

含挫屈束制支撐之RC構架耐震設計試驗與應用研討會

雙斜挫屈束制斜撐於既有 RC建築物補強之應用研究

永盛結構技師事務所
結構技師 許志強

簡報大綱

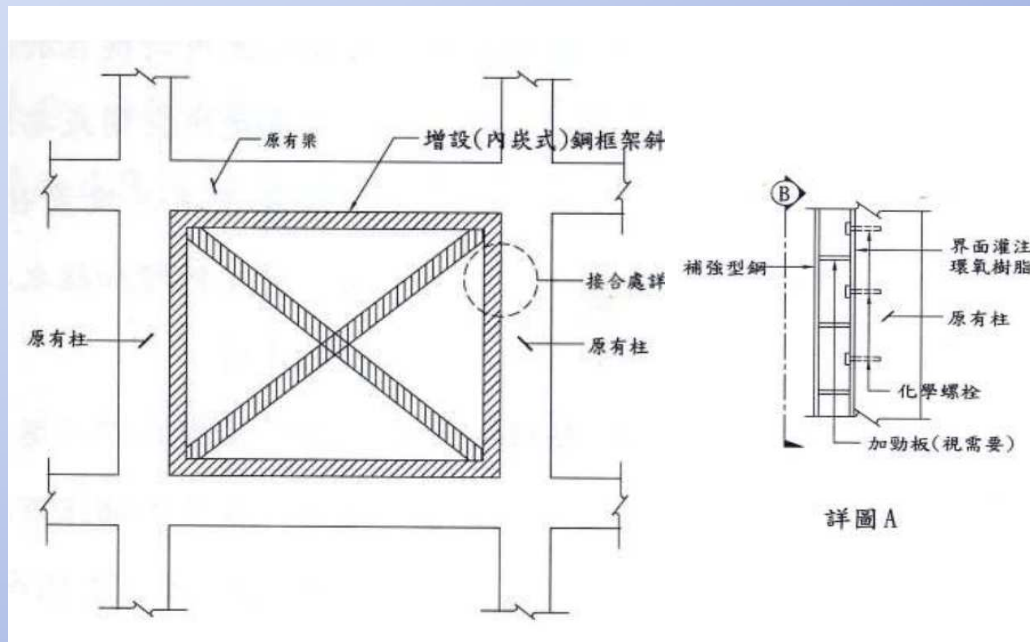
- 鋼製斜撐/阻尼器應用於RC建物之補強
- 承壓塊傳力系統-單斜BRB佈置
- 承壓塊傳力系統-雙斜BRB佈置
- 承壓塊傳力系統-雙斜BRB構架側推模擬
- 既有RC建物補強應用之研究
- 結論

鋼製斜撐/阻尼器應用於RC建物之補強

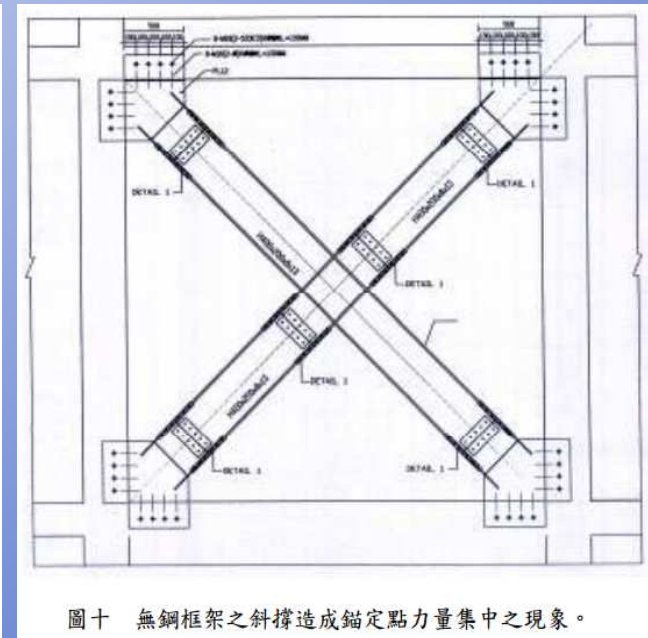


鋼製斜撐/阻尼器應用於RC建物之補強

鋼斜撐用於鋼筋混凝土結構補強之接合設計探討 [陳正平技師]



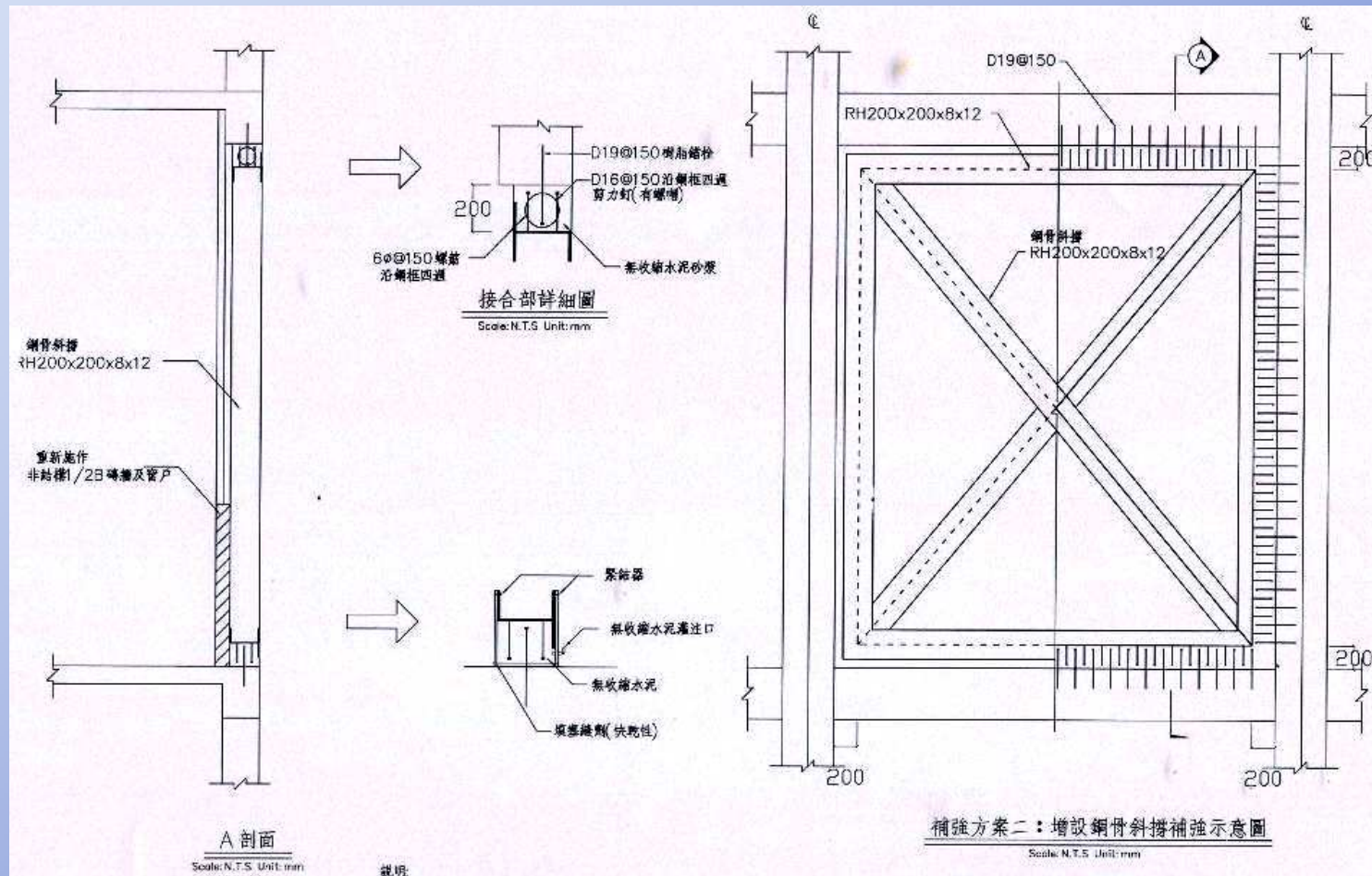
採用鋼構框架方式進行補強，
框架與RC構件以密集化錨鎖固



圖十 無鋼框架之斜撐造成錨定點力量集中之現象。

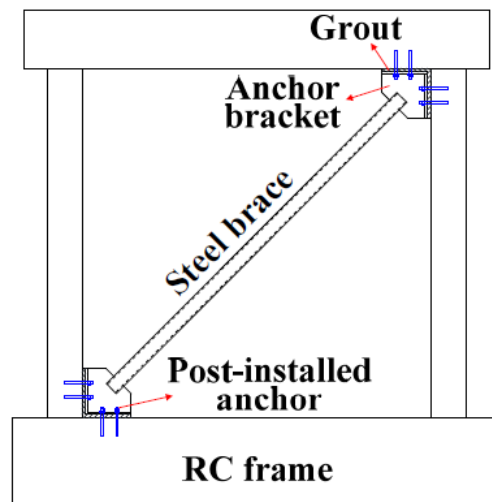
斜撐受拉時錨定問題
較難克服

鋼製斜撐/阻尼器應用於RC建物之補強

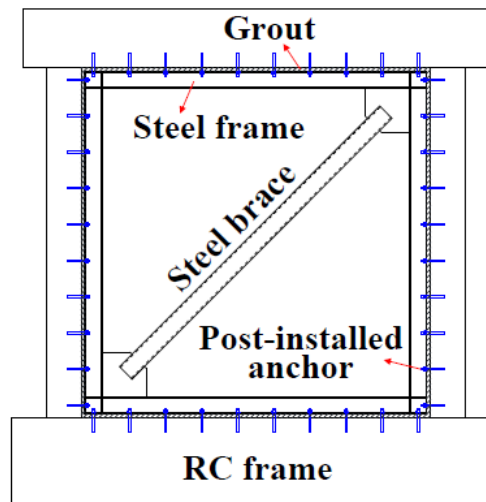


鋼製斜撐/阻尼器應用於RC建物之補強

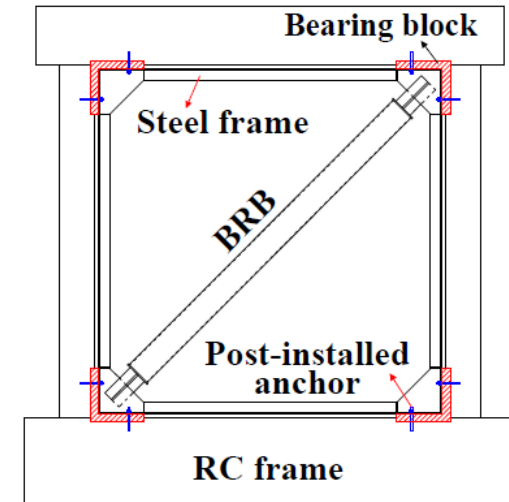
挫屈束制支撐鋼框補強鋼筋混凝土構架之研究[蔡克銓, 潘冠宇等, 2015]



