

表 2.1 混凝土抗壓強度

Cylinder NO.	28 Day (Mpa)	SP1 D.O.T. (Mpa)	SP2 D.O.T. (Mpa)
1	47.4	48.2	48.6
2	41.4	55.4	58.9
3	49.2	55.5	54.4
Average	46.0	53.0	54.0

D.O.T.= Day of Test

表 2.2 鋼材拉力試驗強度

Thickness (mm)	Fy (Mpa)	Fu (Mpa)
5	324	444
3	320	414



表 3.1 試體 SP1 預力施拉紀錄

Step	Average Strain (%)	Stress (MPa)	T <sub>s</sub> (kN)	Jack Pressure (MPa)	T <sub>j</sub> (kN)	Error (%)
1	0.0003	65	173	2.0	176	1.3%
2	0.0008	167	446	4.9	439	-1.5%
3	0.0015	3101	824	9.8	878	6.1%
4	0.0023	470	1251	14.7	1316	4.9%
5	0.0030	609	1620	19.6	1755	7.7%
6	0.0038	767	2041	24.5	2194	7.0%
7	0.0044	906	2409	29.4	2633	8.5%
8	0.0051	1045	2780	33.9	3035	8.4%
Power Seating	0.0044	889	2365	-	2620	9.7%
After Test	0.0043	875	2329	-	2584	-

表 3.2 試體 SP2 預力施拉紀錄

Step	Averages Strain (%)	Stress (MPa)	T <sub>s</sub> (kN)	Jack Pressure (MPa)	T <sub>j</sub> (kN)	Error (%)
1	0.0003	68	182	2.0	176	-3.7%
2	0.0009	184	490	4.9	439	-11.8%
3	0.0017	354	942	9.8	878	-7.4%
4	0.0025	513	1366	14.7	1316	-3.8%
5	0.0033	667	1775	19.6	1755	-1.2%
6	0.0041	829	2206	24.5	2194	-0.6%
7	0.0048	979	2605	29.4	2633	1.0%
8	0.0055	1128	3000	33.9	3035	1.1%
Power Seating	0.0045	926	2462	-	2497	1.4%
After Test	0.0042	860	2288	-	2323	-

表 3.3 試體 SP1 與試體 SP2 試驗觀察第 1 點與第 2 點側位移角

Specimen	Segment	Step1	Step2
1	1	0.3%	0.9%
	2	0.4%	1.5%
2	1	0.6%	4.0%
	2	0.3%	0.6%

表 4.1  $\alpha$  值與側位移關係

	Drift	1.5%	2.0%	3.0%	4.0%	5.0%	6.0%	average
Specimen 1	$\alpha$	0.57	0.47	0.42	0.41	0.42	0.43	0.45
Specimen 2	$\alpha$	0.42	0.35	0.31	0.3	0.3	0.3	0.33

表 4.2 六組地震紀錄所對應的  $\eta$  值

Earthquake event	Northridge Castaic Old Ridge Rt.	Landers Joshua Tree	Loma Prieta Saratoga	Loma Prieta Anderson Dam	Loma Prieta Santa Cruz	San Fernando Lake Hughes
Specimen 1 $\eta$ (T=2.55 sec)	0.139	0.244	0.141	0.145	0.082	0.099
Specimen 2 $\eta$ (T=2.55 sec)	0.142	0.249	0.143	0.148	0.084	0.101
Specimen 1 $\eta$ (T=1.0sec)	0.415	0.429	0.204	0.202	0.149	0.104
Specimen 2 $\eta$ (T=1.0 sec)	0.424	0.438	0.208	0.205	0.151	0.106

表 4.3 六組調整地震紀錄 (T = 2.55 秒)

Earthquake event	Date	Magnitude	Station	Distance (km)	Soil Type	Scale Factor	Scaled PGA(g)
Northridge	1/17/1994	6.7	Castaic Old Ridge Rt.	20.8	C	3.86	1.98
Landers	6/28/1992	7.3	Joshua Tree	11.3	C	3.97	1.13
Loma Prieta	10/18/1989	6.9	Saratoga	11.7	C	3.89	1.96
Loma Prieta	10/18/1989	6.9	Anderson Dam Downstream	20.0	C	7.61	1.90
Loma Prieta	10/18/1989	6.9	Santa Cruz	12.5	C	7.58	3.35
San Fernando	2/9/1971	6.6	Lake Hughes	17.0	C	7.91	2.79

表 4.4 六組調整地震紀錄 (T = 1.0 秒)

Earthquake event	Date	Magnitude	Station	Distance (km)	Soil Type	Scale Factor	Scaled PGA(g)
Northridge	1/17/1994	6.7	Castaic Old Ridge Rt.	20.8	C	1.29	0.66
Landers	6/28/1992	7.3	Joshua Tree	11.3	C	2.26	0.64
Loma Prieta	10/18/1989	6.9	Saratoga	11.7	C	2.68	1.35
Loma Prieta	10/18/1989	6.9	Anderson Dam Downstream	20.0	C	5.47	1.37
Loma Prieta	10/18/1989	6.9	Santa Cruz	12.5	C	4.21	1.86
San Fernando	2/9/1971	6.6	Lake Hughes	17.0	C	7.54	2.66

