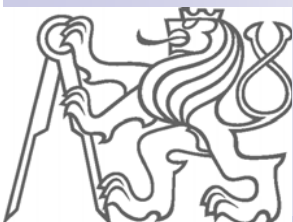
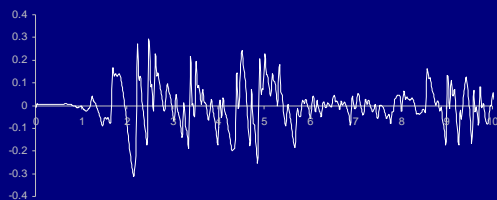




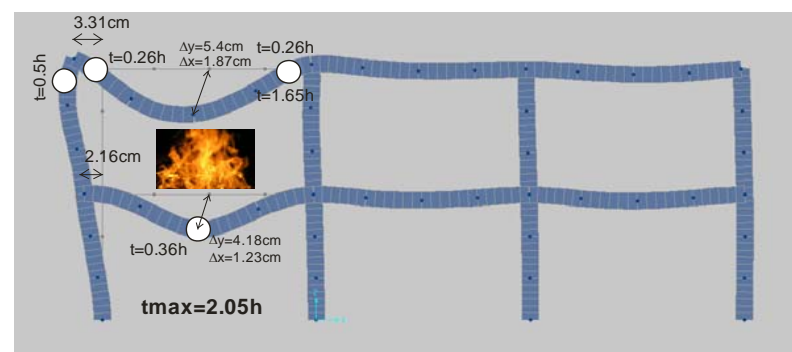
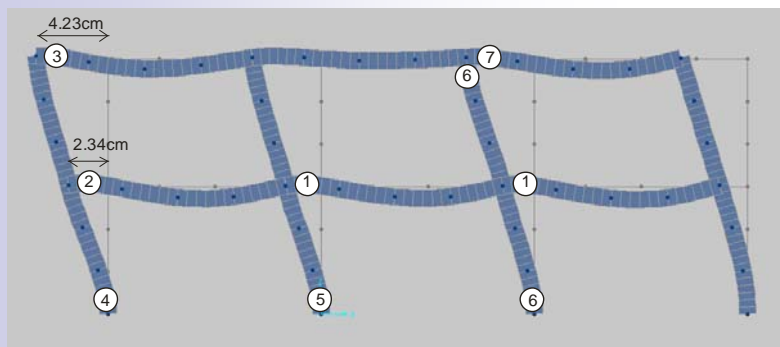
University "Ss. Cyril and Methodius"  
Faculty of Civil Engineering, Skopje  
Macedonia



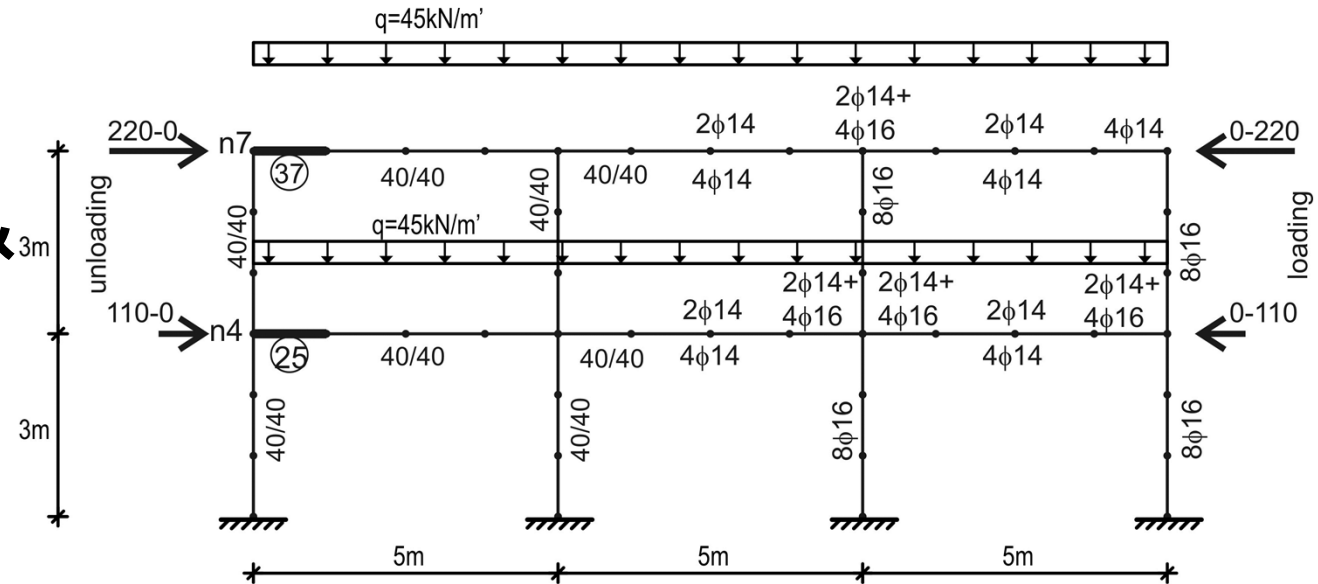
# RC Frame Exposed to Fire After Earthquake



