



國立成功大學
National Cheng Kung University

NonStructural Element (NSE) Research

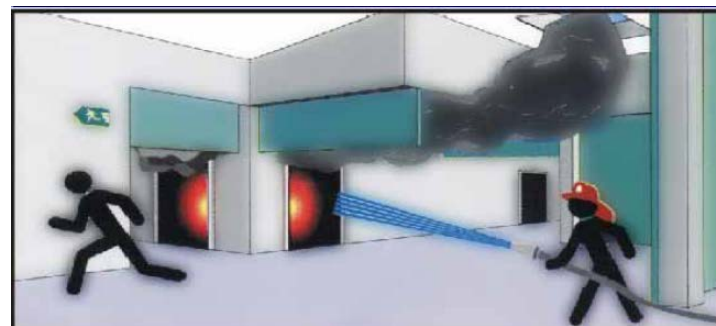
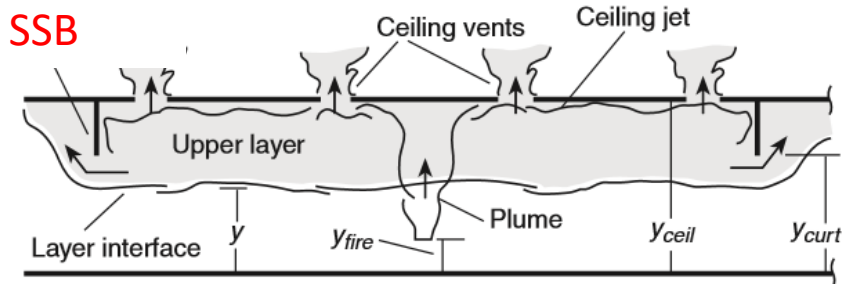
- Seismic performance of glass-type static smoke barriers (SSB)
- Suspended Ceilings under large Vertical Motion

George C. Yao, Prof.
Dept. Architecture, NCKU



SSB Background

- Static Smoke Barriers(SSB) : a critical element of fire safety
 - Smoke zone



- Damage in EQ
 - Reduce the smoke control capacity in Fire Following EQ
 - Falling hazard



Shaking Table Test for SSB

- Out-of-plane seismic performance

- ceiling + glass-type SSB
- AC 156
- PA of 300, 600, 800, 1000 gal
- @NCREE.

- Results :

- Specimens easily cracked at 800 gal at End Panel or adjacent panel.

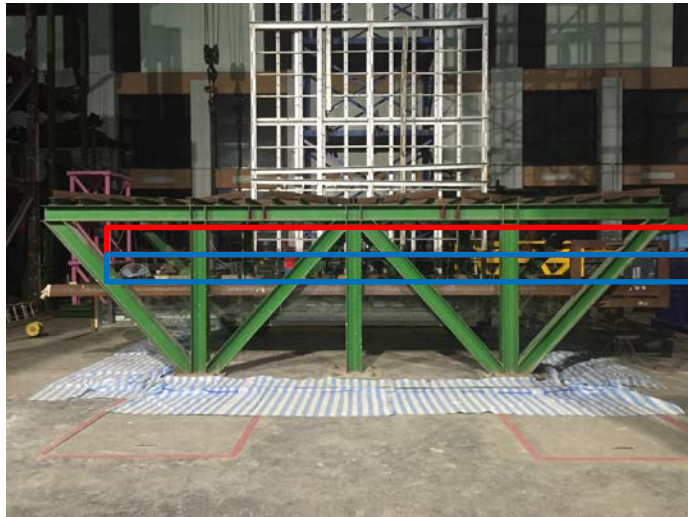
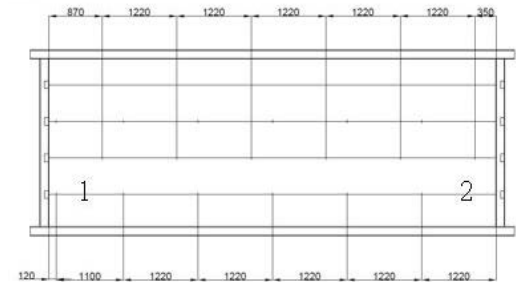