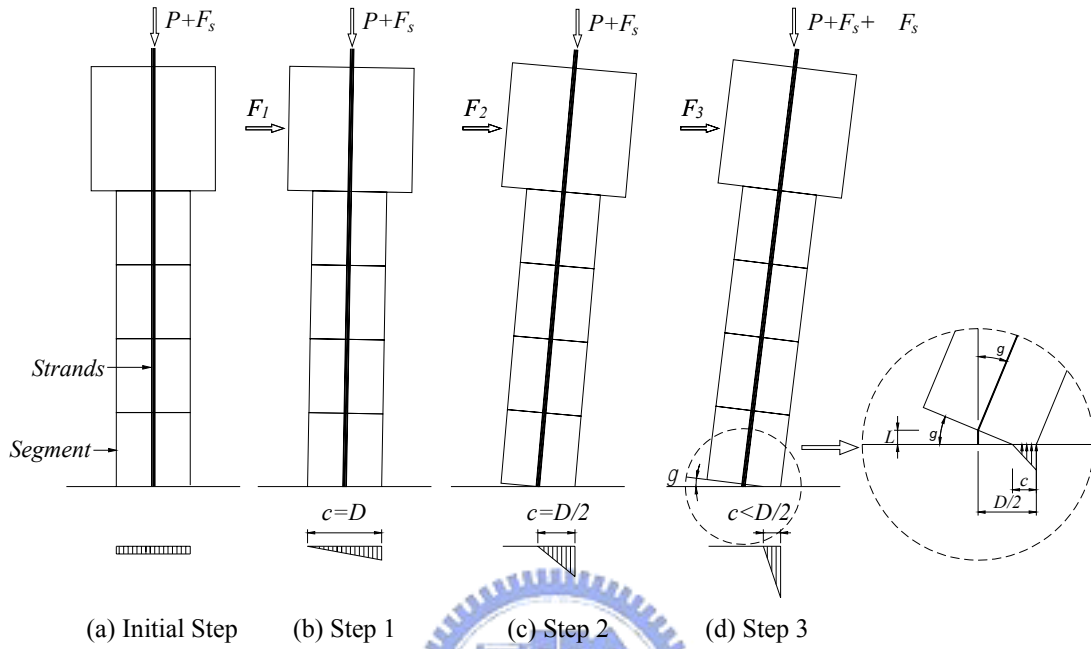


圖 2.1 預力混凝土節塊橋柱行為示意圖

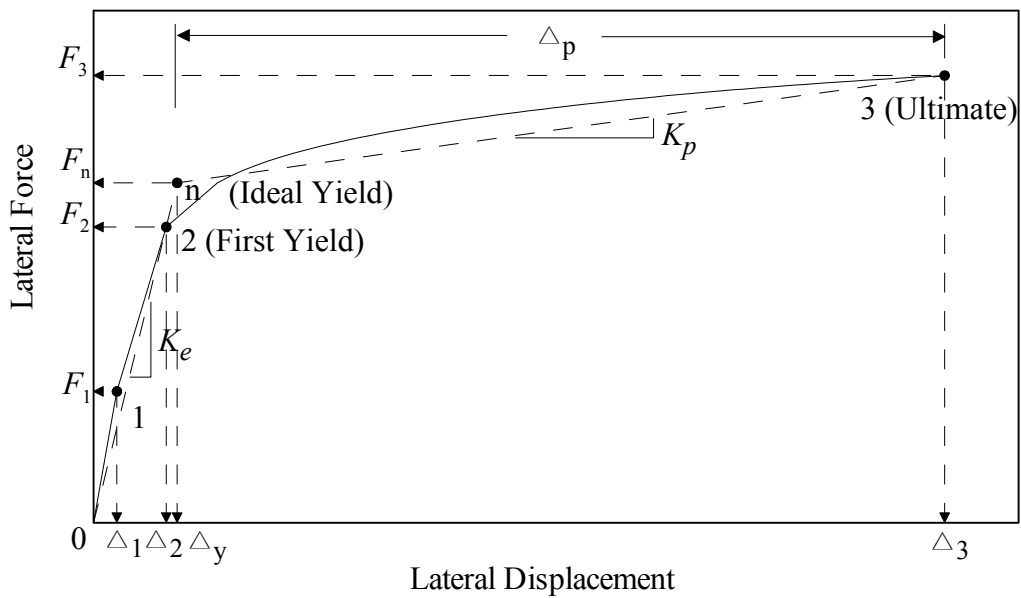


圖 2.2 預力節塊橋柱理想力量-位移關係示意圖

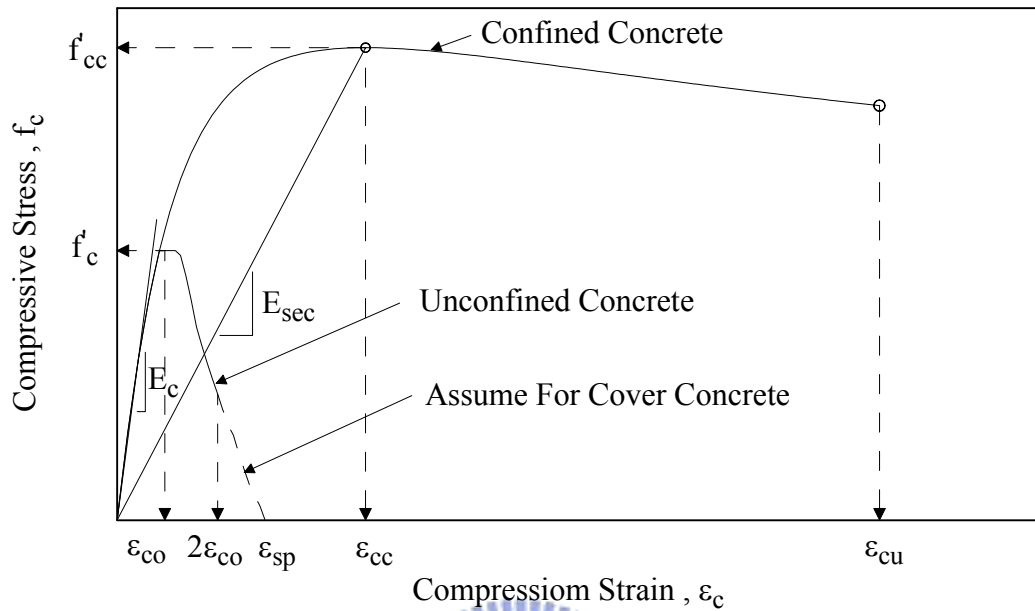


圖 2.3 Mander 混凝土應力-應變模型

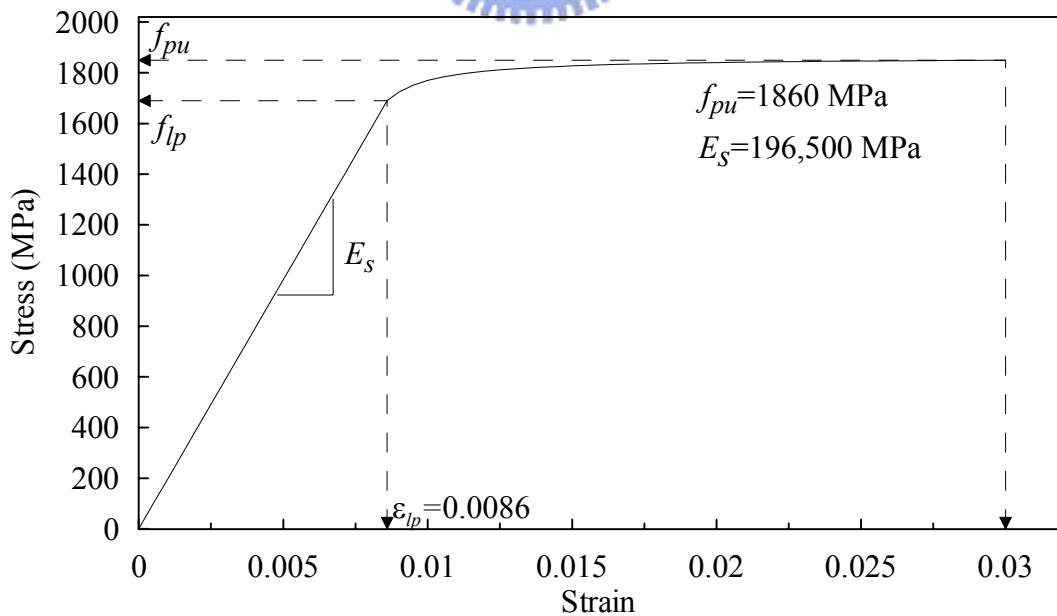


圖 2.4 理想化鋼鍵應力-應變關係圖

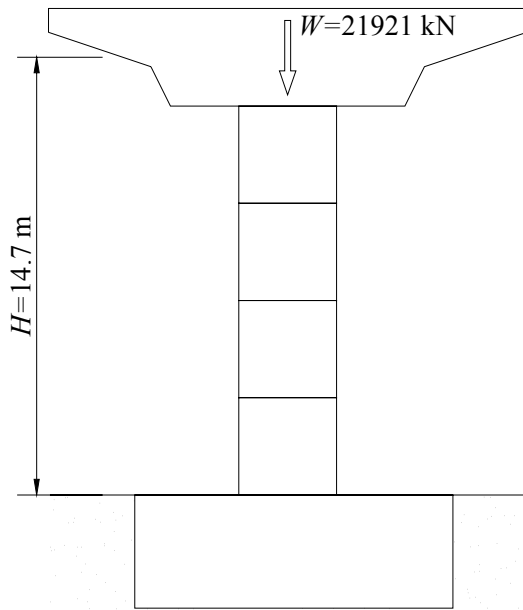


圖 2.5 全尺寸橋柱設計案例示意圖

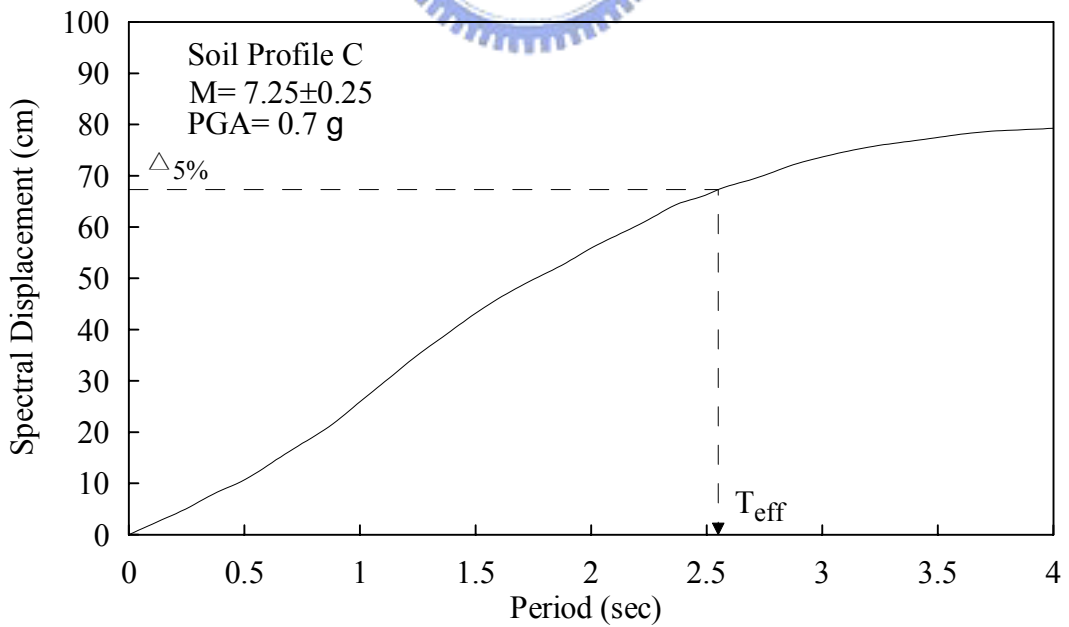


圖 2.6 ATC 32 設計位移反應譜

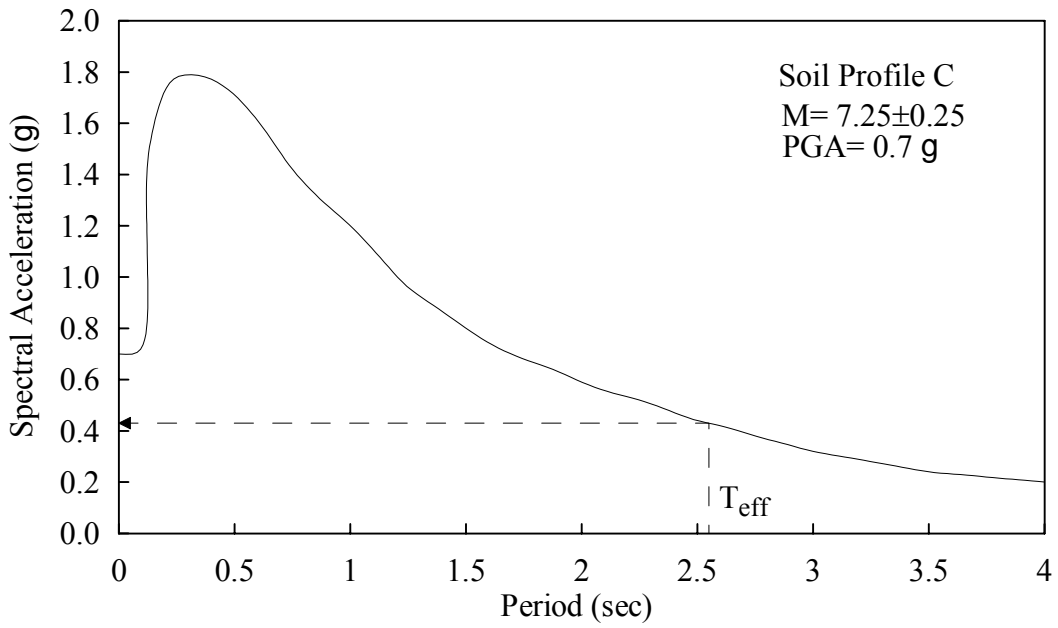


圖 2.7 ATC 32 設計加速度反應譜

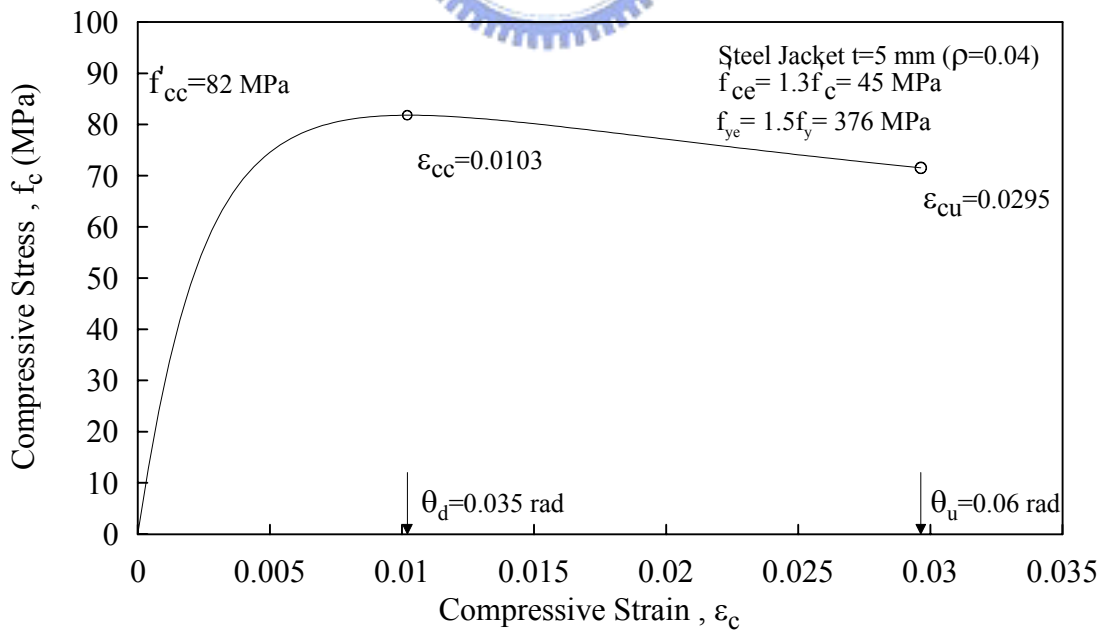


圖 2.8 第一節塊鋼套管圍束後混凝土應力應變關係圖

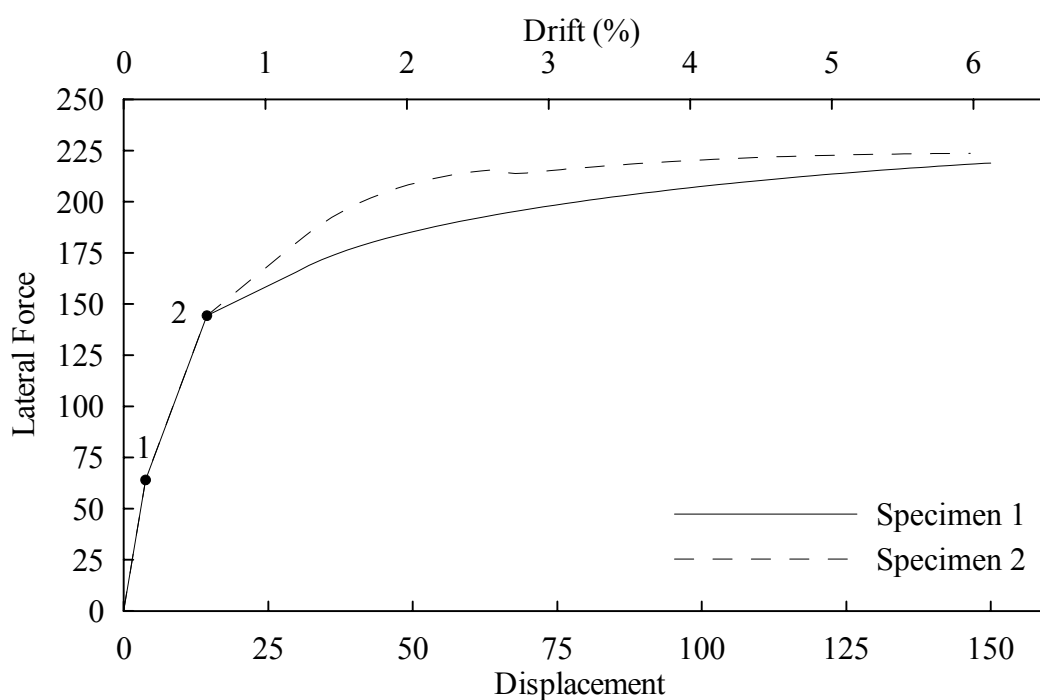


圖 2.9 試體 SP1 與試體 SP2 力量-位移關係圖

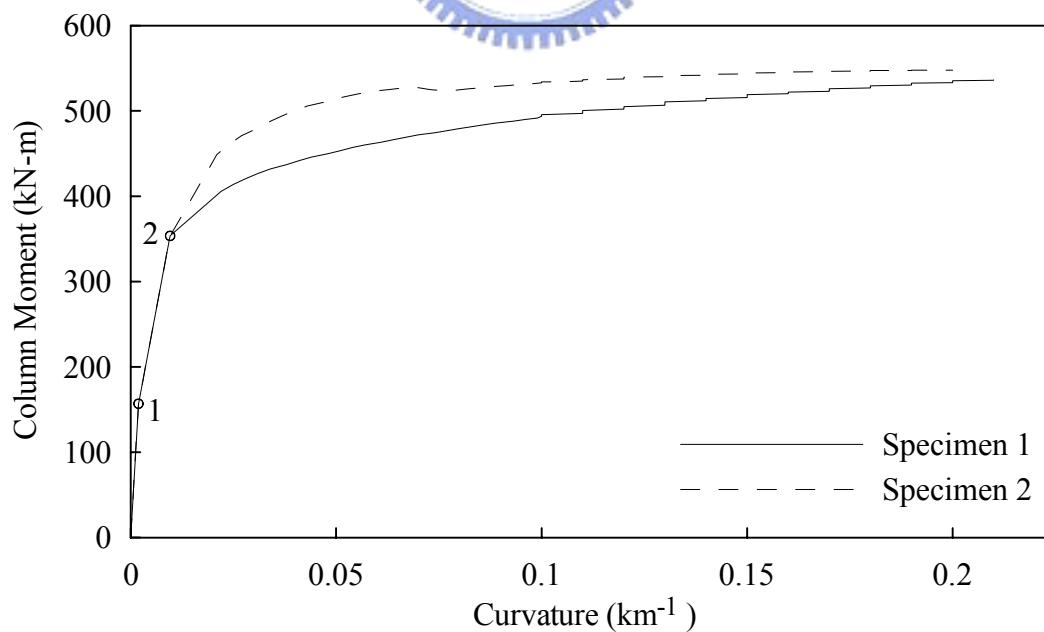


圖 2.10 試體 SP1 與試體 SP2 彎矩-曲率關係圖



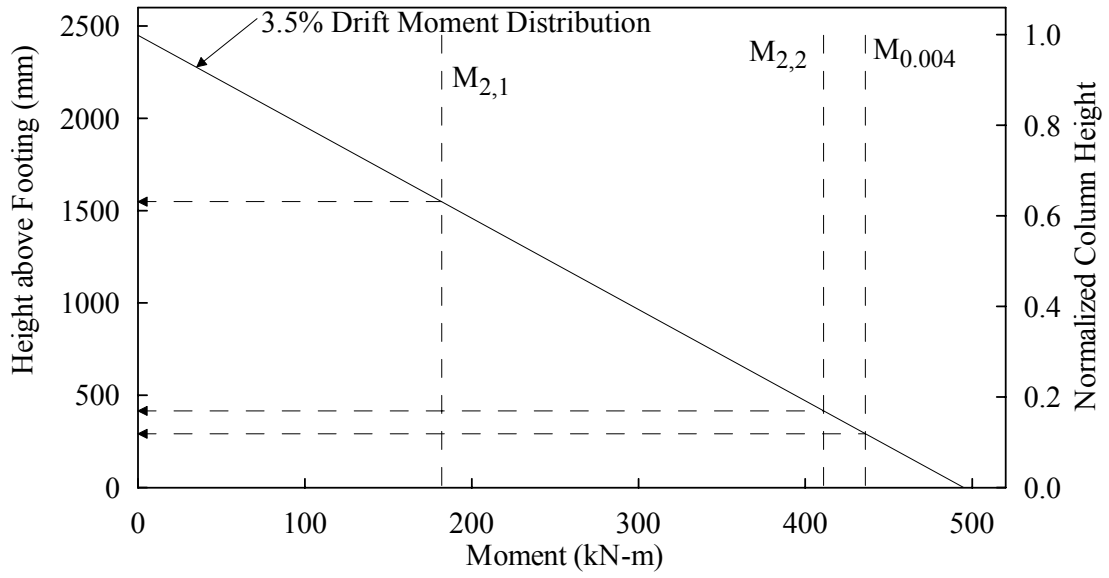


圖 2.11 第一與第二節塊間彎矩強度與彎矩分佈關係圖

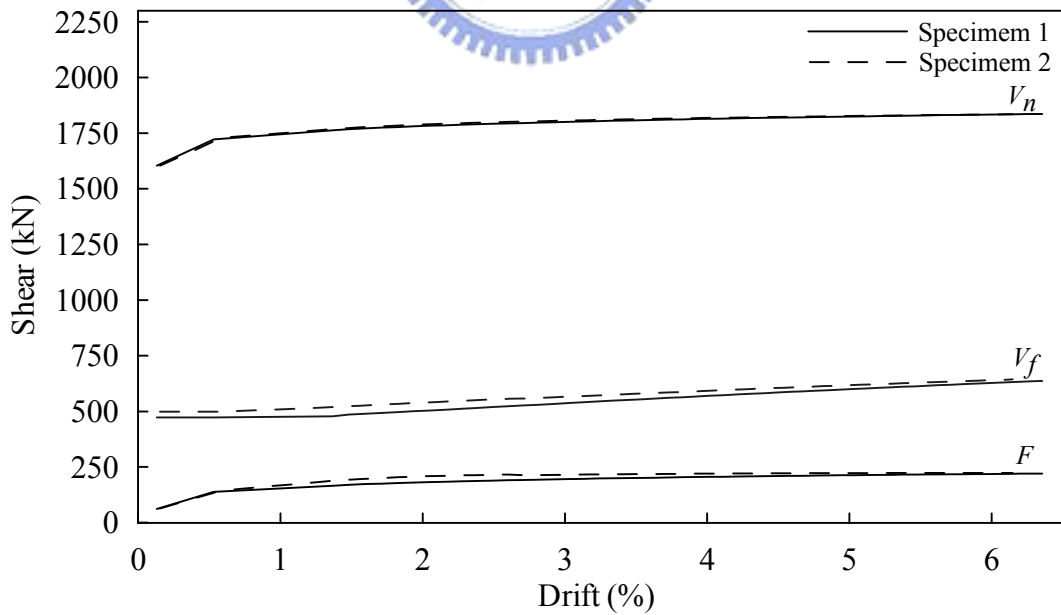


圖 2.12 橋柱試體剪力強度隨側位移變化關係圖

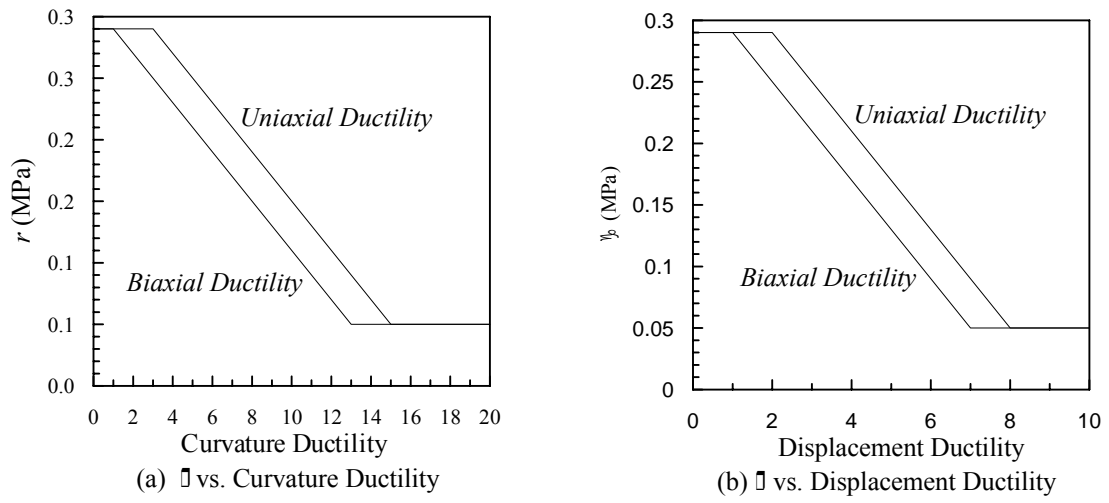


圖 2.13 係數  $\gamma$  與橋柱韌性關係圖

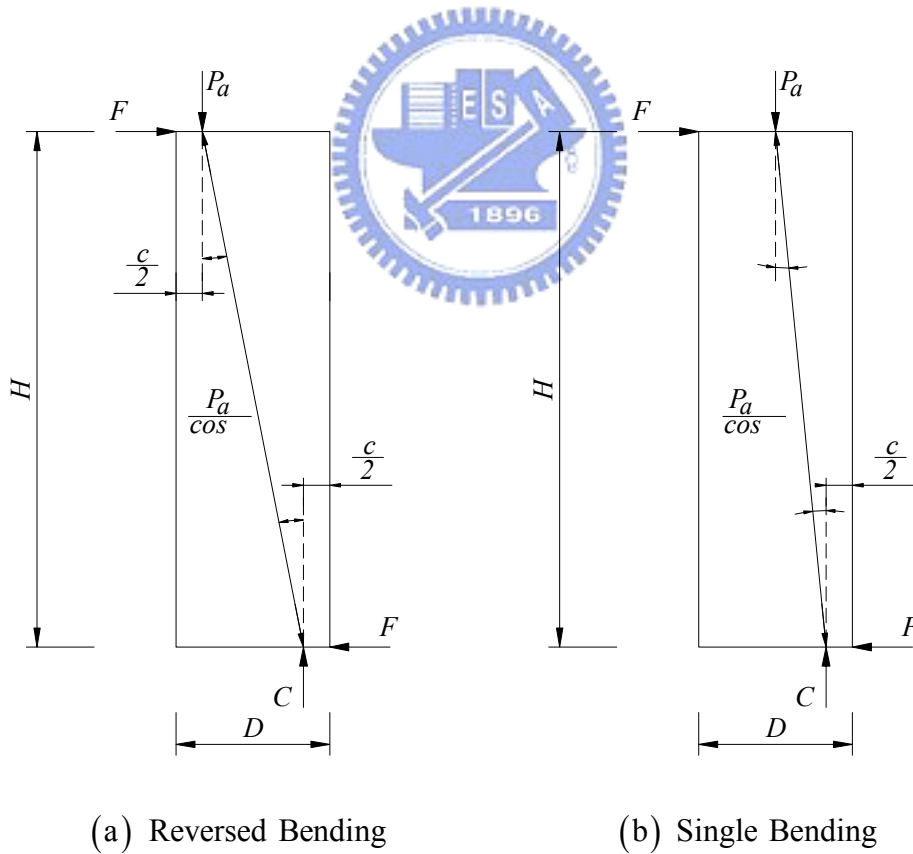
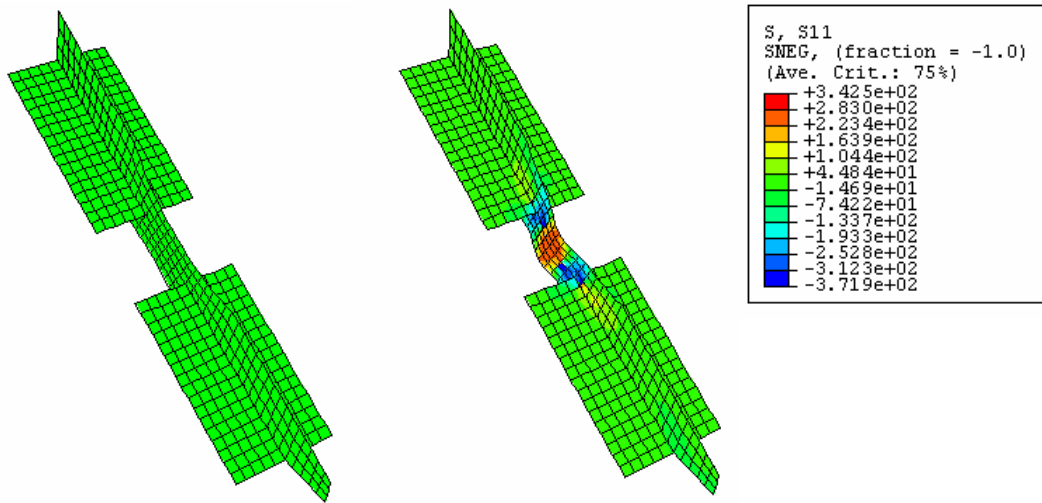


圖 2.14 柱軸力提供抗剪強度示意圖



(a) Unloading State

(b) Initial Buckling State

圖 2.15 消能桿件 ABAQUS 分析模型

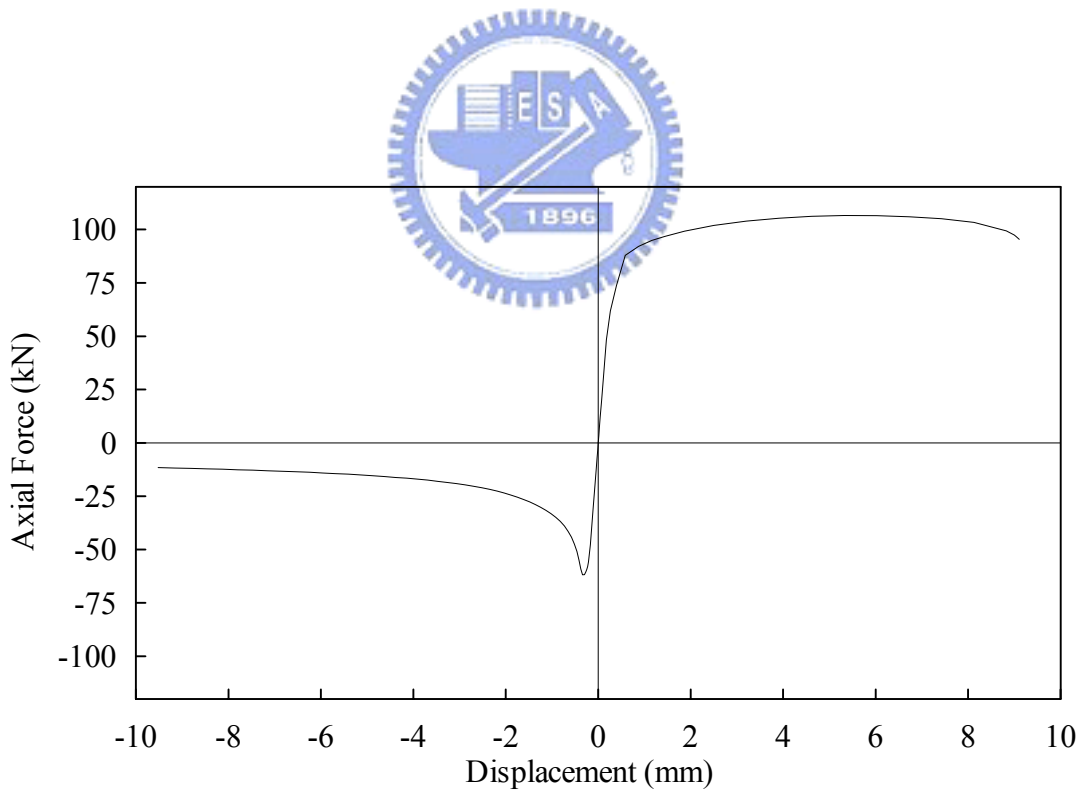


圖 2.16 消能桿件軸向變位與軸向力關係圖

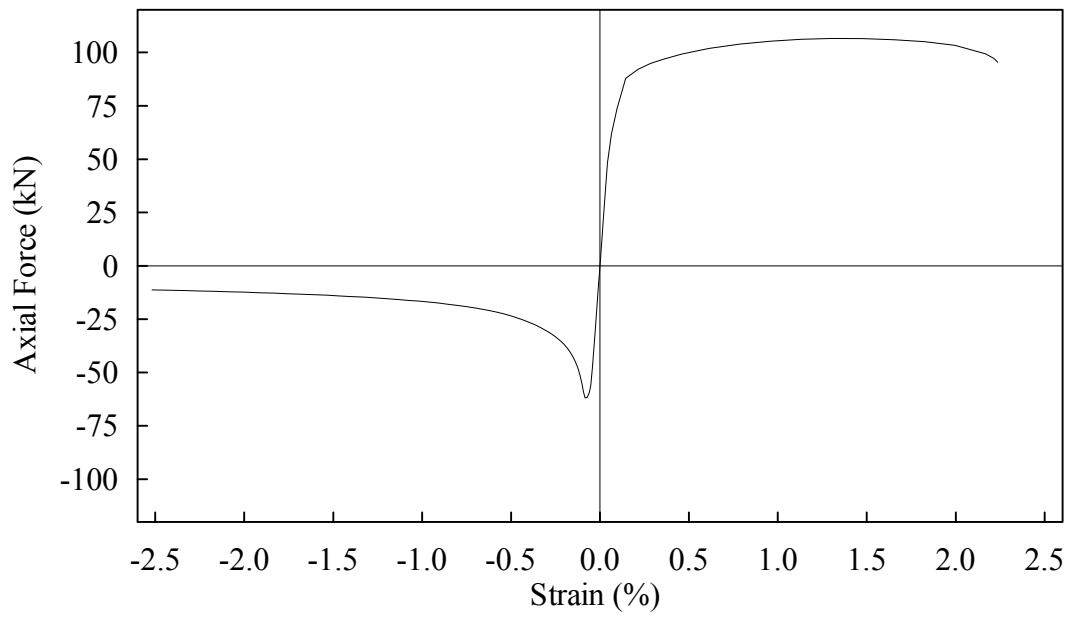
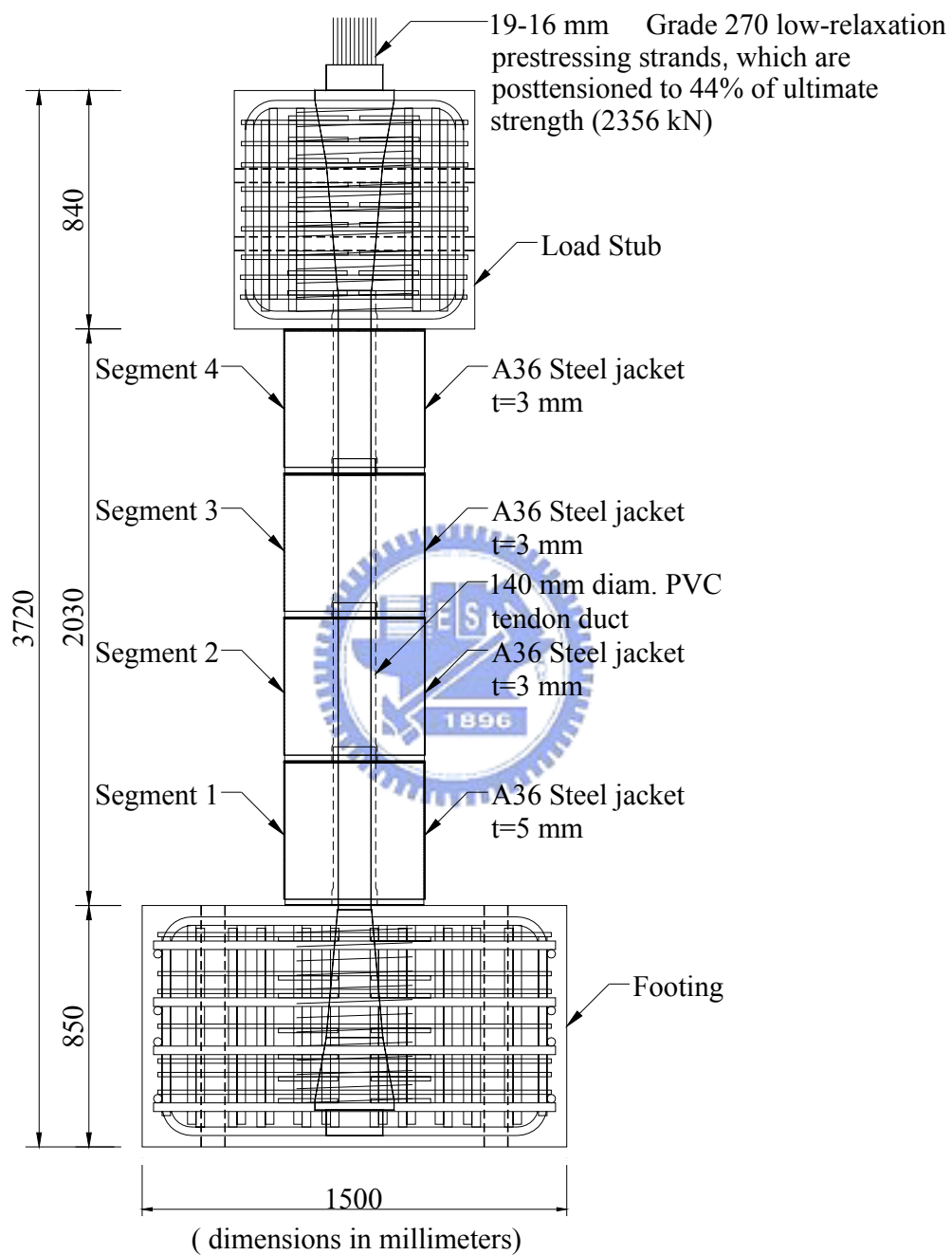


圖 2.17 消能桿件軸向應變與軸向力關係圖





Specimen 1

圖 2.18 試體 SP1 立面圖

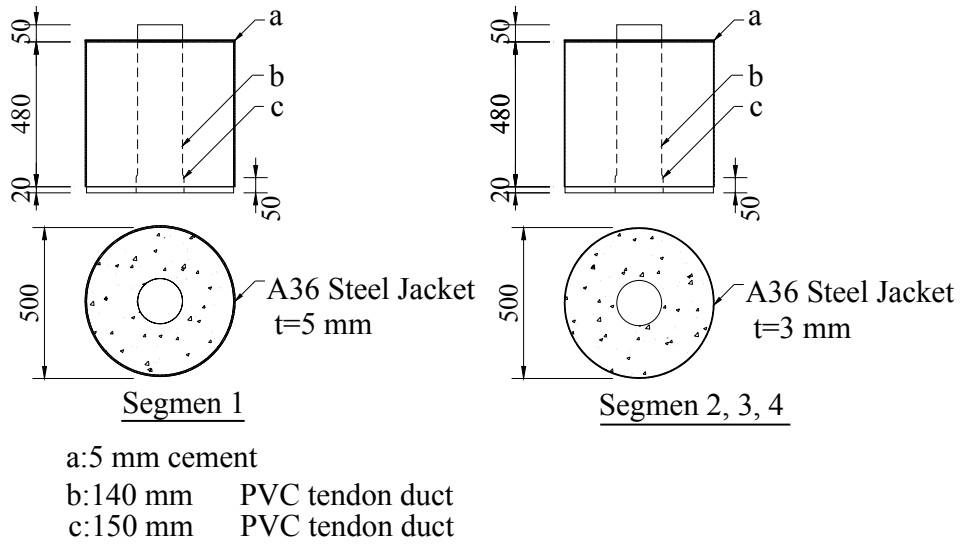


圖 2.19 試體 SP1 鋼管混凝土詳圖

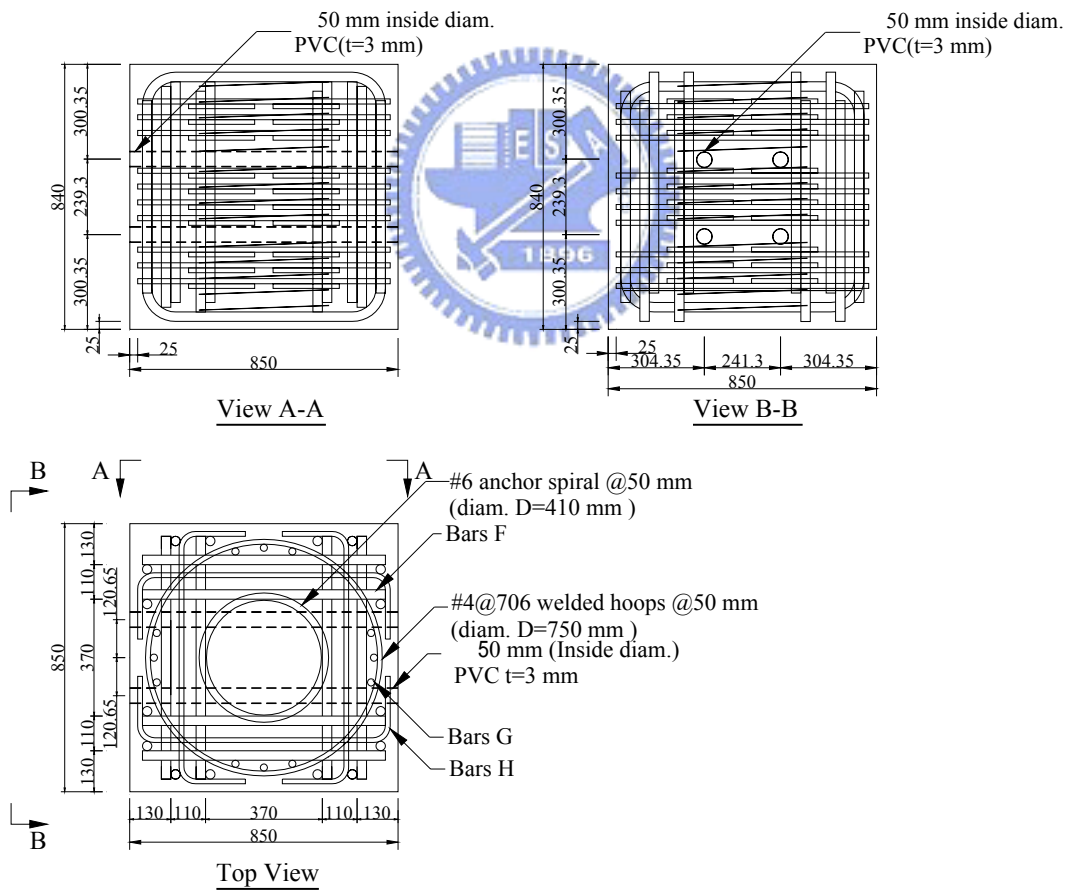


圖 2.20 試體 SP1 柱頂端錨詳圖

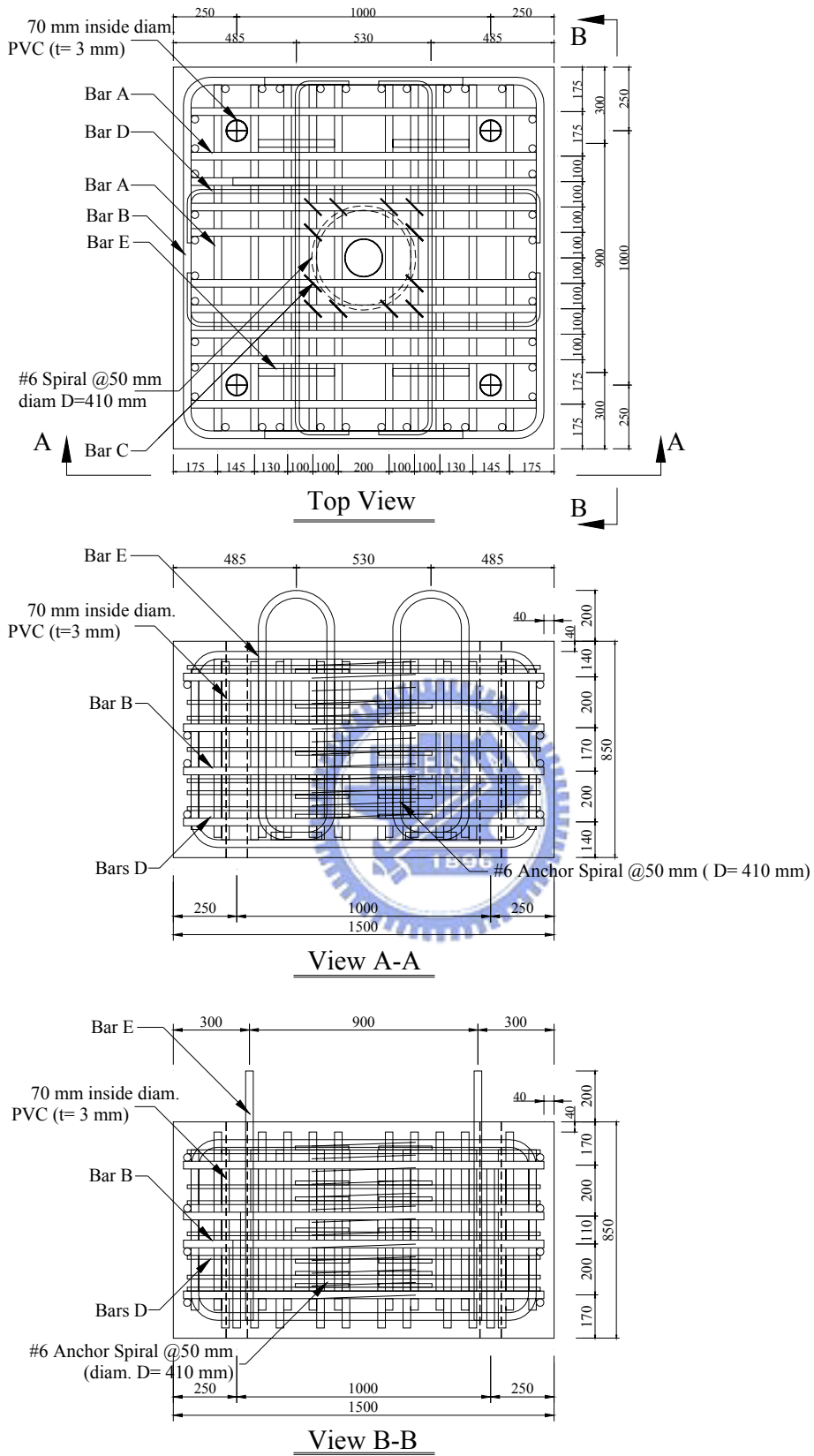
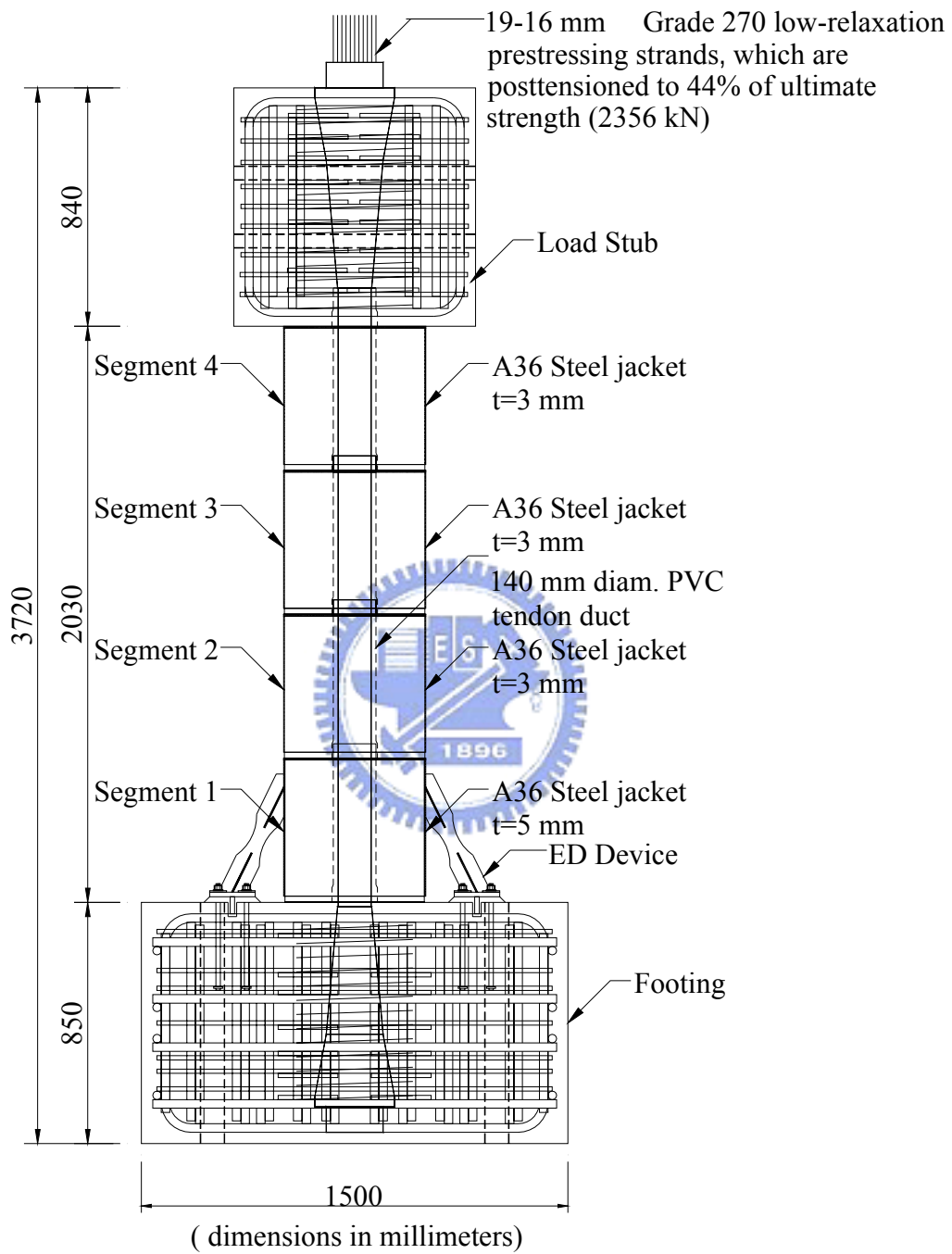


