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

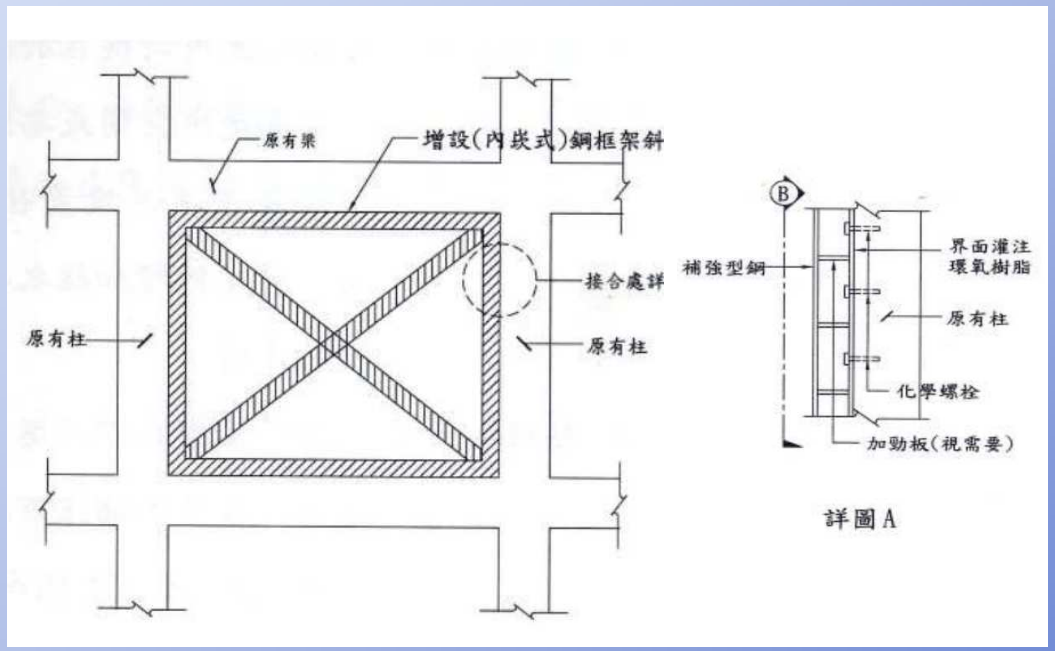
簡報大綱

- 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

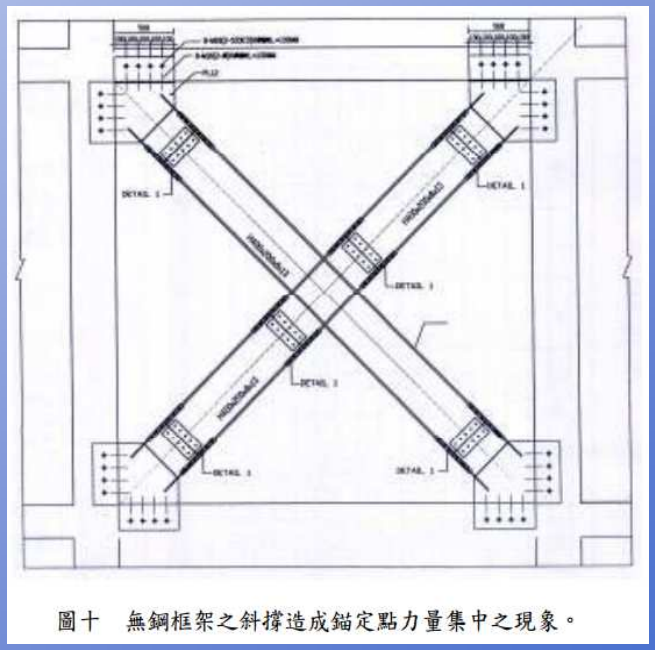
鋼製斜撐/阻尼器應用於RC建物之補強

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］



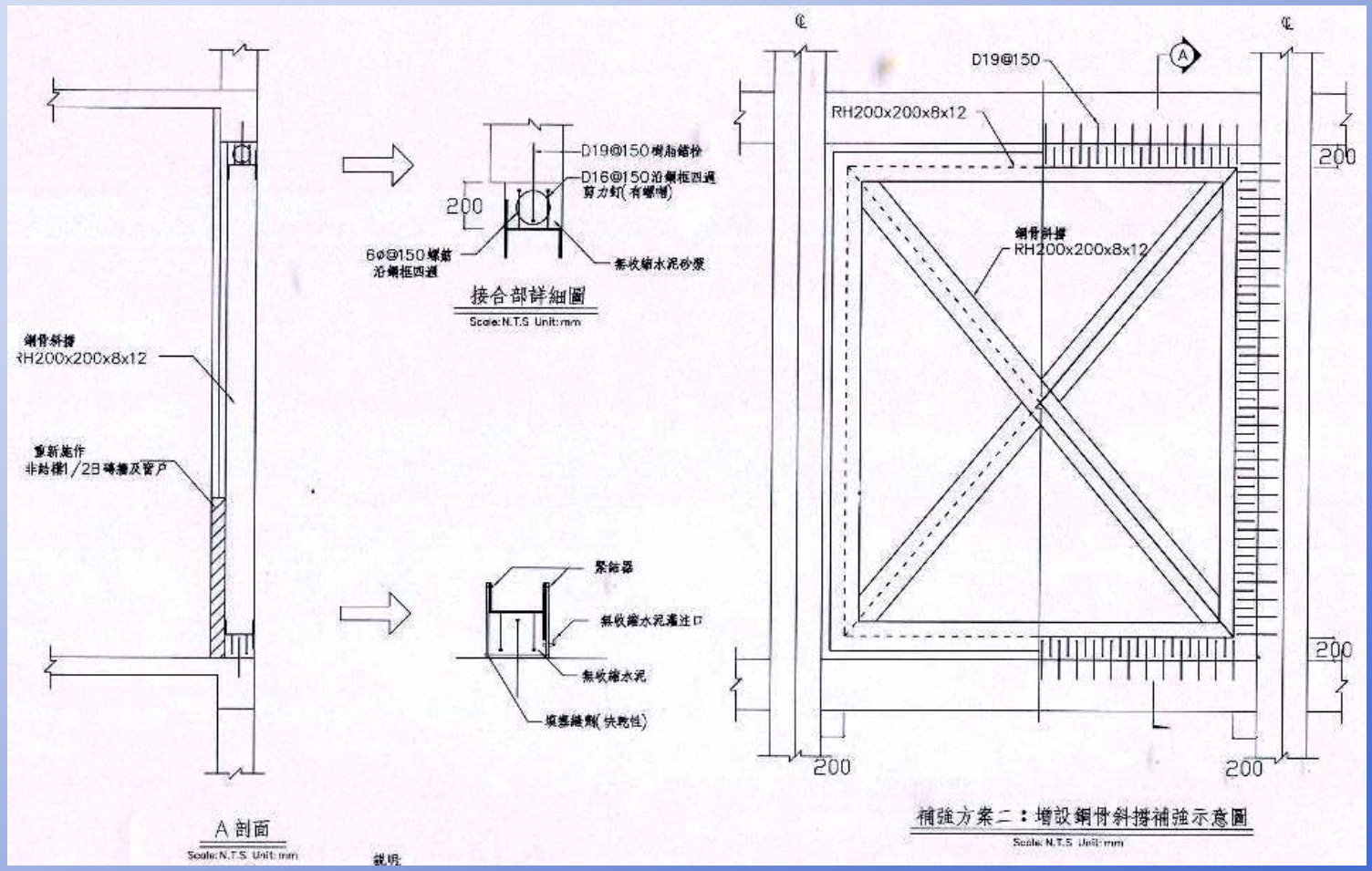
採用鋼構框架方式進行補強，
框架與RC構件以密集化錨鎖固



圖十　無鋼框架之斜撐造成錨定點力量集中之現象。

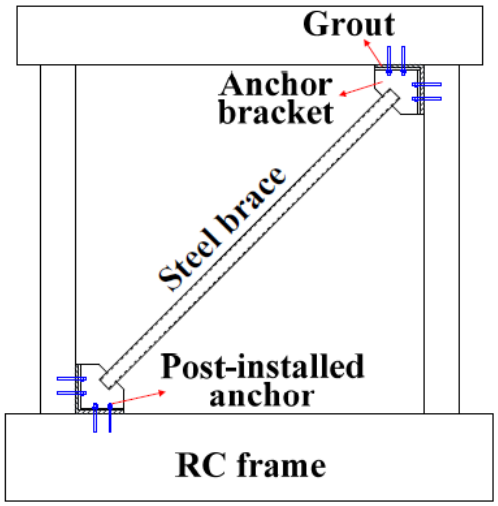
斜撐受拉時錨定問題
較難克服

鋼製斜撐/阻尼器應用於RC建物之補強

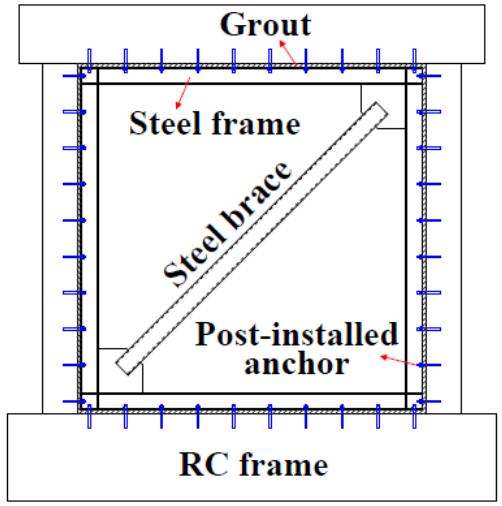


鋼製斜撐/阻尼器應用於RC建物之補強

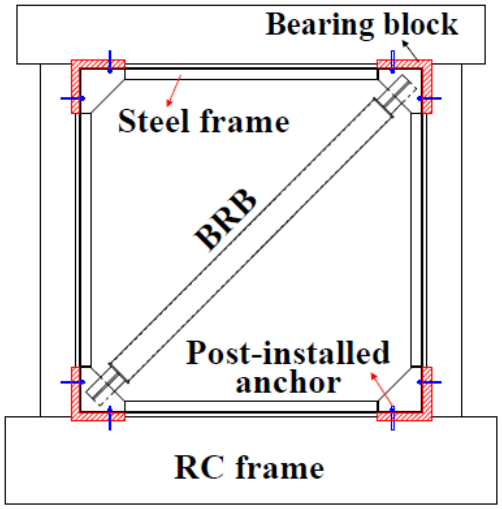
挫屈束制支撐鋼框補強鋼筋混凝土構架之研究[蔡克銓, 潘冠宇等, 2015]



