達極限載重 P_u 時之破壞情形 (續)



(a) 採用 Taiwan SRC Code 設計
(箍筋間距 75 mm)



(b) 採用 Taiwan SRC Code 設計
(箍筋間距 75 mm)



(c) 採用 Weng's Formula 設計
(箍筋間距 90 mm)

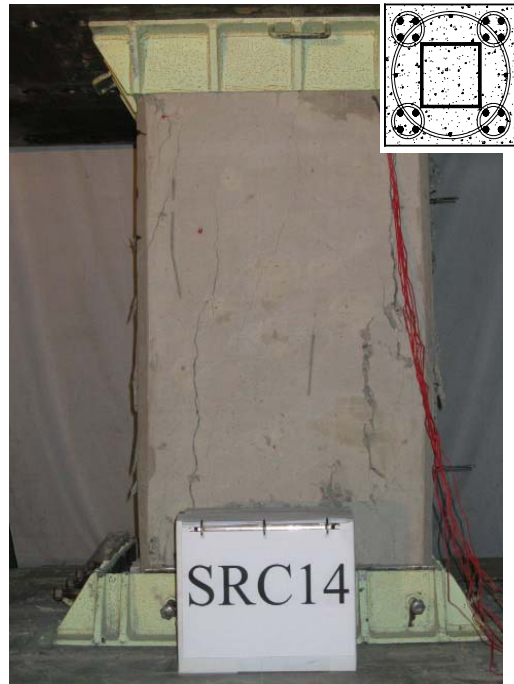


(d) 採用 Weng's Formula 設計
(箍筋間距 90 mm)

照片 3.9 傳統橫箍 SRC 柱十字型鋼骨斷面 (試體 SRC2、SRC3) 與箱型鋼骨斷面 (試體 SRC6、SRC7) 達極限載重 P_u 時之破壞情形



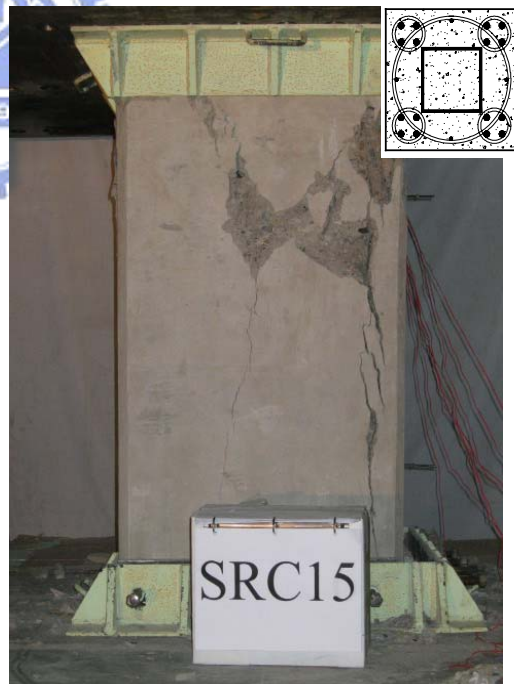
(a) 採用 Taiwan SRC Code 設計
(箍筋間距 95 mm)



(b) 採用 Taiwan SRC Code 設計
(箍筋間距 95 mm)

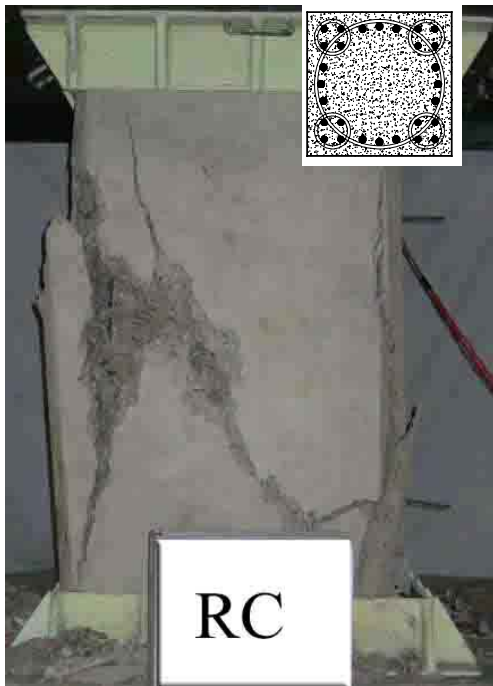


(c) 採用 Weng's Formula 設計
(箍筋間距 115 mm)

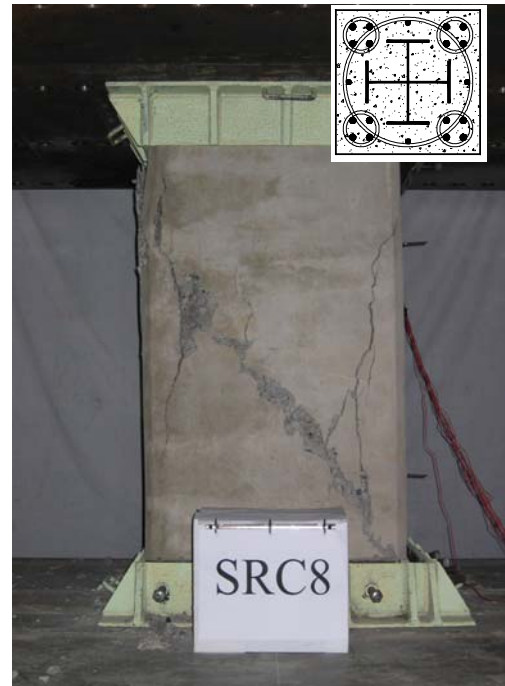


(d) 採用 Weng's Formula 設計
(箍筋間距 110 mm)