(a) 直接系統



(b) 間接系統



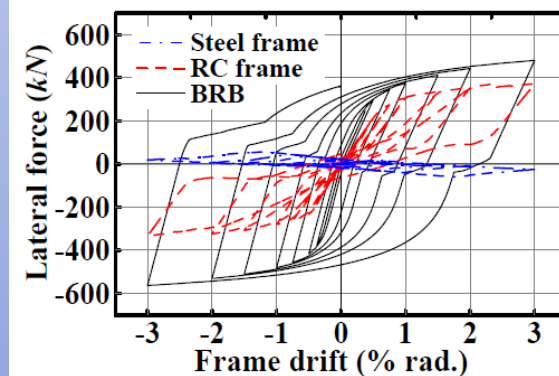
(c) 承壓塊傳力系統

斜撐受壓時直接受力，
斜撐受拉時恐錨定不足

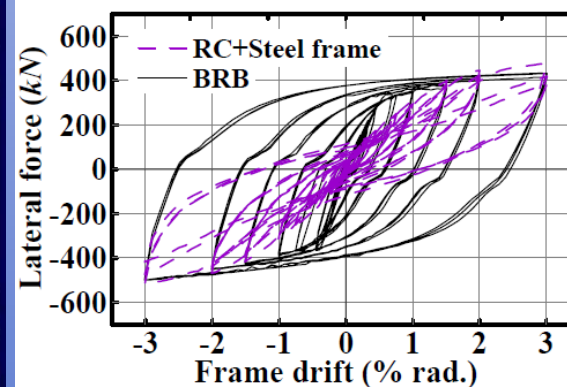
鋼框架與RC構件以密集的
錨栓接合，鋼框架與RC構
建之複合行為複雜。
[楊季軒, 2014]

斜撐受壓時如直接系統，
斜撐受拉時以鋼框架傳遞
並平衡斜撐應力。
[Paret, 2007]

承壓塊傳力系統-單斜佈置



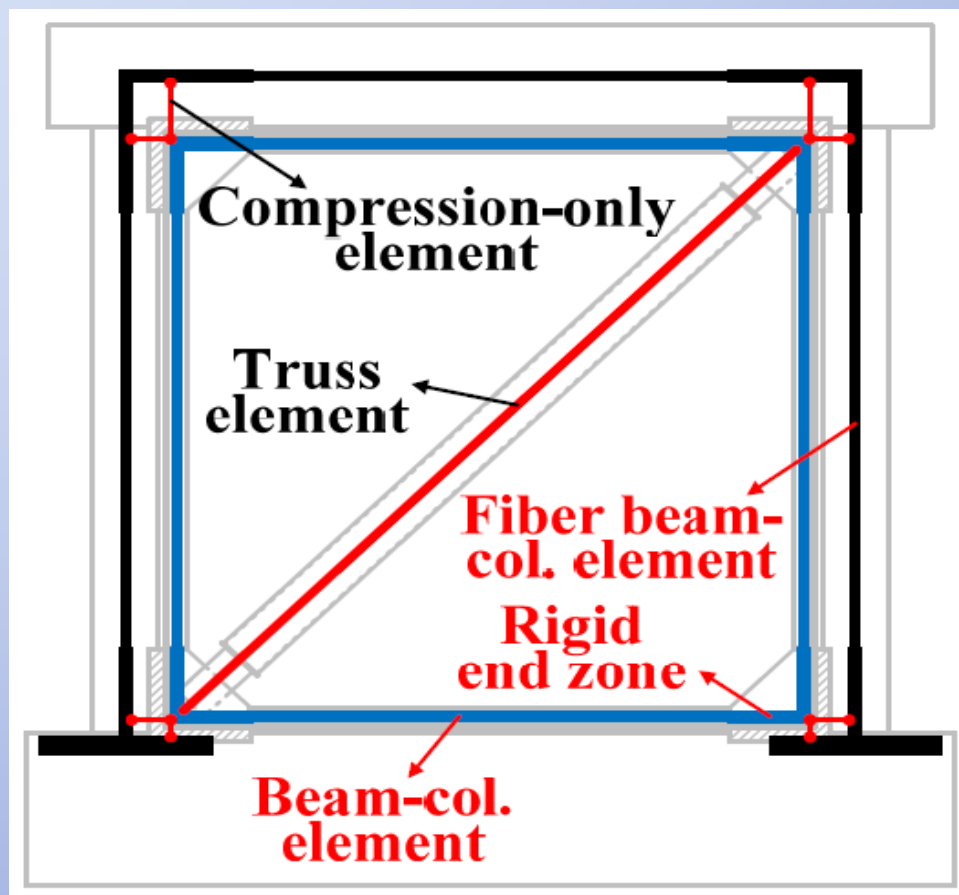
(a) PISA3D 分析結果



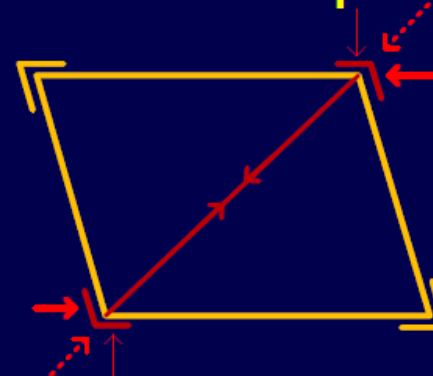
(b) 試驗結果

挫屈束制支撐鋼框補強鋼筋混凝土構架之研究[蔡克銓, 潘冠宇等, 2015]

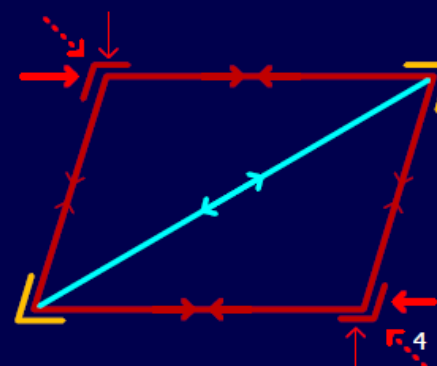
承壓塊傳力系統-單斜佈置



● Brace in compression

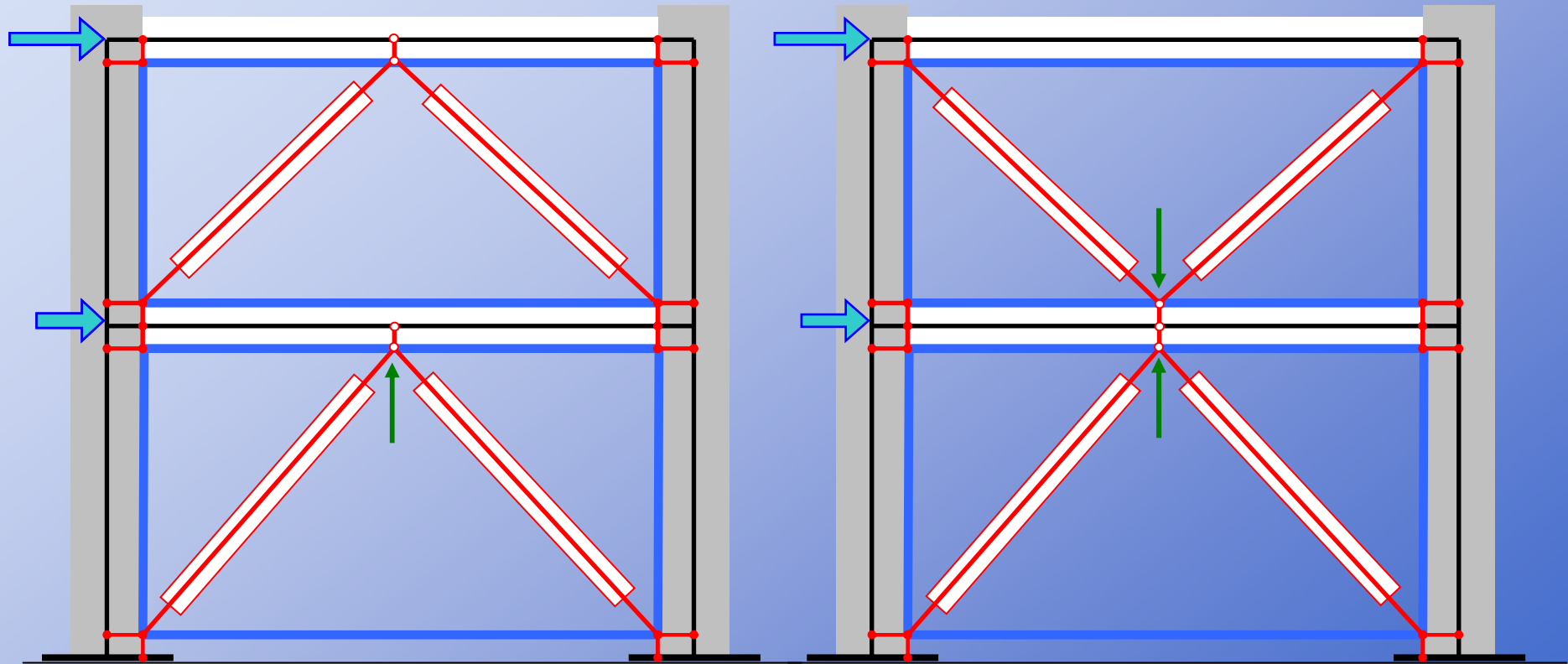


● Brace in tension



挫屈束制支撐鋼框補強鋼筋混凝土構架之研究[蔡克銓,潘冠宇等,2015]