(a) 直接系統



(b) 間接系統



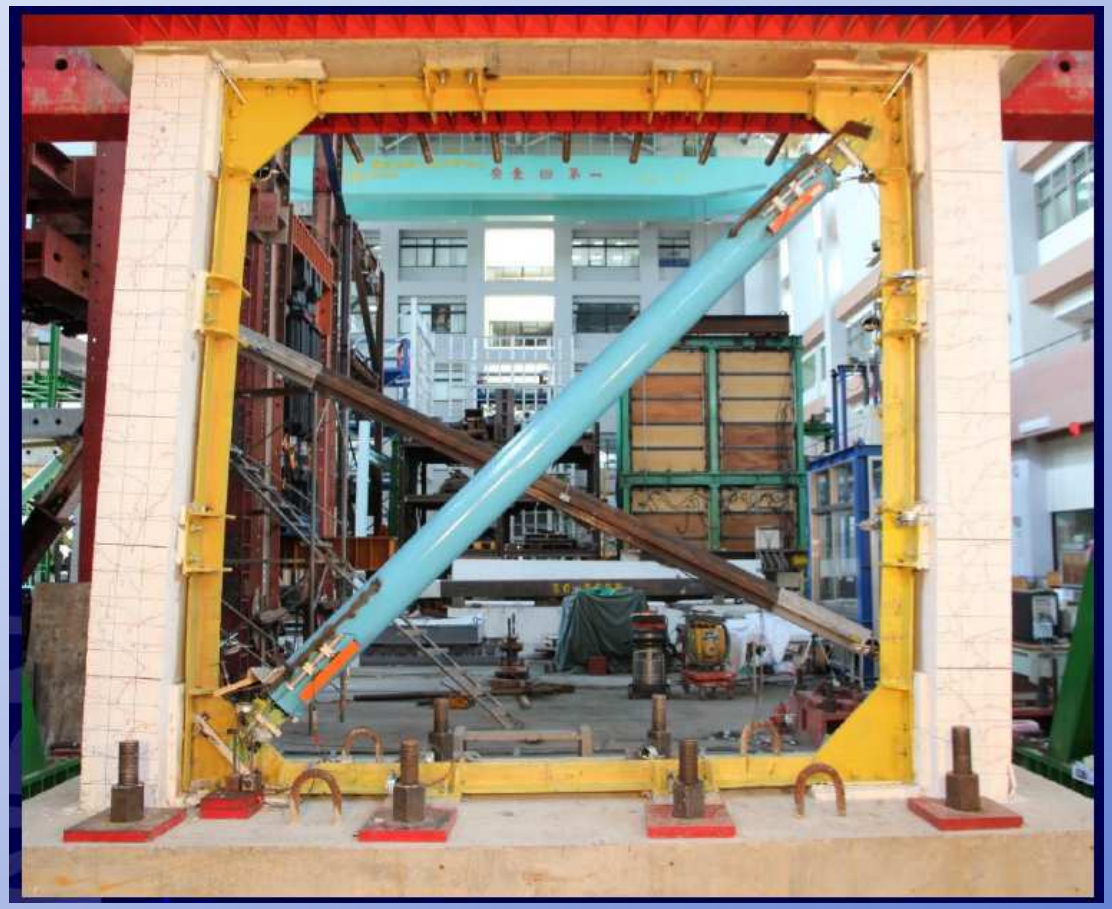
(c) 承壓塊傳力系統

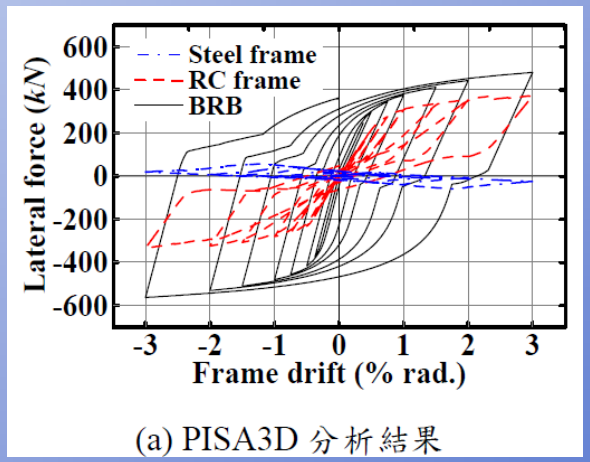
斜撐受壓時直接受力，
斜撐受拉時恐錨定不足

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]

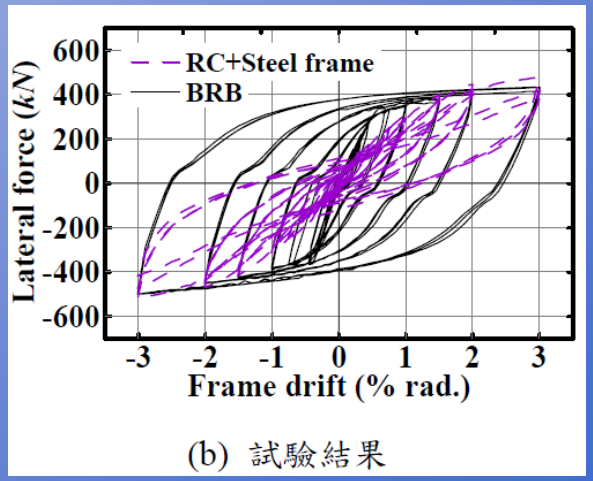
斜撐受壓時如直接系統，
斜撐受拉時以鋼框架傳遞並平衡斜撐應力。
[Paret, 2007]

承壓塊傳力系統-單斜佈置





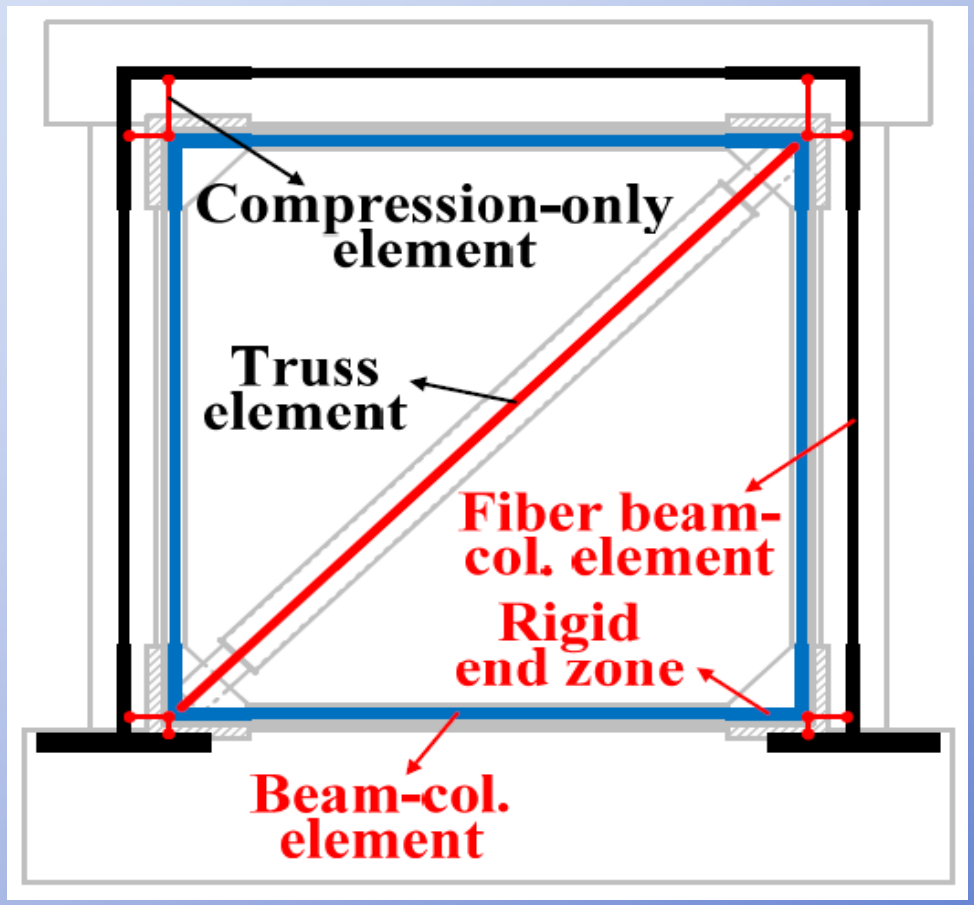
(a) PISA3D 分析結果

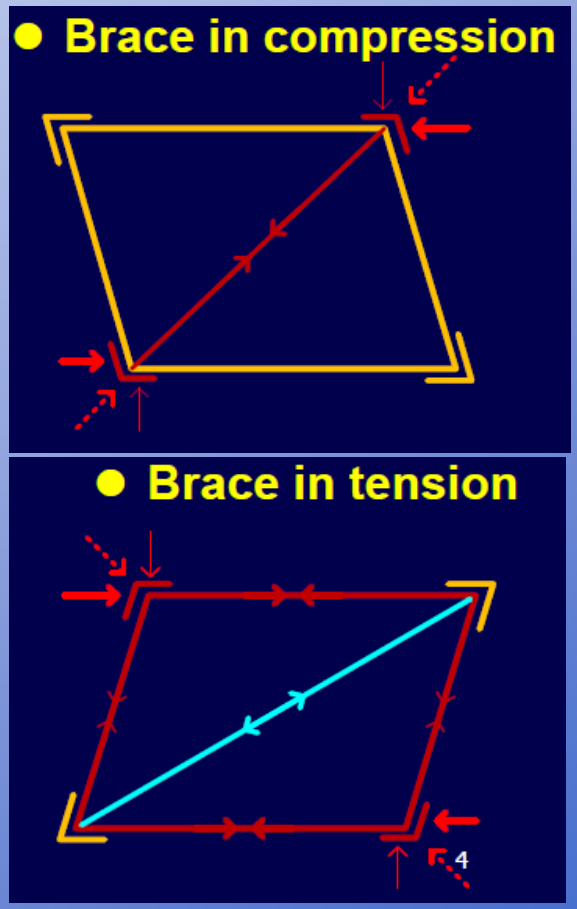


(b) 試驗結果

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]