圖 2.21 試體 SP1 基礎詳圖



Specimen 2

圖 2.22 試體 SP2 立面圖



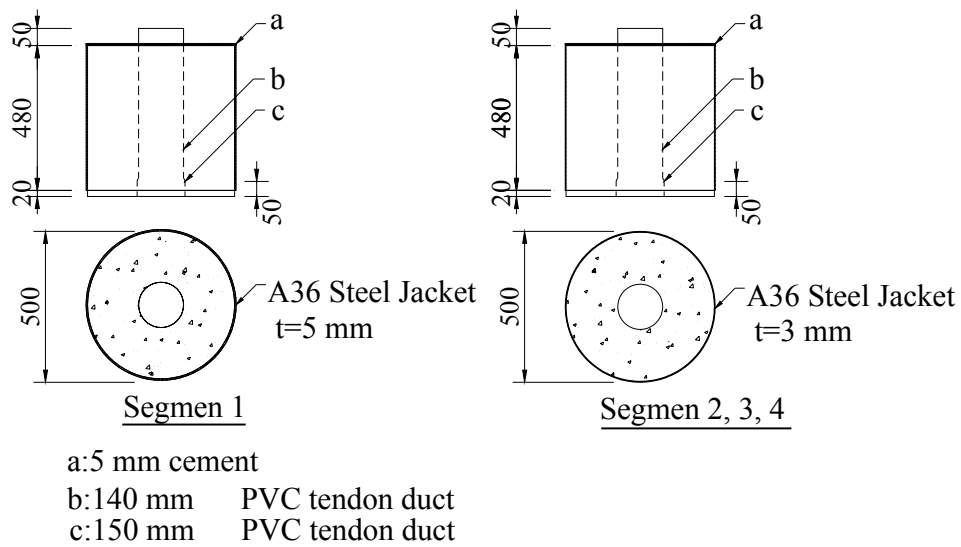


圖 2.23 試體 SP2 鋼管混凝土詳圖

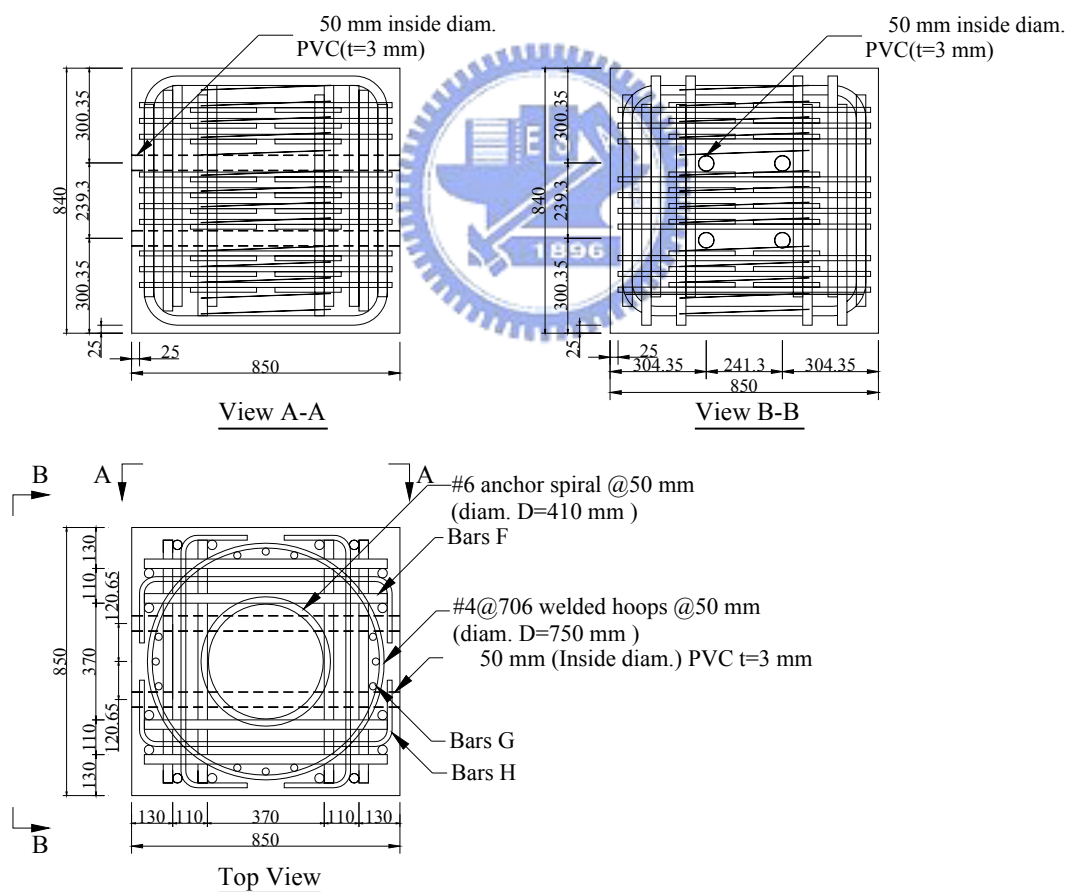


圖 2.24 試體 SP2 柱頂端錨詳圖

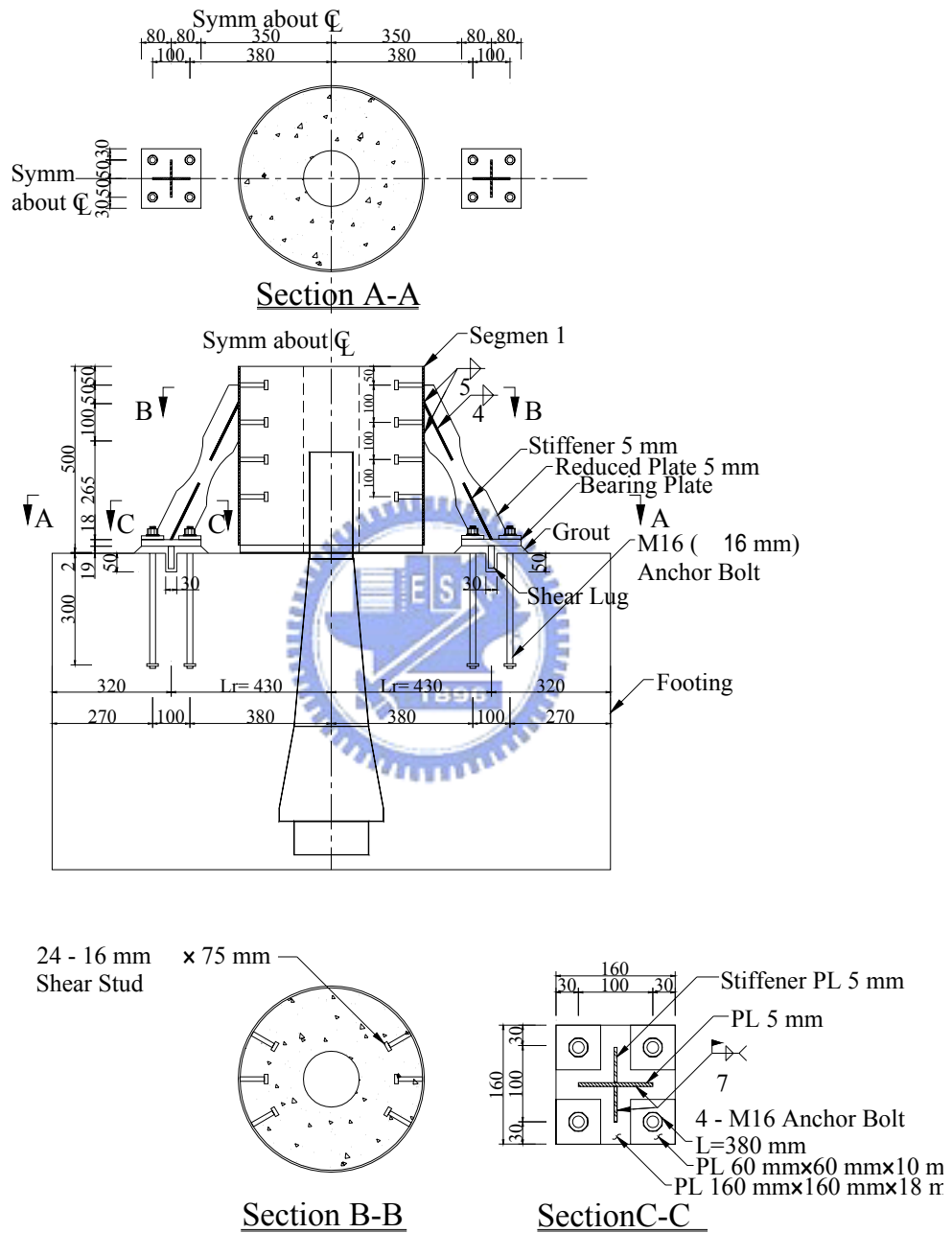
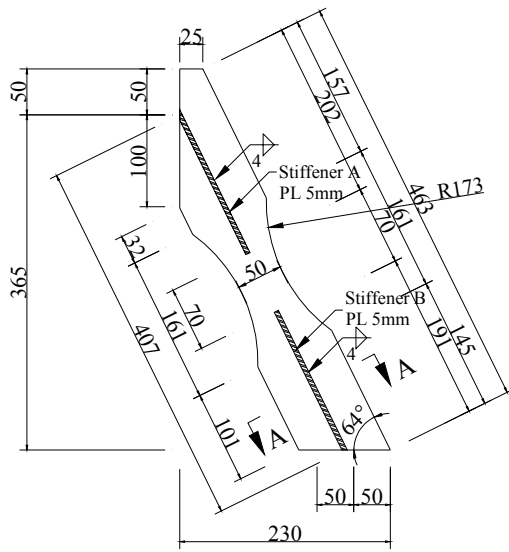
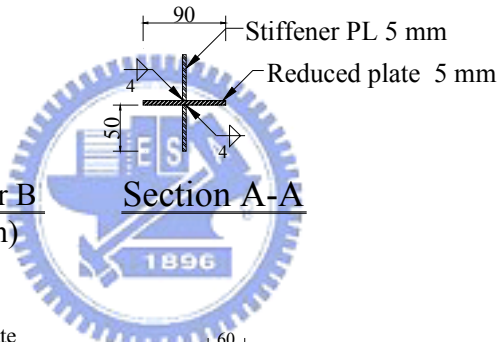
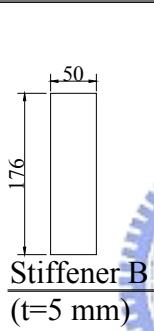
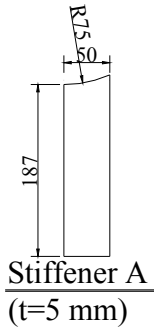


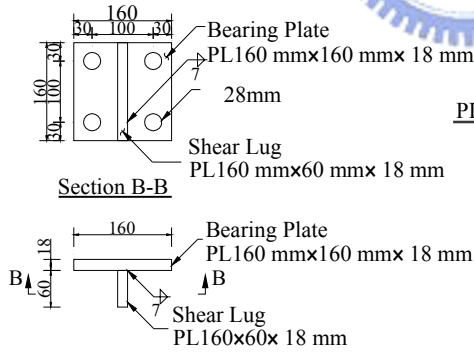
圖 2.25 試體 SP2 第 1 節塊詳圖



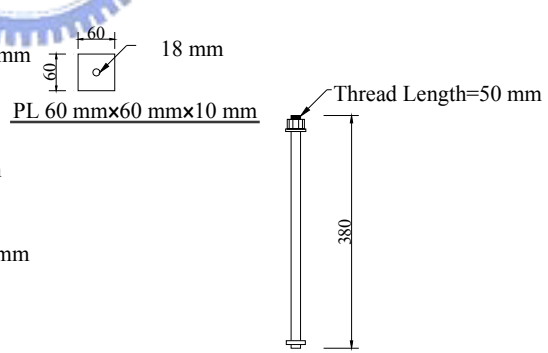
**Reduced Steel Plate**



**Section A-A**



**Bearing Plate & Shear Lug**



**M16 Anchor Bolt**

圖 2.26 試體 SP2 消能桿詳圖

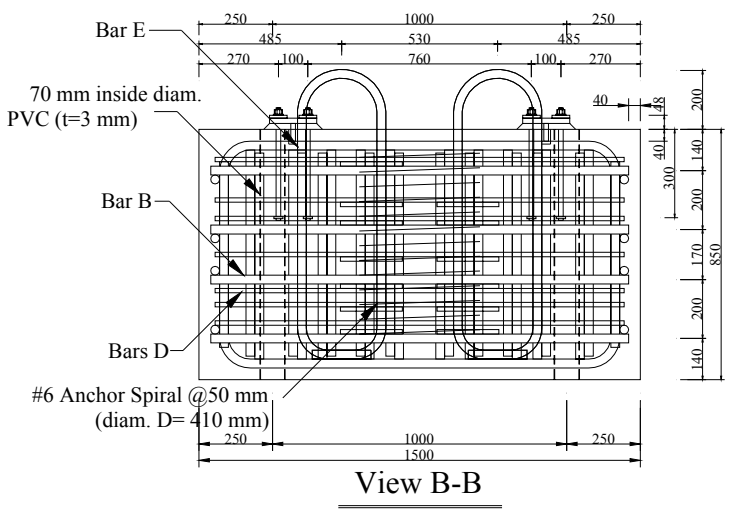
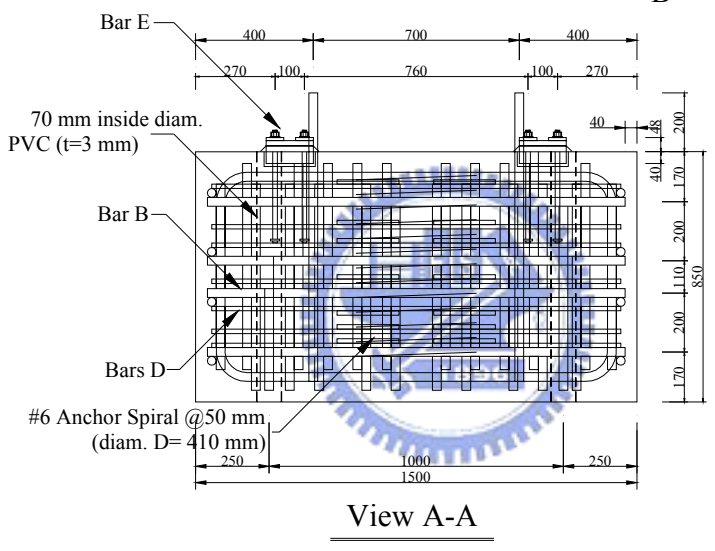
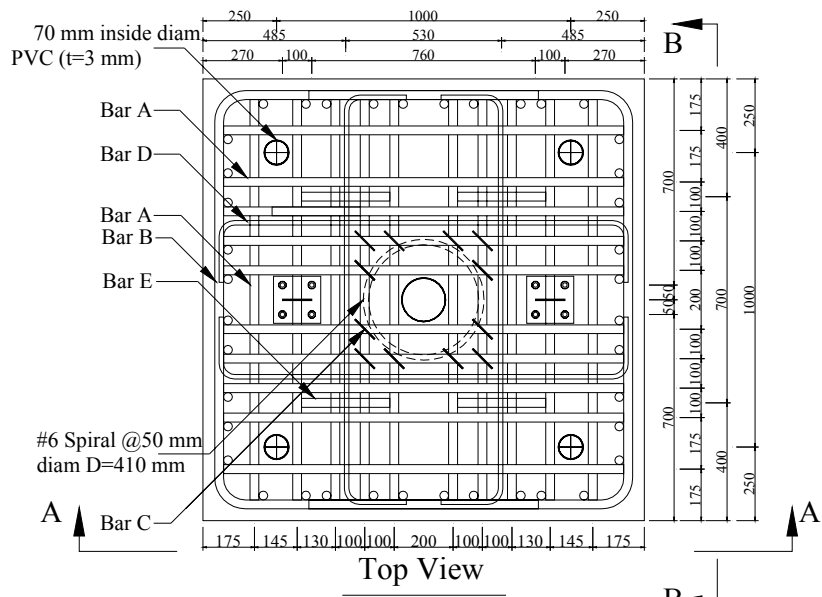