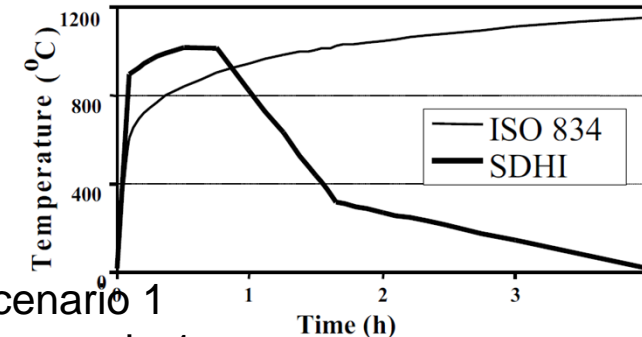
Lazarov Lj., Todorov K., Cvetkovska M.



# Structural geometry & loading cases

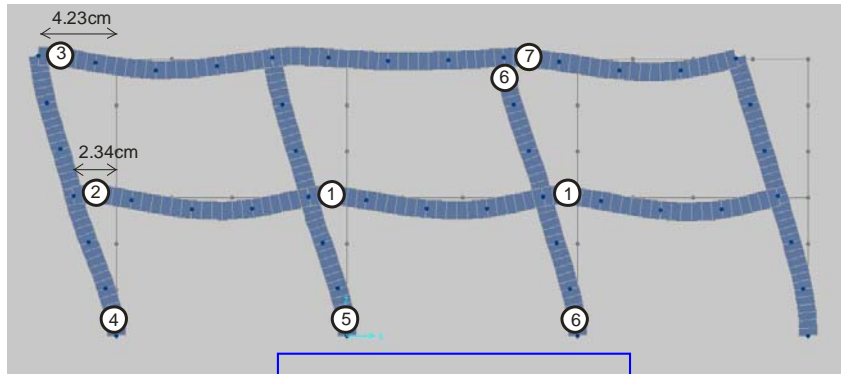


1. Gravity load,  $q=45\text{kN/m'}$
2. Gravity load + ISO fire scenario 1
3. Gravity load + SDHI fire scenario 1
4. Gravity load + ISO fire scenario 2
5. Gravity load + SDHI fire scenario 2
6. Gravity load + Pushover (loading + unloading) + ISO fire scenario 1
7. Gravity load + Pushover (loading + unloading) + SDHI fire scenario 1
8. Gravity load + Pushover (loading + unloading) + ISO fire scenario 2
9. Gravity load + Pushover (loading + unloading) + SDHI fire scenario 2
10. Gravity+Pushover (loading+ unloading +opposite loading+ unloading) + ISO fire scenario 1
11. Gravity+Pushover (loading+unloading+opposite loading+ unloading)+ SDHI fire scenario 1
12. Gravity+Pushover (loading+unloading +opposite loading+ unloading)+ ISO fire scenario 2
13. Gravity+Pushover (loading+unloading +opposite loading+ unloading)+SDHI fire scenario 2