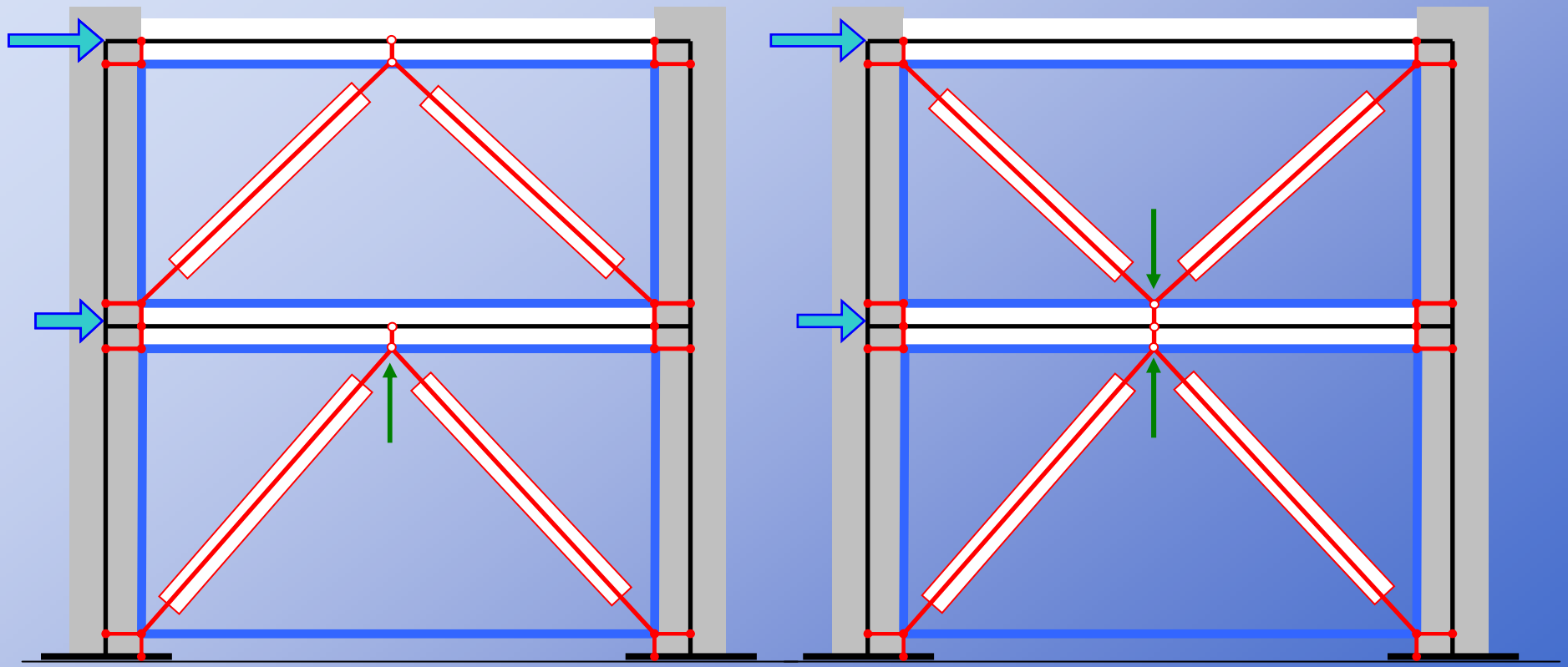
承壓塊傳力系統-單斜佈置





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



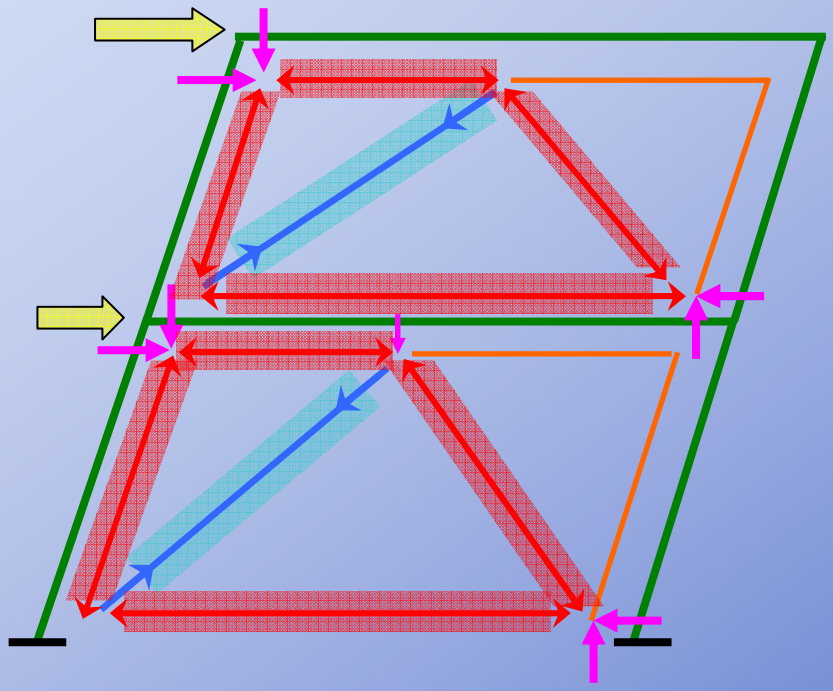
CASEA: Invert V Brace

CASE B: 2 Story X Brace

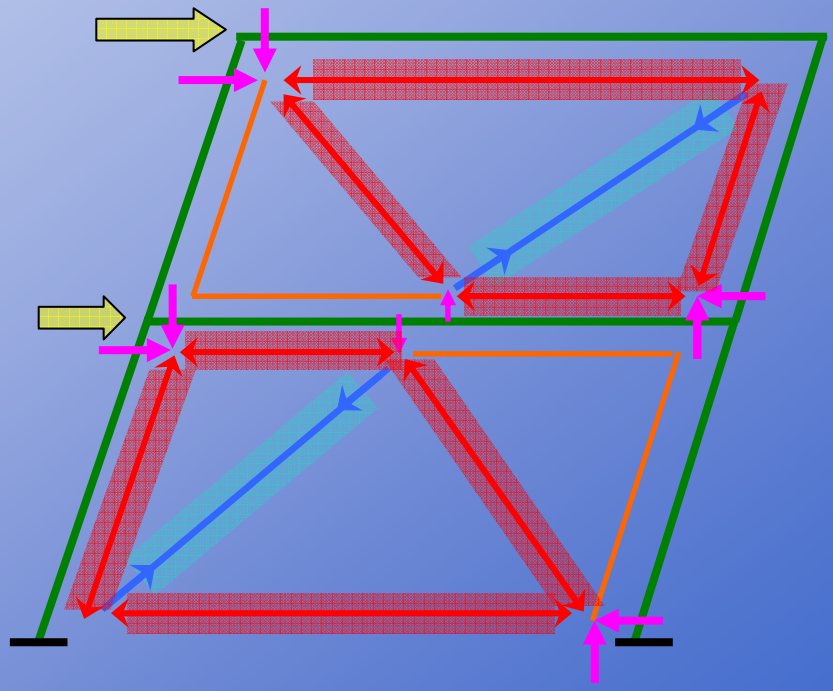
↑ BRB拉壓軸力不平衡可能產生之額外作用力

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

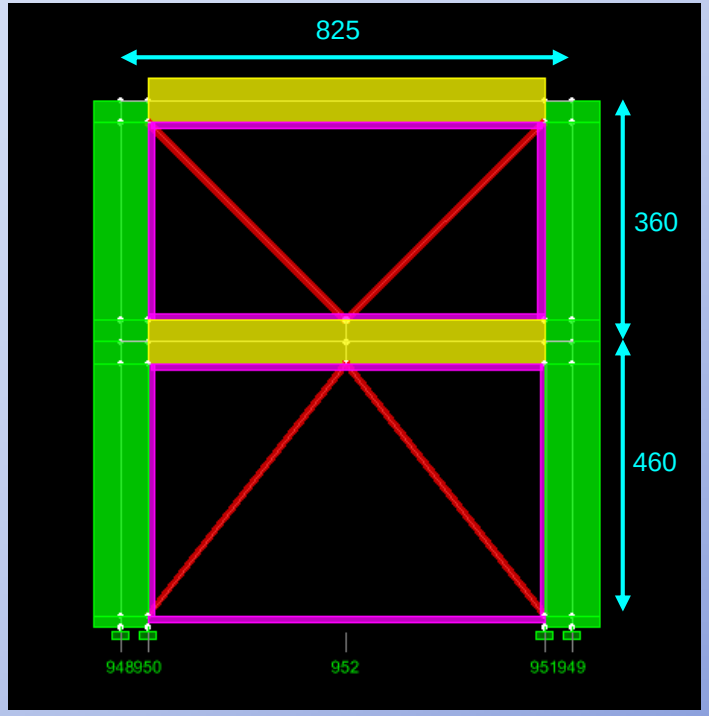


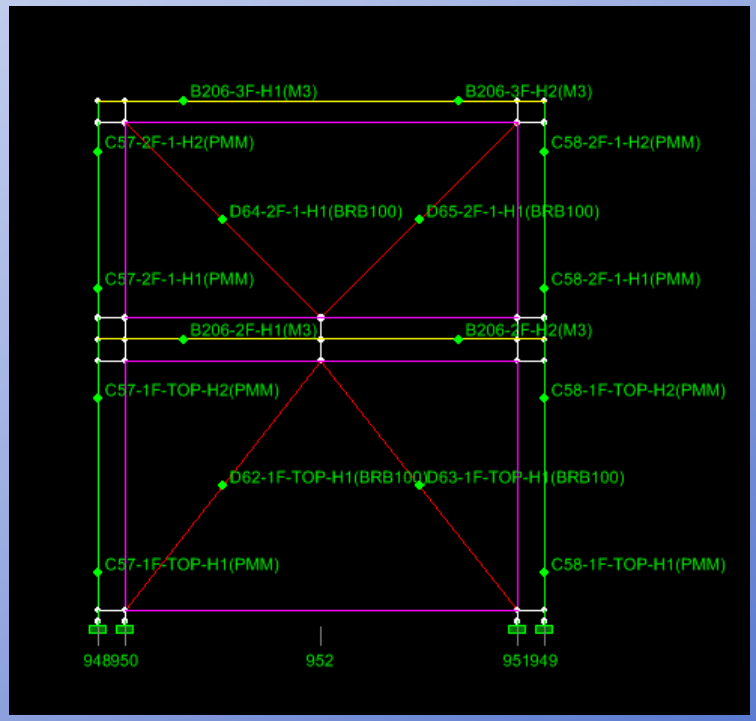
CASEA: Invert V Brace



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)