圖 2.27 試體 SP2 基礎詳圖

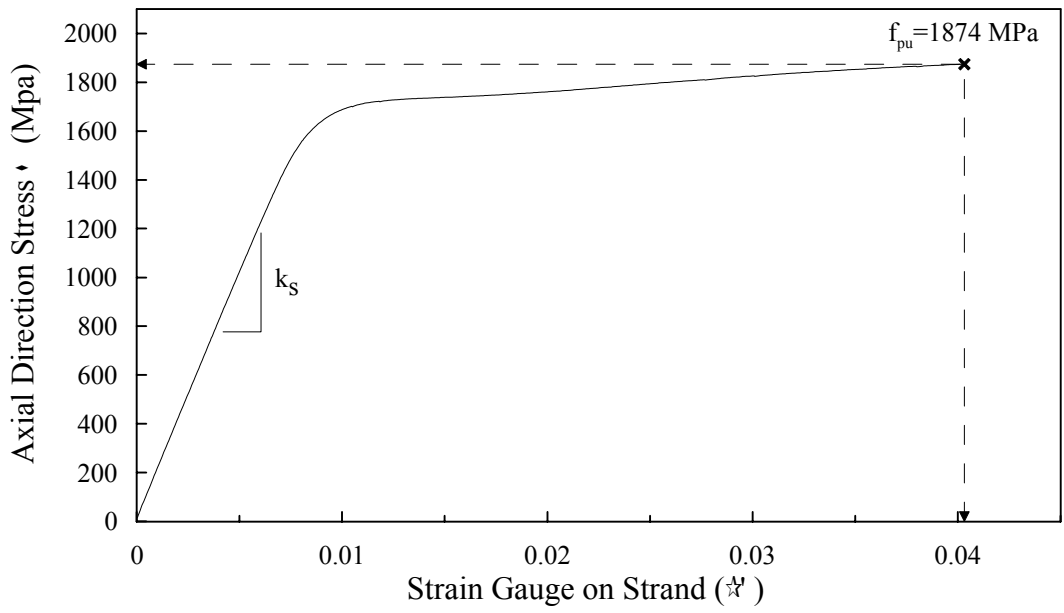


圖 2.28 預力鋼絞線上應變計之應力-應變關係

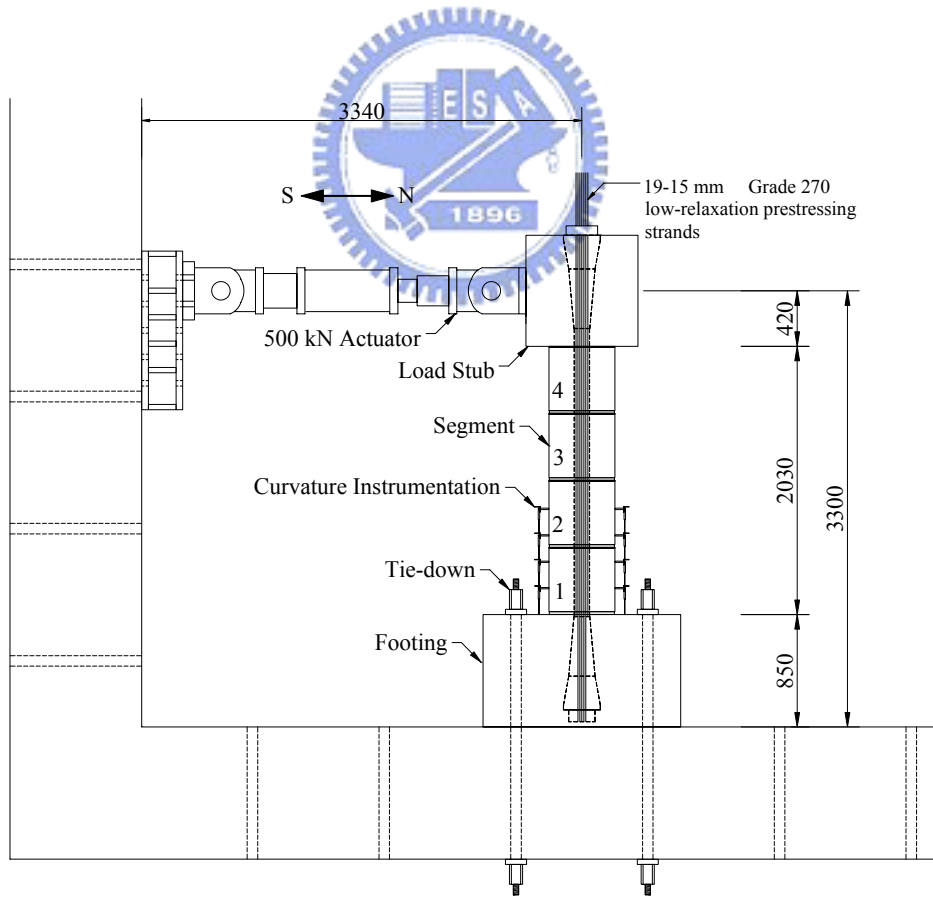


圖 2.29 試體 SP1 與 SP2 試驗設備裝置圖

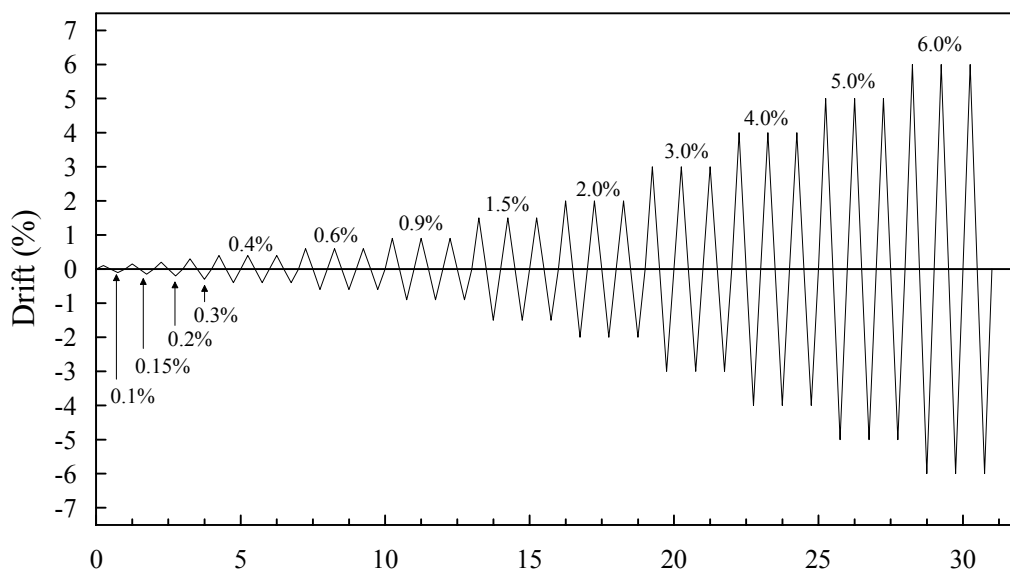


圖 2.30 反覆載重歷時



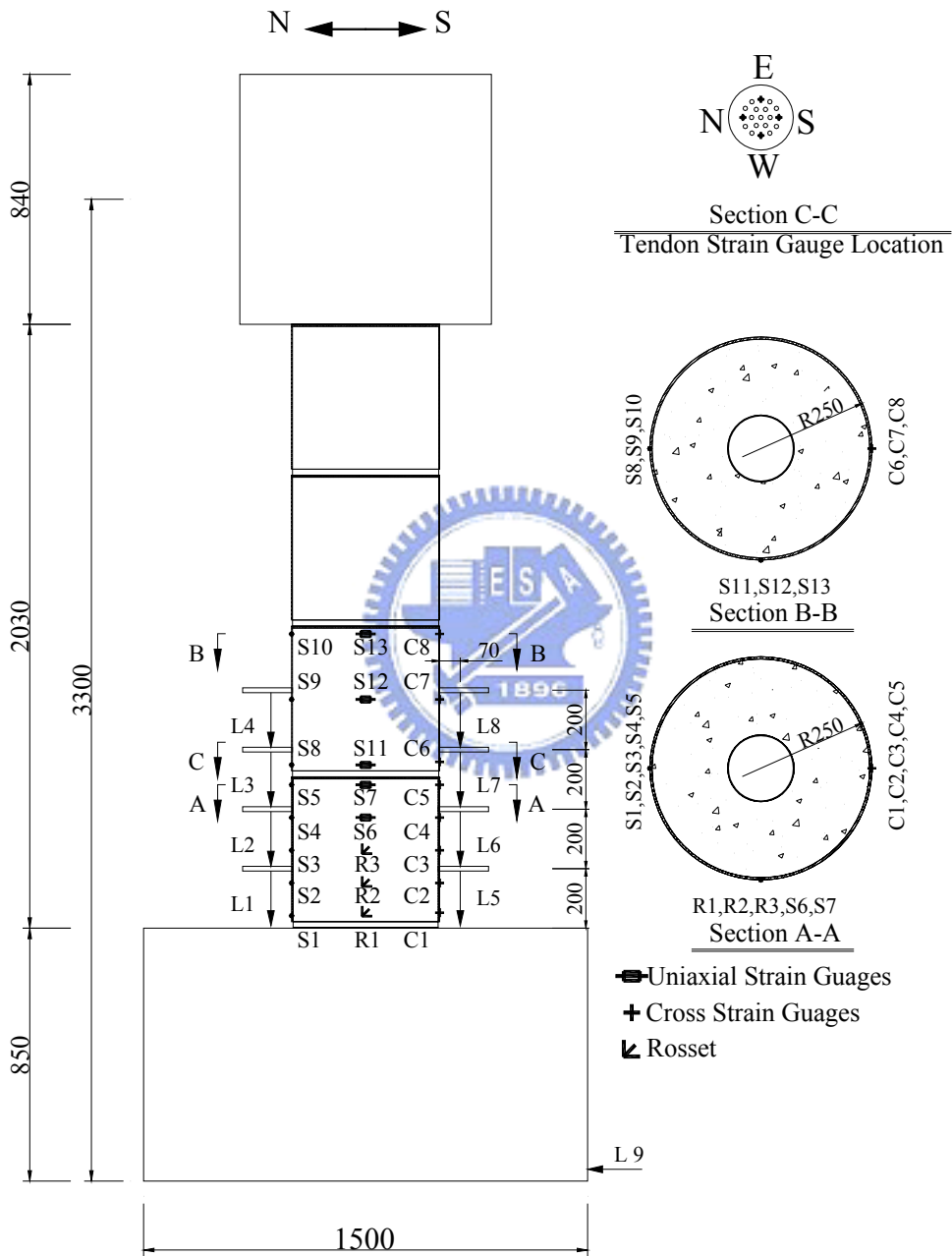


圖 2.31 試體 SP1 應變計配置圖

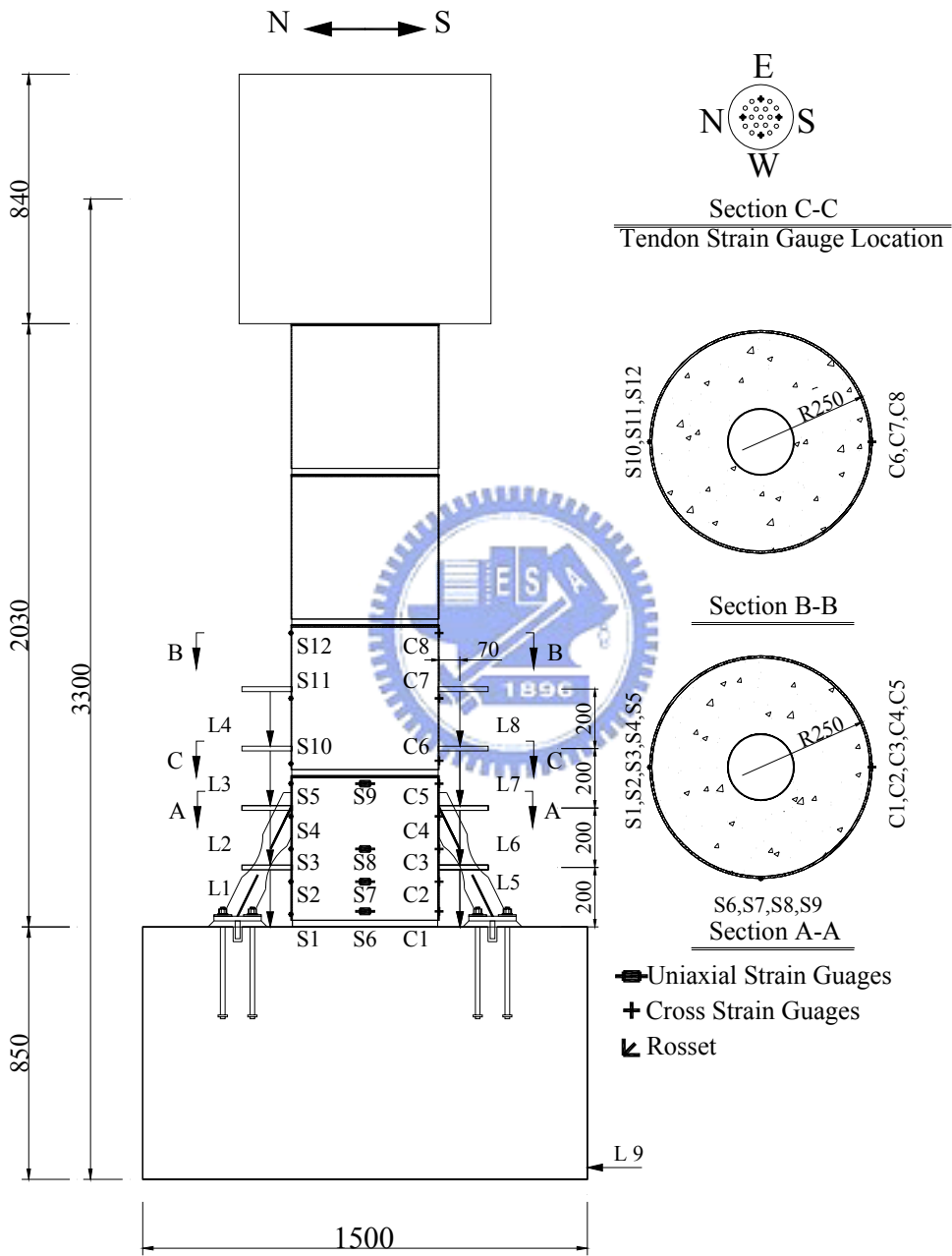


圖 2.32 試體 SP2 應變計配置圖



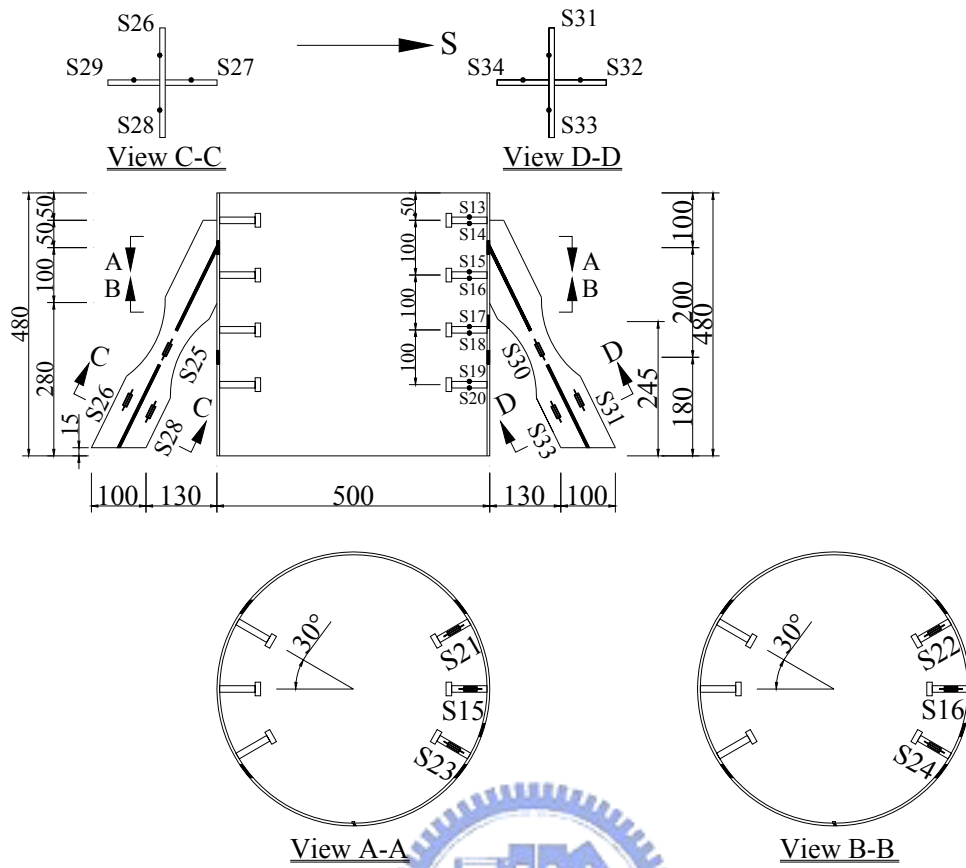


圖 2.33 試體 SP2 第一節塊應變計配置圖

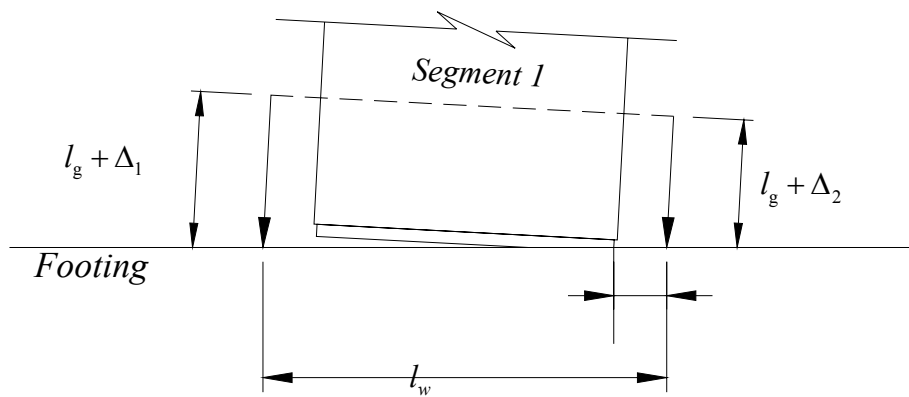


圖 2.34 彎曲曲率示意圖

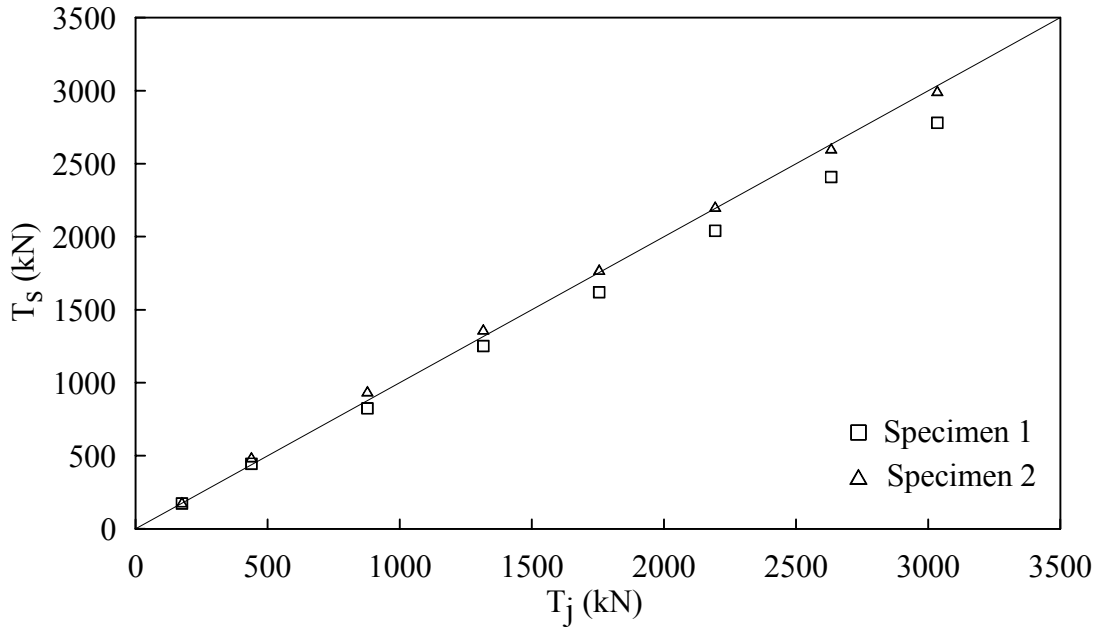


圖 3.1 試體 SP1 與試體 SP2 應變計與油壓機施拉的預力比較圖

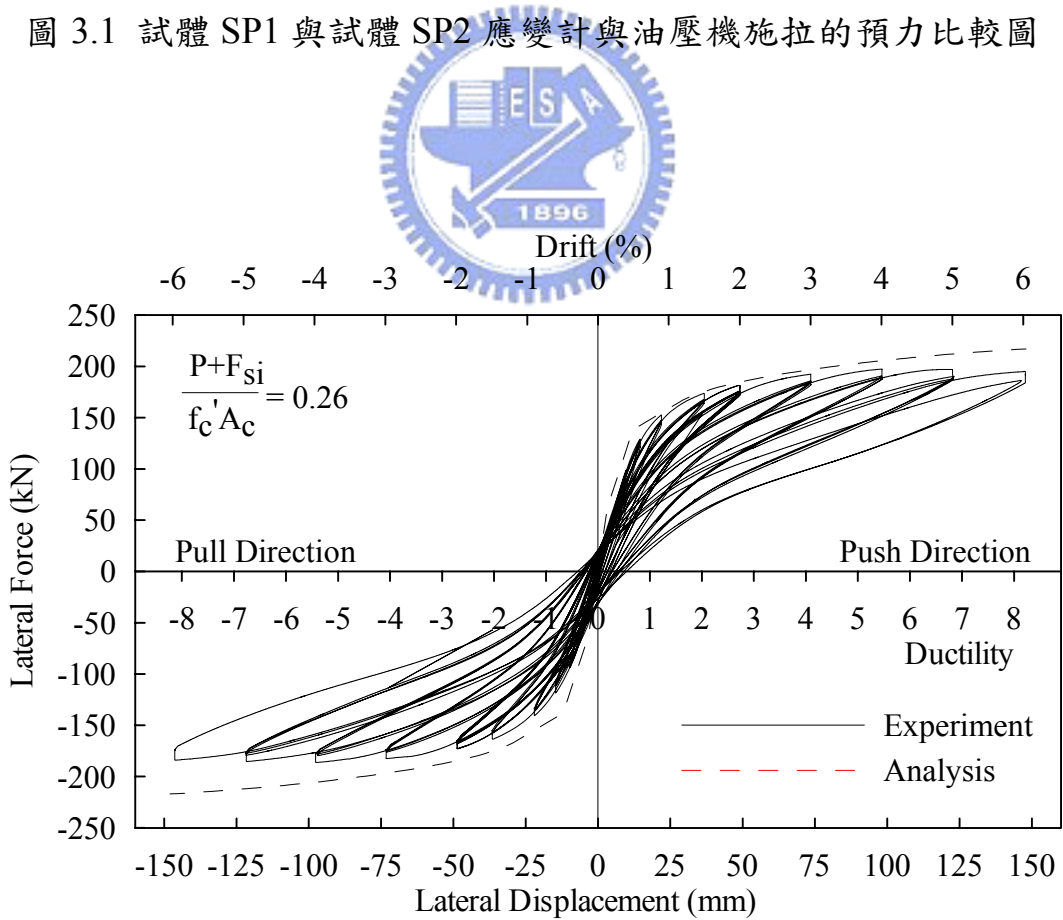


圖 3.2 試體 SP1 力量-位移關係圖

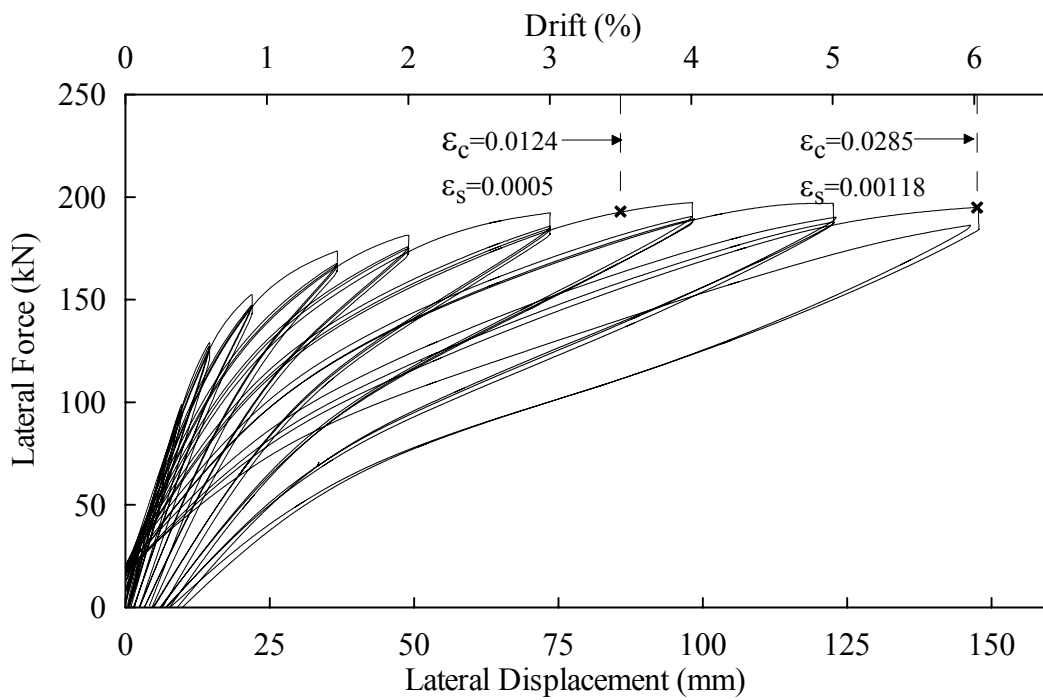


圖 3.3 試體 SP1 正方向力量-位移關係圖

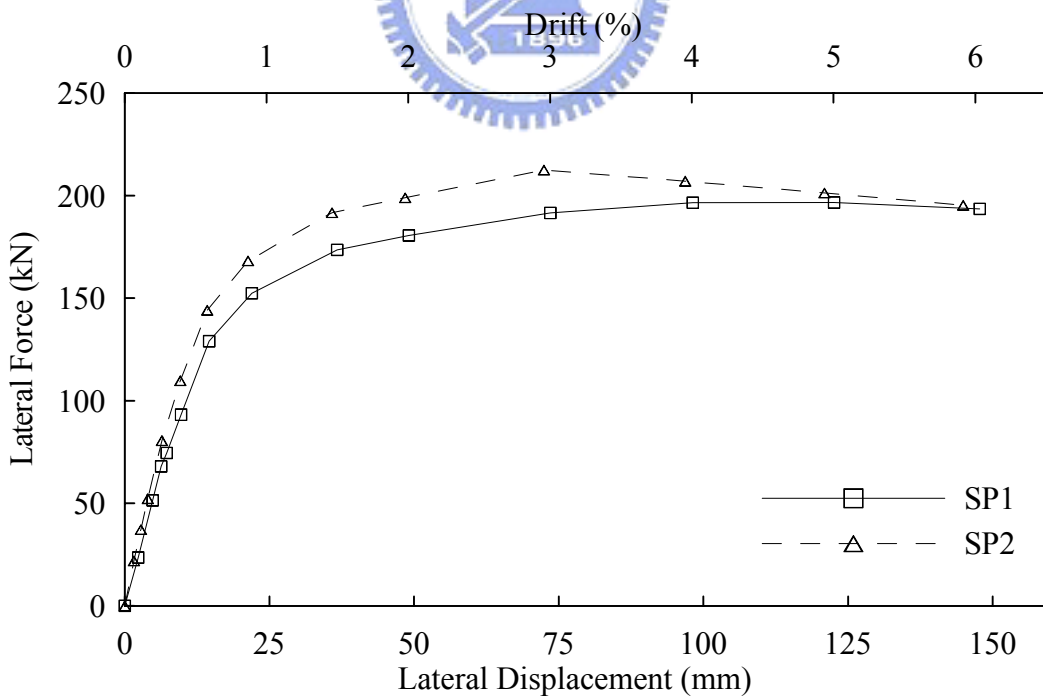


圖 3.4 試體 SP1 與試體 SP2 正方向力量-位移關係包絡線圖