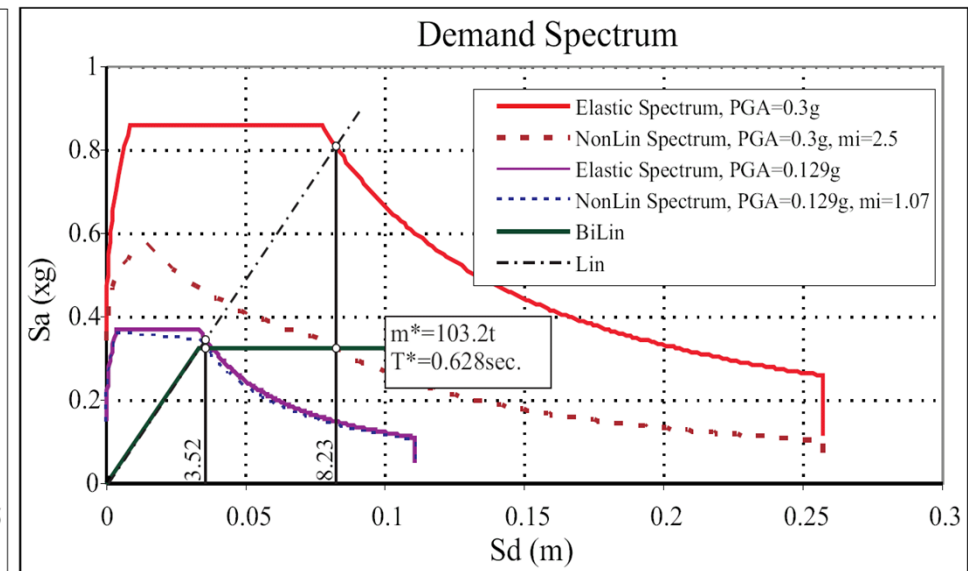
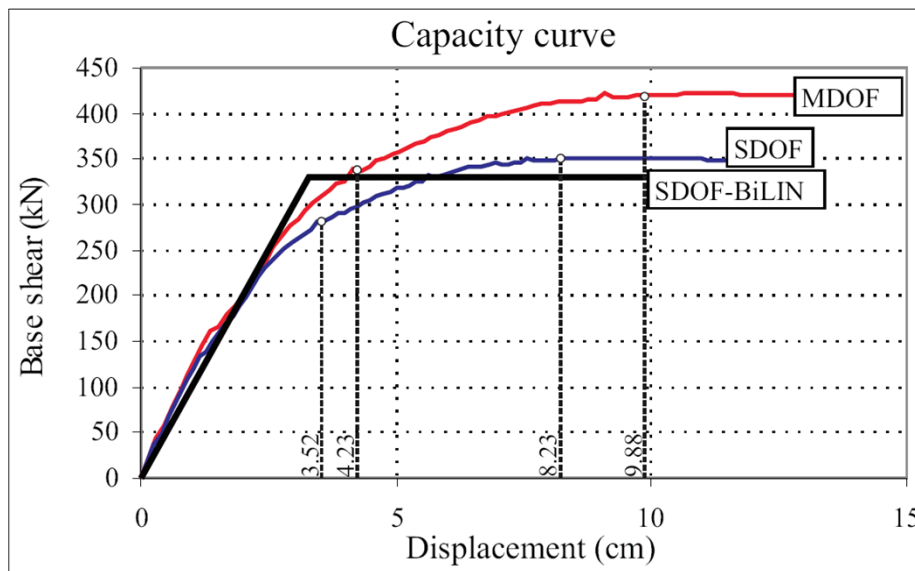
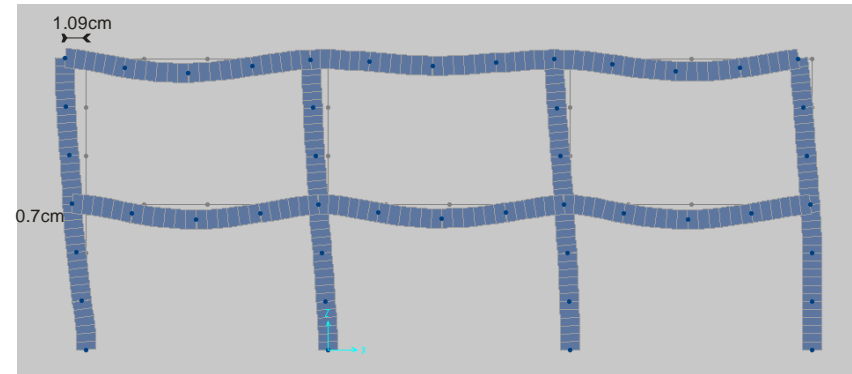
# Pushover analysis - seismic capacity