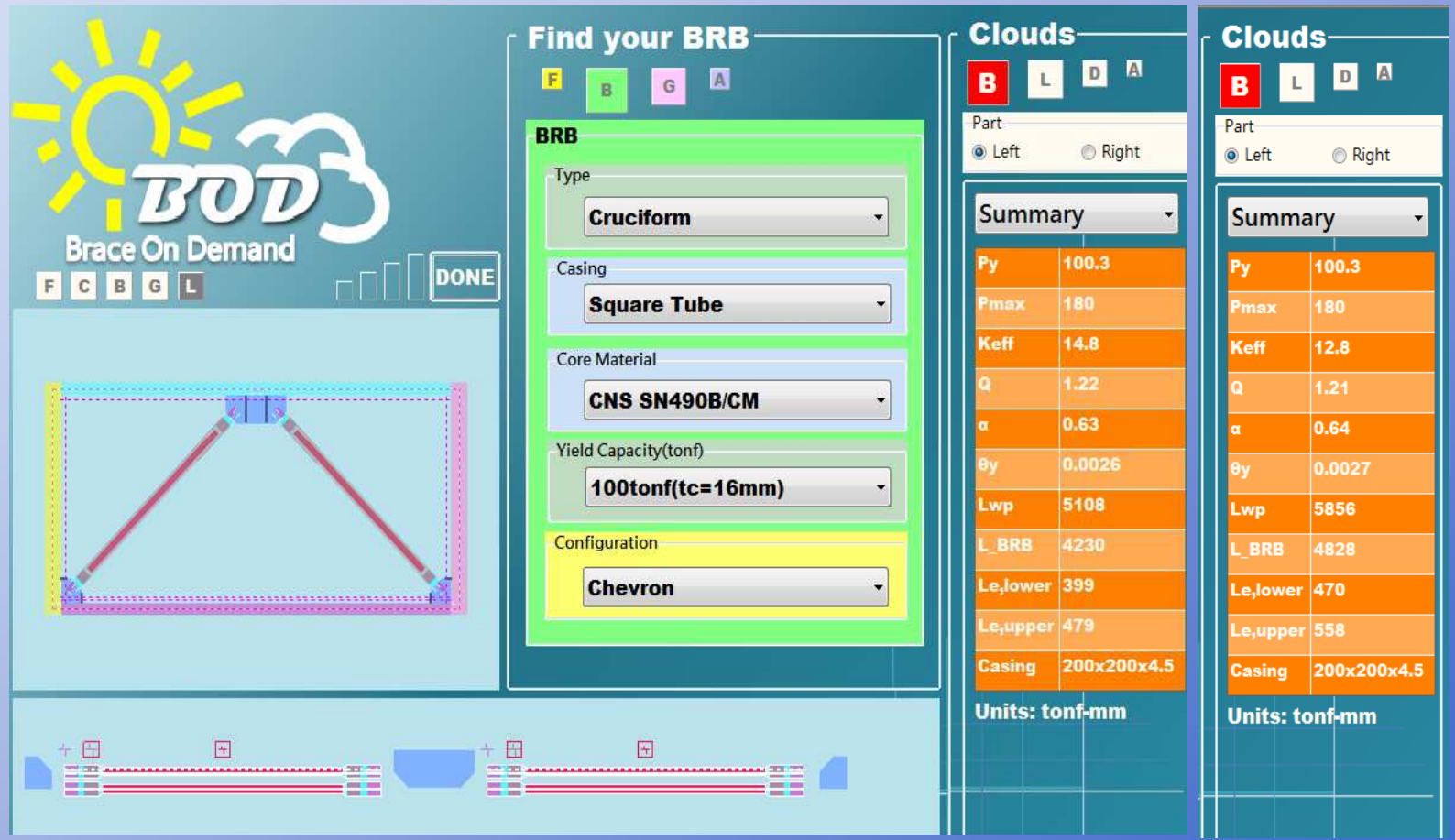
梁 B60X80 上層主筋8-＃8，下層主筋6-＃6

柱 C100X100 柱主筋24-#8（1.2%）

BRB 100噸（壓降伏120噸）Keff=14.8~12.8 t-mm

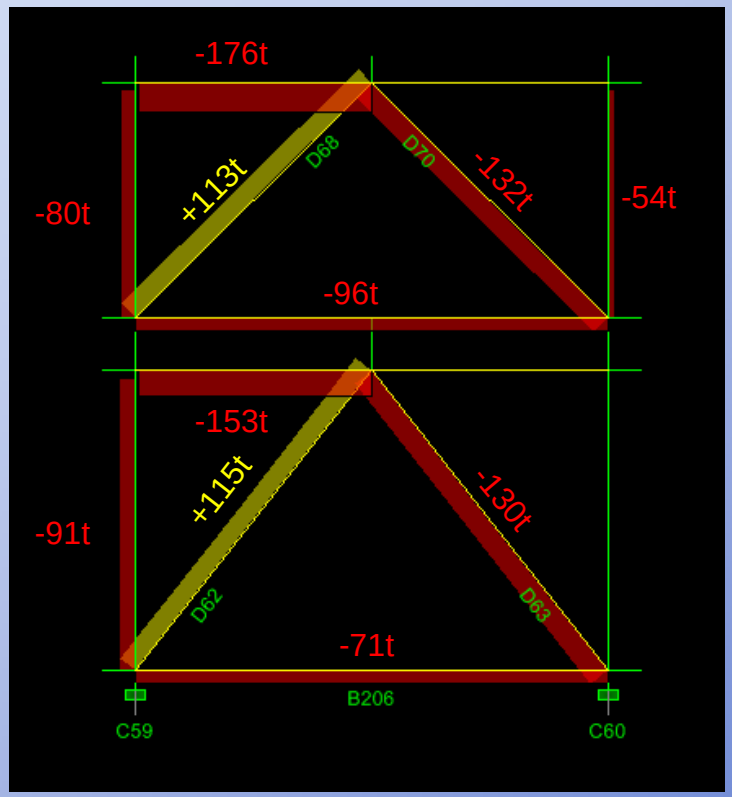
承壓塊傳力系統-雙斜BRB構架側推模擬

側推分析使用BRB參數與性質

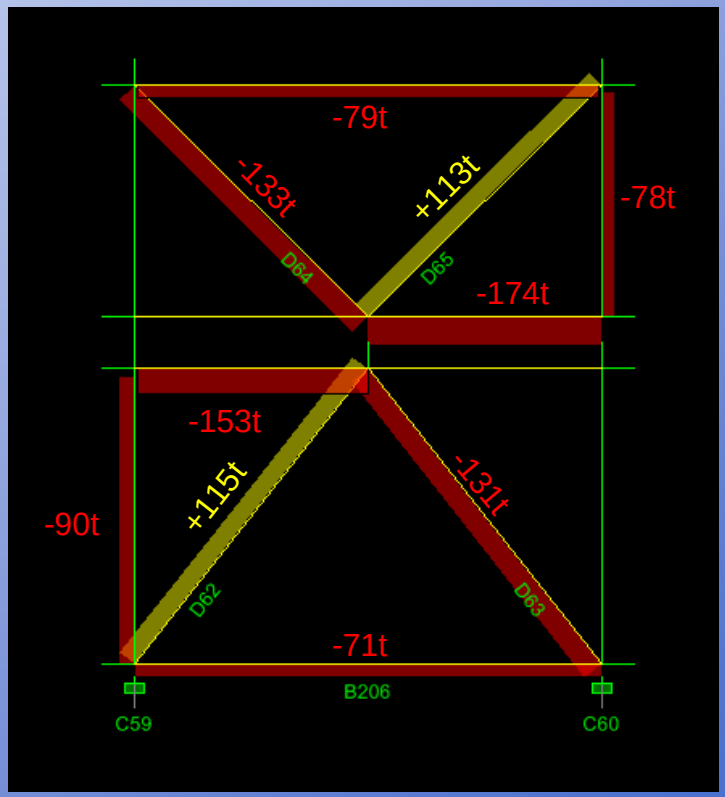


承壓塊傳力系統-雙斜BRB構架側推模擬

側推分析結果：鋼框架與BRB受力狀況



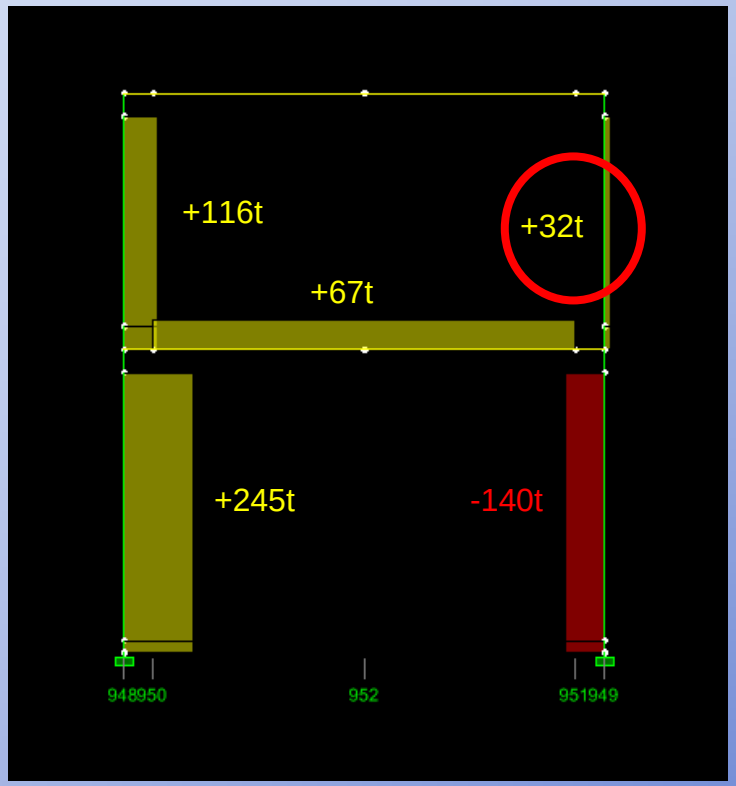
CASE A: Invert V Brace

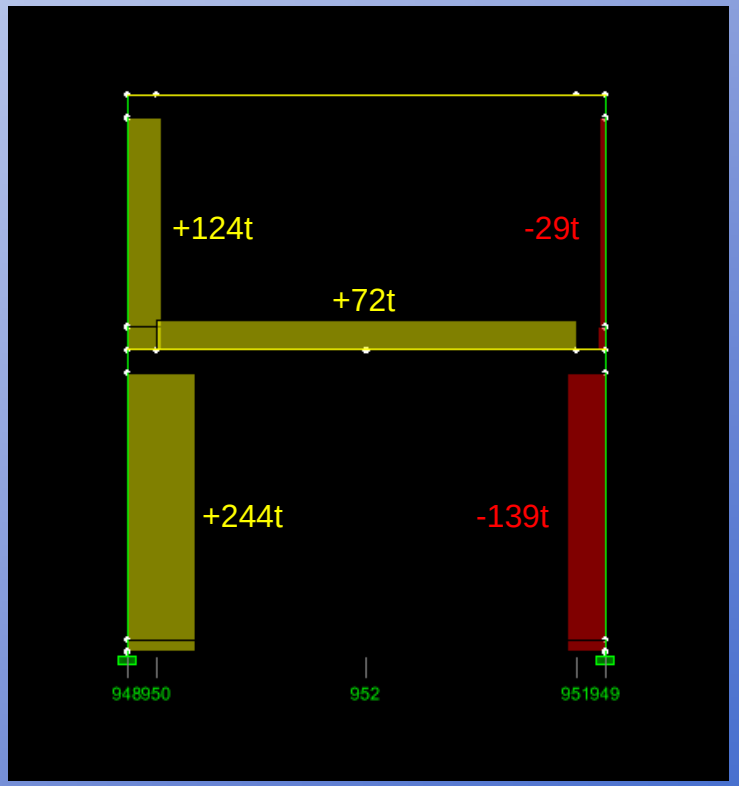


CASE B: 2 Story X Brace

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)



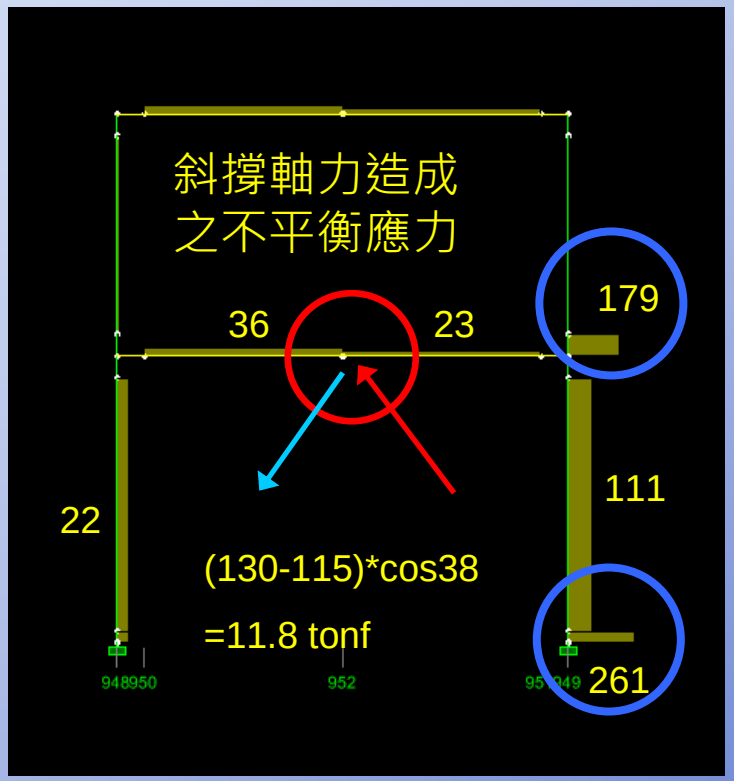


CASEA: Invert V Brace

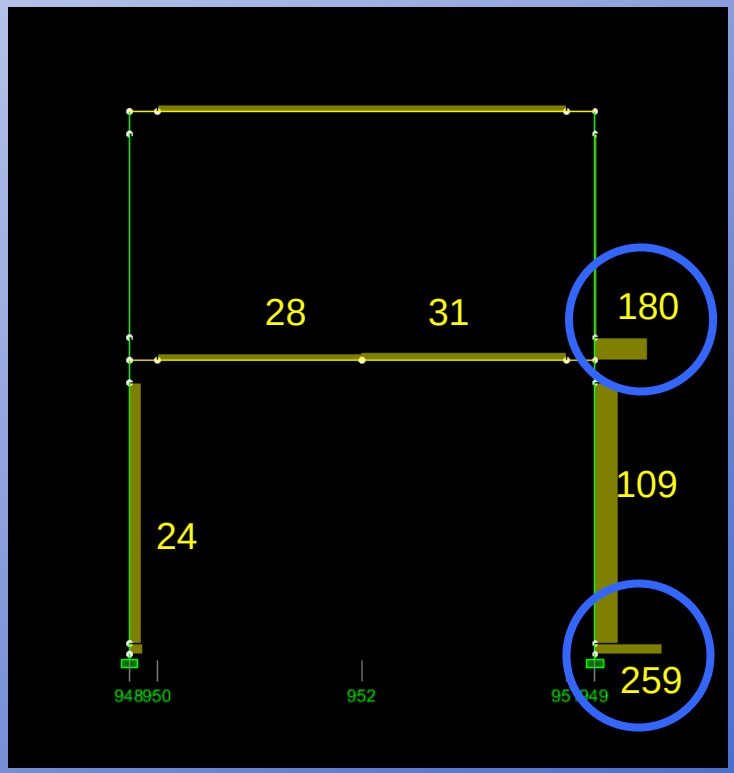
CASE B: 2 Story X Brace

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)