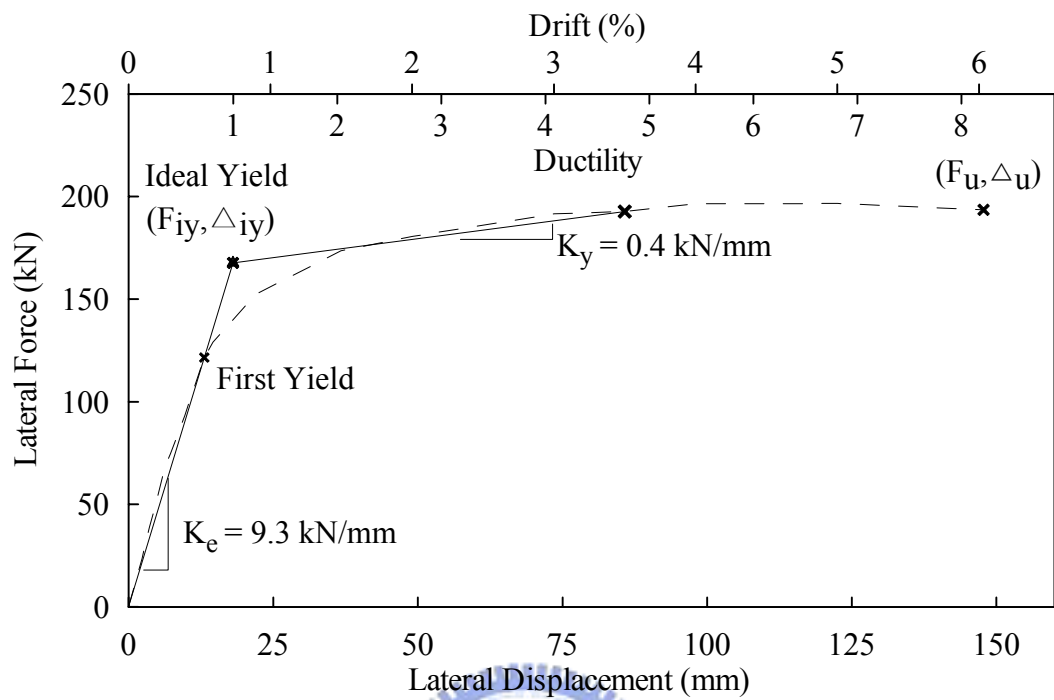


圖 3.5 試體 SP1 雙線性模擬力量位移關係圖

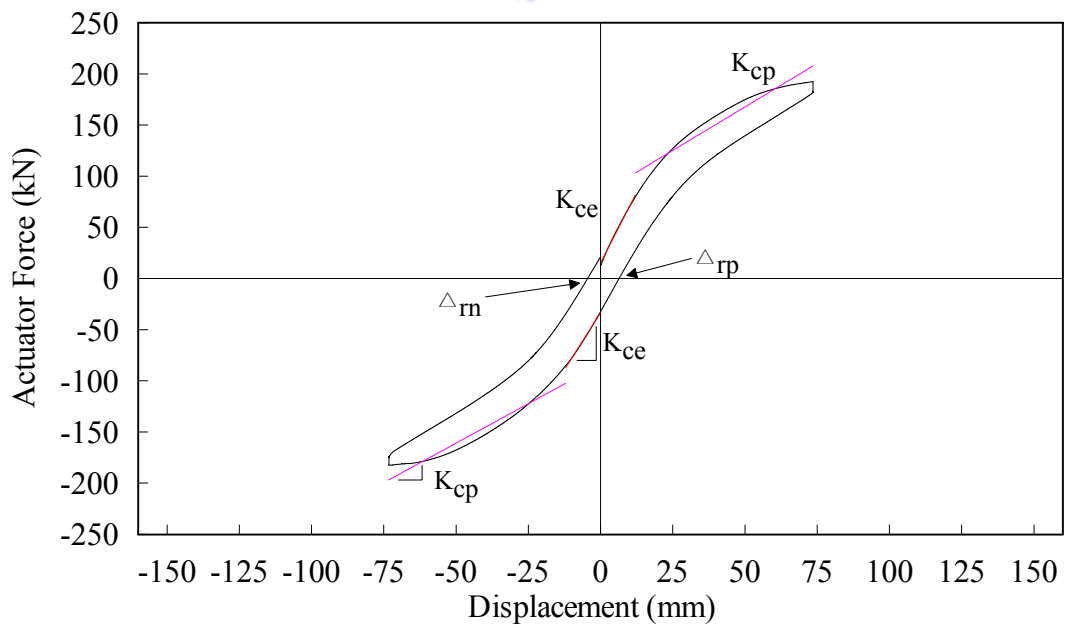


圖 3.6 彈性勁度與非彈性勁度計算示意圖

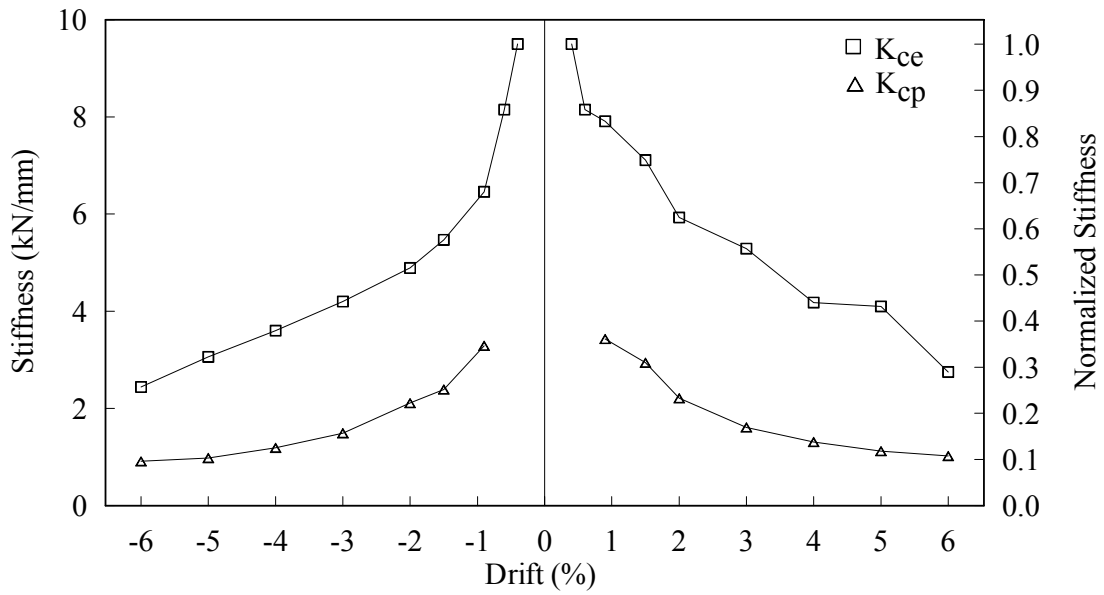


圖 3.7 試體 SP1 勁度變化圖與側位移關係圖

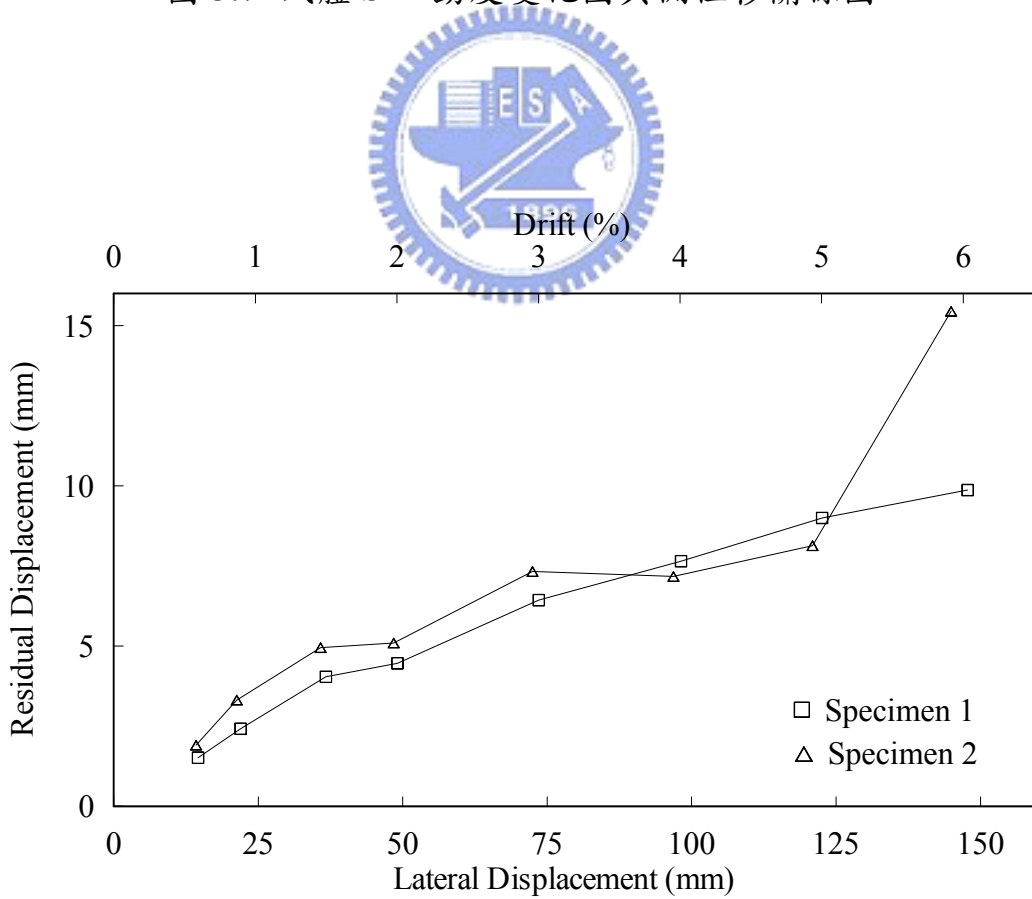


圖 3.8 試體 SP1 與試體 SP2 殘餘變形與側位移關係圖

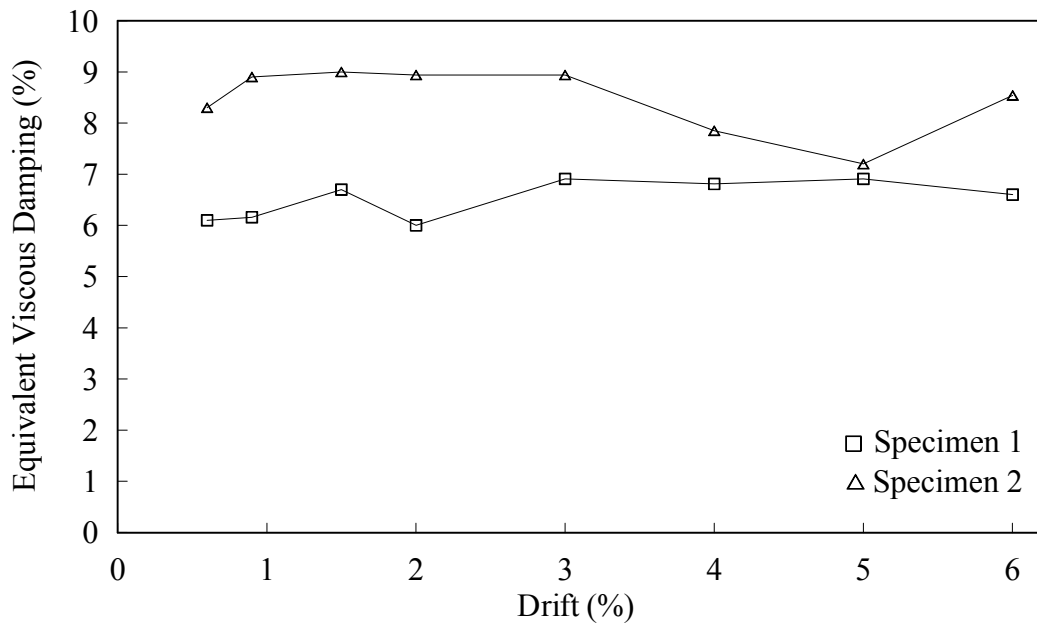


圖 3.9 試體 SP1 與試體 SP2 系統等效阻尼比變化與側位移關係圖

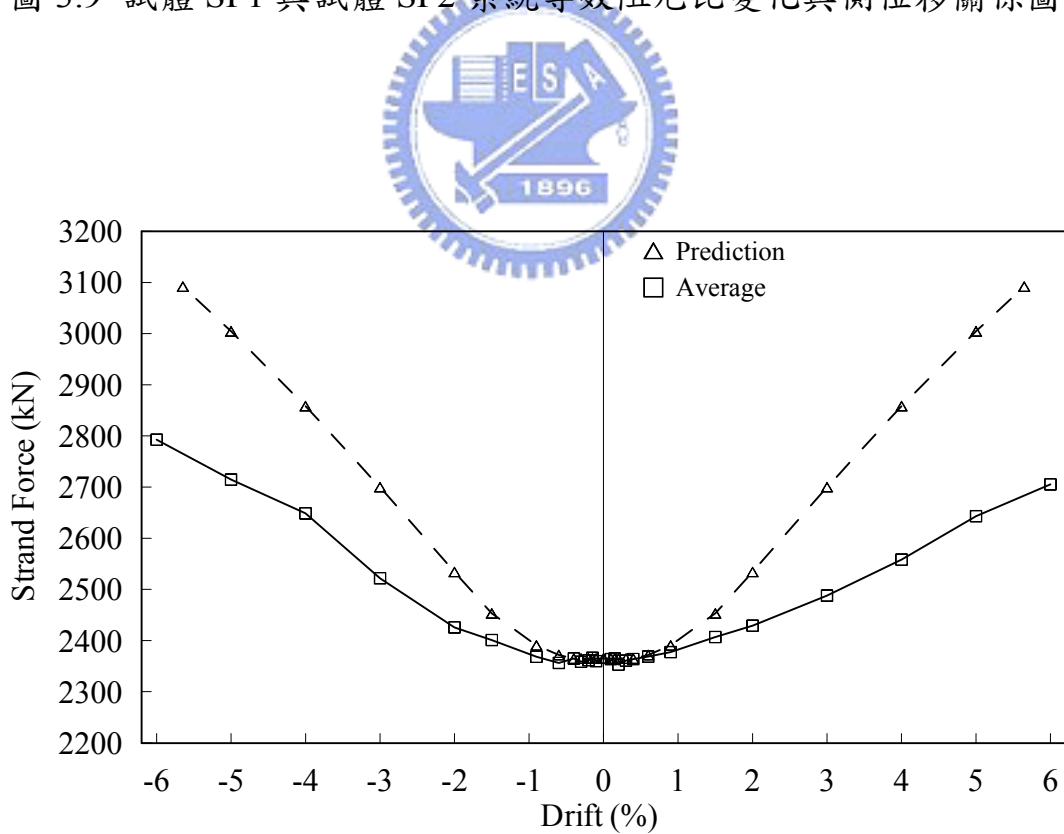


圖 3.10 試體 SP1 鋼腱預力量變化圖

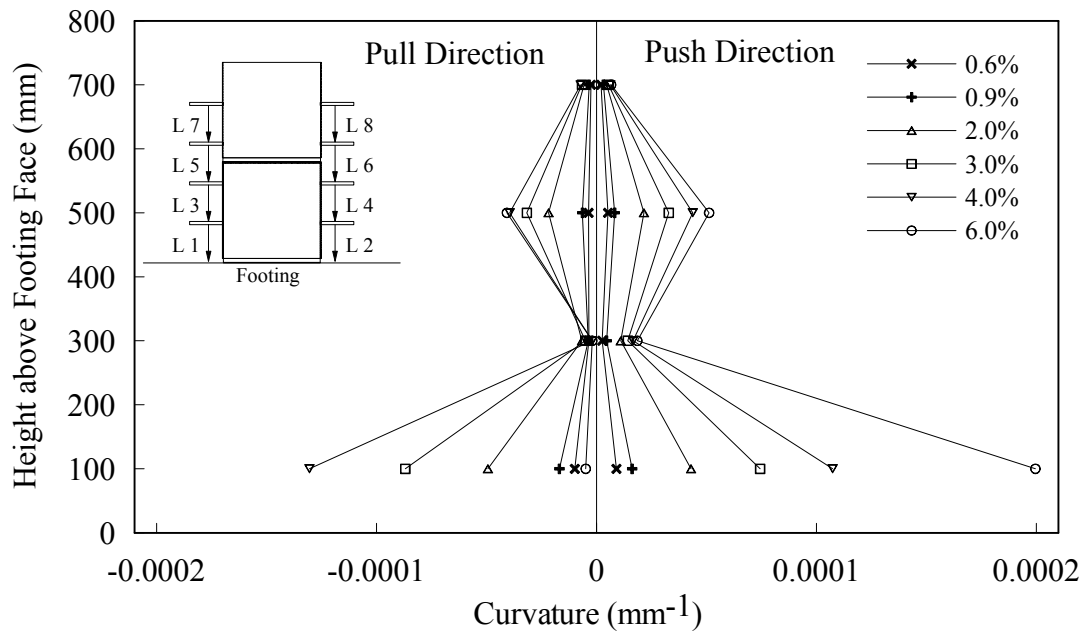


圖 3.11 SP1 曲率變化關係圖

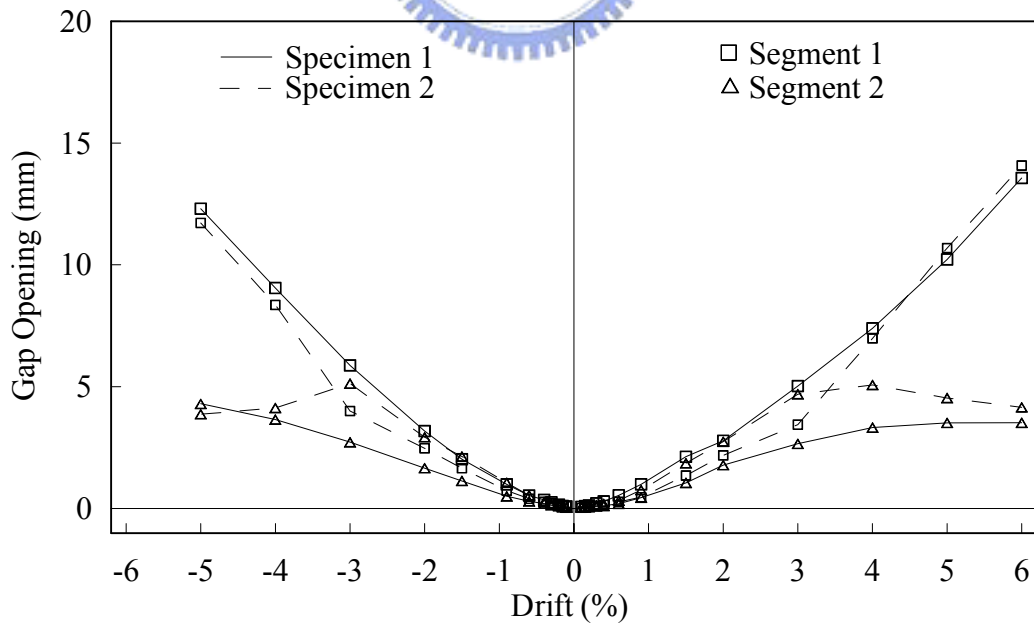


圖 3.12 試體 SP1 與試體 SP2 節塊裂縫與側位移關係圖

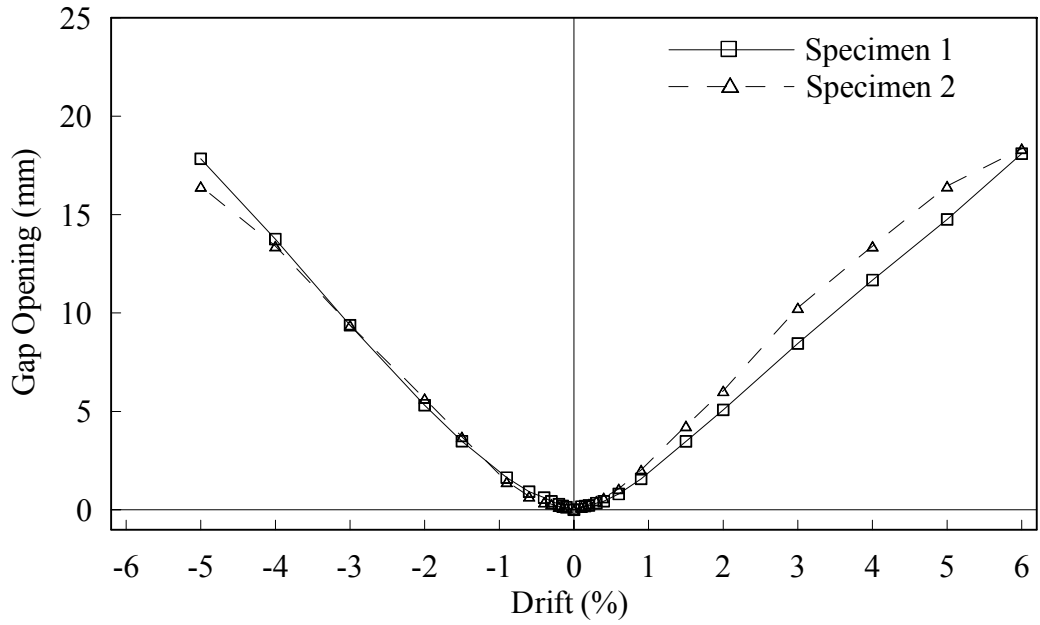


圖 3.13 試體 SP1 與試體 SP2 節塊裂縫總合與側位移關係圖

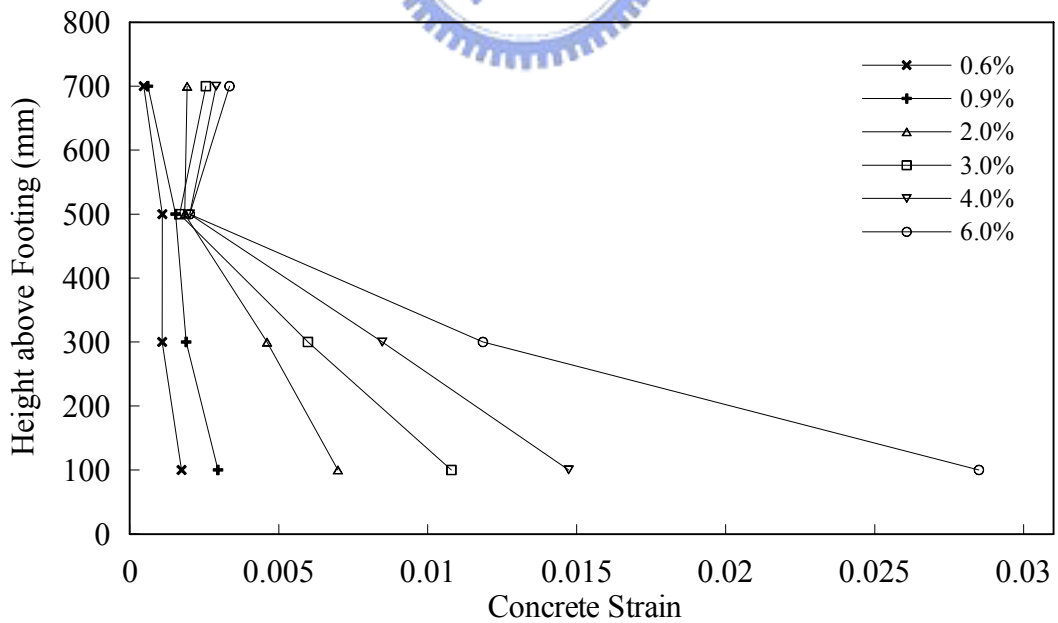


圖 3.14 試體 SP1 正方向混凝土最外纖維壓應變隨柱高變化圖



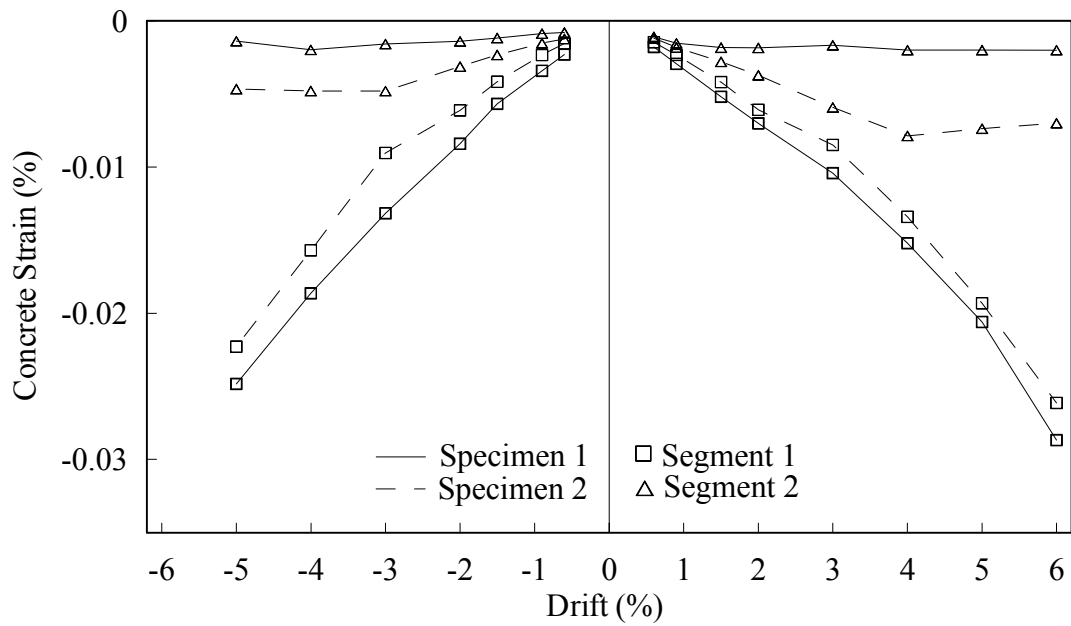


圖 3.15 試體 SP1 與試體 SP2 柱底混凝土應變與側位移關係圖