承壓塊傳力系統-雙斜BRB佈置



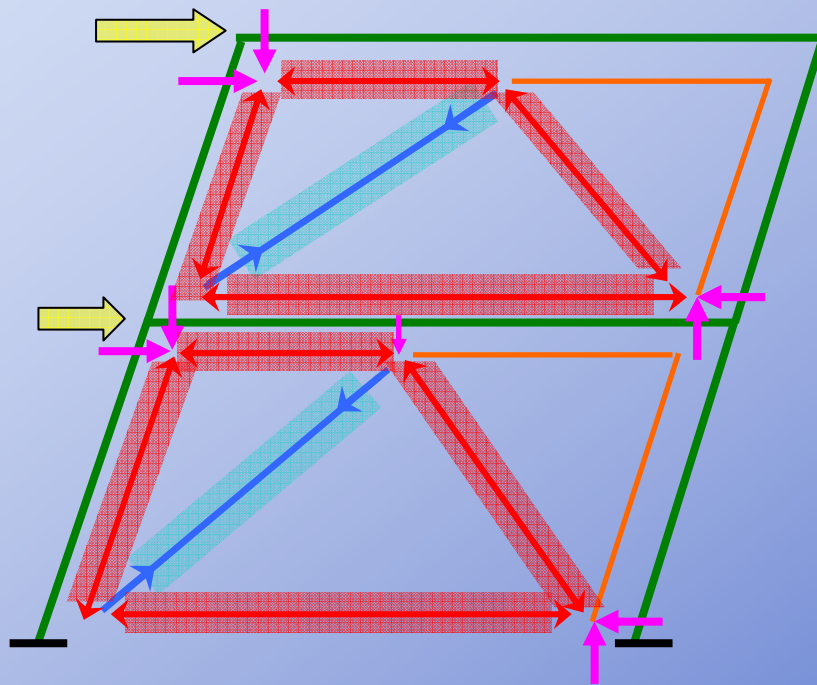
CASE A: Invert V Brace

CASE B: 2 Story X Brace

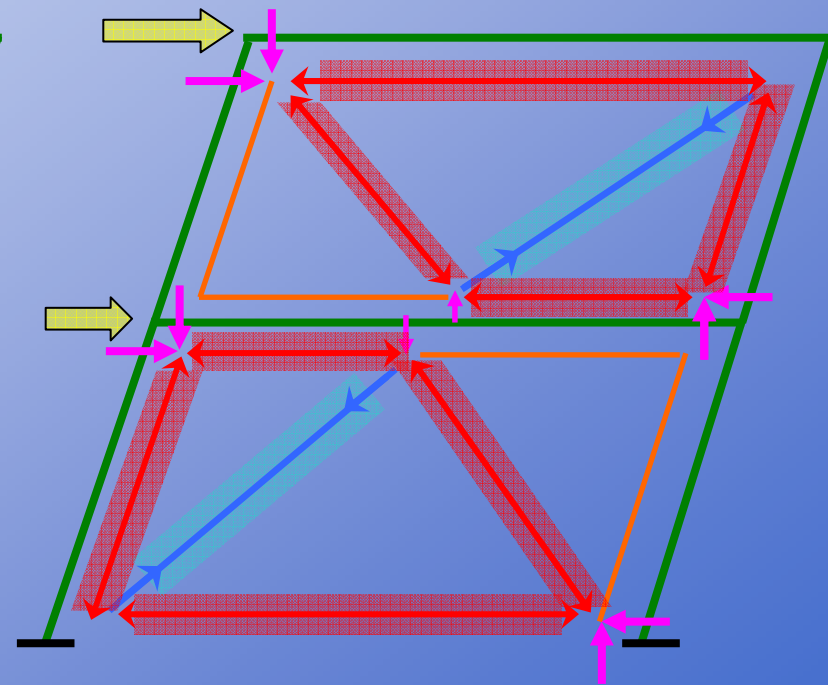
↑ BRB拉壓軸力不平衡可能產生之額外作用力

承壓塊傳力系統-雙斜BRB佈置

鋼框架與BRB受力狀況與水平橫力傳遞路徑

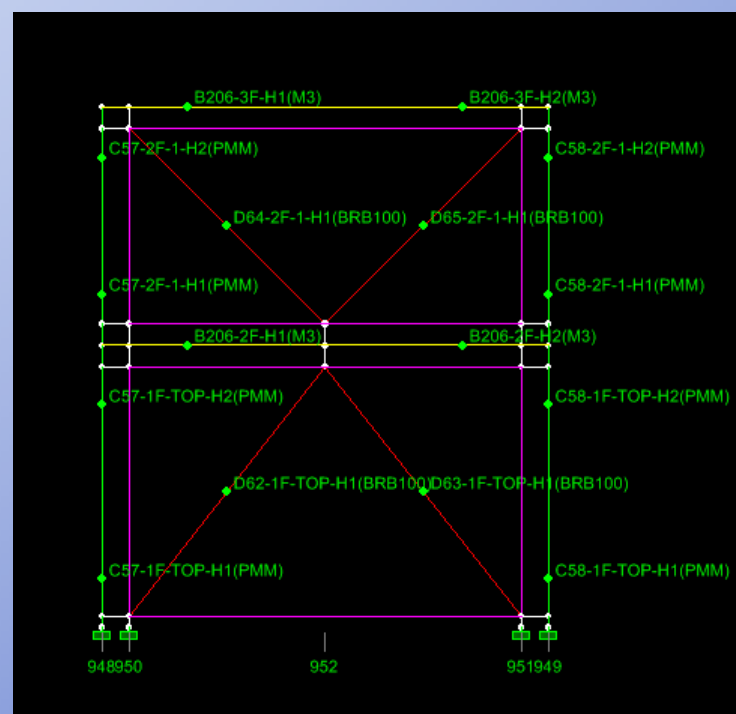
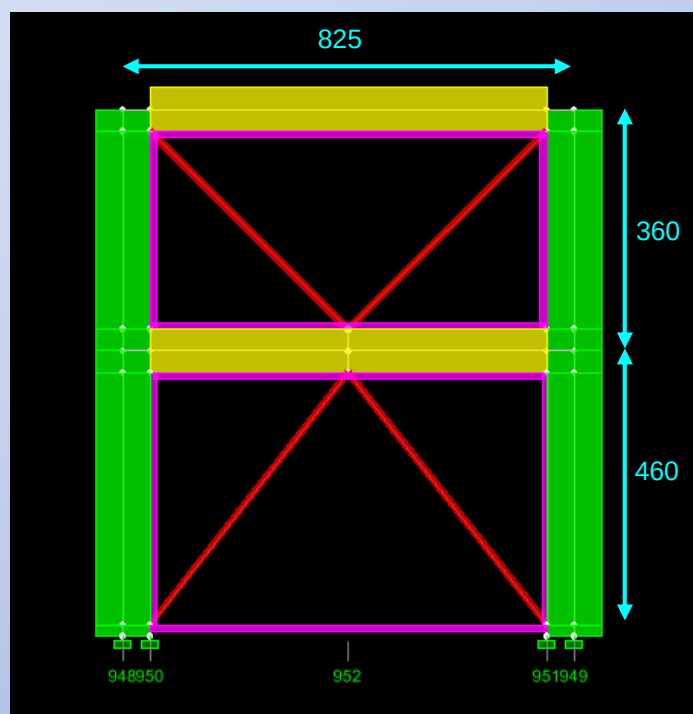


CASE A: Invert V Brace



CASE B: 2 Story X Brace

承壓塊傳力系統-雙斜BRB構架側推模擬



ETABS側推模型之建立 (ATC-40)

梁 B60X80 上層主筋8-#8，下層主筋6-#6

柱 C100X100 柱主筋24-#8 (1.2%)

BRB 100噸 (壓降伏120噸) $K_{eff}=14.8\sim12.8$ t-mm

承壓塊傳力系統-雙斜BRB構架側推模擬

側推分析使用BRB參數與性質

The screenshot displays the BOD (Brace On Demand) software interface. On the left, there is a logo with a sun and the text "BOD Brace On Demand" and a set of buttons labeled F, C, B, G, L, and a "DONE" button. Below the logo is a diagram of a rectangular frame with two diagonal braces forming a chevron shape. At the bottom, there are two horizontal diagrams showing the frame's behavior under lateral load, with red arrows indicating the direction of the push.

The central panel, titled "Find your BRB", contains several dropdown menus for configuring the BRB properties:

- Type: Cruciform
- Casing: Square Tube
- Core Material: CNS SN490B/CM
- Yield Capacity(tonf): 100tonf(tc=16mm)
- Configuration: Chevron

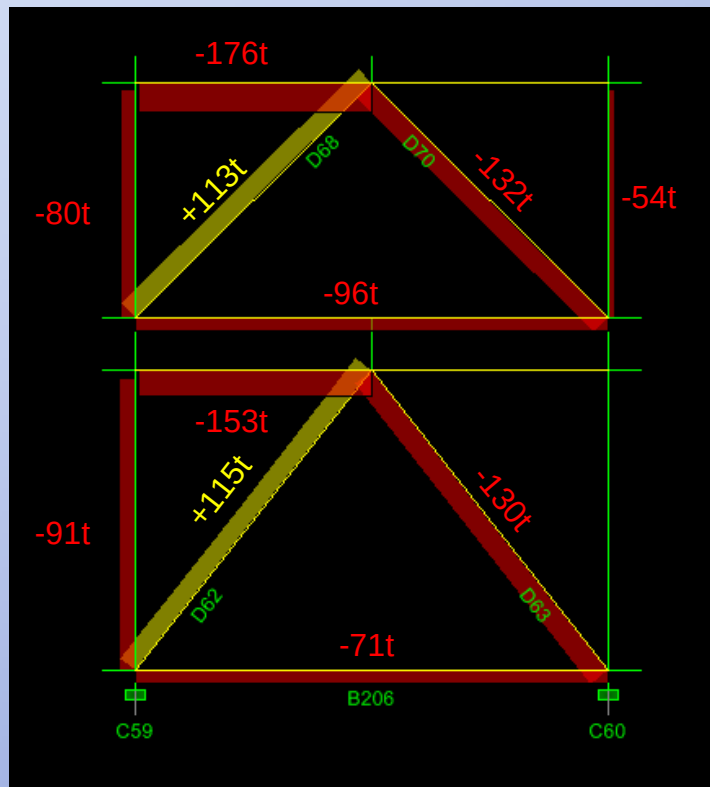
On the right, there are two "Clouds" panels, each showing a "Summary" table of properties. The left "Clouds" panel is for the "Left" part, and the right "Clouds" panel is for the "Right" part. Both panels show the same summary table:

Py	100.3
Pmax	180
Keff	14.8
Q	1.22
α	0.63
θ_y	0.0026
Lwp	5108
L_BRB	4230
Le,lower	399
Le,upper	479
Casing	200x200x4.5

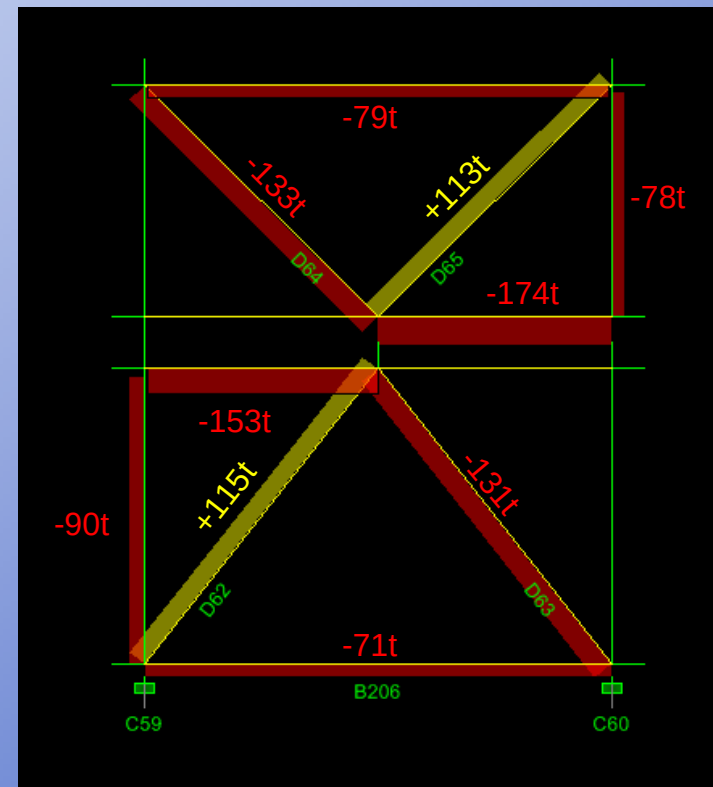
Units: tonf-mm

承壓塊傳力系統-雙斜BRB構架側推模擬

側推分析結果：鋼框架與BRB受力狀況



CASE A: Invert V Brace



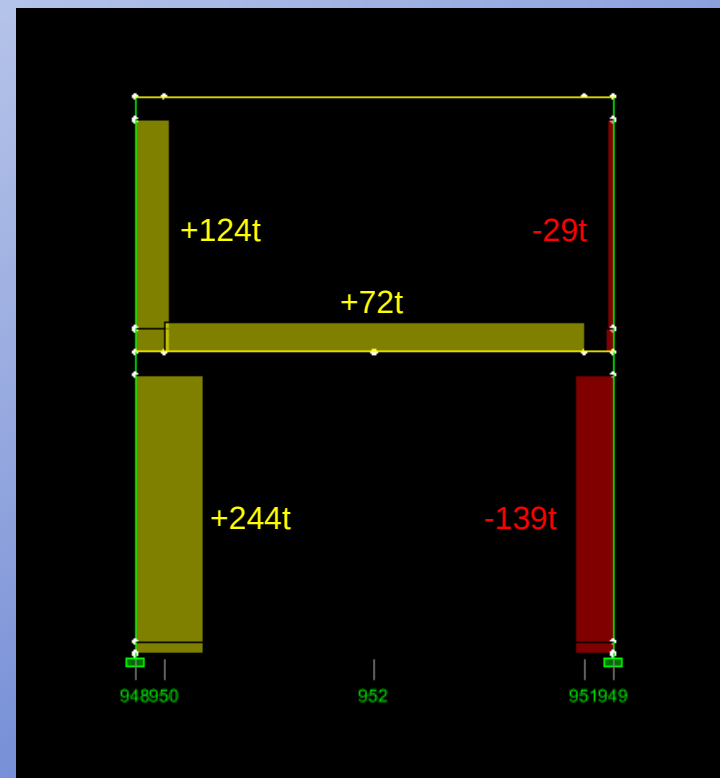
CASE B: 2 Story X Brace

承壓塊傳力系統-雙斜BRB構架側推模擬

側推分析結果：RC框架受力狀況(桿件軸力)