Table Extn Frm

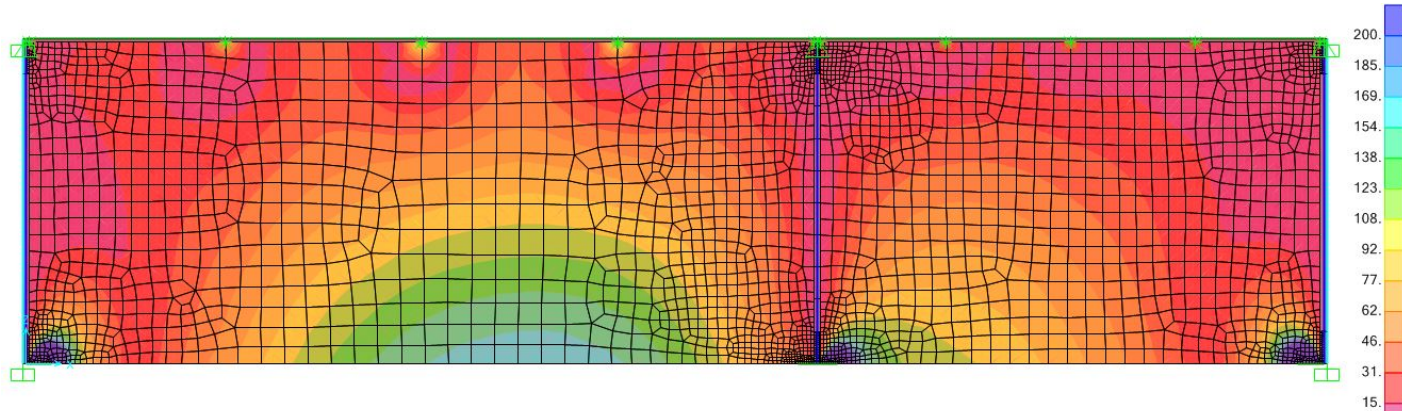
Ceiling

SSB



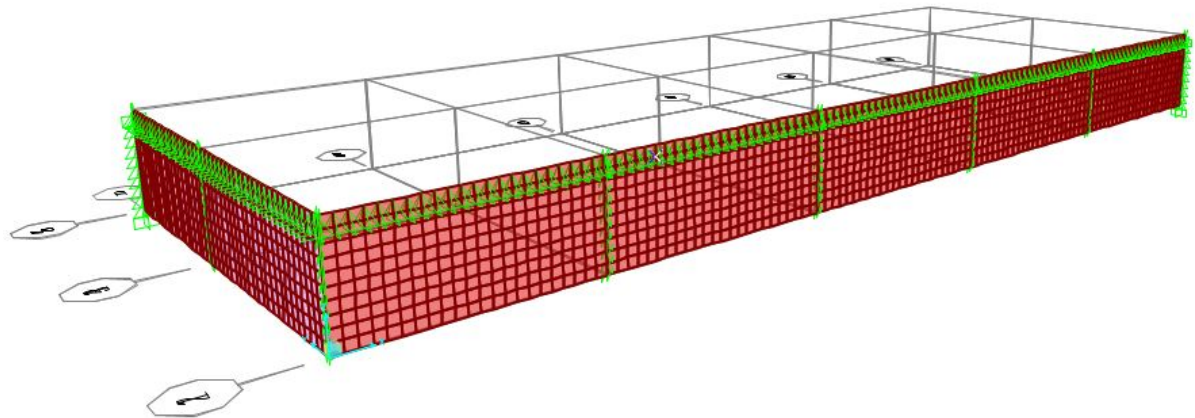
Out-of-Plane behavior

- FEM model shows max stress at corners.
 - Matches the crack initiation point



Future studies for SSB

- **The seismic performance of different SSB layout.**
- **Interaction btw ceiling and SSB**
 - Effect of vertical excitation
- **Retrofit of the glass-typed SSB.**