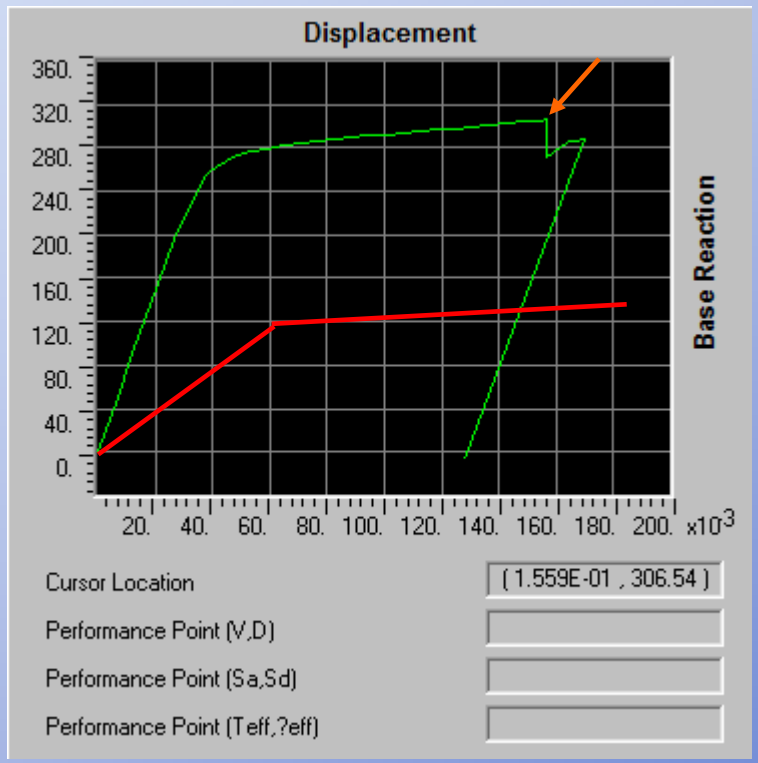
CASEA: Invert V Brace

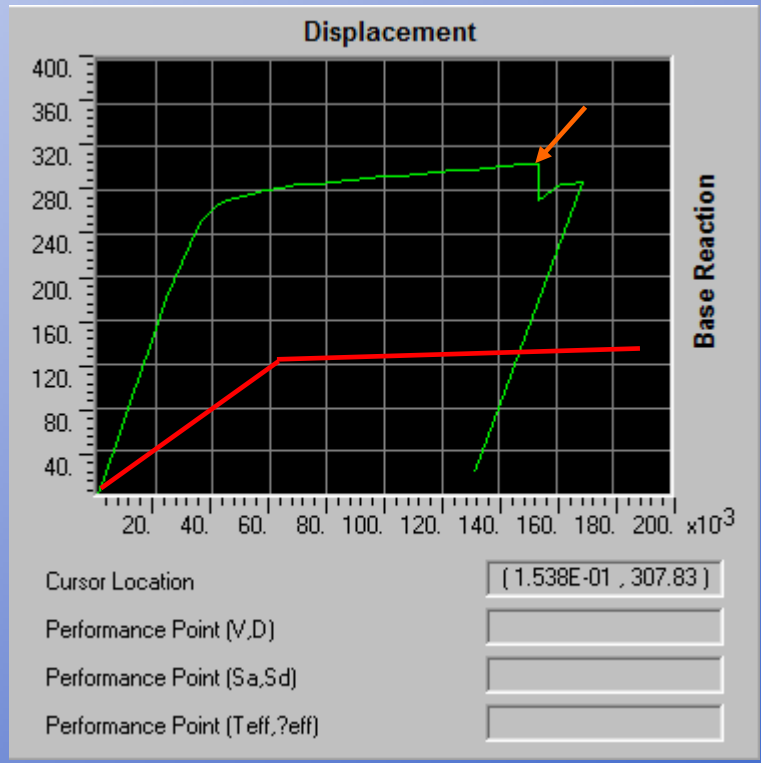


CASE B: 2 Story X Brace

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





CASEA: Invert V Brace

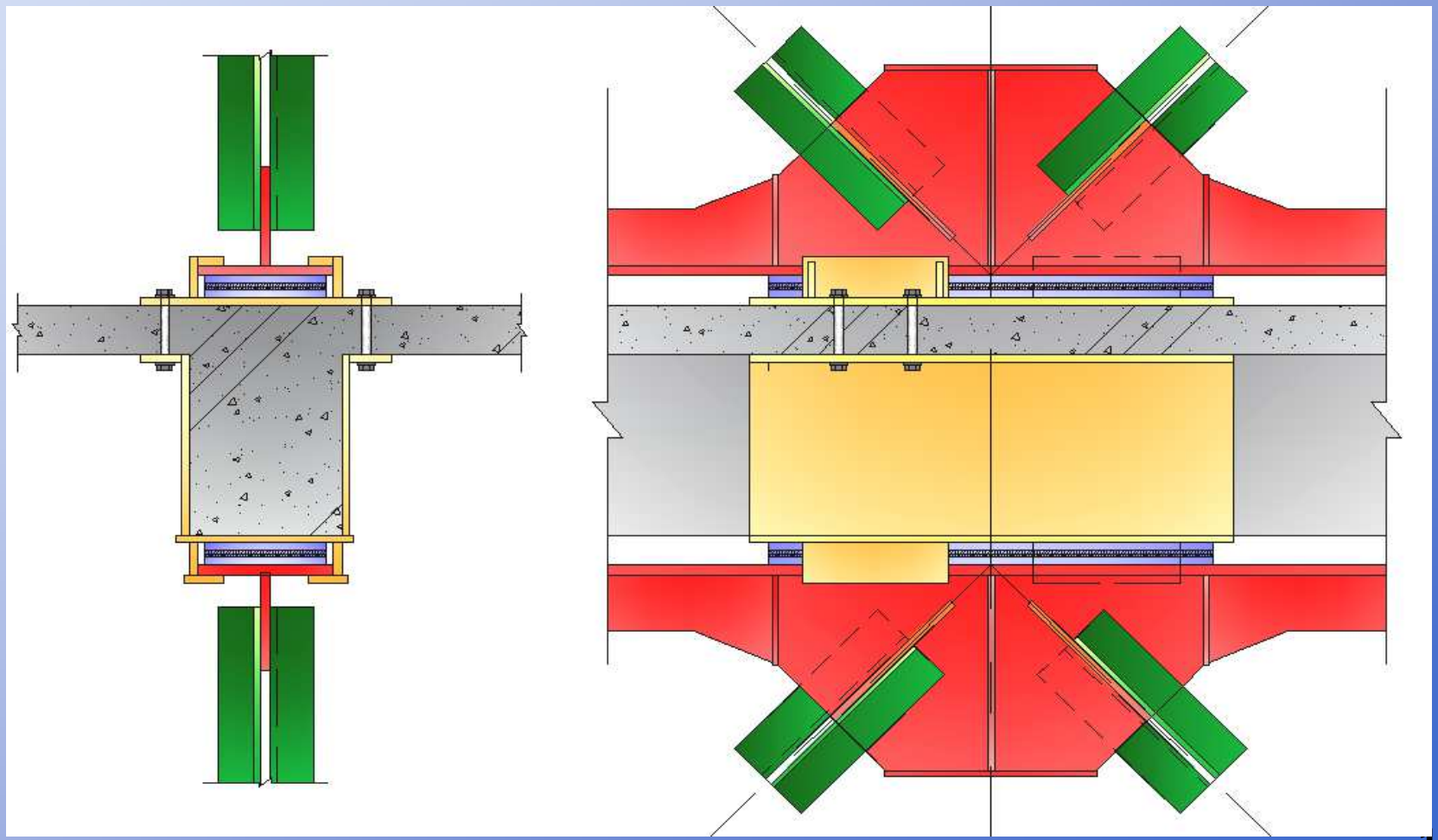
P=306.54tonf △=15.59cm

CASE B: 2 Story X Brace

P=307.83tonf △=15.38cm

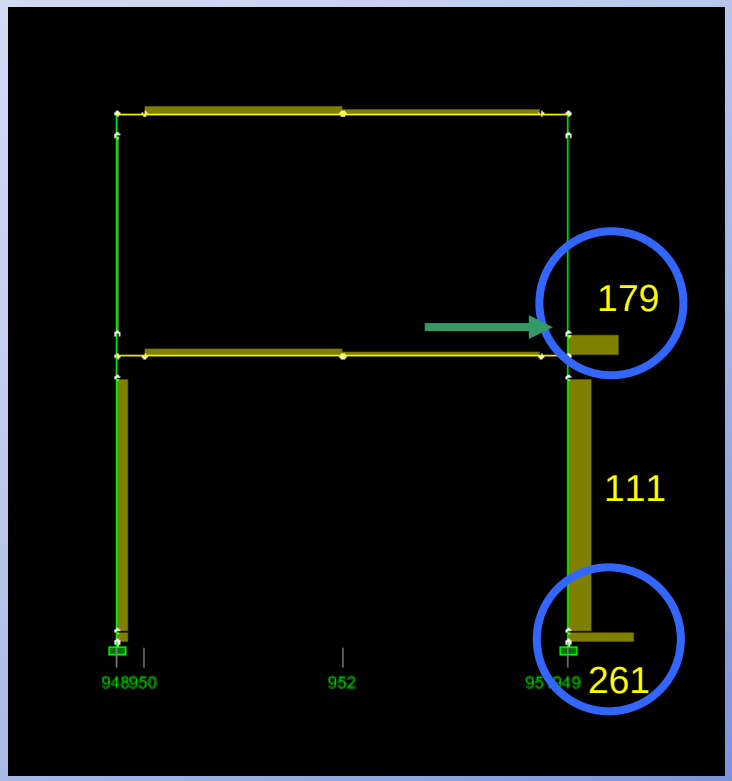
承壓塊傳力系統-雙斜BRB構架側推模擬

滑動及側向固定裝置



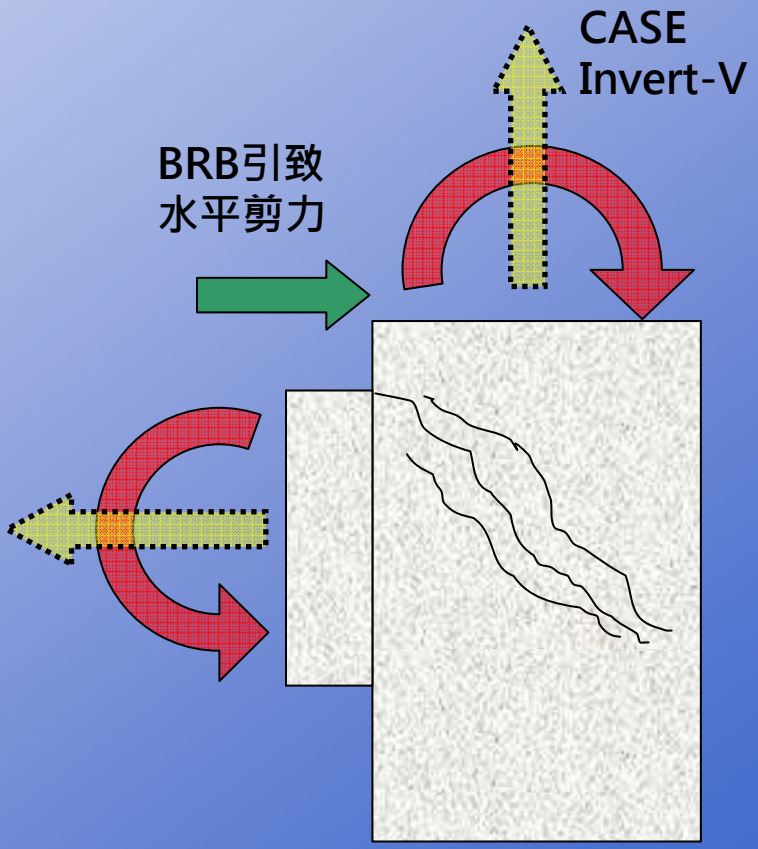
承壓塊傳力系統-雙斜BRB構架側推模擬

BRB對柱引致可觀之水平剪力



FRAME SHEAR Dia.

CASEA: Invert V Brace

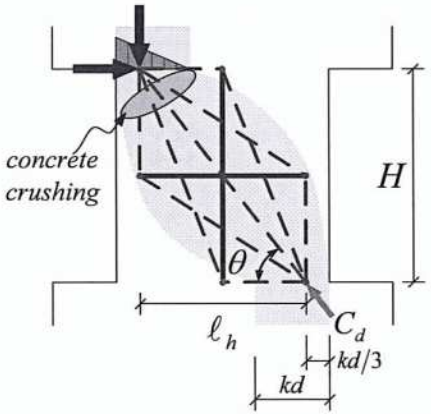


可能加劇接頭處剪力破壞

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)



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

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

$$A = 12\frac{f_y}{f_c'}\rho \le 1 \qquad B = 30\frac{f_y}{f_c'}\rho \le 1$$

$$\zeta = \frac{3.35}{\sqrt{f_c'(MPa)}} \le 0.52$$

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

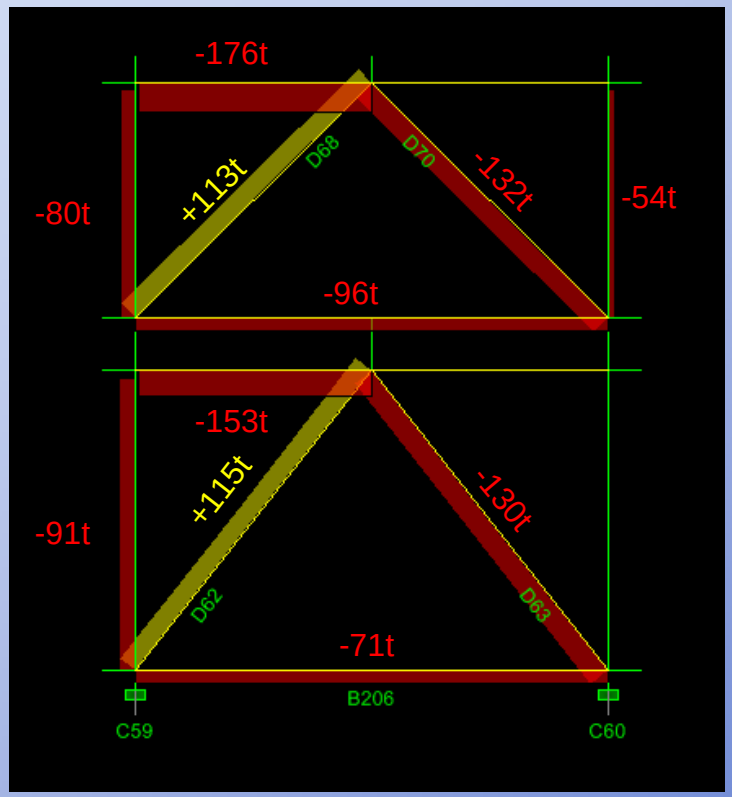
$$kd = \left(0.25 + 0.85\frac{N}{A_g f_c'}\right)h$$