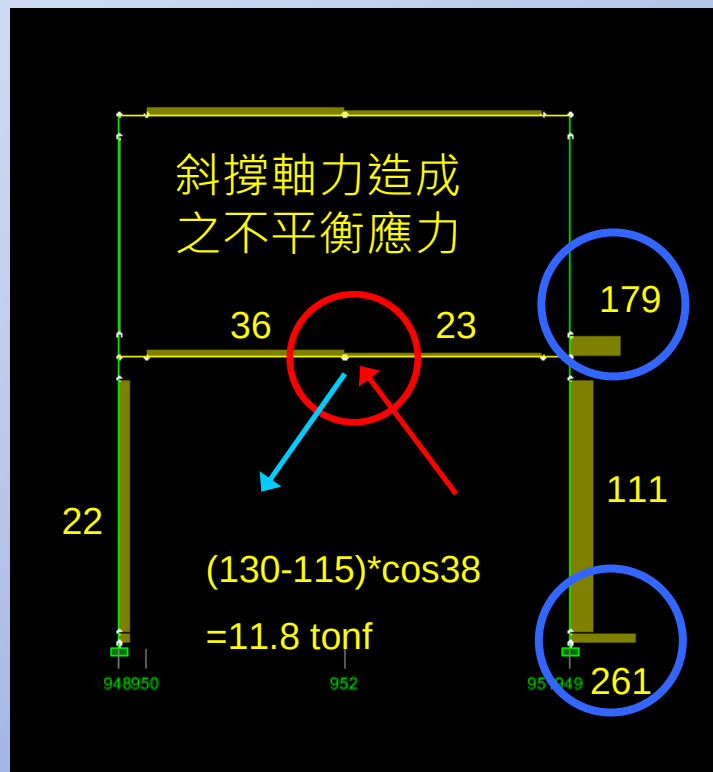
CASE A: Invert V Brace



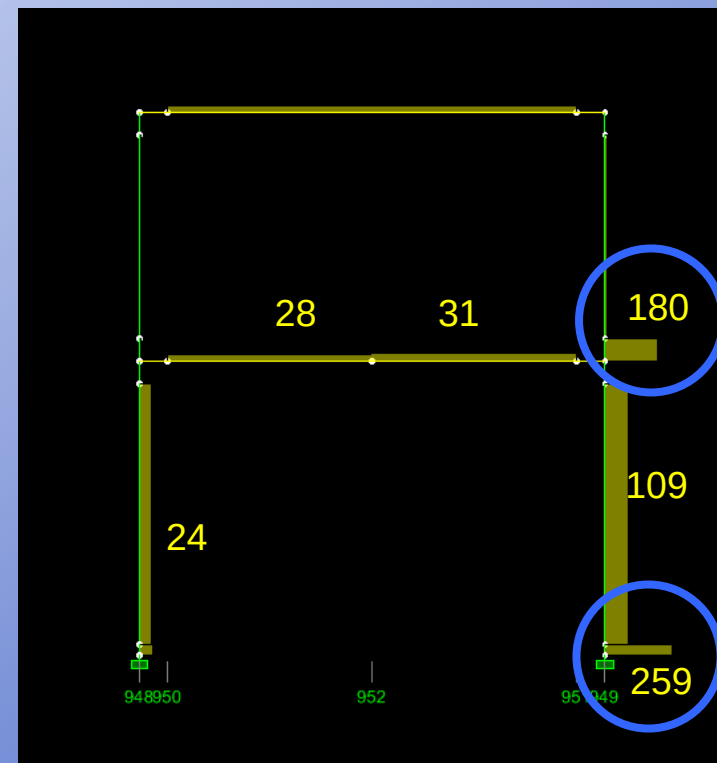
CASE B: 2 Story X Brace

承壓塊傳力系統-雙斜BRB構架側推模擬

側推分析結果：RC框架受力狀況(桿件剪力)