國立成功大學
National Cheng Kung University

Suspended Ceiling

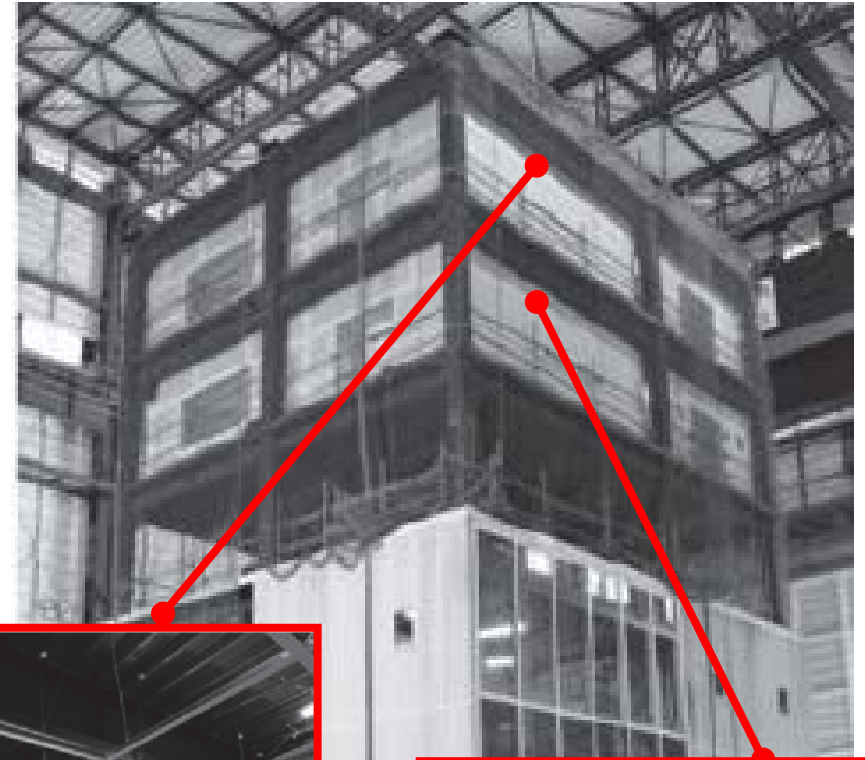
0206 Meinong Earthquake



Seismic-R Ceiling Grid/**No Brace**



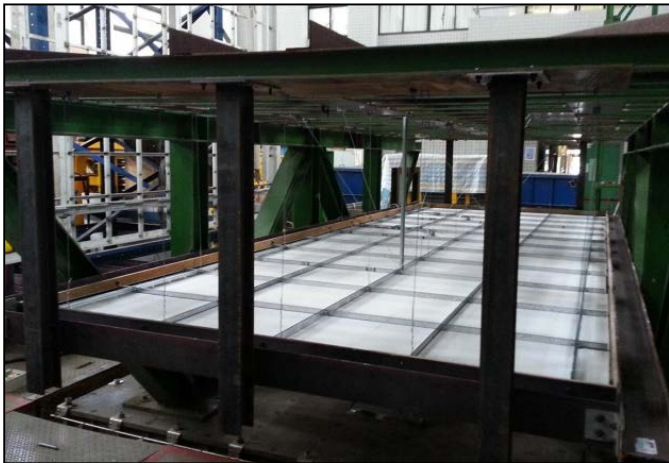
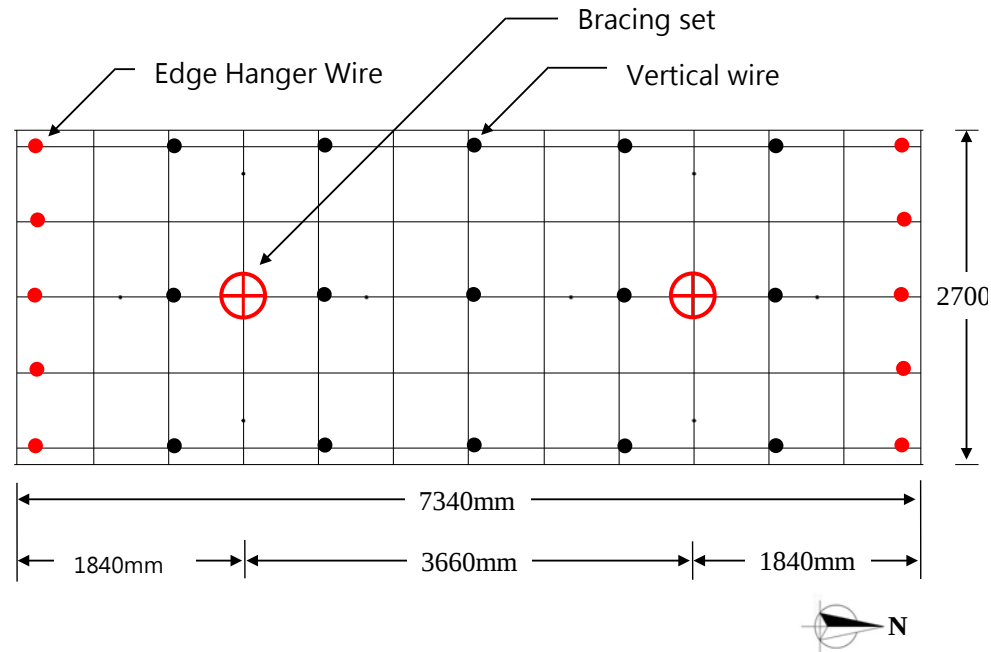
PGA 400 gal