照片 3.10 五螺箍 SRC 柱十字型鋼骨斷面 (試體 SRC9、SRC10) 與箱型鋼骨斷面 (試體 SRC14、SRC15) 達極限載重 P_u 時之破壞情形



(a) 採用 ACI-318 Code 設計
(箍筋間距 75 mm)



(b) 採用 ACI-318 Code 設計
(箍筋間距 75 mm)

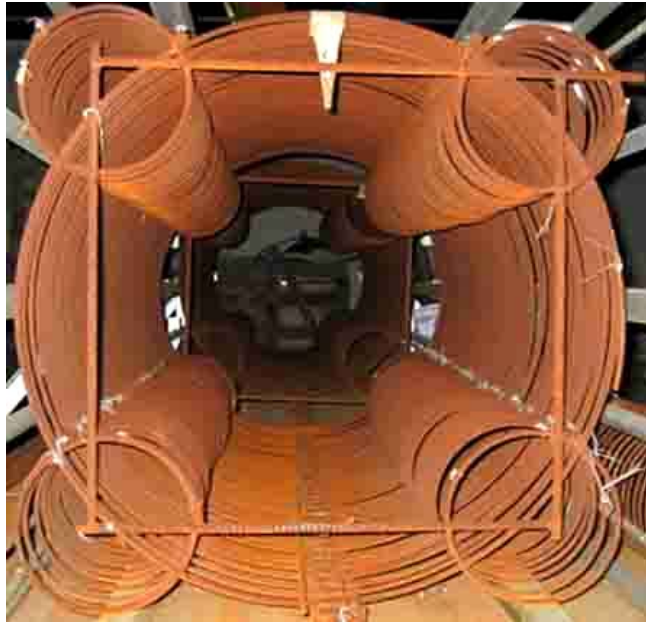


(c) 採用 Taiwan SRC Code 設計
(箍筋間距 95 mm)

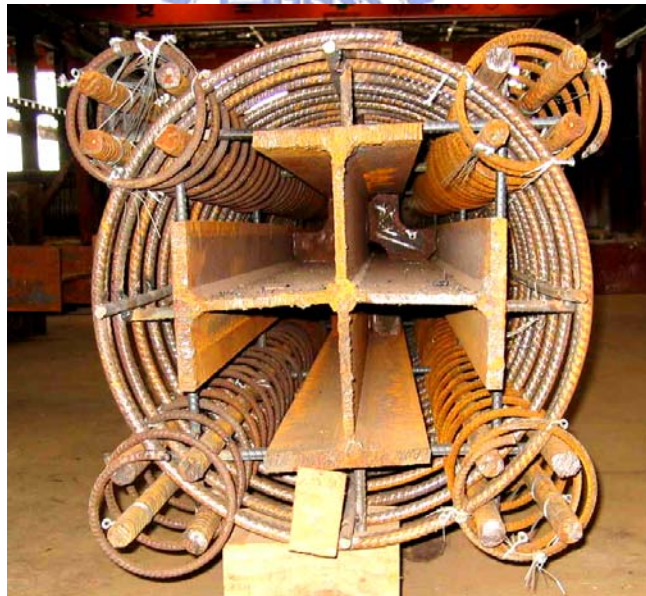


(d) 採用 Weng's Formula 設計
(箍筋間距 115 mm)

照片 3.11 五螺箍 SRC 柱 (試體 SRC8、SRC9、SRC10) 與五螺箍 RC 柱 (試體 RC) 達極限載重 P_u 時之破壞情形



(a) 新型式之五螺箍



(b) 內含十字型鋼骨之五螺箍 SRC 柱

照片 4.1 五螺箍(5-Spirals)與內含十字型鋼骨之五螺箍 SRC 柱



(a) 鋼骨、主筋與柱基礎主筋
組立完成



(b) 柱基礎混凝土灌漿完成



(c) 柱身箍筋與主筋綁紮完成



(d) 柱主體混凝土灌漿完成

照片 4.2 本研究 SRC 柱鋼骨、主筋及箍筋組立與混凝土灌漿完成情形



照片 4.3 本研究 SRC 柱反覆載重試驗配置



(a) 變位角達 3.0% 弧度時

(b) 變位角達 5.9% 弧度時

照片 4.4 試體 C-SRC1 在層間變位角達 3.0% 及 5.9% 弧度時之情形



(a) 變位角達 3.0% 弧度時



(b) 變位角達 5.7% 弧度時

照片 4.5 試體 C-SRC2 在層間變位角達 3.0% 及 5.7% 弧度時之情形



(a) 柱底塑鉸區混凝土剝落情形



(b) 在五螺箍圍束區域內之混凝土、主筋與箍筋仍然保持良好狀態

照片 4.6 試體 C-SRC2 最終破壞情形



(a) 變位角達 3.0% 弧度時



(b) 變位角達 6.0% 弧度時

照片 4.7 試體 C-SRC3 在層間變位角達 3.0% 及 6.0% 弧度時之情形



(a) 變位角達 3.0% 弧度時



(b) 變位角達 6.0% 弧度時

照片 4.8 試體 C-SRC4 在層間變位角達 3.0% 及 6.0% 弧度時之情形