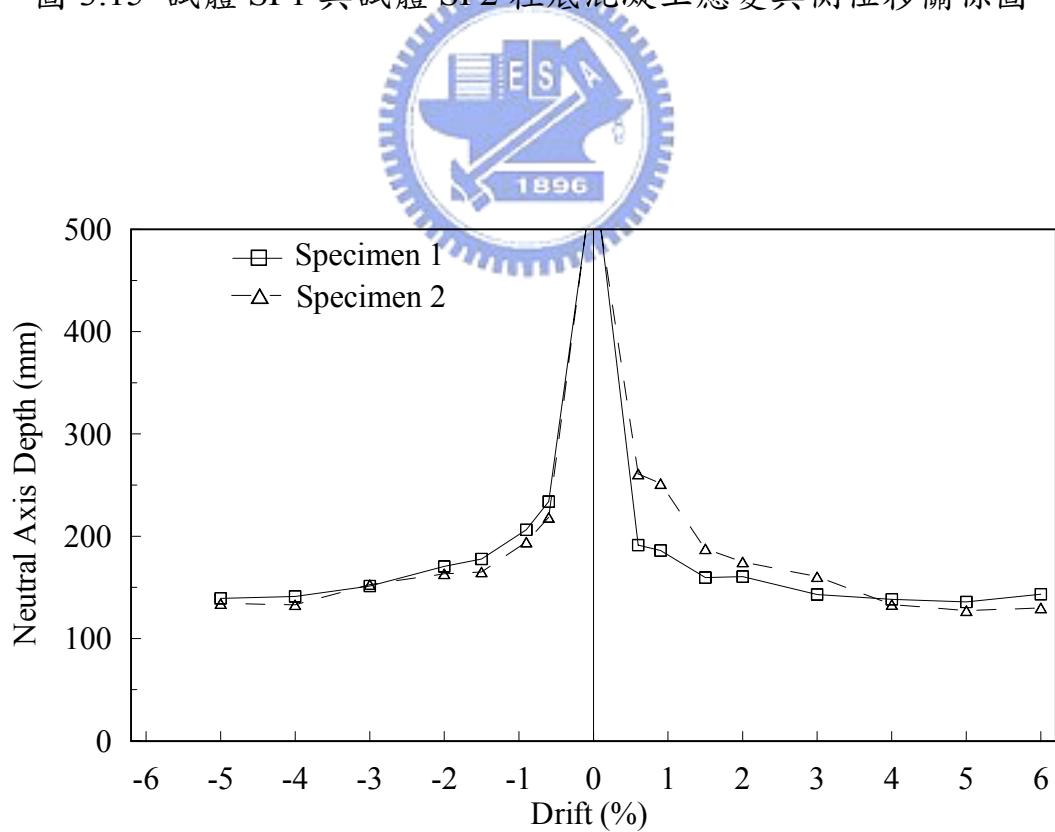


圖 3.16 試體 SP1 與試體 SP2 柱底中性軸位置與側位移關係圖

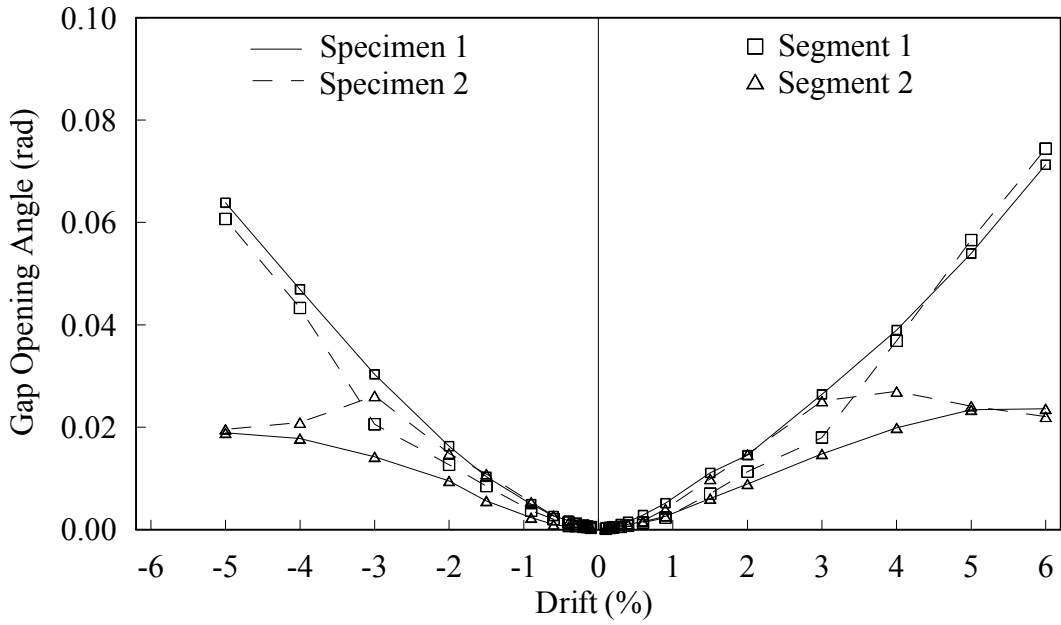


圖 3.17 試體 SP1 與試體 SP2 撓曲裂縫張開角度與側位移關係圖

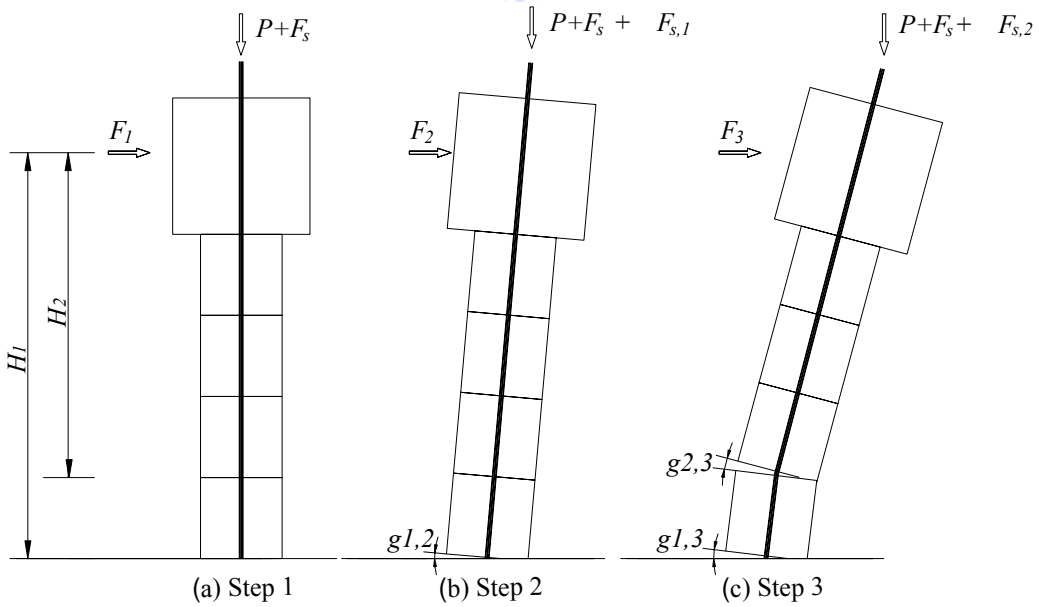


圖 3.18 試體 SP1 試驗側位移變形示意圖

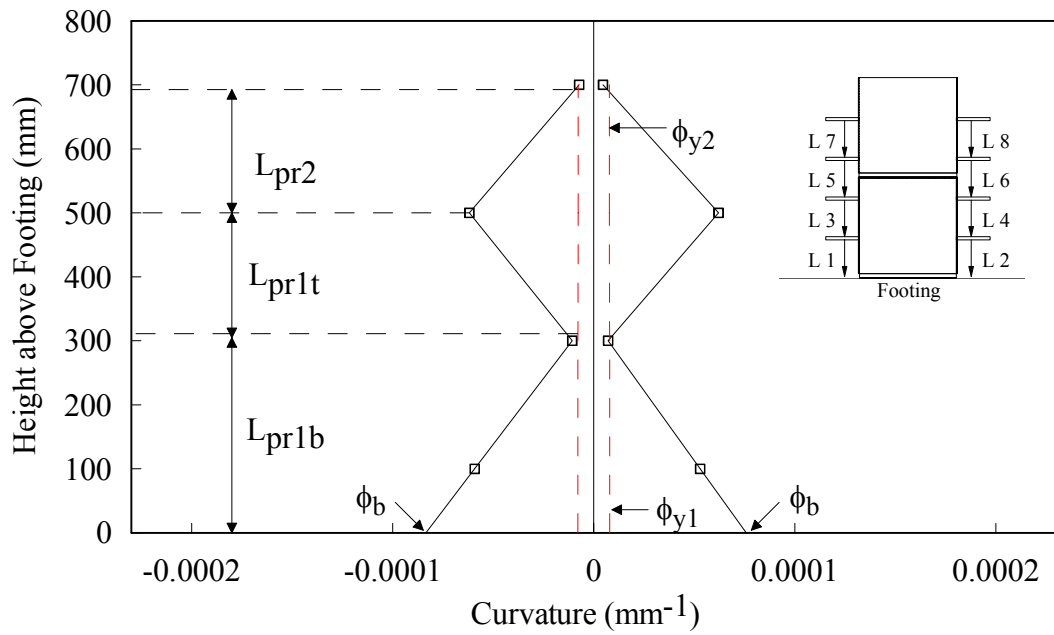


圖 3.19 理想降伏曲率與塑鉸範圍關係圖

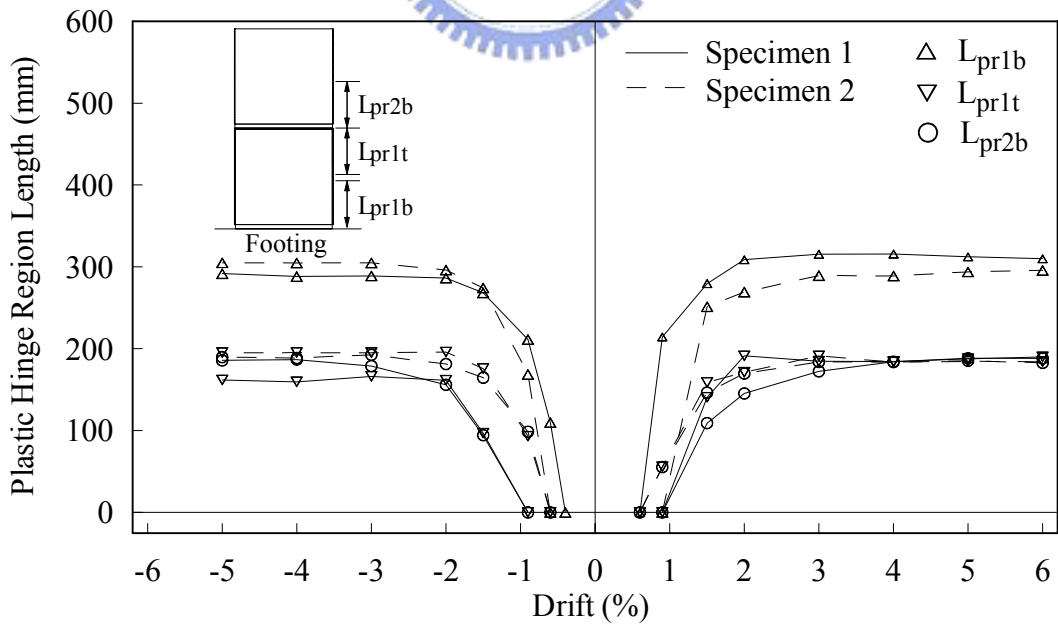


圖 3.20 試體 SP1 與試體 SP2 塑鉸範圍與側位移關係圖

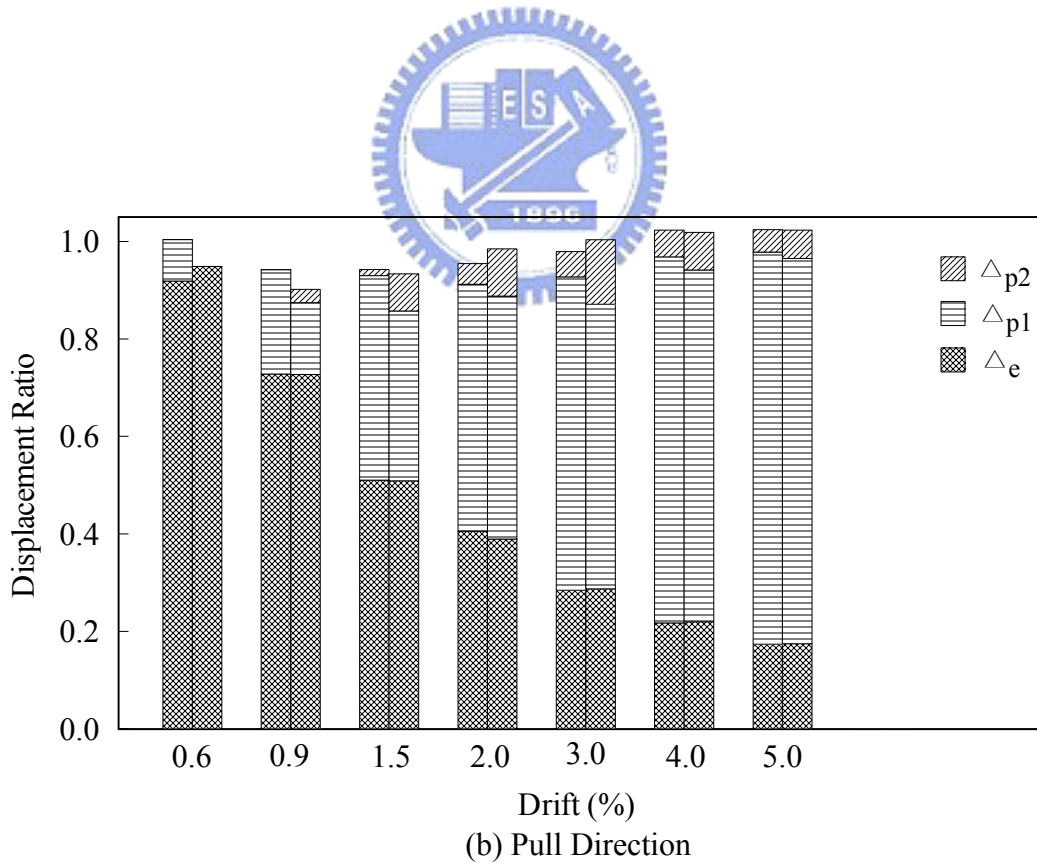
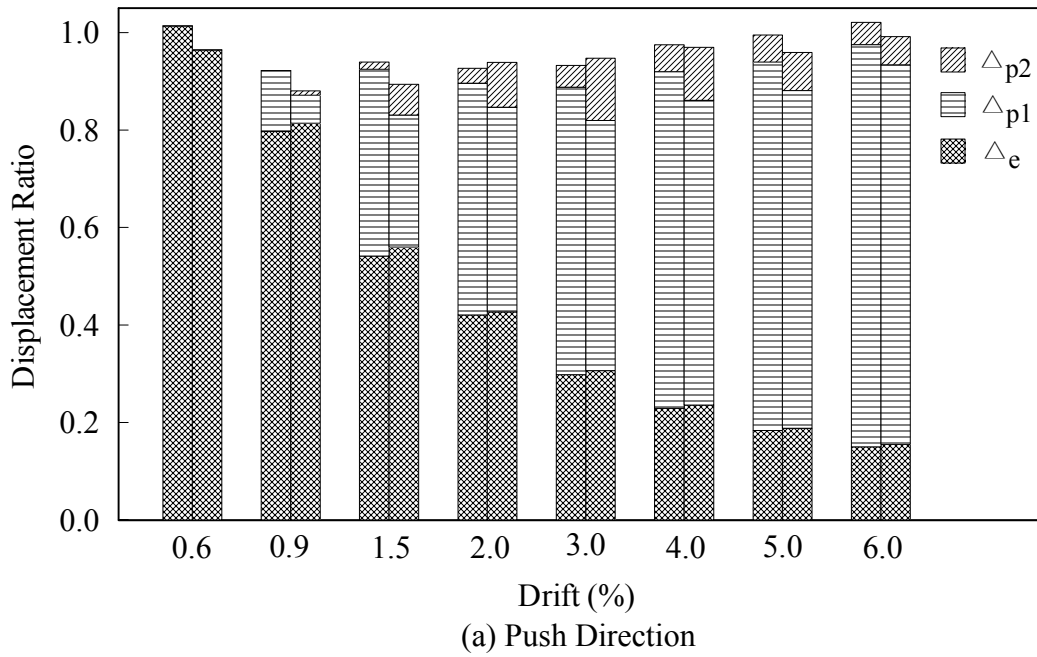
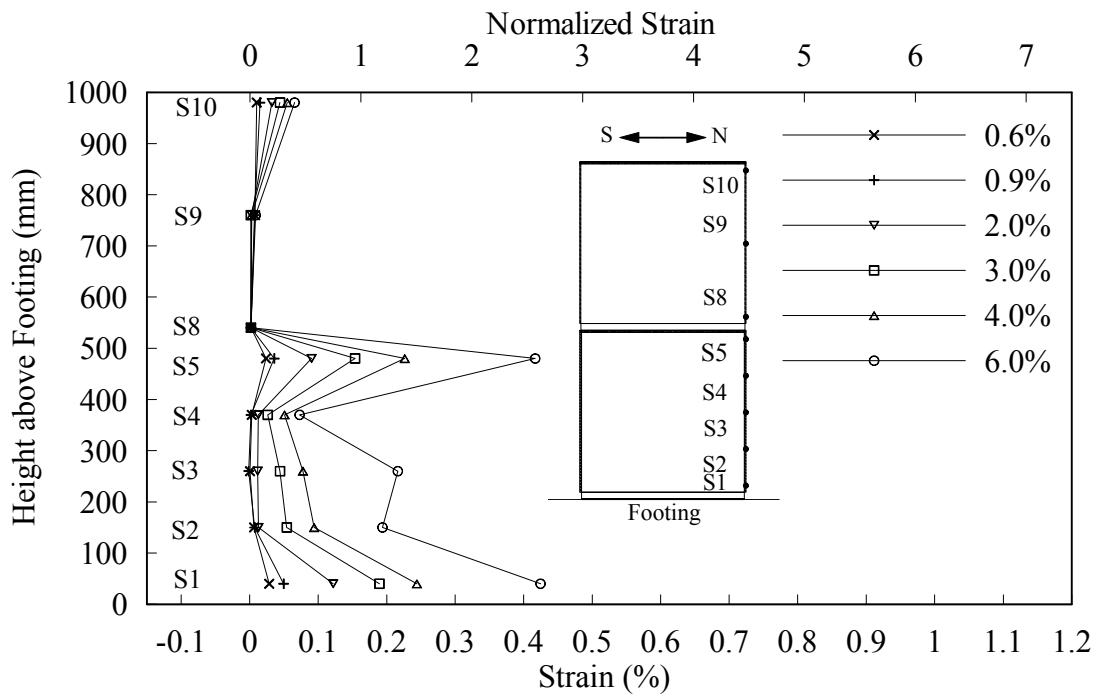
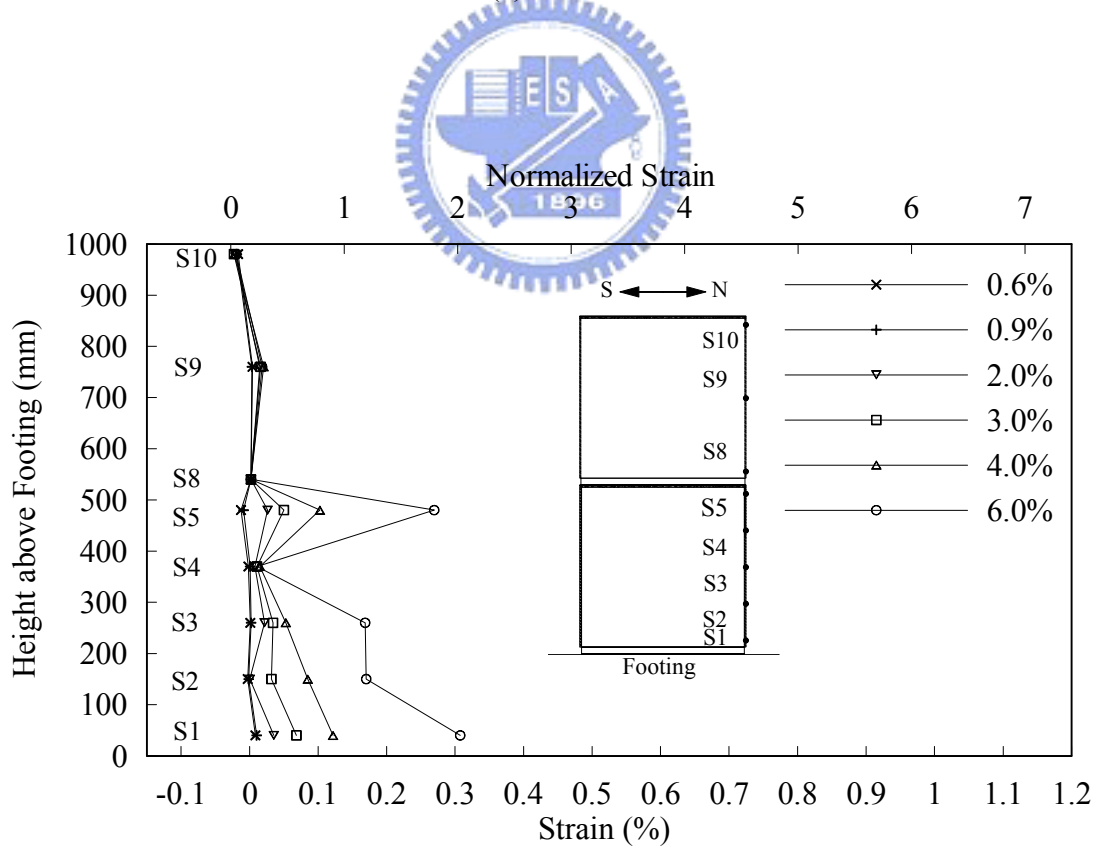


圖 3.21 試體 SP1 與試體 SP2 各側位移分量比例關係圖



(a) Push Direction



(b) Pull Direction

圖 3.22 試體 SP1 鋼管北側環向應變隨高度變化圖

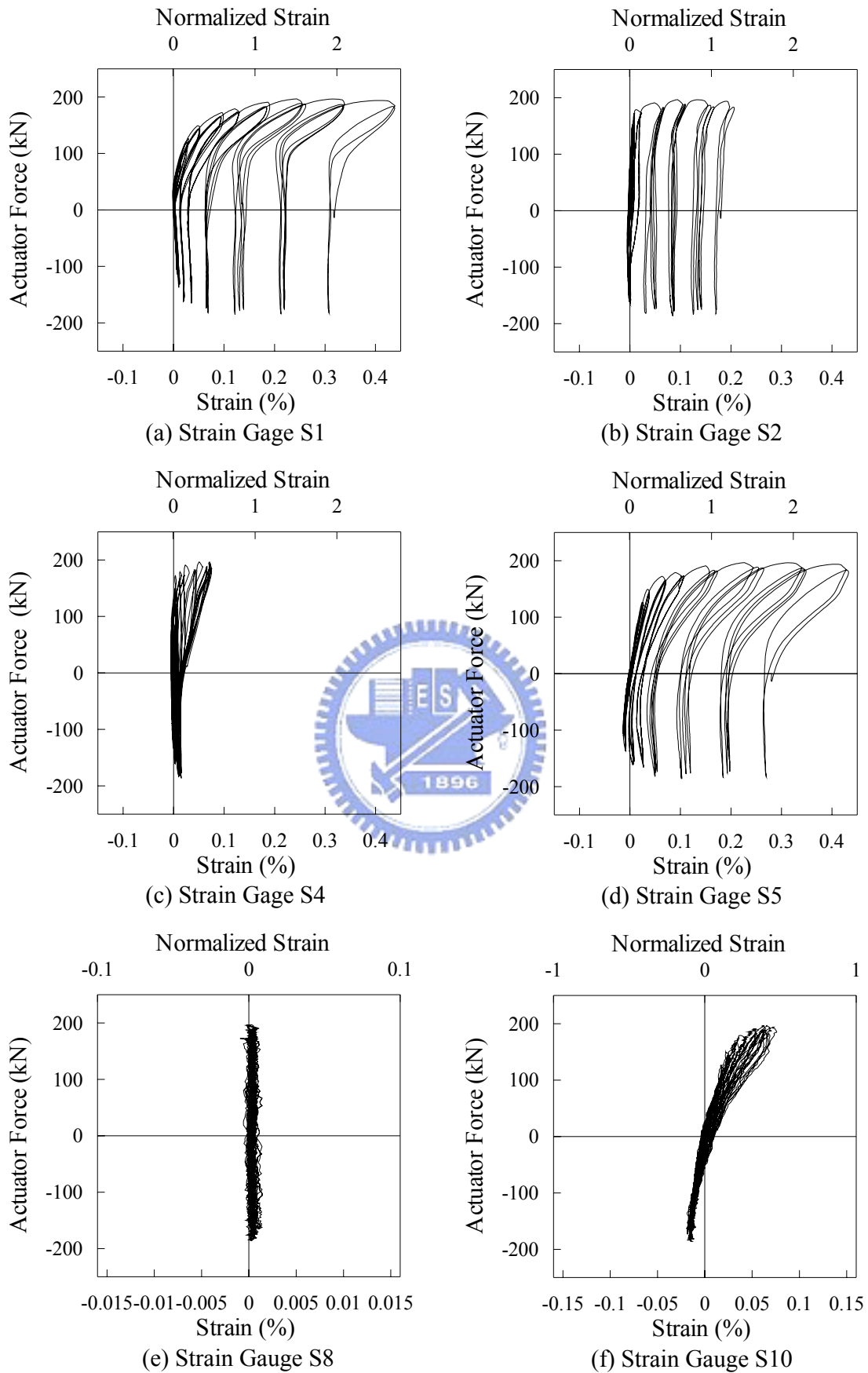
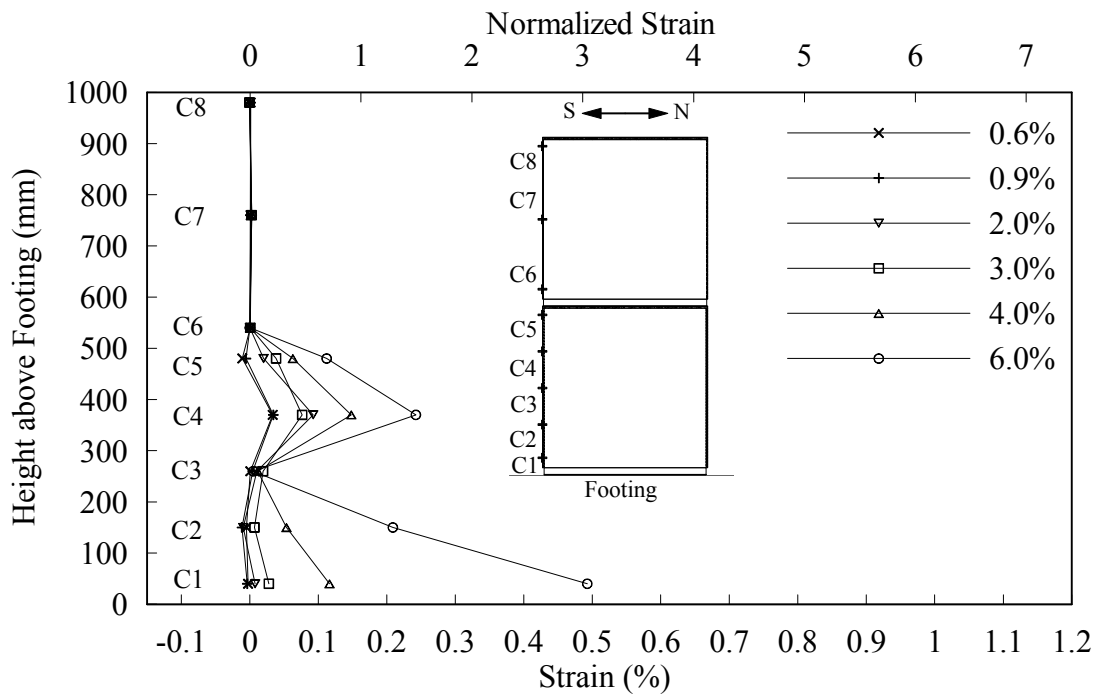
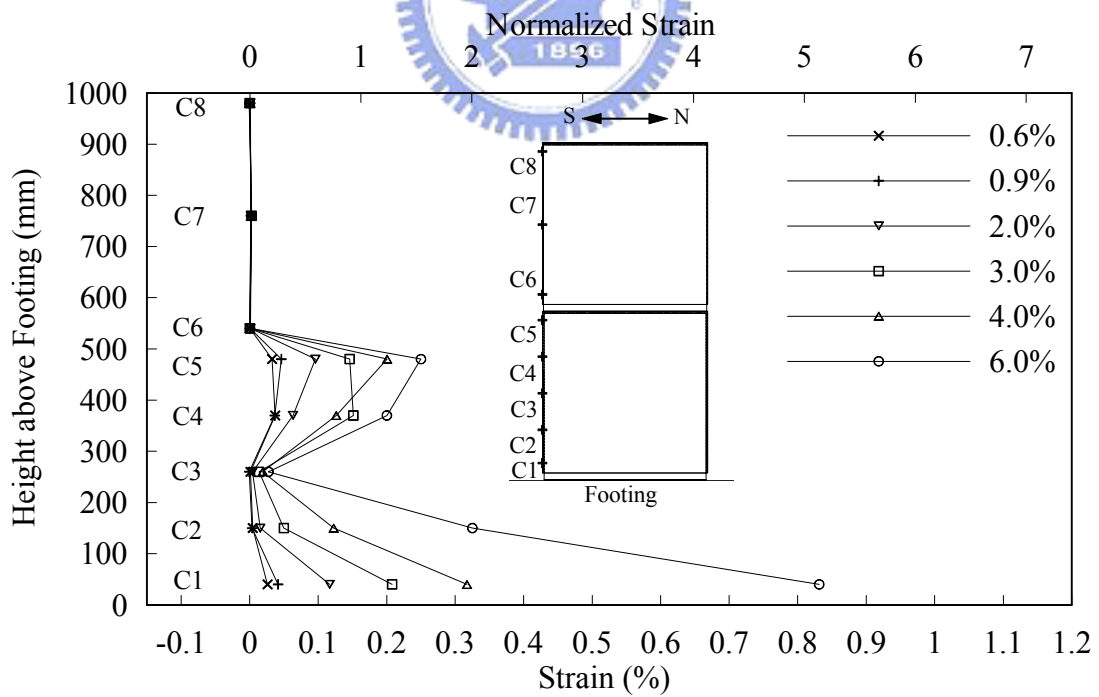