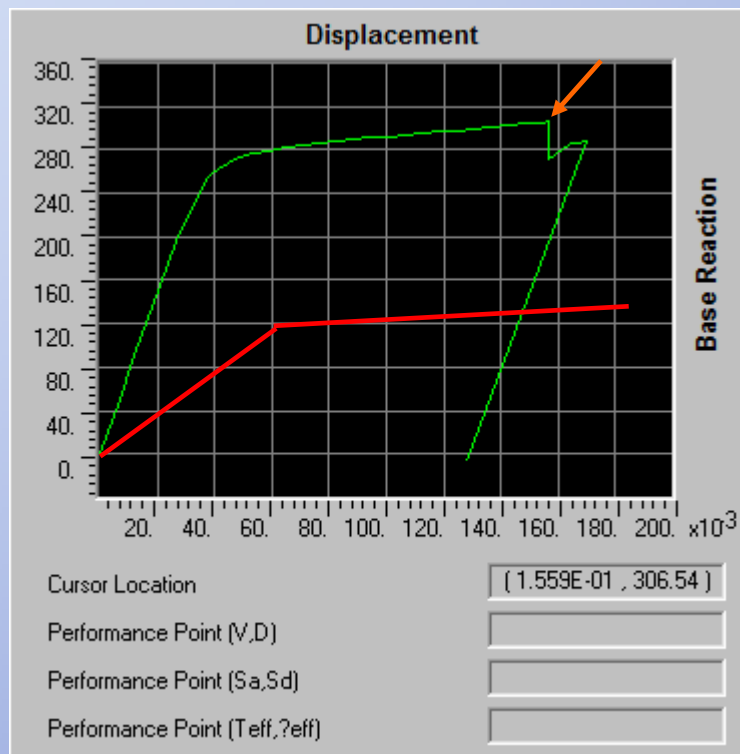
CASE A: Invert V Brace



CASE B: 2 Story X Brace

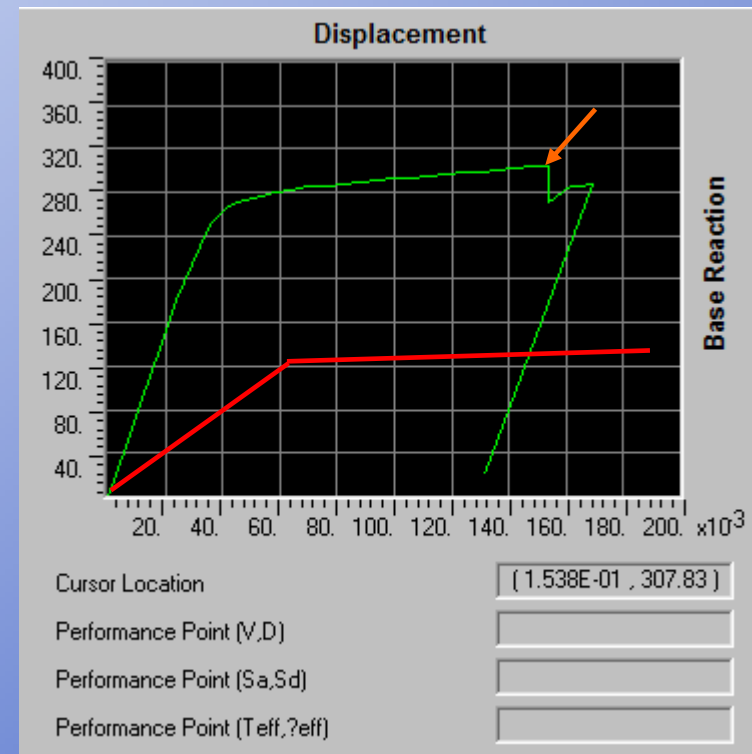
承壓塊傳力系統-雙斜BRB構架側推模擬

側推分析結果：Base Shear vs. Displacement



CASE A: Invert V Brace

P=306.54tonf Δ =15.59cm

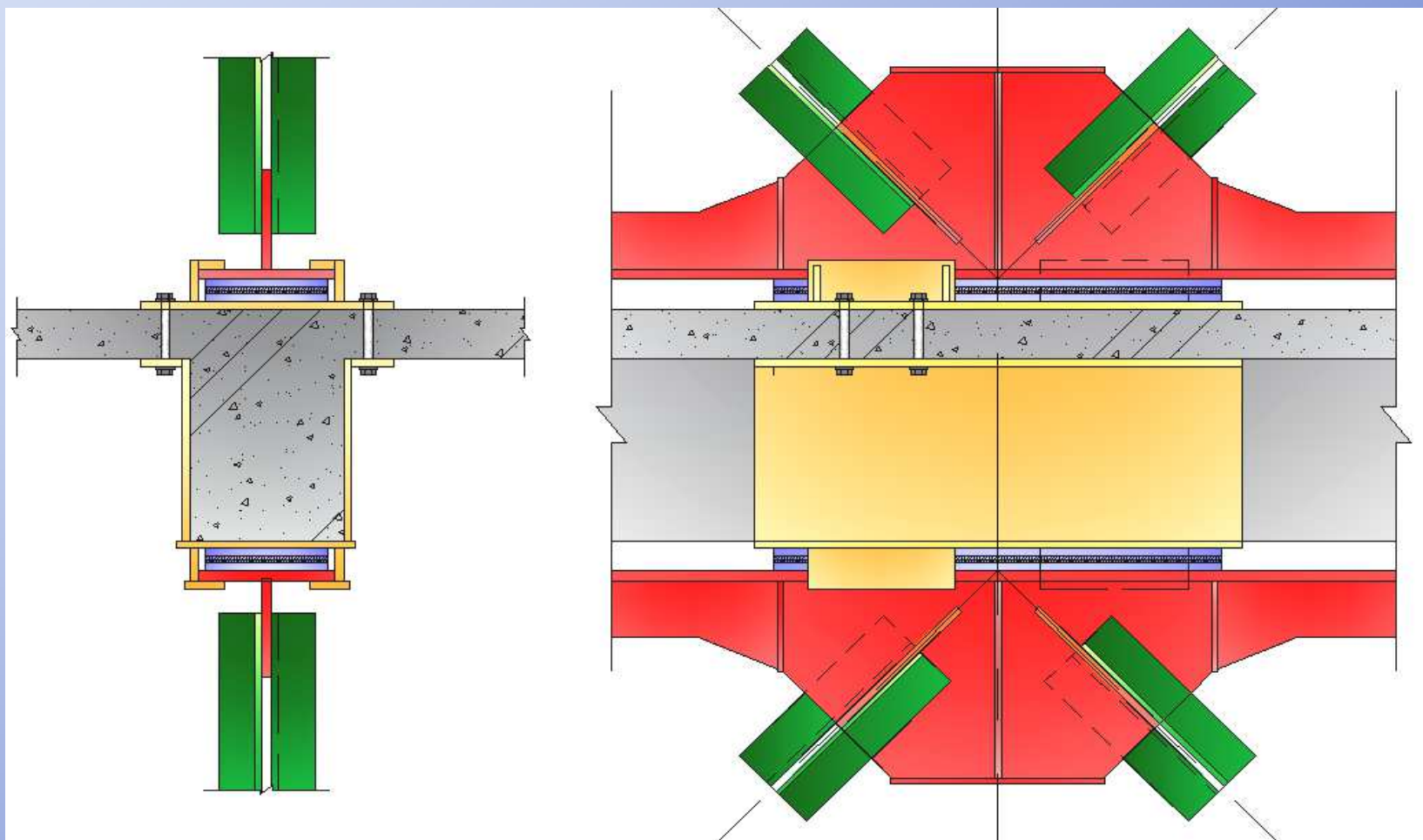


CASE B: 2 Story X Brace

P=307.83tonf Δ =15.38cm

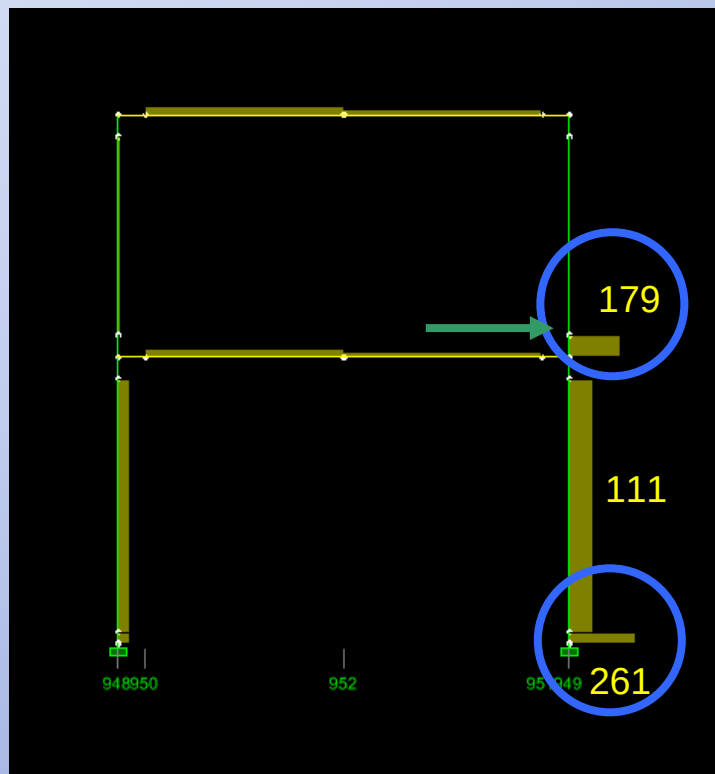
承壓塊傳力系統-雙斜BRB構架側推模擬

滑動及側向固定裝置



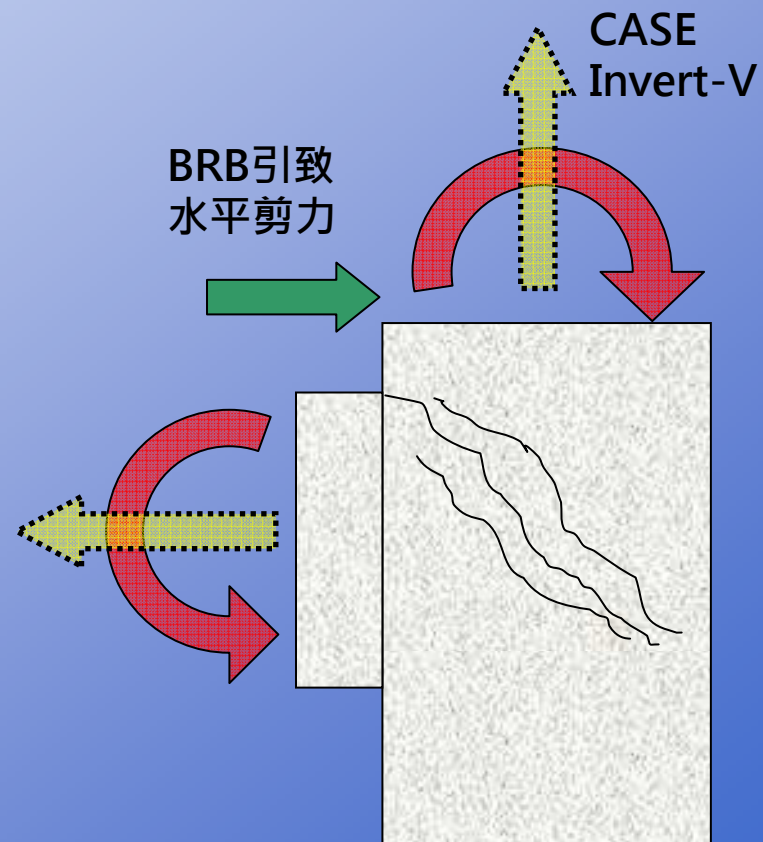
承壓塊傳力系統-雙斜BRB構架側推模擬

BRB對柱引致可觀之水平剪力



FRAME SHEAR Dia.

CASEA: Invert V Brace



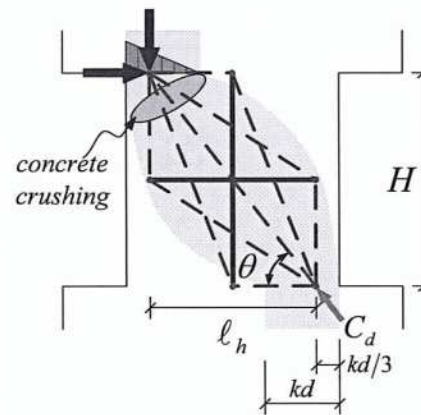
可能加劇接頭處剪力破壞

承壓塊傳力系統-雙斜BRB構架側推模擬

應用壓拉桿模型分析或予以補強



(Hwang and Lee, 2002)



$$V_n = K \zeta f'_c A_{str} \cos \theta$$

$$K = \tan^A \theta + \cot^A \theta - 1 + 0.14B \leq 1.67$$

$$A = 12 \frac{f_y}{f'_c} \rho \leq 1 \quad B = 30 \frac{f_y}{f'_c} \rho \leq 1$$

$$\zeta = \frac{3.35}{\sqrt{f'_c (\text{MPa})}} \leq 0.52$$

$$A_{str} = kd \times b$$

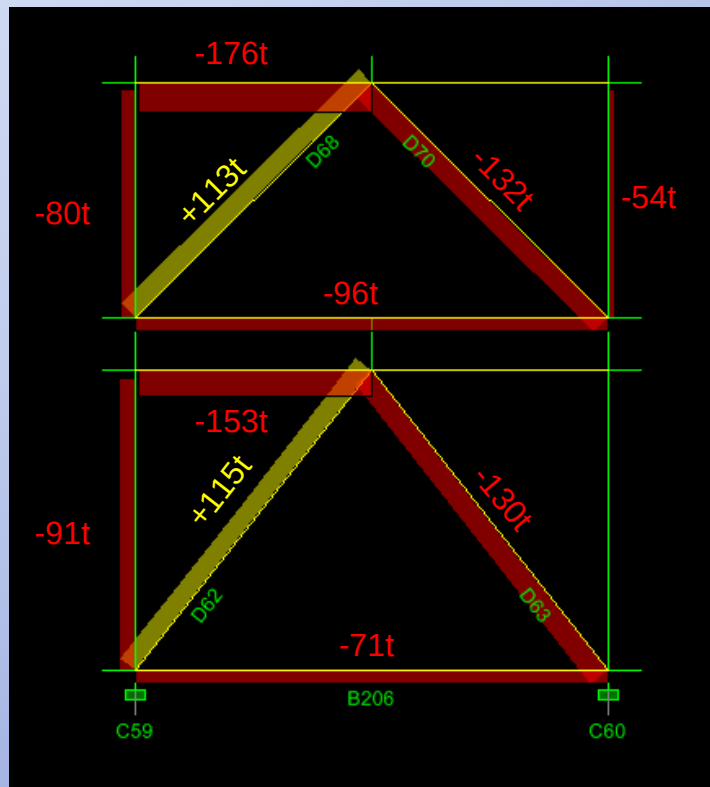
$$kd = \left(0.25 + 0.85 \frac{N}{A_g f'_c} \right) h$$

NAR Labs 國家實驗研究院
National Applied Research Laboratories

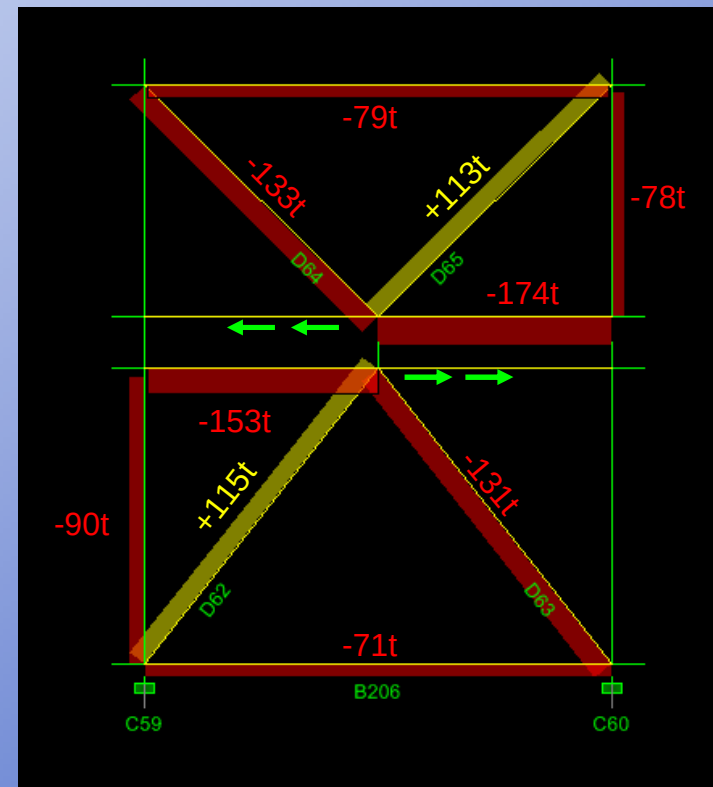
[低矮鋼筋混凝土建築耐震設計、評估與補強技術及政策推動研討會] 2015.11.06