NARLabs 國家實驗研究院

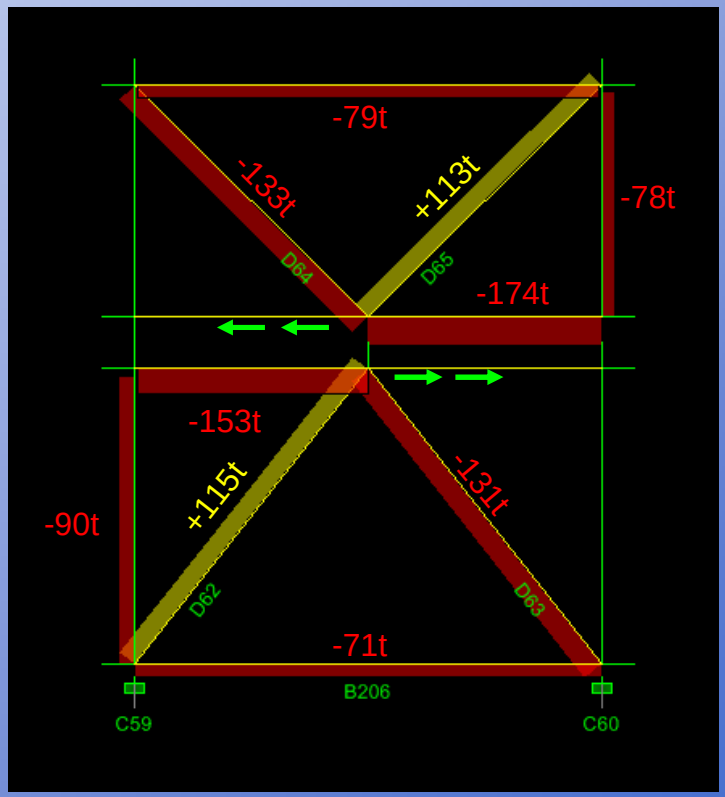
[低矮鋼筋混凝土建築耐震設計、評估與補強技術及政策推動研討會] 2015.11.06