圖 3.23 試體 SP1 鋼管北側環向應變與側向力歷時

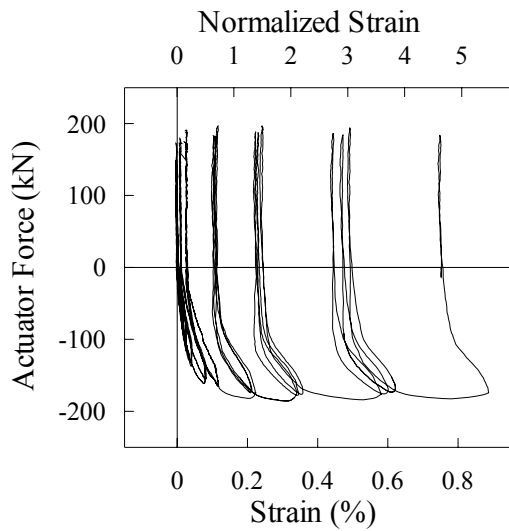


(a) Push Direction

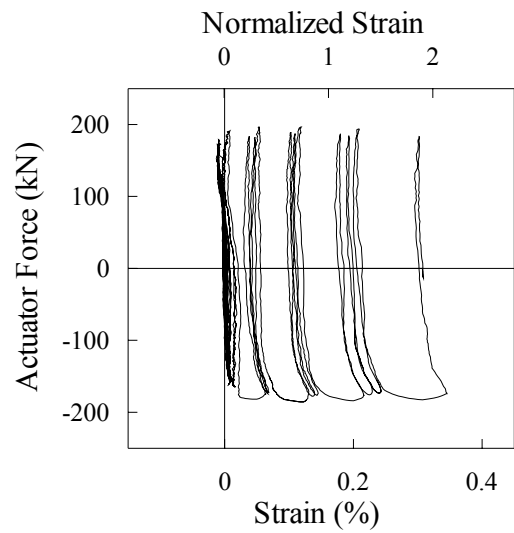


(b) Pull Direction

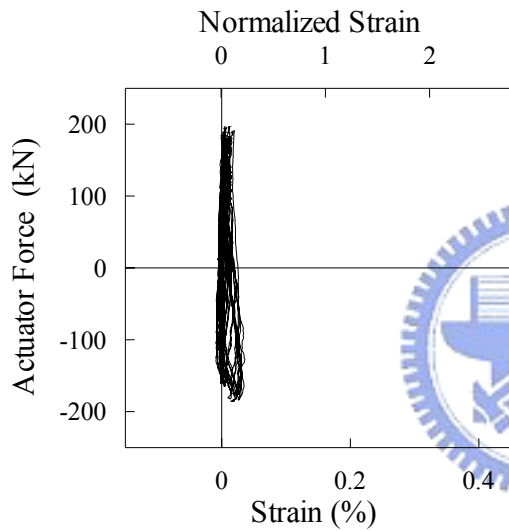
圖 3.24 試體 SP1 鋼管南側環向應變隨柱高度變化圖



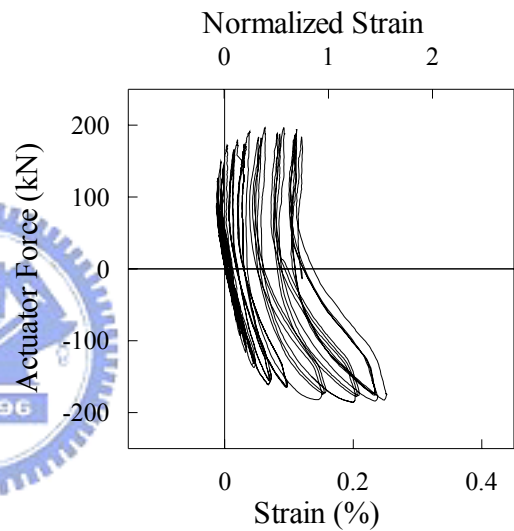
(a) Strain Gauge C1-1



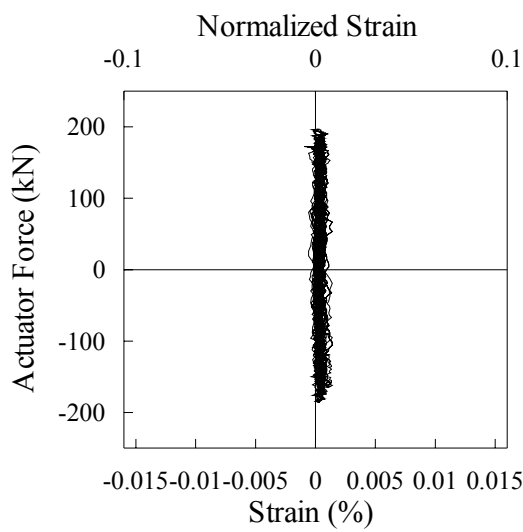
(b) Strain Gauge C2-1



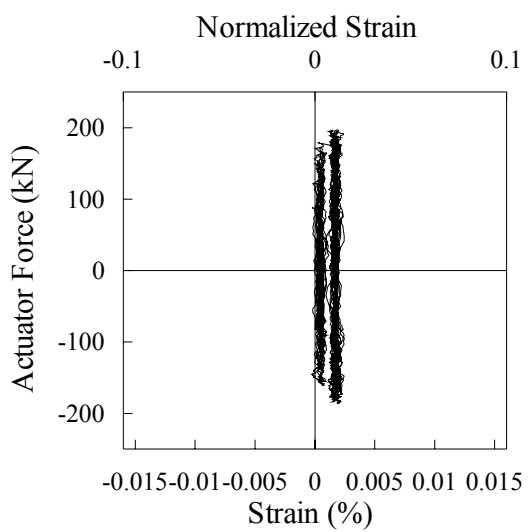
(c) Strain Gauge C3-1



(d) Strain Gauge C5-1



(e) Strain Gauge C6-1



(f) Strain Gauge C7-1

圖 3.25 試體 SP1 鋼管南側環向應變與側向力歷時



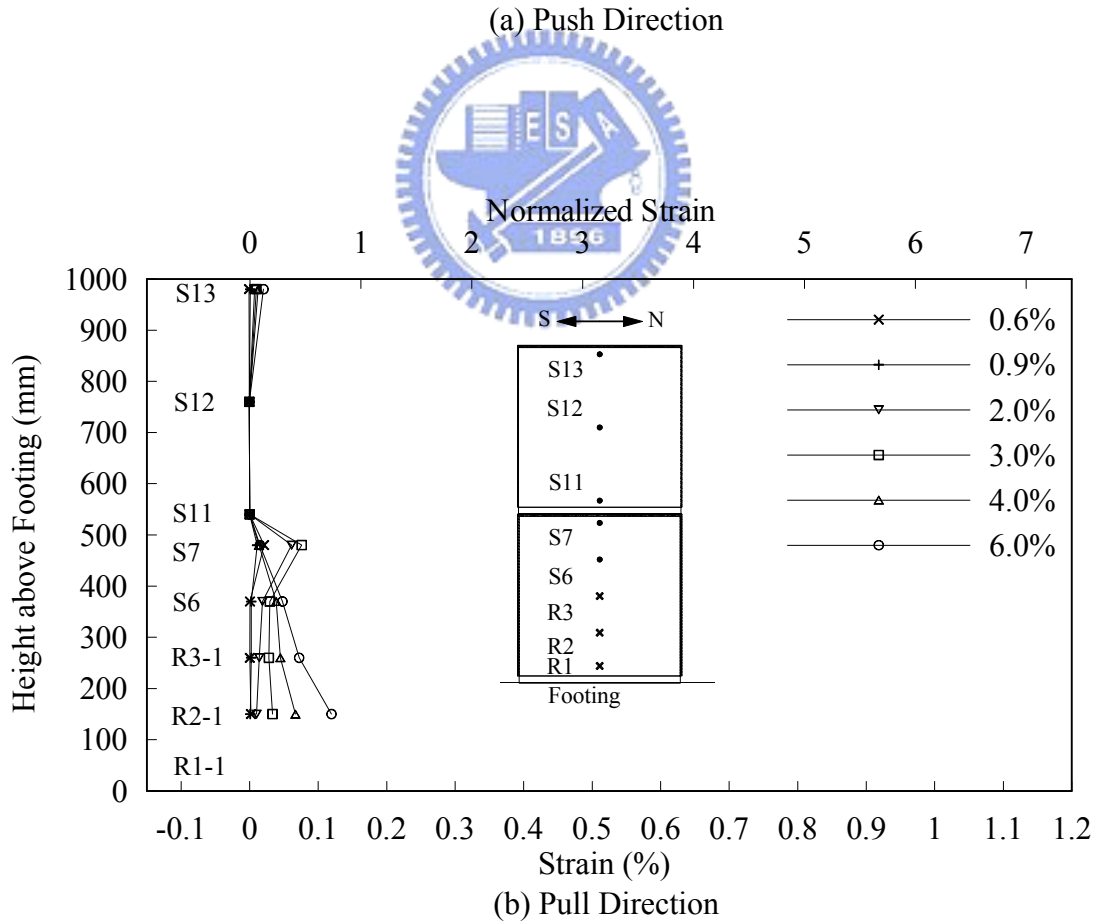
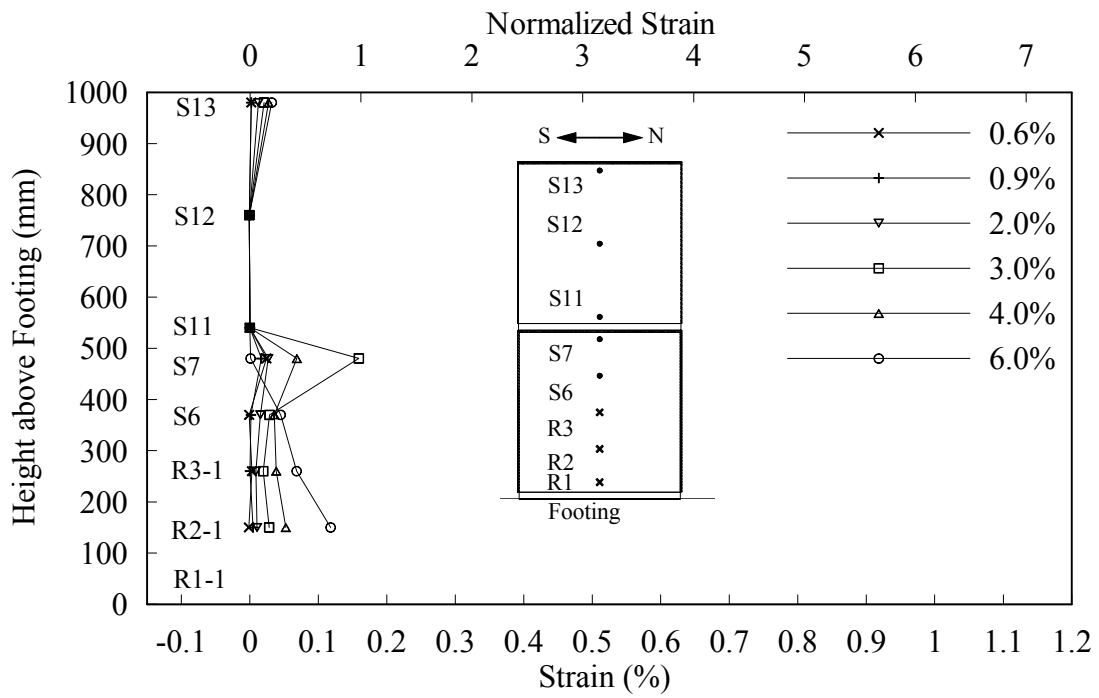


圖 3.26 試體 SP1 鋼管西側環向應變隨柱高度變化圖

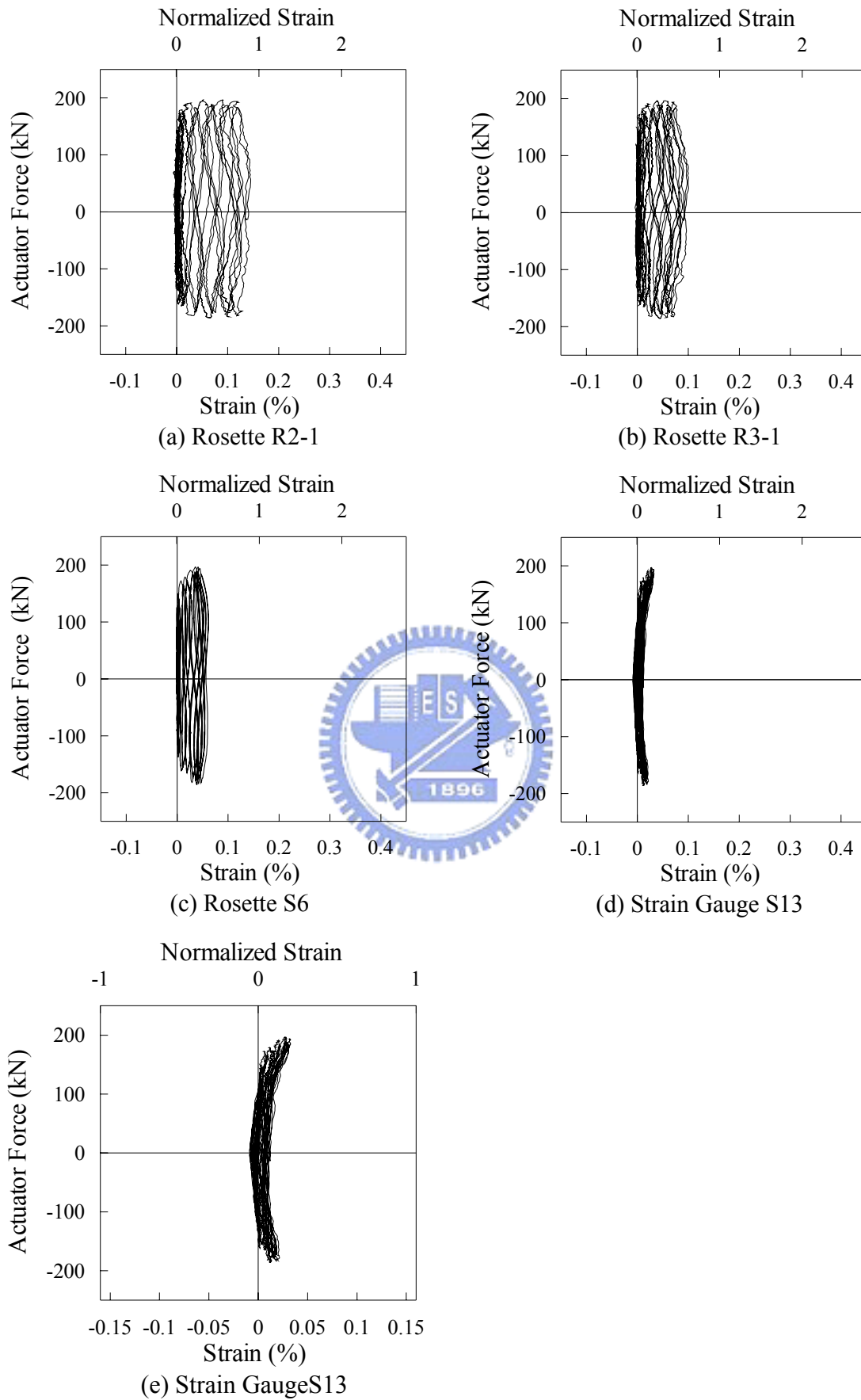


圖 3.27 試體 SP1 鋼管西側環向應變與側向力歷時

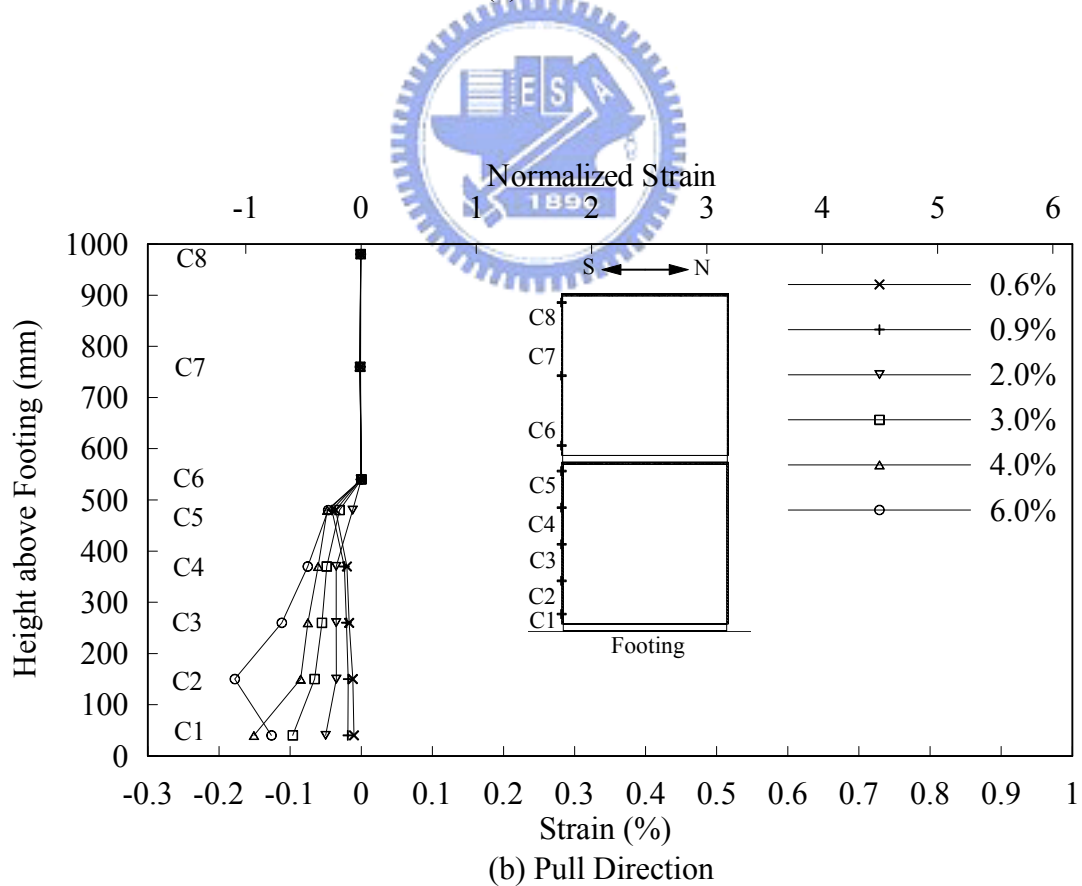
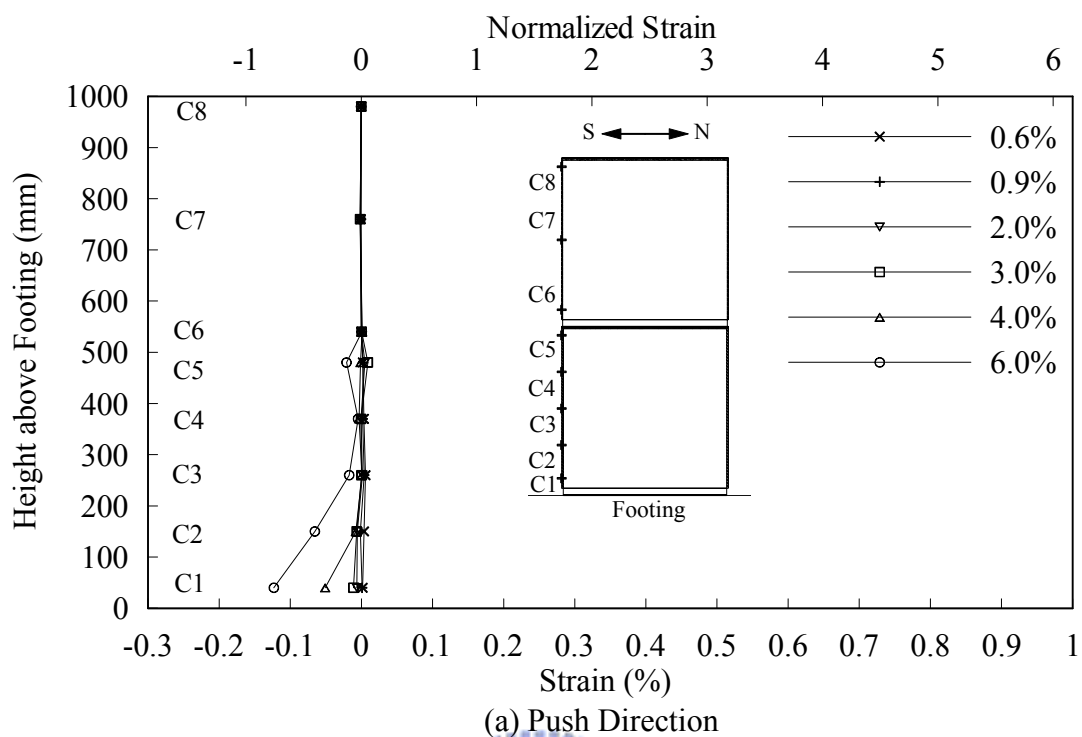