承壓塊傳力系統-雙斜BRB構架側推模擬

考慮將受壓部分框架力量分散

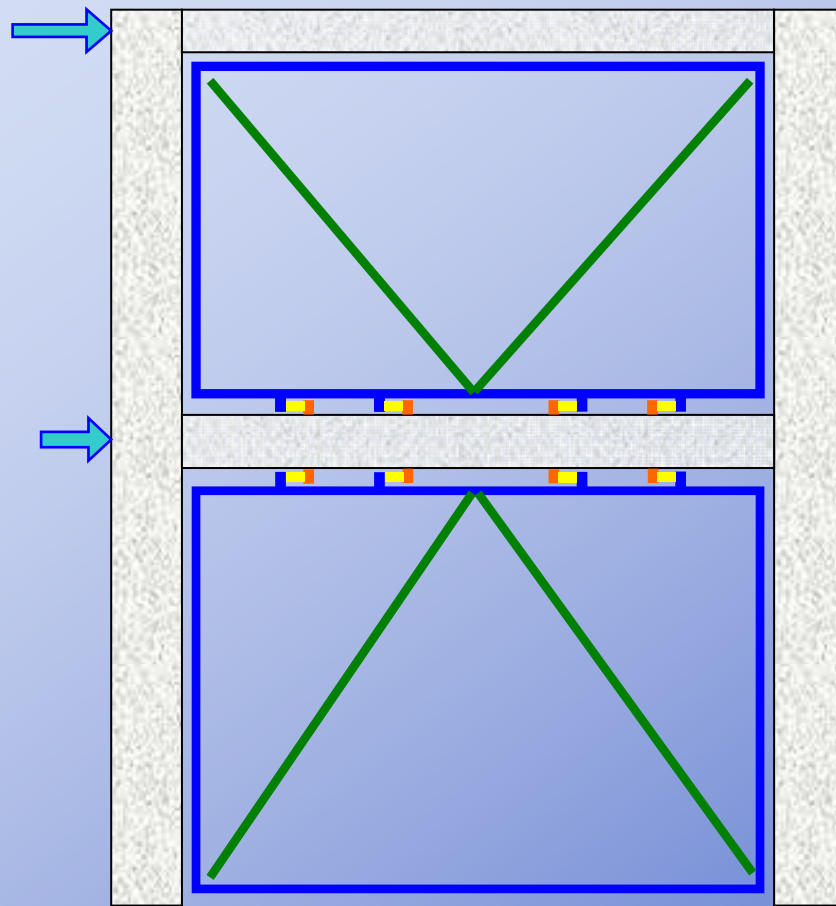


CASE A: Invert V Brace

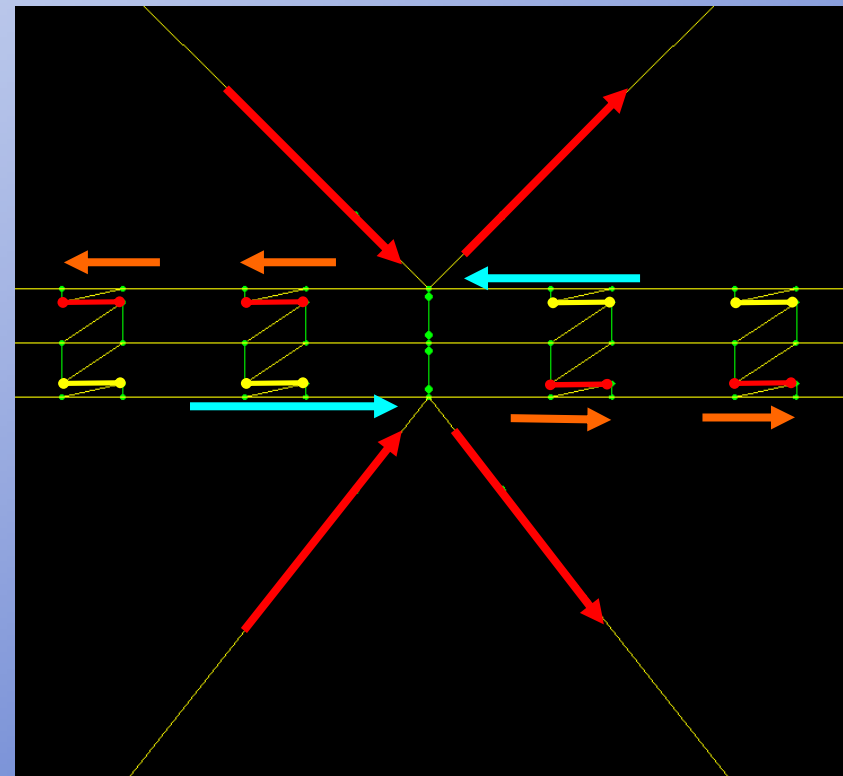


CASE B: 2 Story X Brace

承壓塊傳力系統-雙斜BRB構架側推模擬



■ Compression Only Material



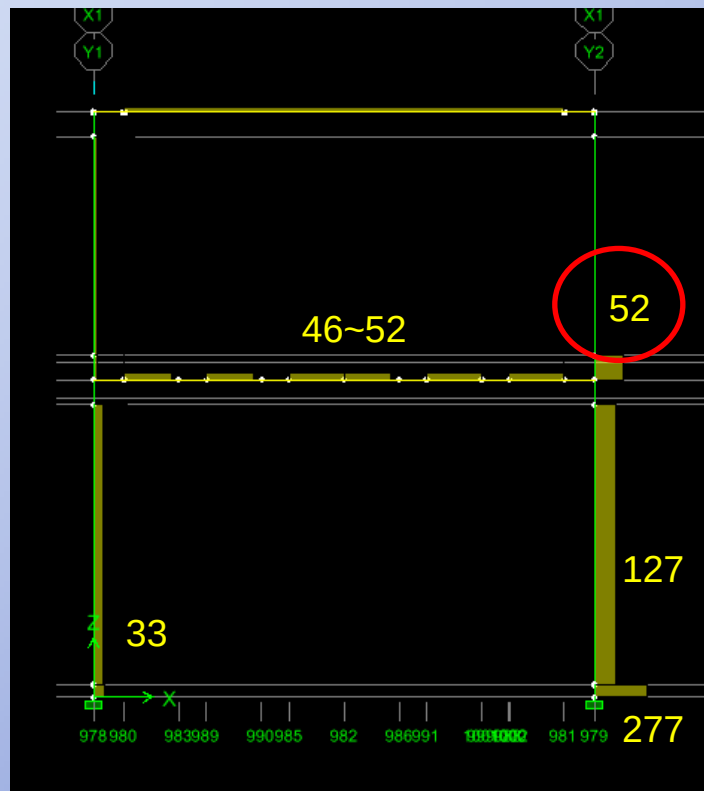
—●— Compression Only Link

—●— Tension Only Link

CASE C: Modified X Brace

承壓塊傳力系統-雙斜BRB構架側推模擬

CASE C: Modified X 側推分析結果



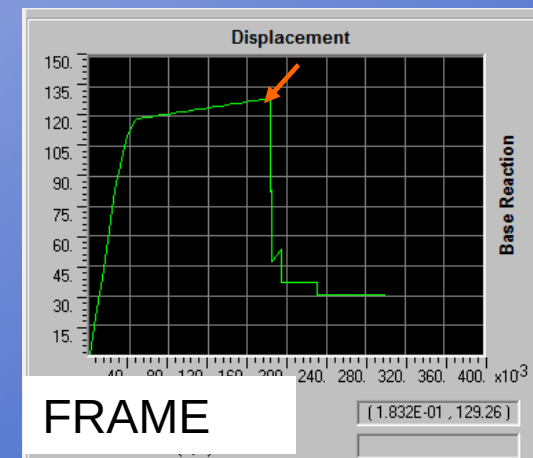
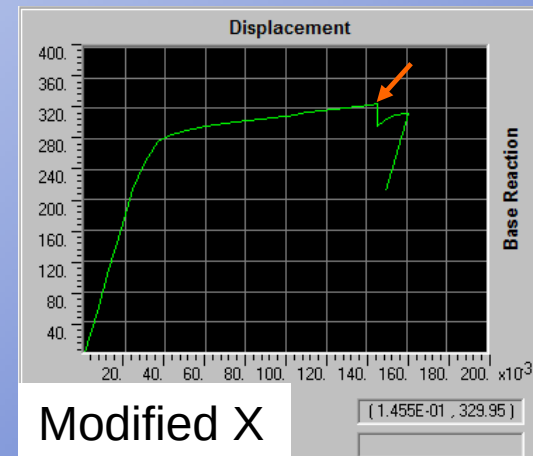
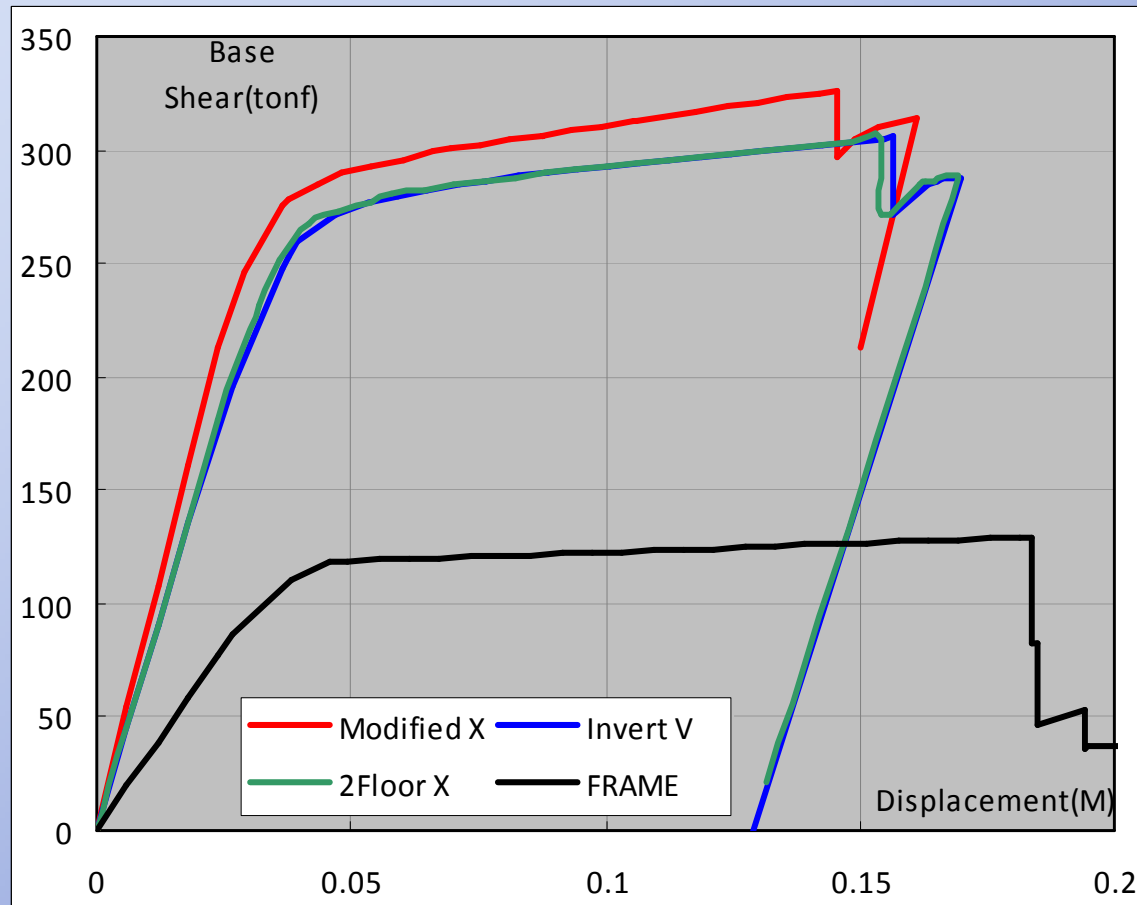
桿件剪力