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

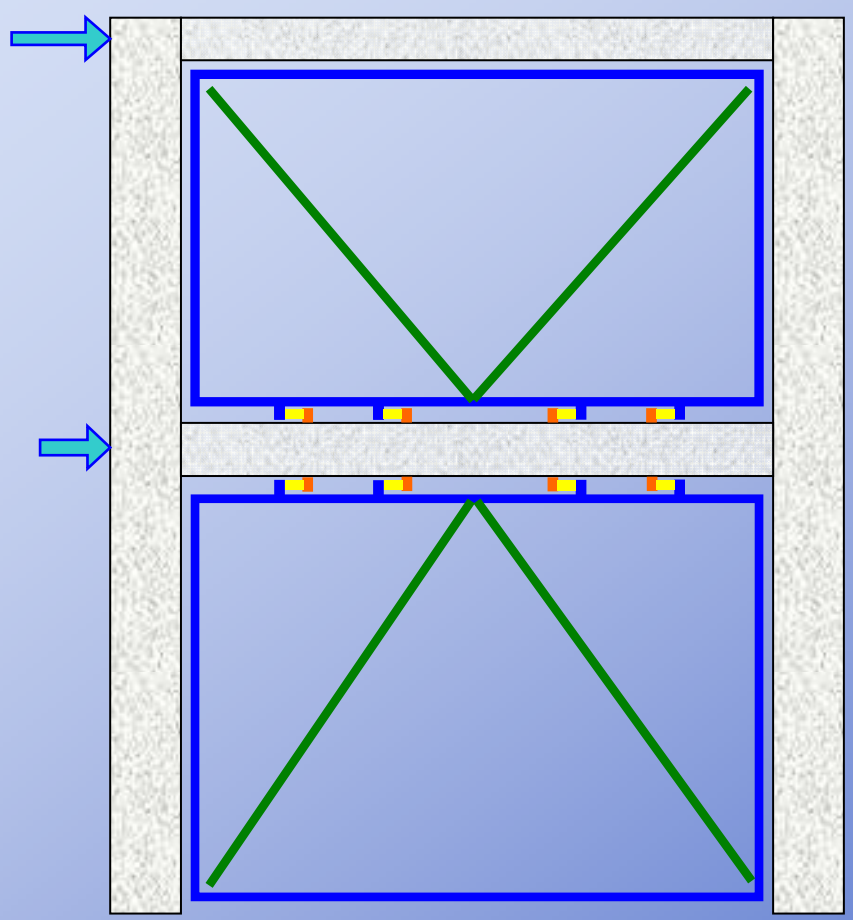


CASE A: Invert V Brace

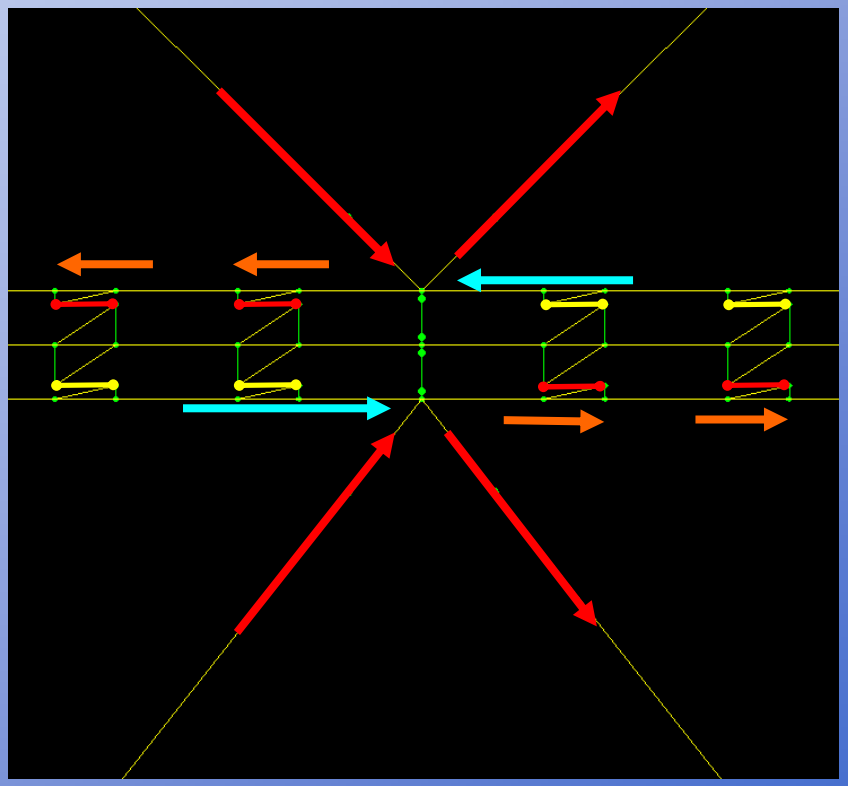


CASE B: 2 Story X Brace

承壓塊傳力系統-雙斜BRB構架側推模擬



Compression Only Material



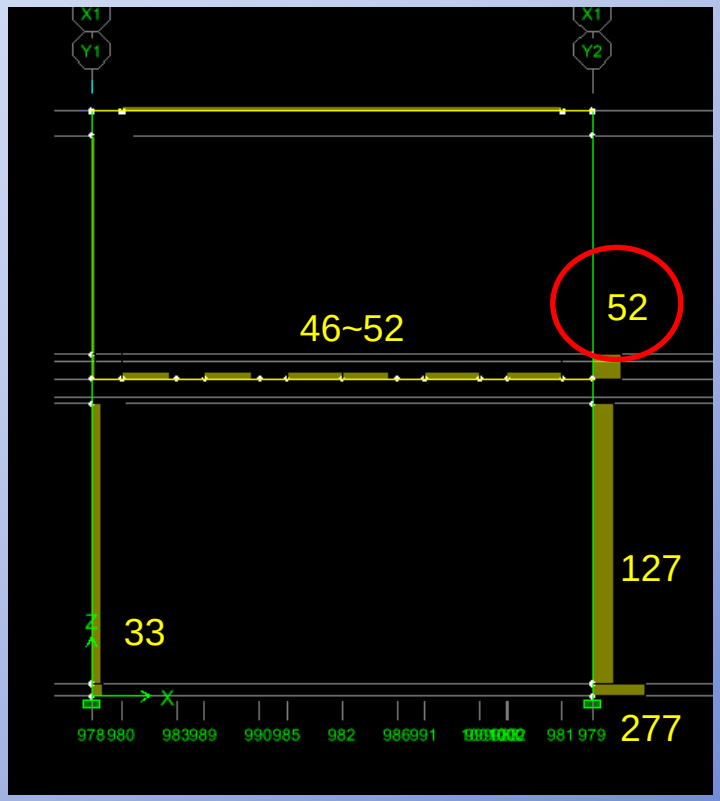
Compression Only Link

Tension Only Link

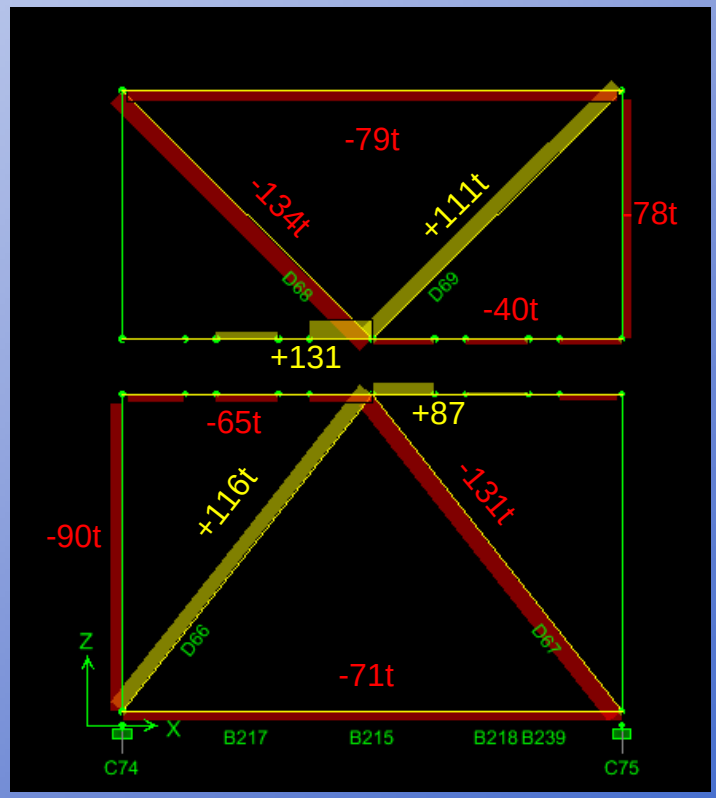
CASE C: Modified X Brace

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



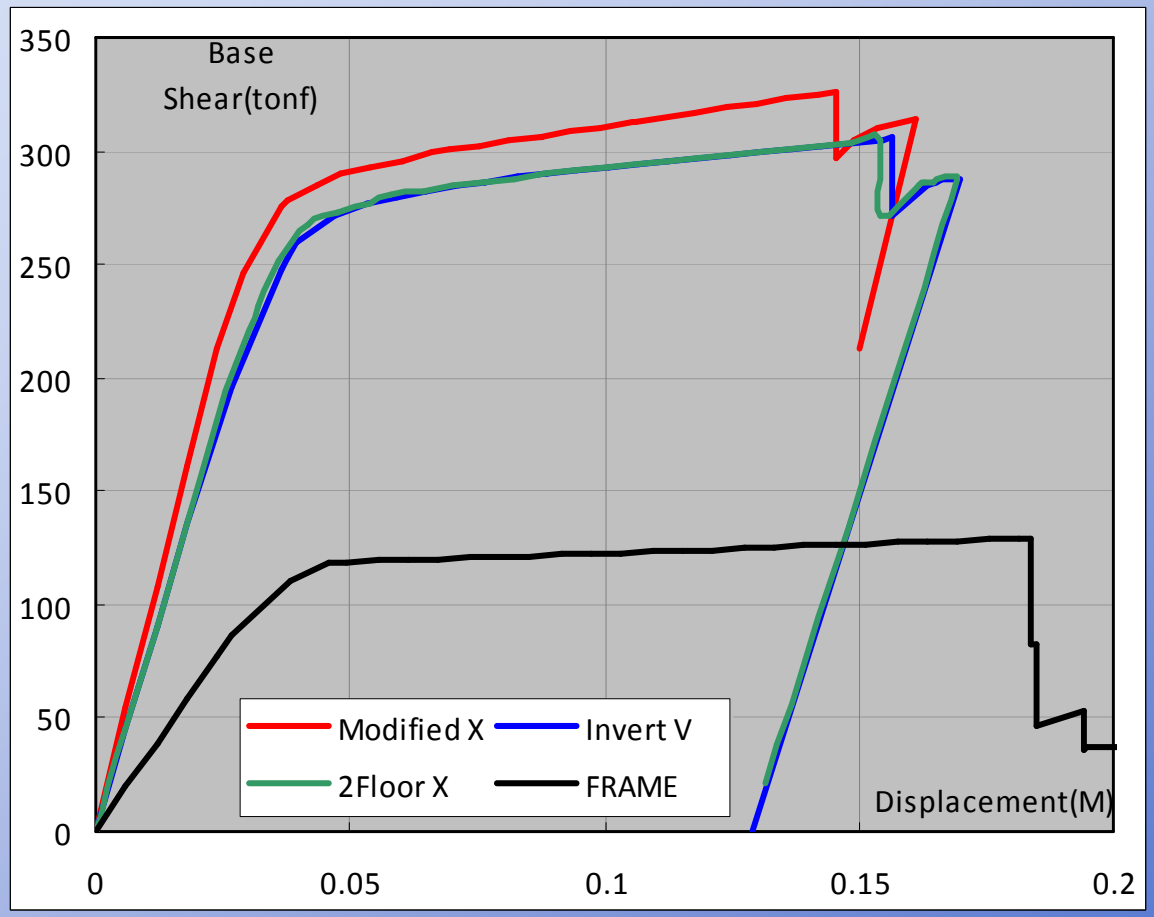
桿件剪力

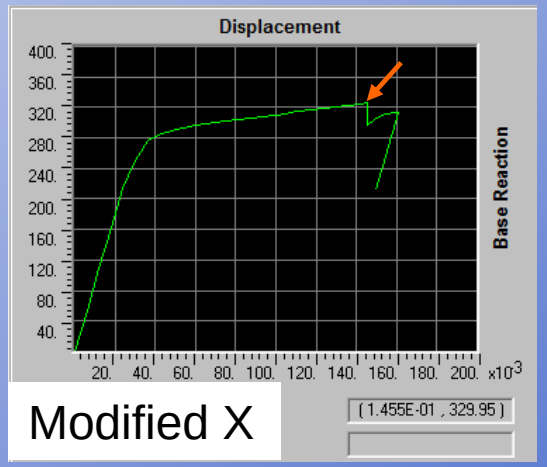


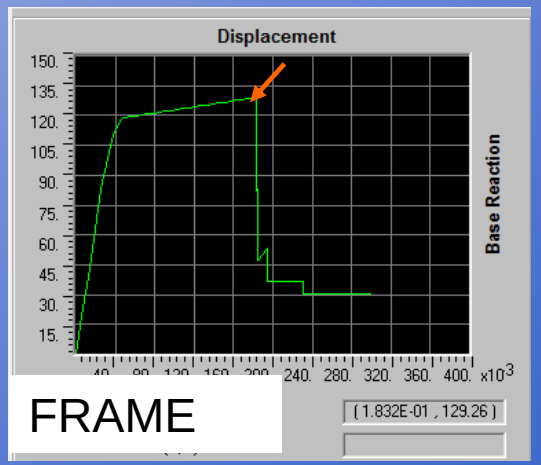
BRB/框架軸力

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

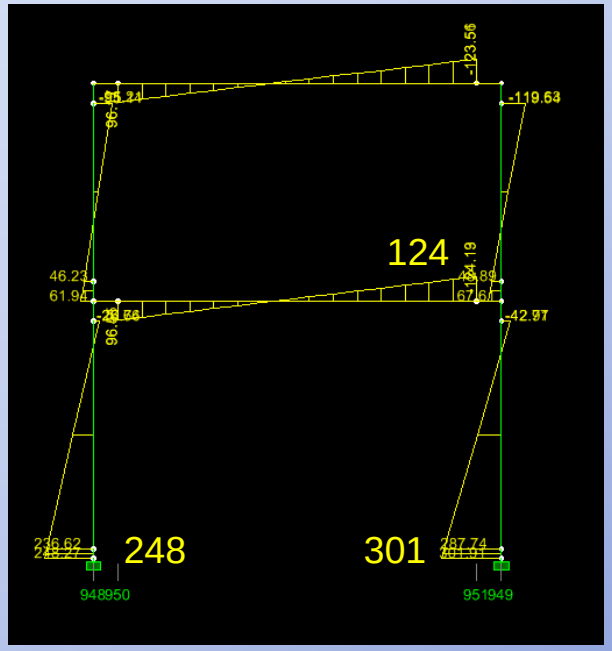


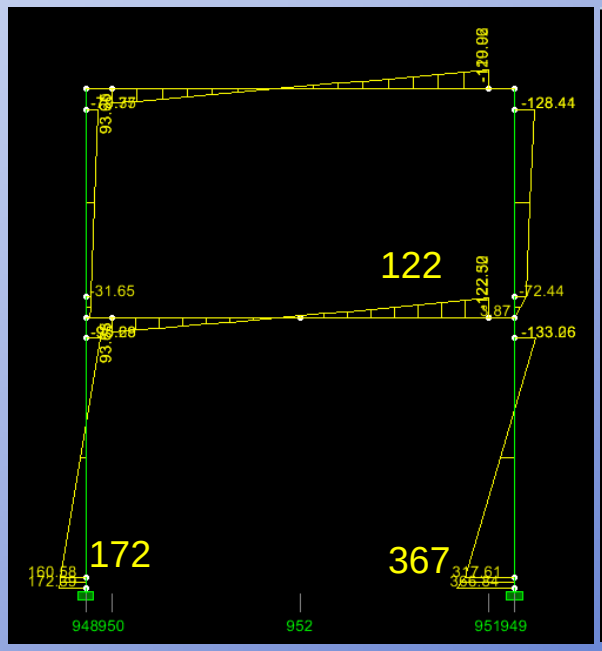


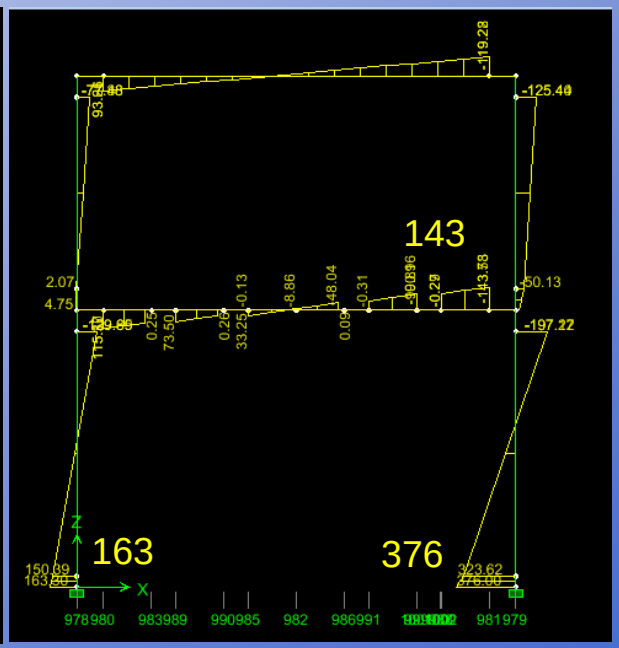


承壓塊傳力系統-雙斜BRB構架側推模擬

各種模式側推分析RC桿件彎矩比較







FRAME

2Floor-X

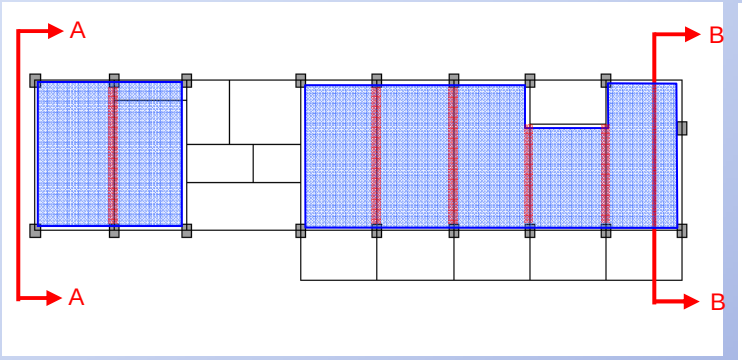
中間梁承受額外拉力

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)



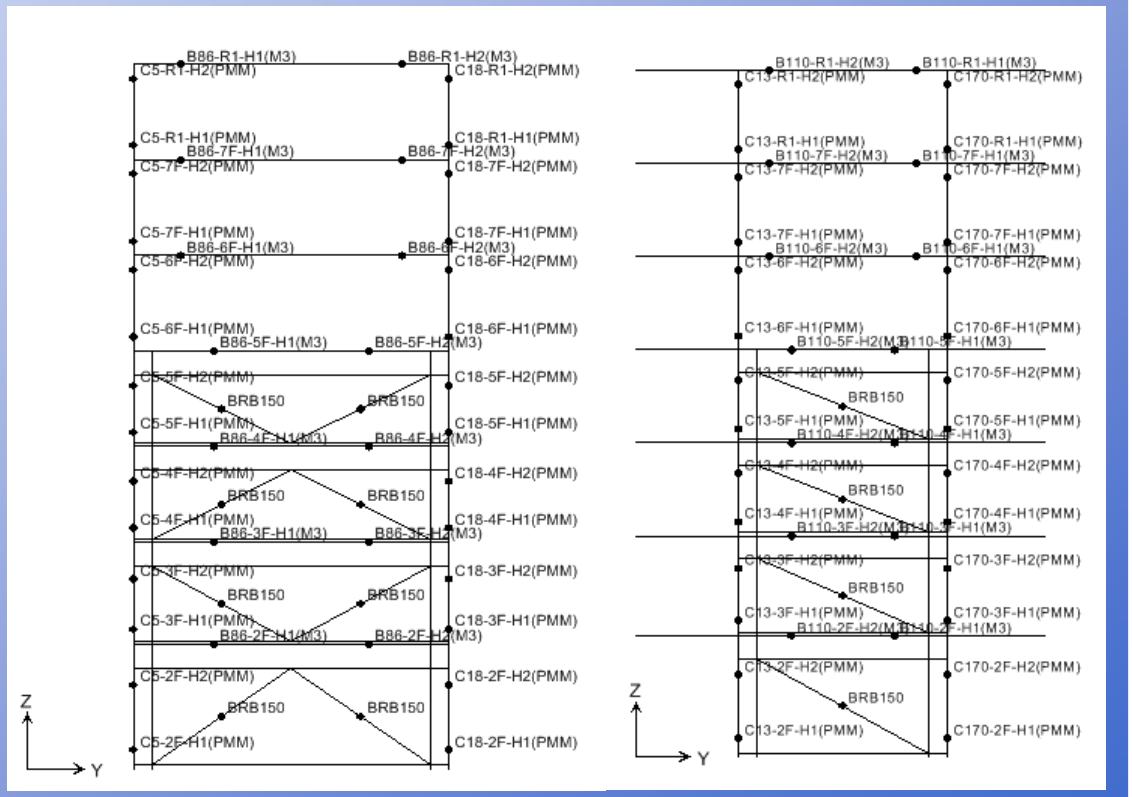
1.地上七層,地下一層

2.RC造,高度21米(不含屋突)

3.柱斷面口60x80

4.梁斷面B50x70,B50x35

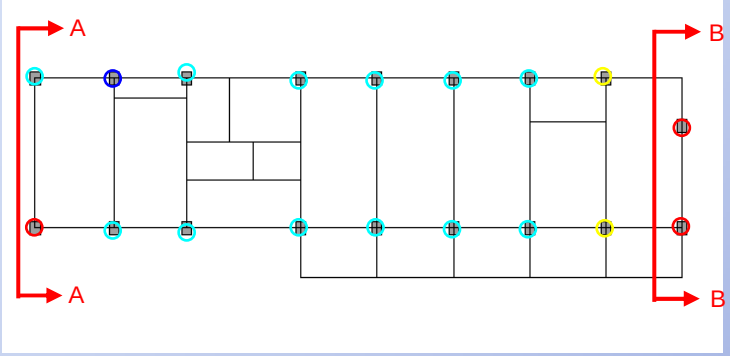
5.採用35公分中空樓版(鋼管)