E-Defense Test



2015 Shaking Table Experiments (NCREE)



Damage Patterns of Suspended Ceilings (Seismic-R type, with bracing)

Sin-H1200



Dislodged tapping screw



Damaged wall moldings

Sin-H800 V800



Damaged perimeter connection



Damaged latches of cross tee

Sin-H1000 V1000



Failure of ceiling panel



Damaged main grid

Sin-H1200 V1200

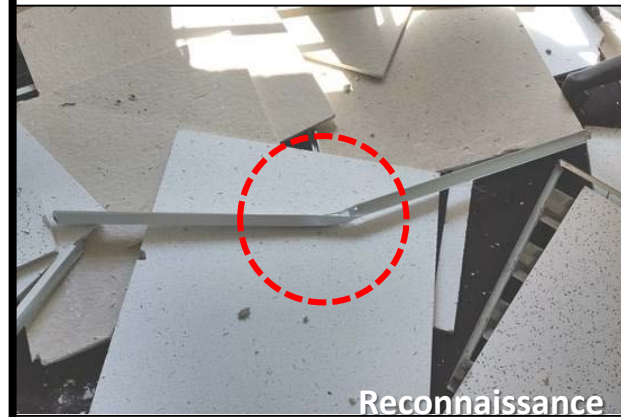
Grid Failure Study (LTB)



Ultimate Bearing Load : 34kgf/m
Calcium Silicate Tiles : 7.2 kgf/m
Mineral Fiber Tiles : 5.67kgf/m
Rock Wool Tiles : 2.27 kgf/m

LTB failure of Grids

Grid Failure



Future studies for Susp. Ceilings

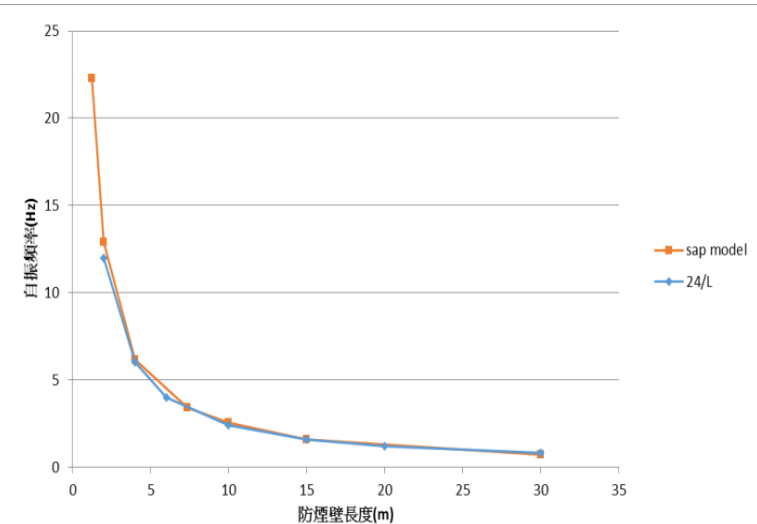
- **Vertical amplification effect of large-area ceiling systems**
 - **$>100 \text{ m}^2$**



**Thank you for your
attention!**

Out-of-Plane behavior

- Field ambient test to find f_n
 - Length dependent



- SAP2000 model established and verified by test model.

- FEM model shows max stress at corners.
 - Matches the crack initiation point