BRB/框架軸力

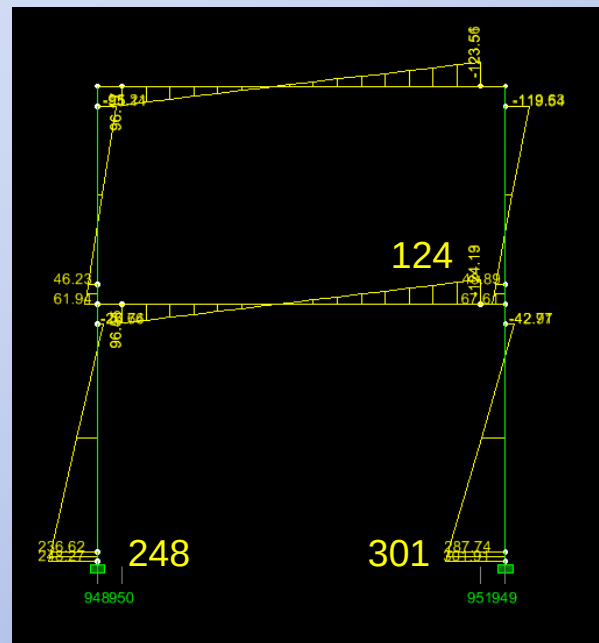
承壓塊傳力系統-雙斜BRB構架側推模擬

加設雙斜BRB後對原有空構架之性能提昇

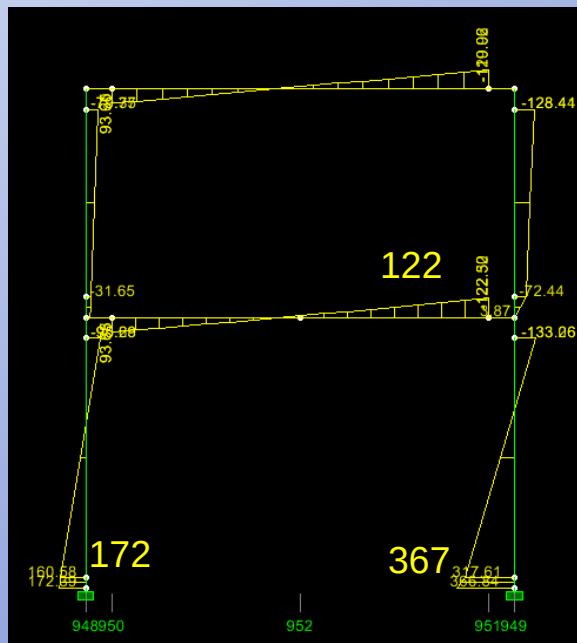


承壓塊傳力系統-雙斜BRB構架側推模擬

各種模式側推分析RC桿件彎矩比較

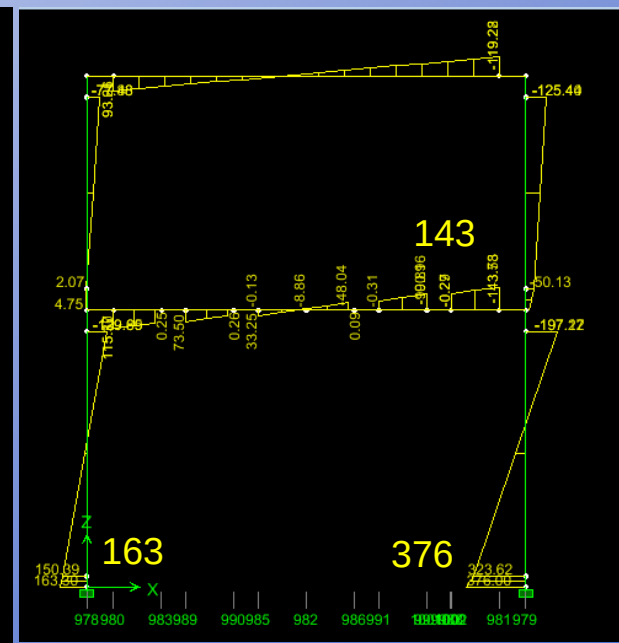


FRAME



2Floor-X

中間梁承受額外拉力

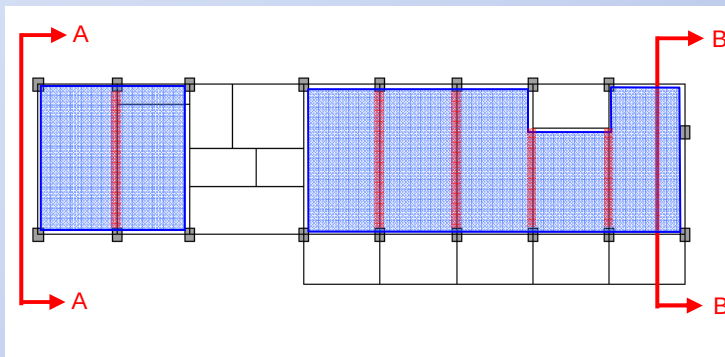


Modified-X

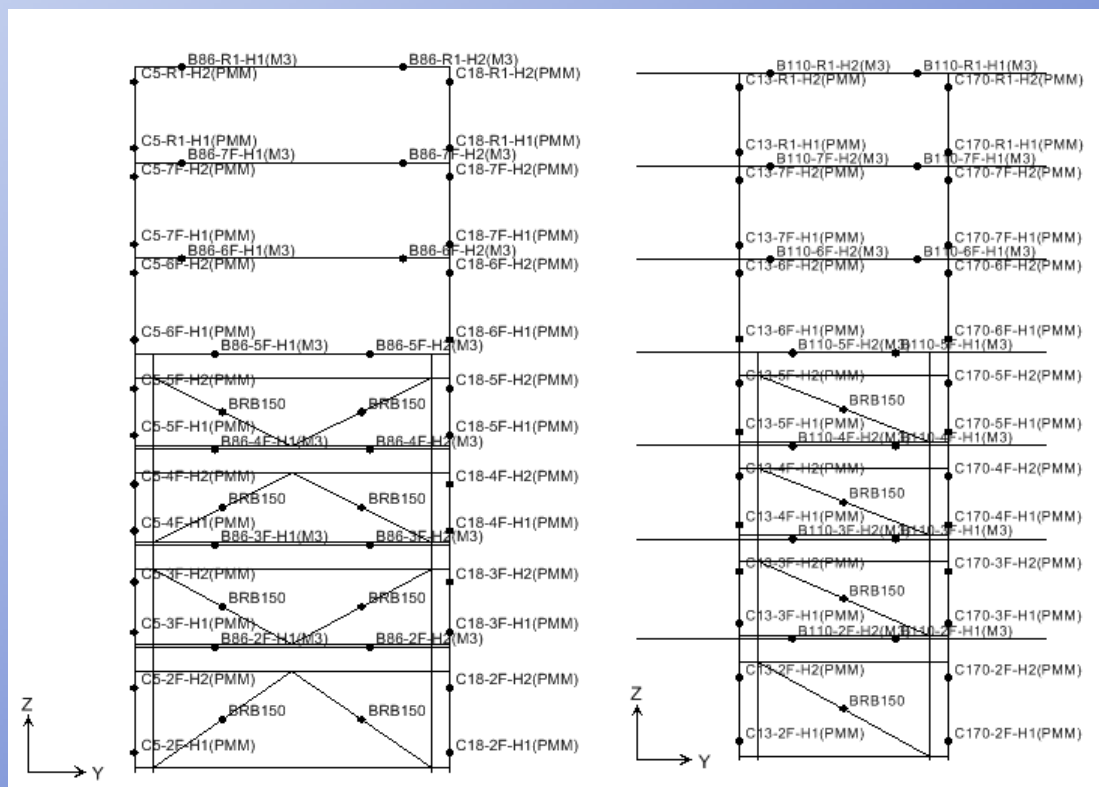
中間梁承受額外拉力

中間梁承受額外彎矩

既有RC建物補強應用之案例(規劃中)



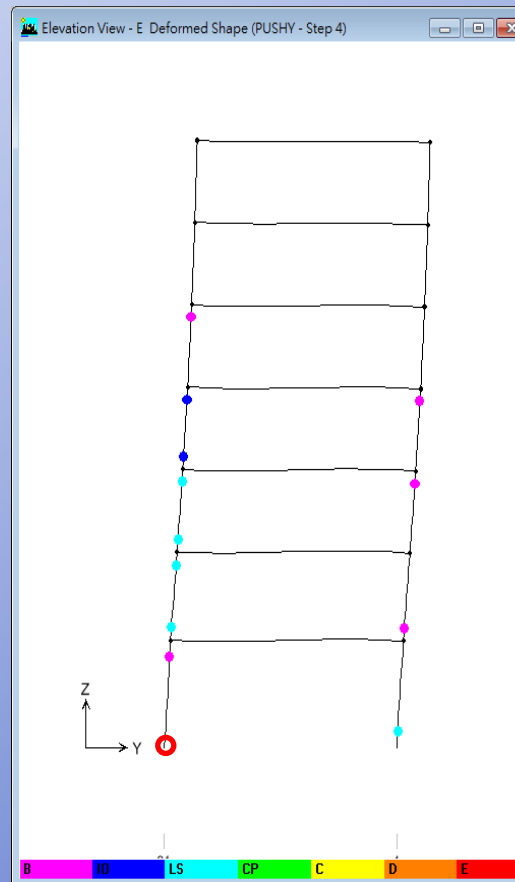
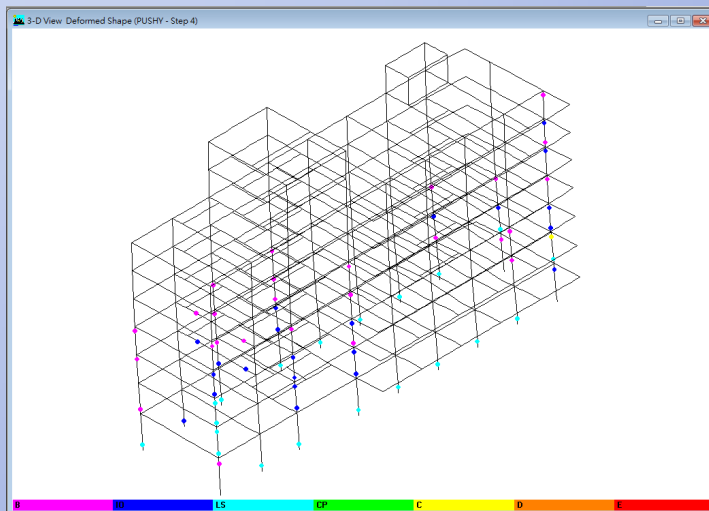
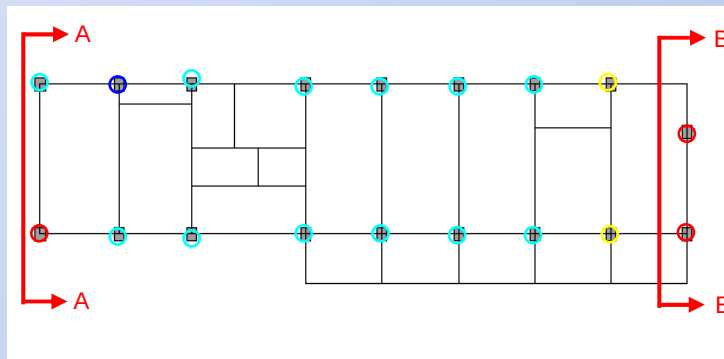
- 1.地上七層,地下一層
- 2.RC造,高度21米(不含屋突)
- 3.柱斷面口60x80
- 4.梁斷面B50x70,B50x35
- 5.採用35公分中空樓版(鋼管)