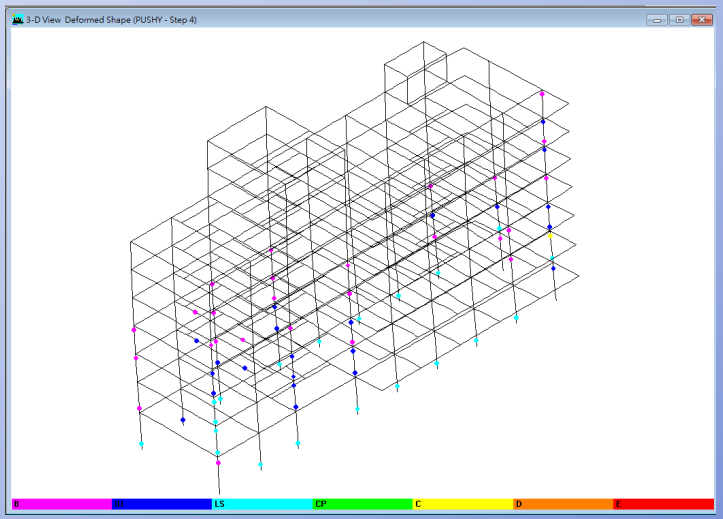


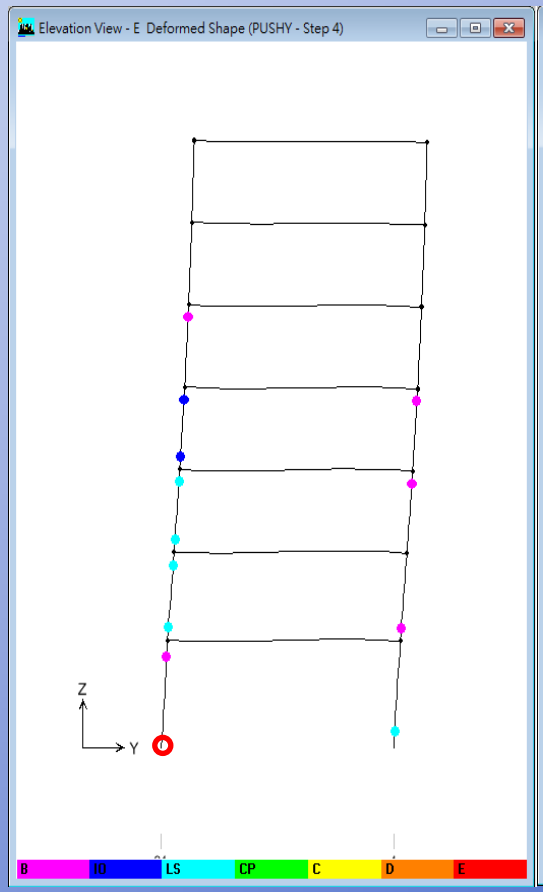
A-A SECTION

B-B SECTION

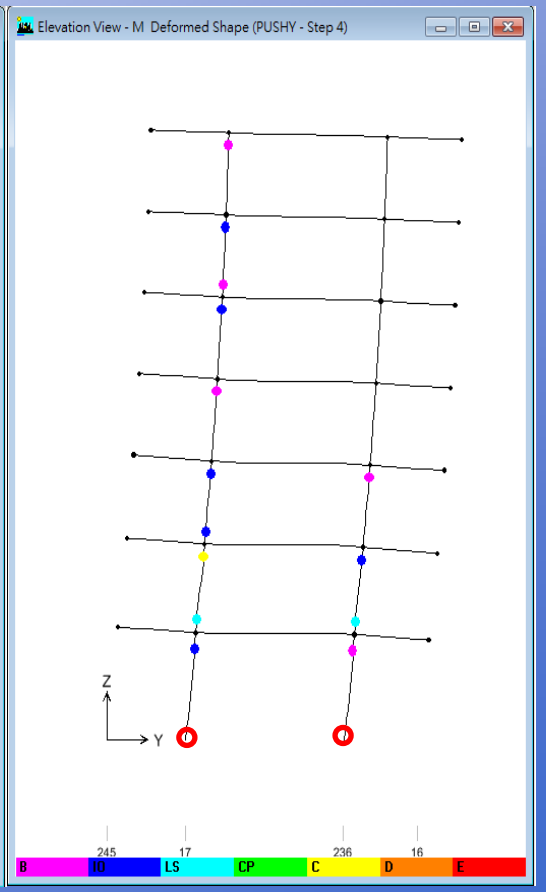
既有RC建物(空構架)





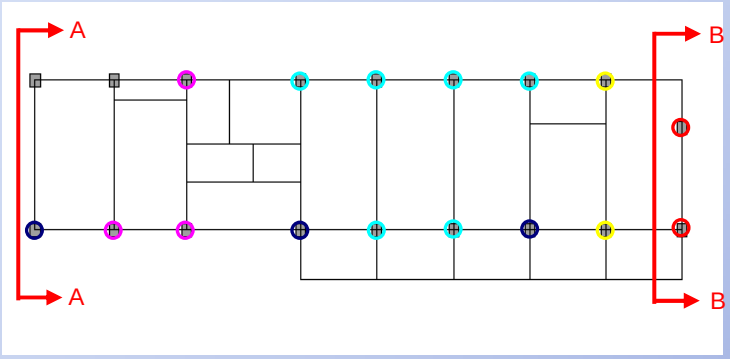


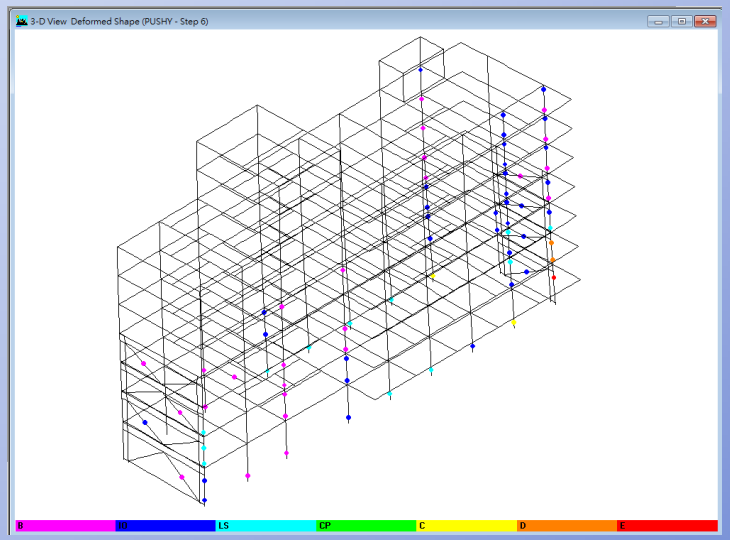
A-A SECTION

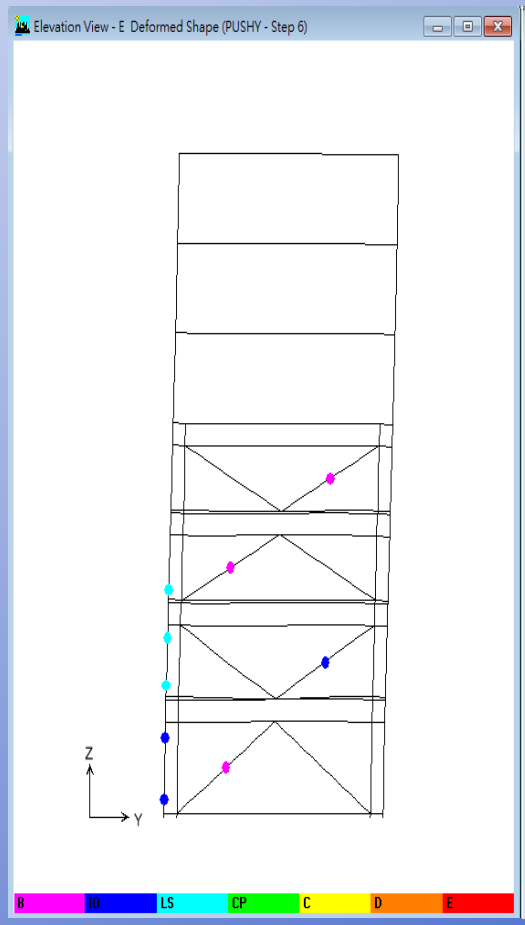


B-B SECTION

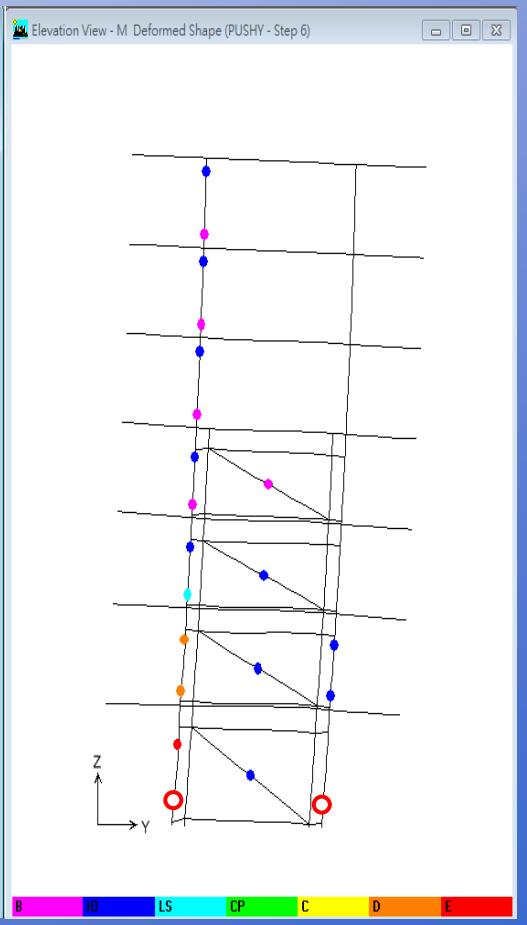
既有RC建物(空構架+BRB150)





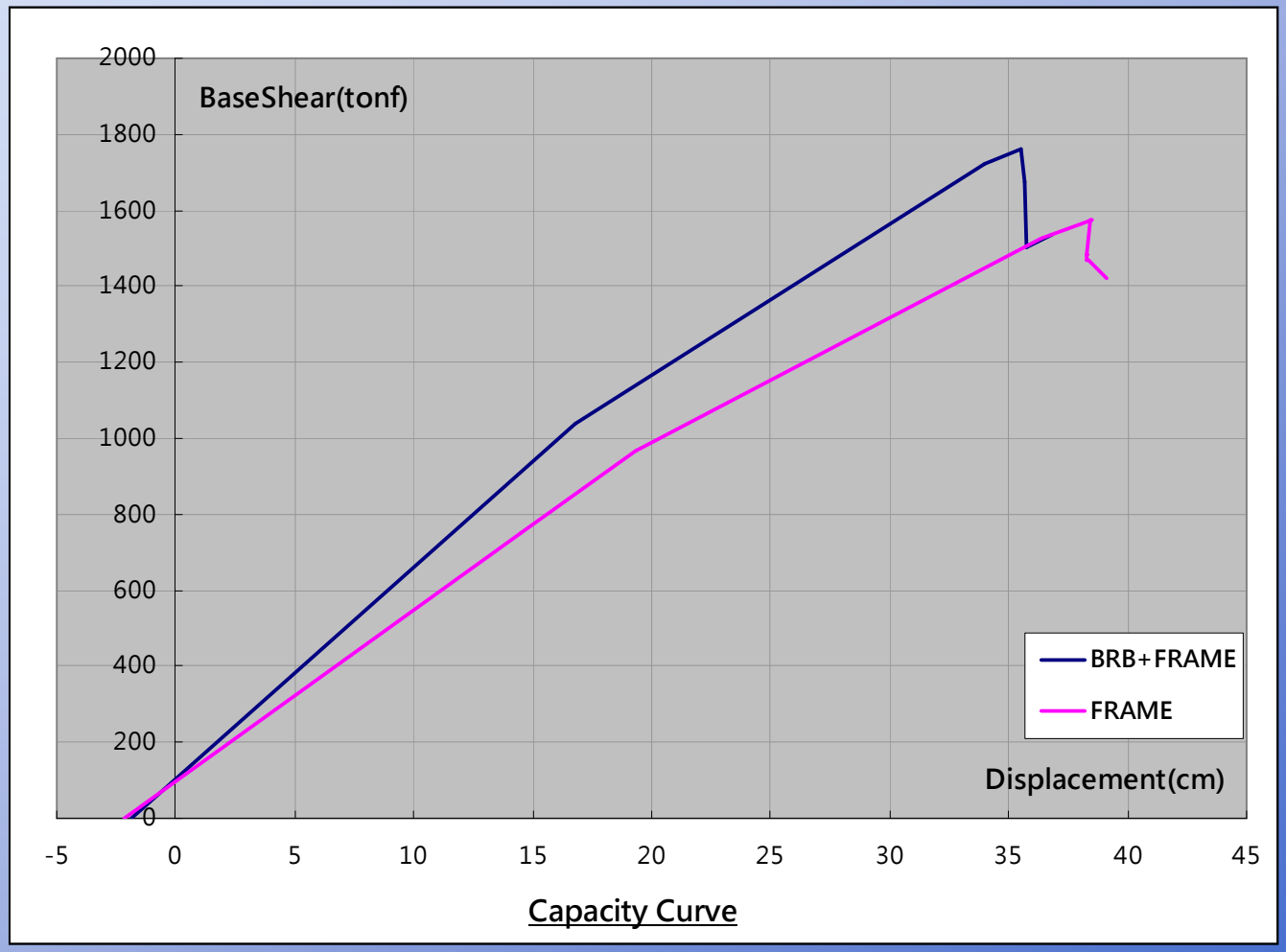


A-A SECTION



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韌數太大可能使既有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