圖 3.28 試體 SP1 鋼管南側縱向應變隨柱高度圖

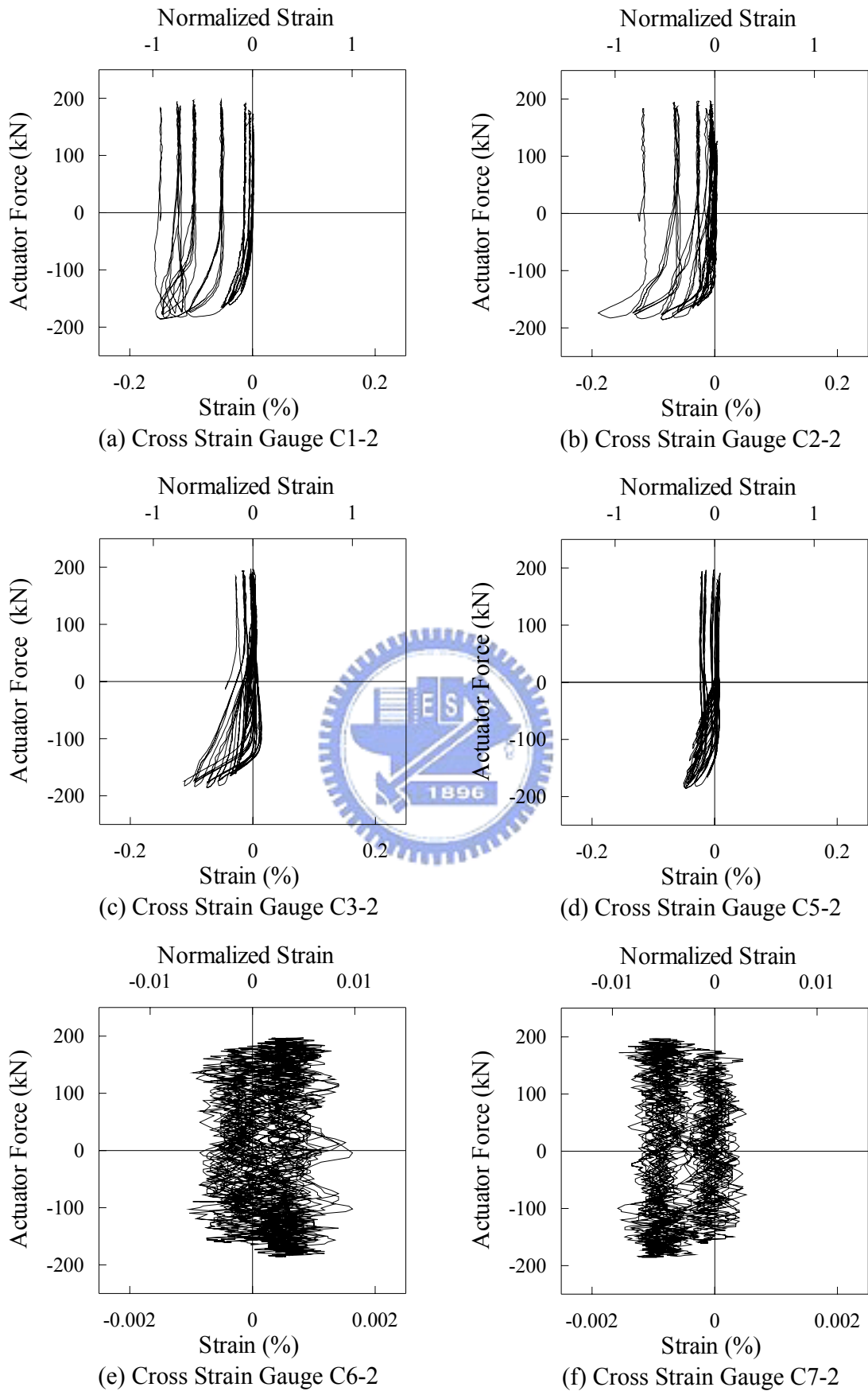


圖 3.29 試體 SP1 鋼管南側縱向應變圖

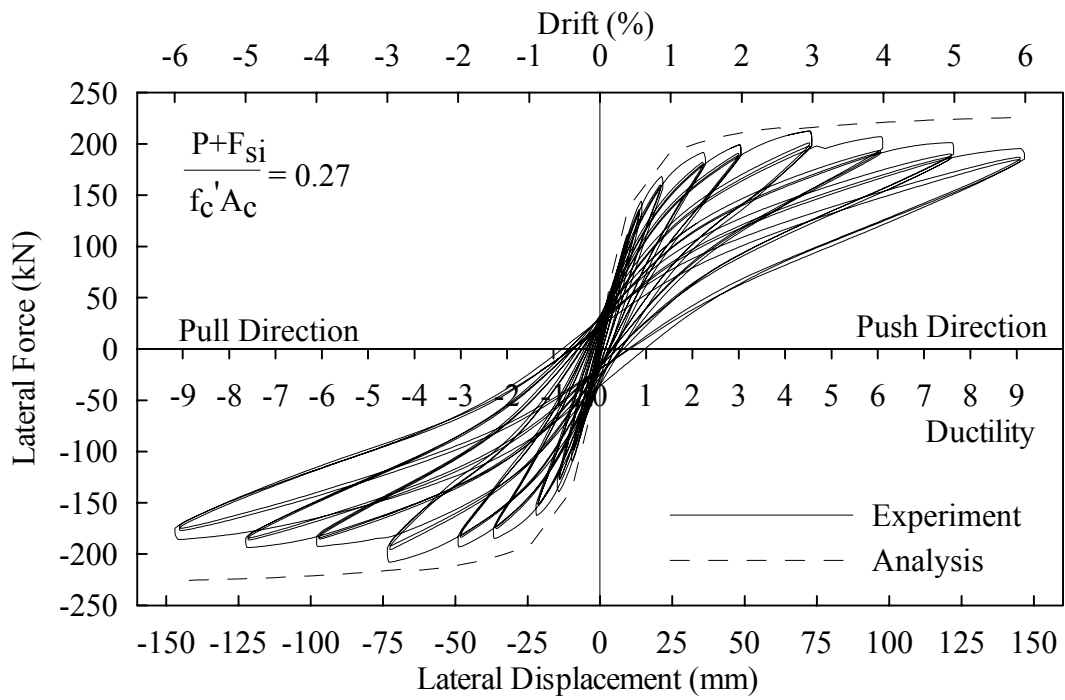


圖 3.30 試體 SP2 力量-位移關係圖

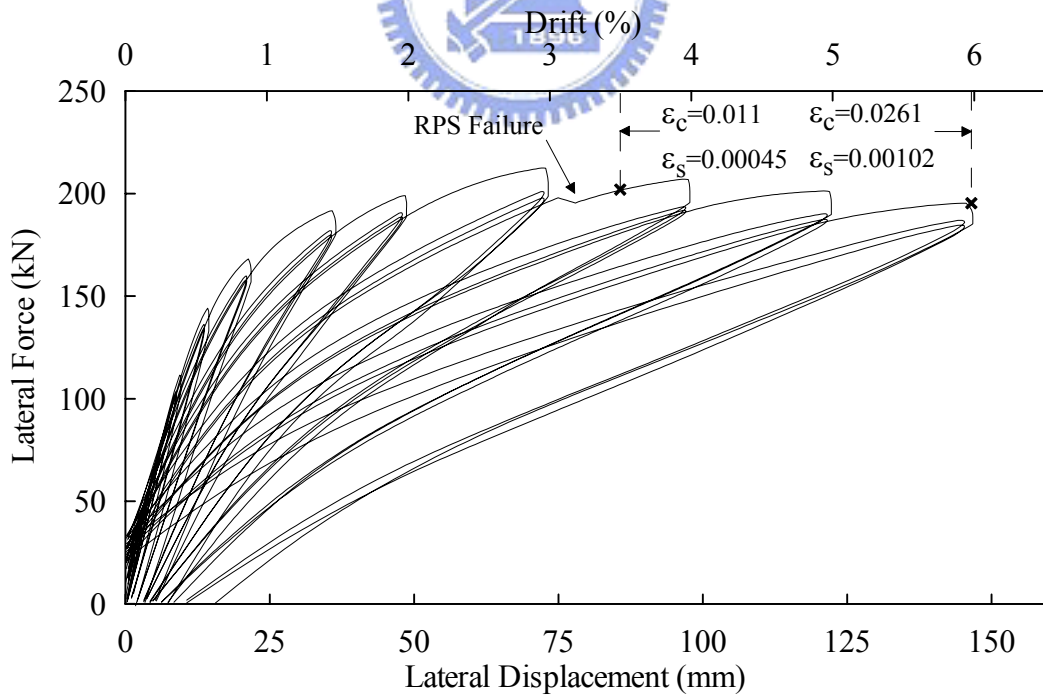


圖 3.31 試體 SP2 正方向力量-位移關係圖

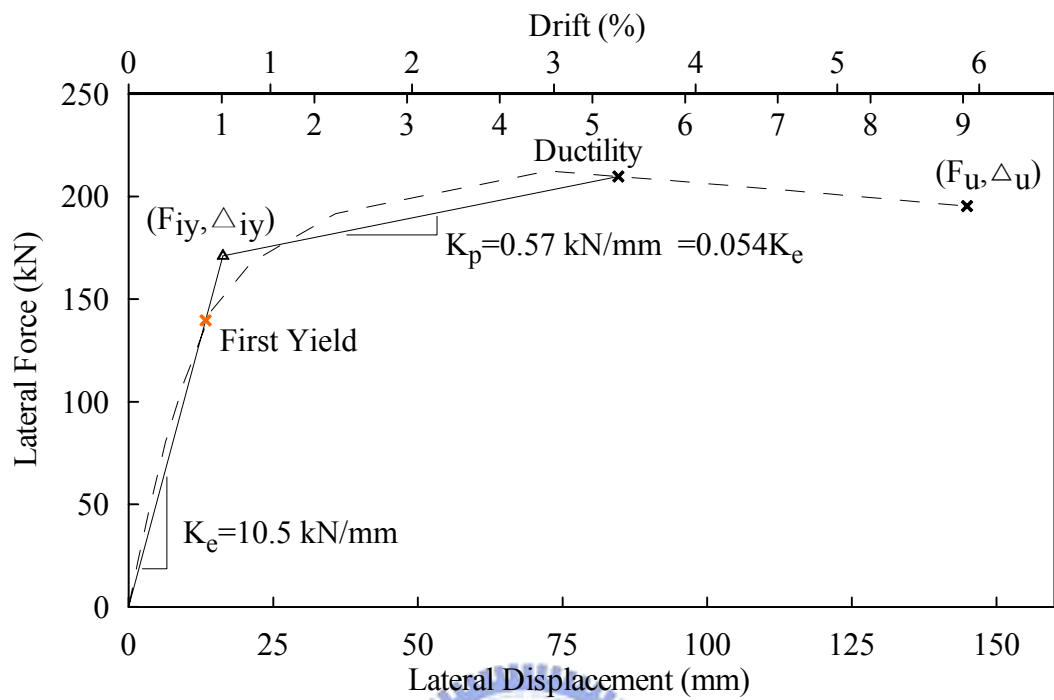


圖 3.32 試體 SP2 雙線性模擬力量-位移關係圖

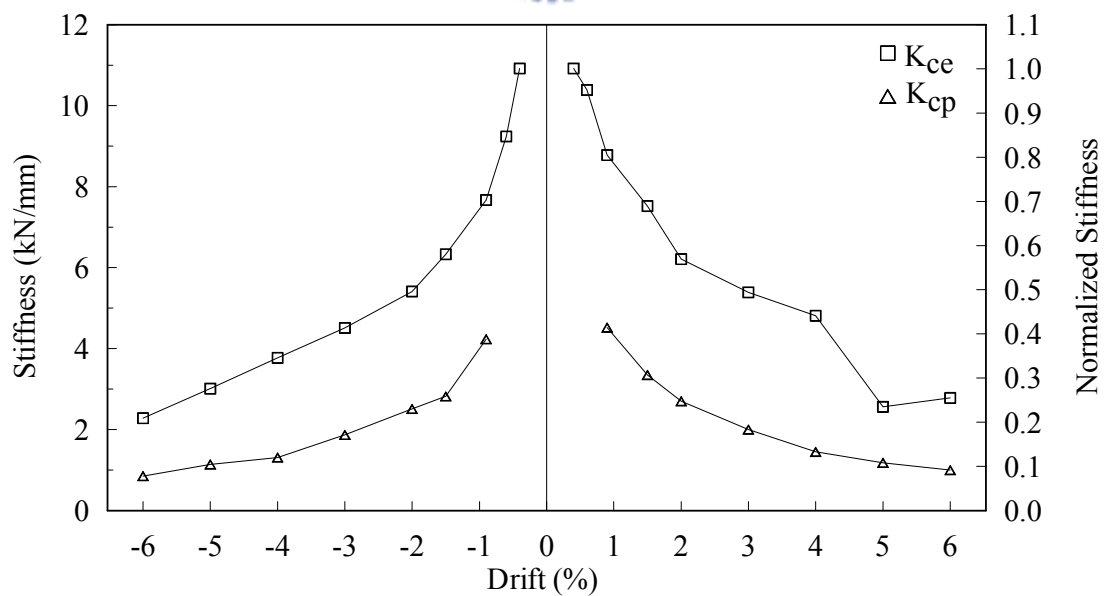


圖 3.33 試體 SP2 彈性勁度與非彈性勁度隨側位移變化圖

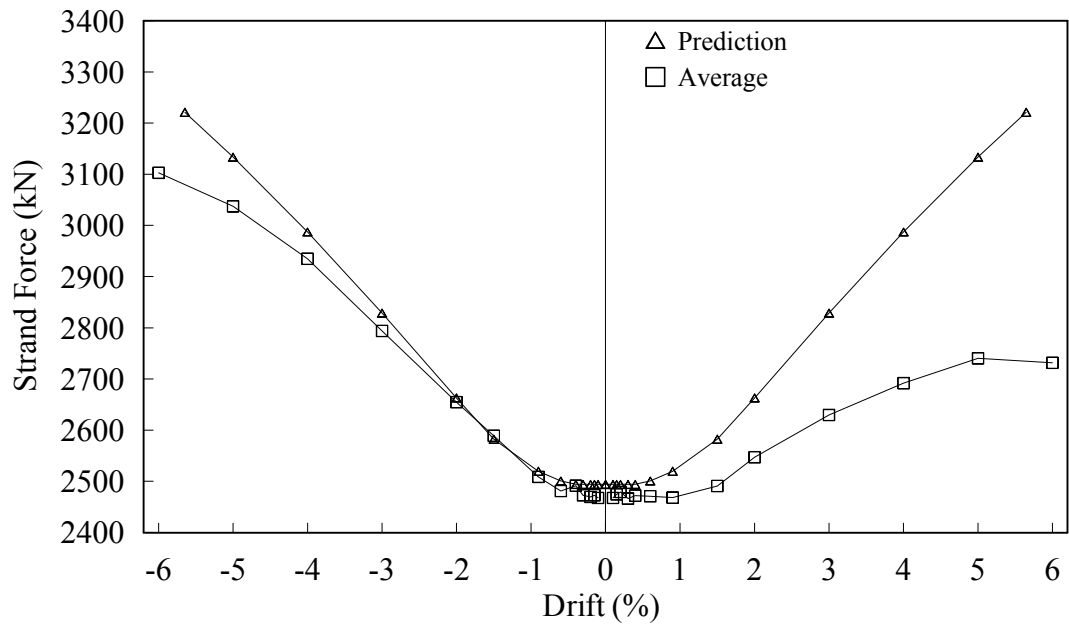


圖 3.34 試體 SP2 預力鋼腱預力量變化圖

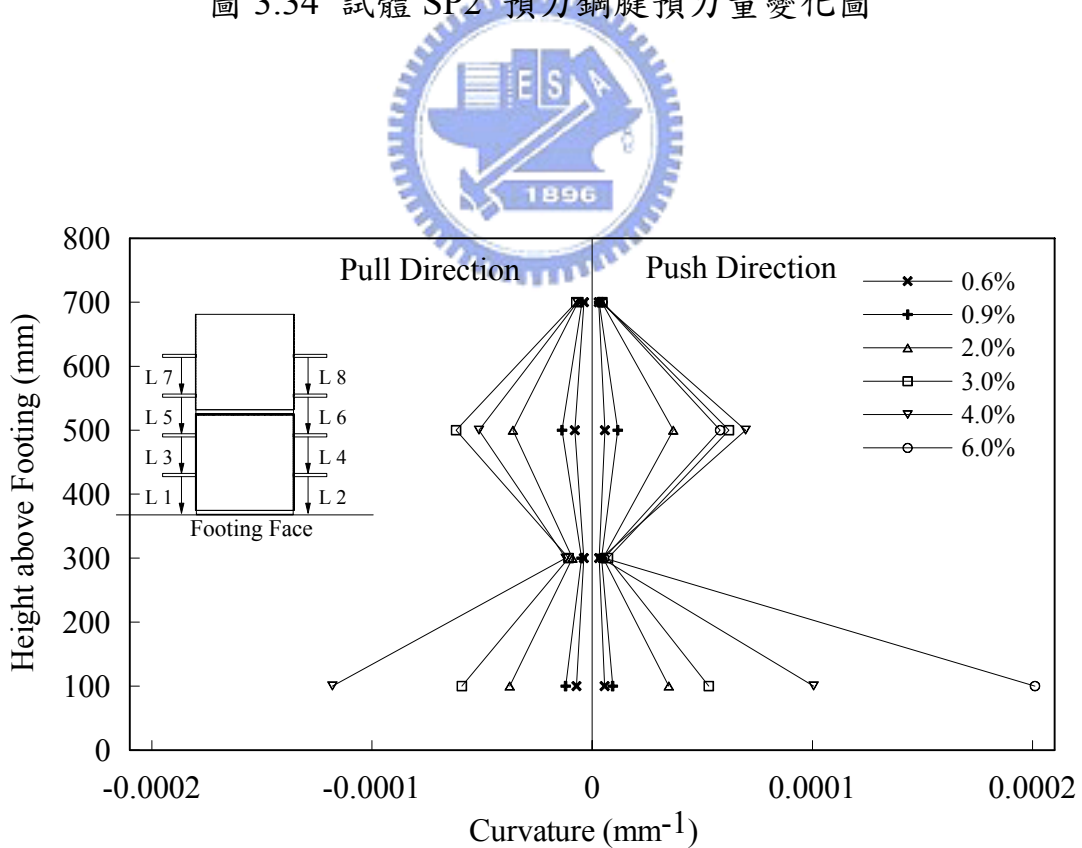


圖 3.35 試體 SP2 量測曲率變化關係圖

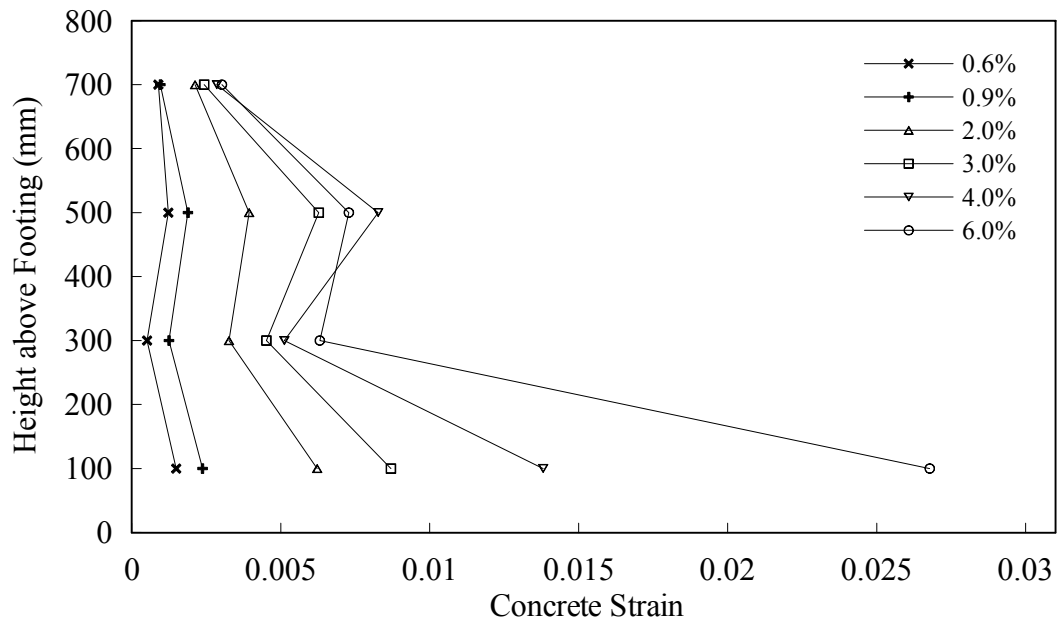
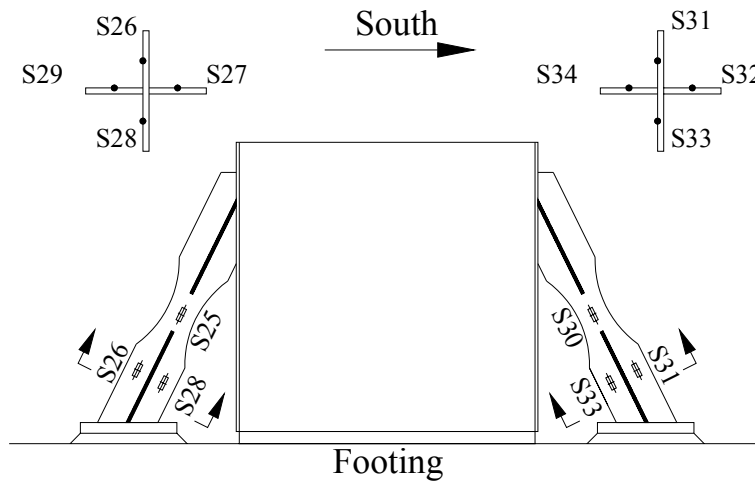


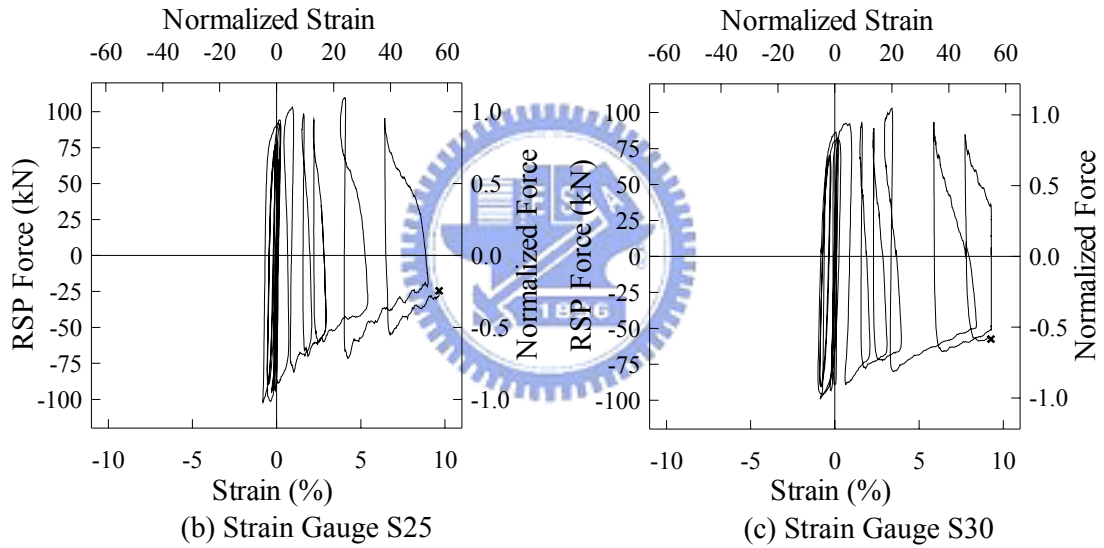
圖 3.36 試體 SP2 正方向混凝土最外纖維壓應變隨柱高變化圖







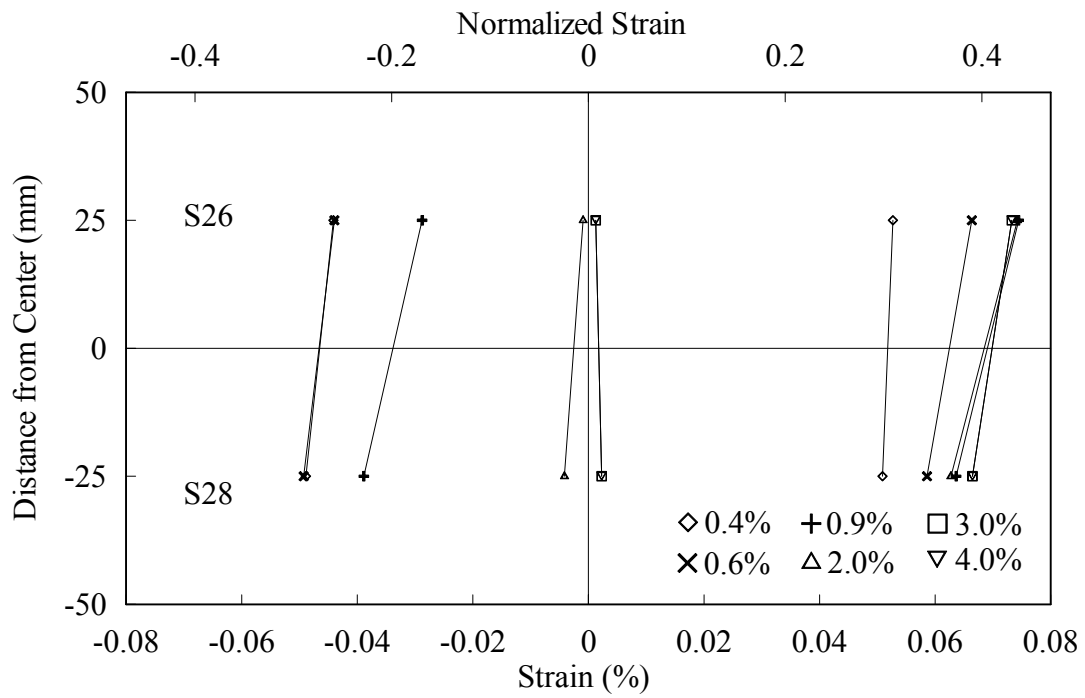
(a) Gauge Location



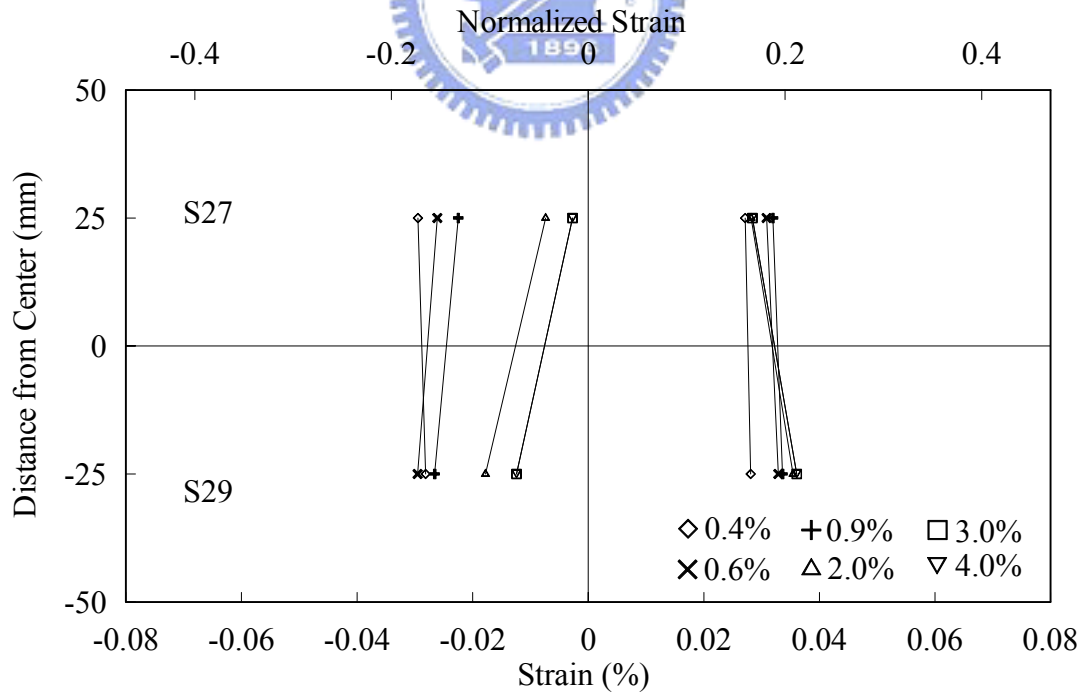
(b) Strain Gauge S25

(c) Strain Gauge S30

圖 3.37 試體 SP2 消能桿件上削切斷面處的應變計與力量關係圖

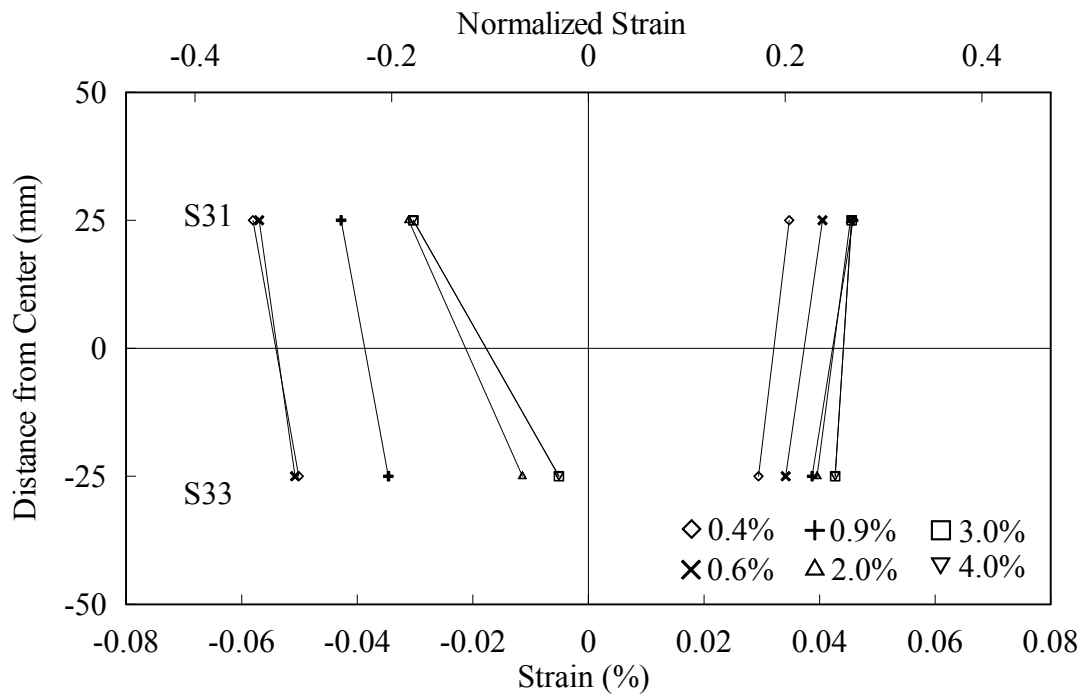


(a) Strain Profiles (S26 and S28)

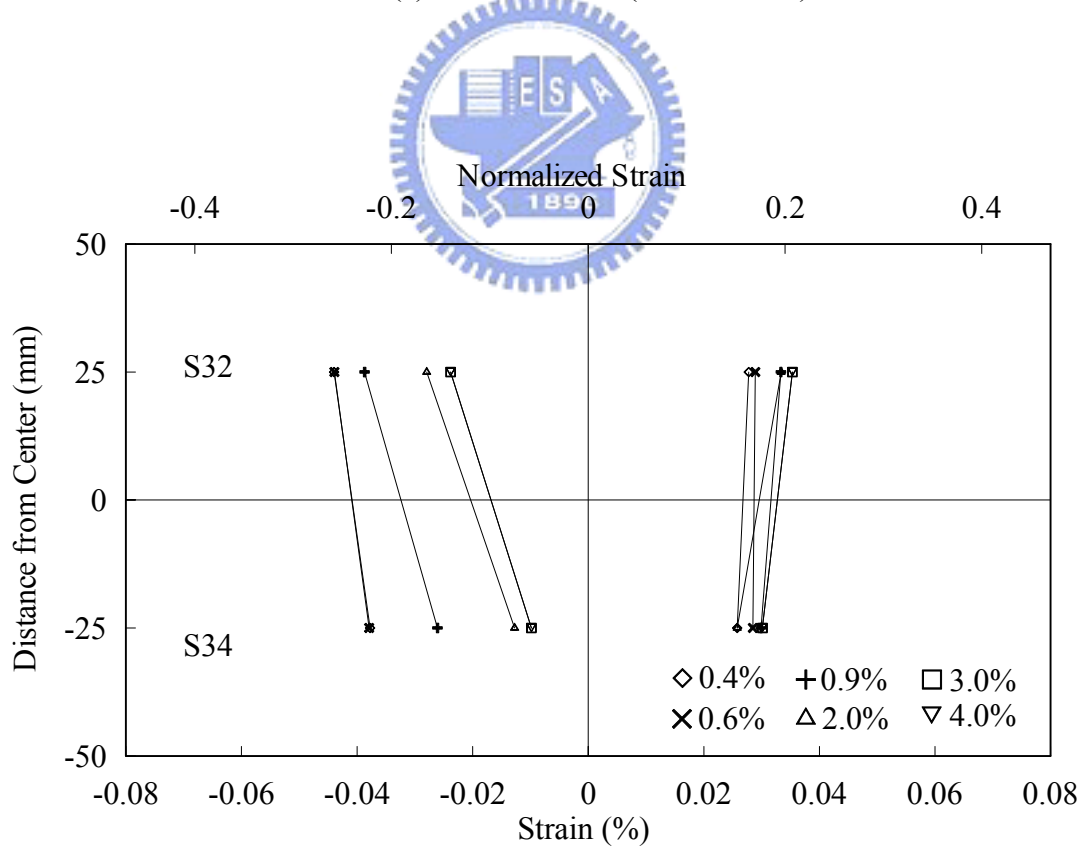


(b) Strain Profiles (S27 and S29)

圖 3.38 試體 SP2 北側消能桿應變變化圖



(a) Strain Profiles (S31 and S33)



(b) Strain Profiles (S32 and S34)

圖 3.39 試體 SP2 南側消能桿應變變化圖

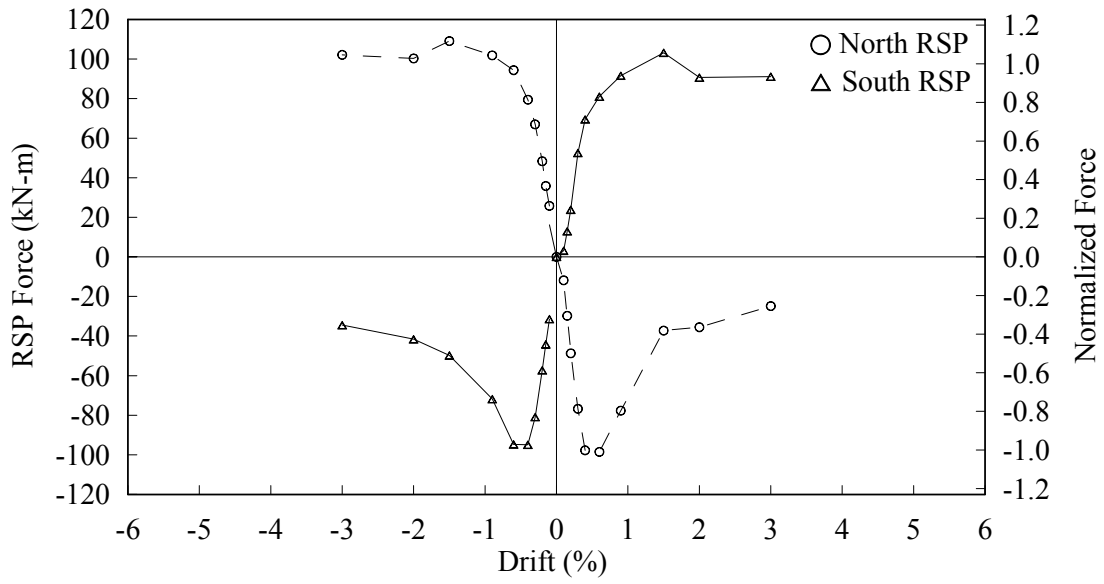


圖 3.40 試體 SP2 消能桿件上力量與側位移變化關係圖

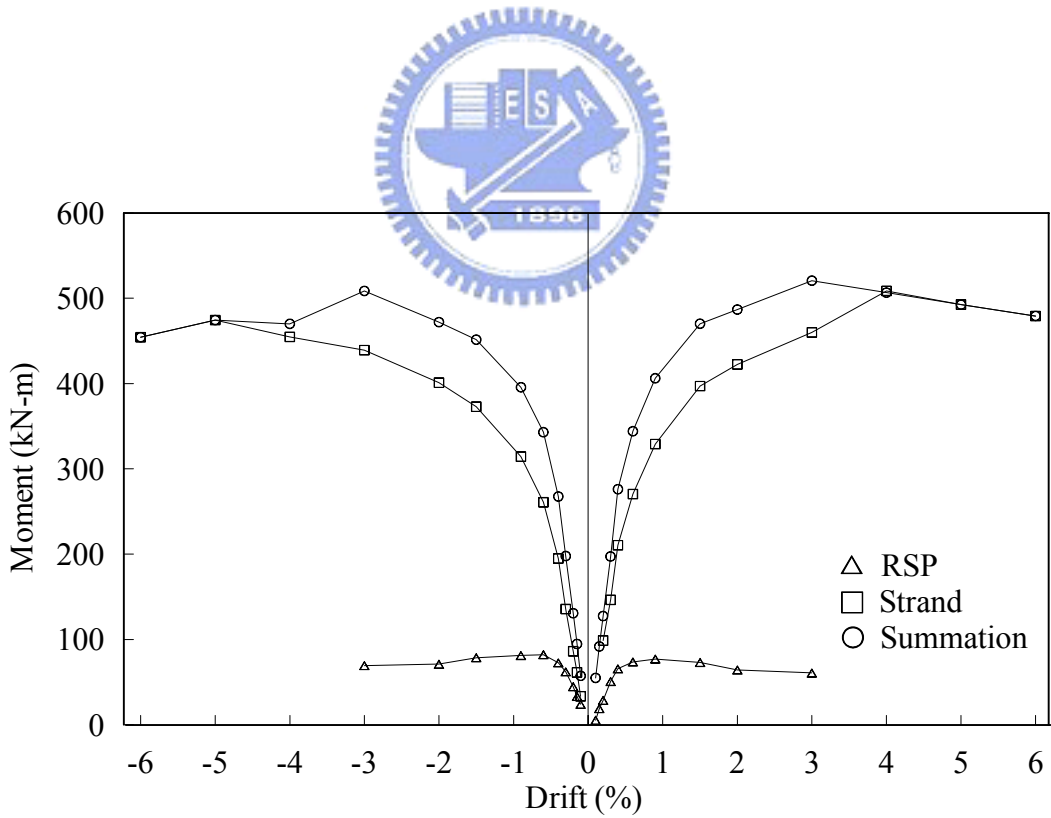


圖 3.41 試體 SP2 彎矩包絡線