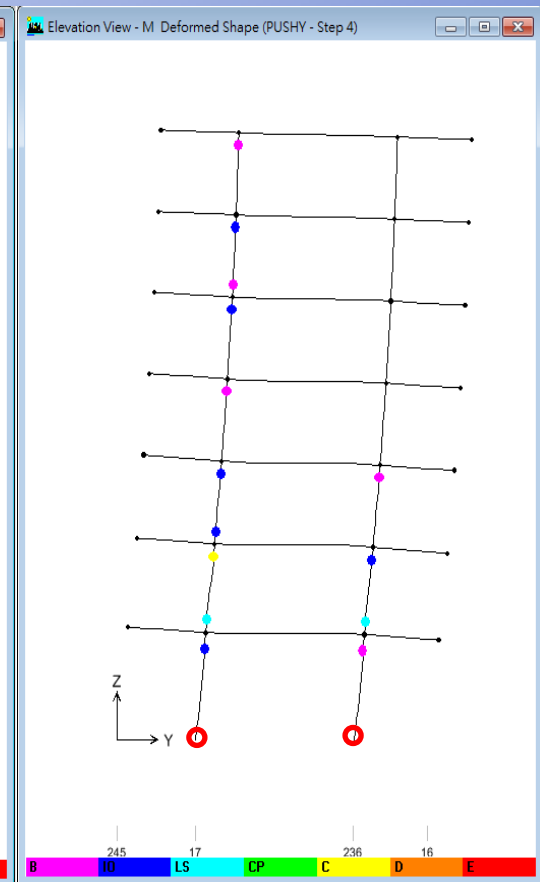
A-A SECTION

B-B SECTION

既有RC建物(空構架)

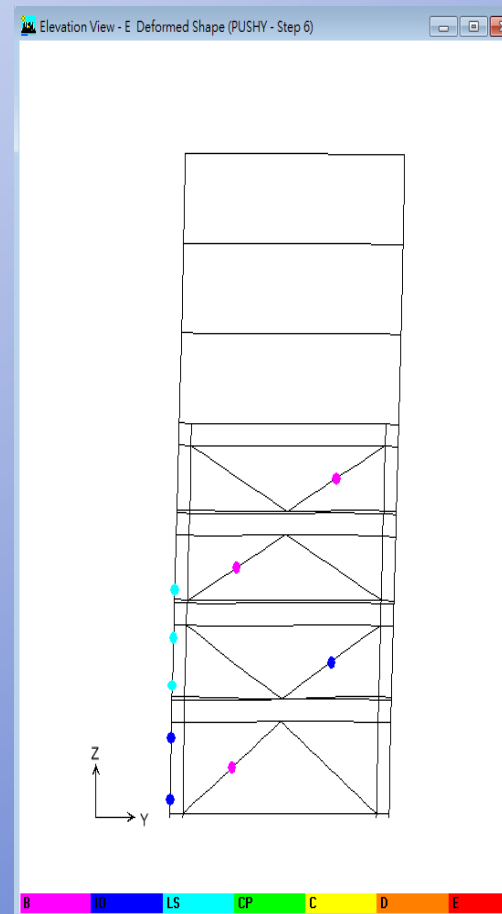
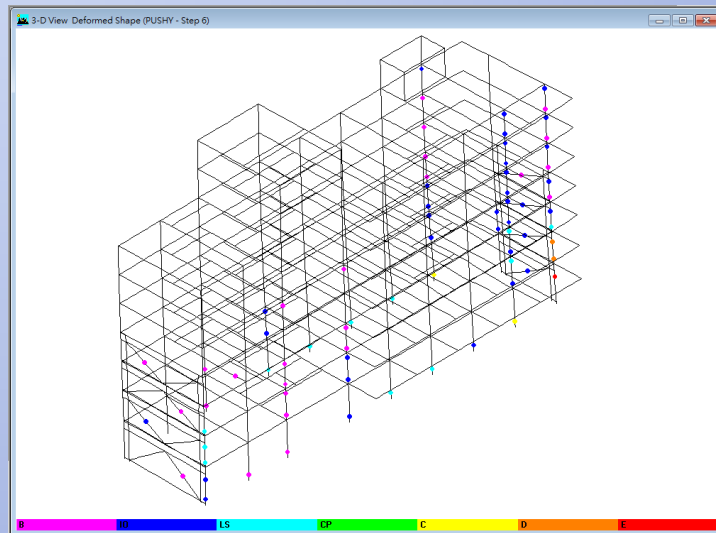
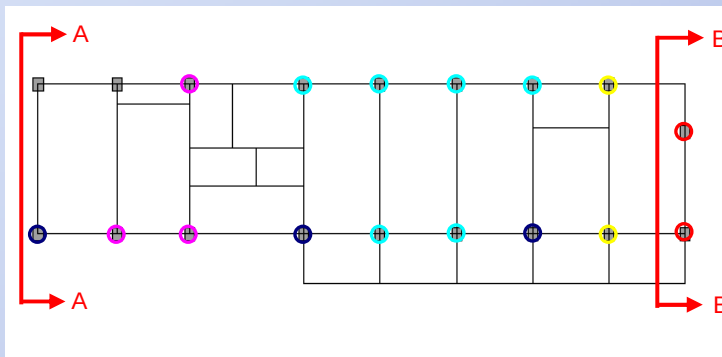


A-A SECTION

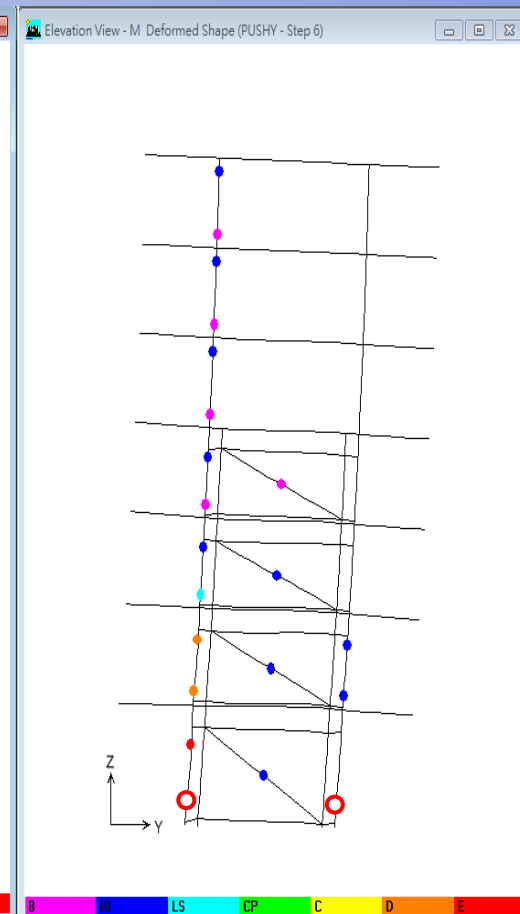


B-B SECTION

既有RC建物(空構架+BRB150)

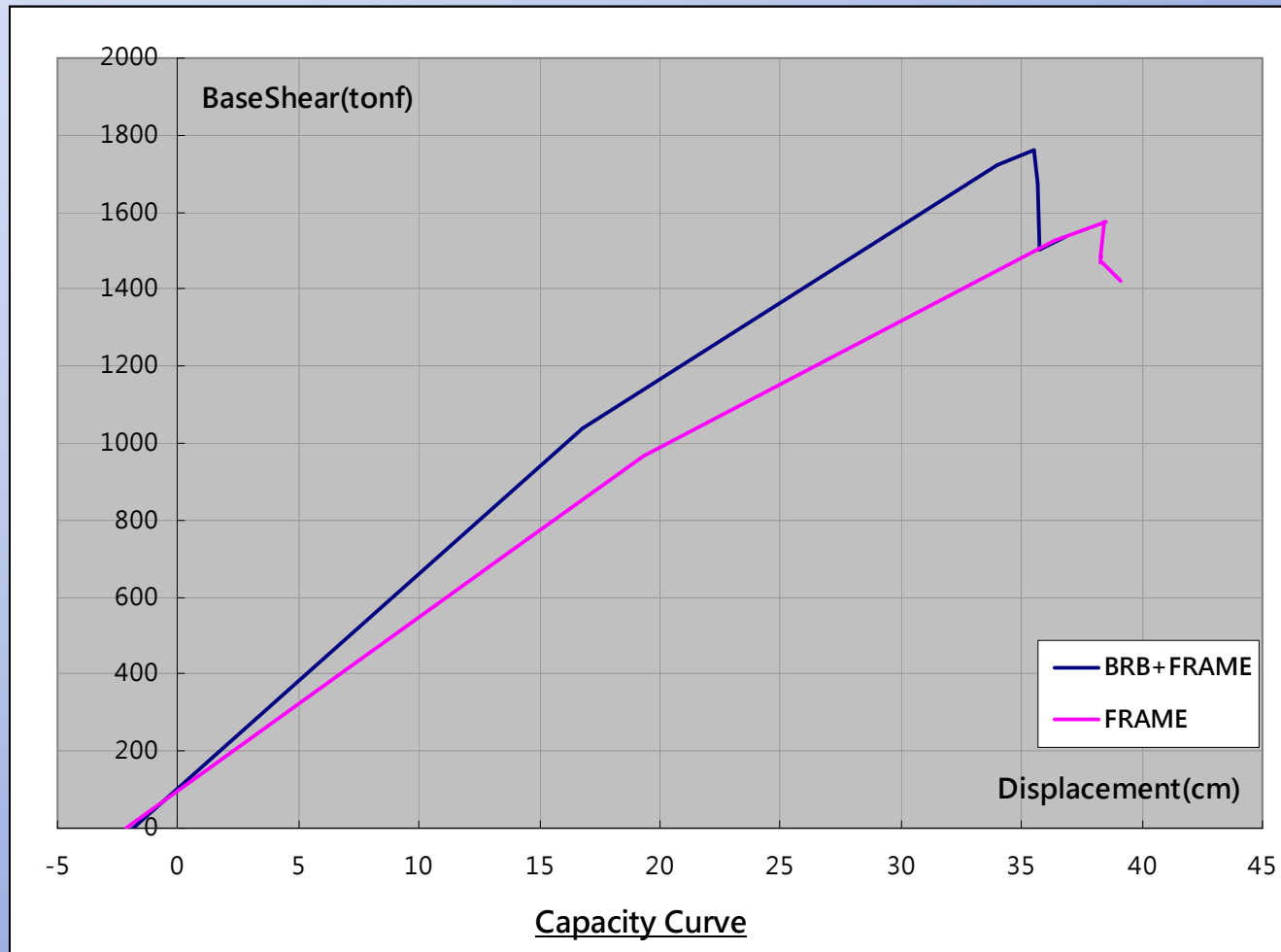


A-A SECTION



B-B SECTION

承壓塊傳力系統-雙斜BRB構架側推模擬



結論

- 承壓塊傳力系統兼具直接系統或間接系統之特性與優點。
- 承壓塊傳力系統行為模式較易預測，並可應用於既有RC建物之側推分析。
- 斜撐或鋼框架對柱產生之額外剪力應設法減輕。
- 使用承壓塊傳力系統搭配BRB屬於柔性補強(相較於剪力牆或間接系統)，BRB噸數太大可能使既有RC梁柱無法負荷。
- 靈活性較高，地下室可搭配擴柱補強。



簡報結束
恭請指導