displacements after Pushover case



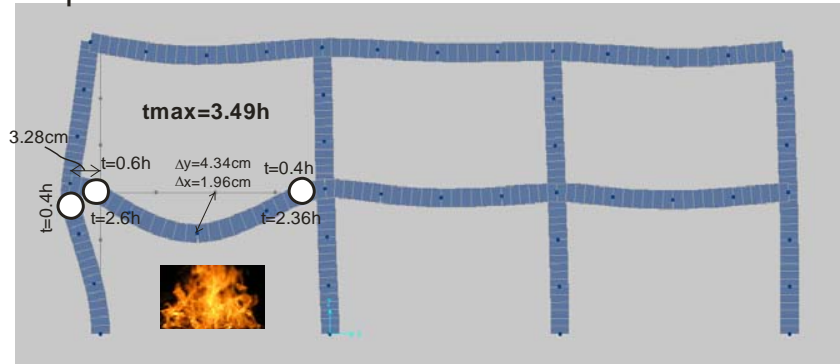
**330kN=0.244W**

residual displacements after Pushover case

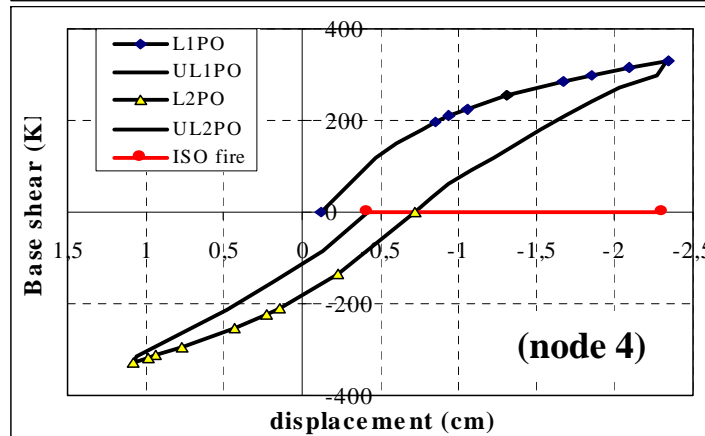
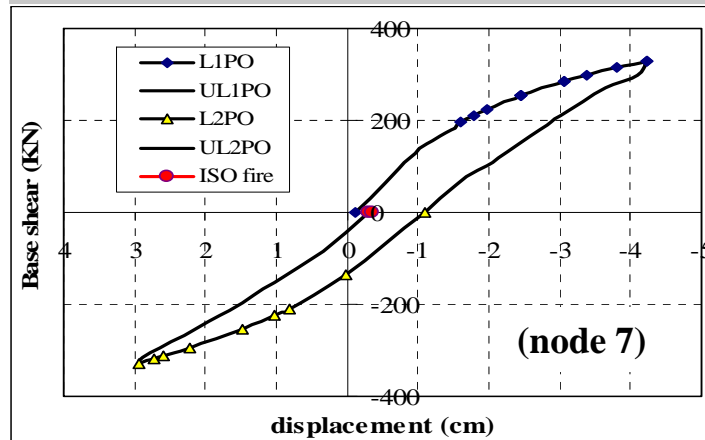
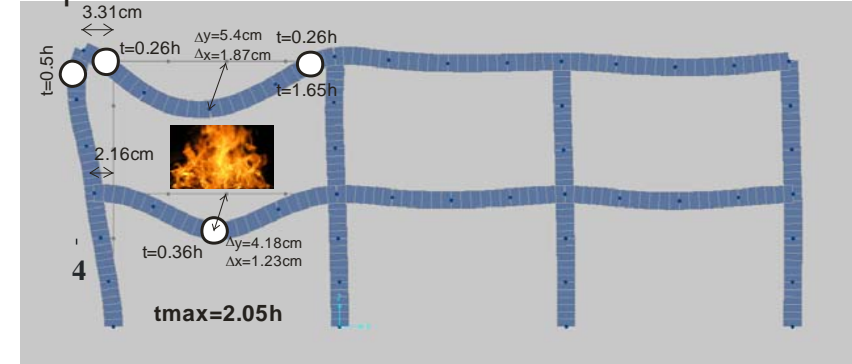


# Application of Structural Fire Design, 29 April 2011, Prague, Czech Republic

displacements after Fire1 scenario



displacements after Fire2 scenario



Fire scenario 1

| node | Displac. (cm) | only "g" and fire action |                 |        |       | "g"+ seismic action + fire action |       |                      |                              |             |       |
|------|---------------|--------------------------|-----------------|--------|-------|-----------------------------------|-------|----------------------|------------------------------|-------------|-------|
|      |               | g                        | g+ISO<br>t=3.3h | g+SDHI |       | g                                 | g+LPO | residual<br>displac. | residual +<br>ISO<br>t=3.49h | resid.+SDHI |       |
|      |               |                          |                 | t=1.1h | t=5h  |                                   |       |                      |                              | t=1.1h      | t=5h  |
| 4    | Δx            | -0.12                    | -2.85           | -1.83  | -1.08 | -0.12                             | -2.34 | -0.72                | -3.28                        | -2.23       | -1.49 |
| 7    | Δx            | -0.13                    | -0.27           | -0.20  | -0.19 | -0.13                             | -4.23 | -1.09                | -1.12                        | -1.03       | -1.01 |
| 9    | Δy            | -0.43                    | -4.14           | -1.27  | -1.61 | -0.43                             | -0.64 | -0.78                | -4.34                        | -1.45       | -1.78 |

Fire scenario 2

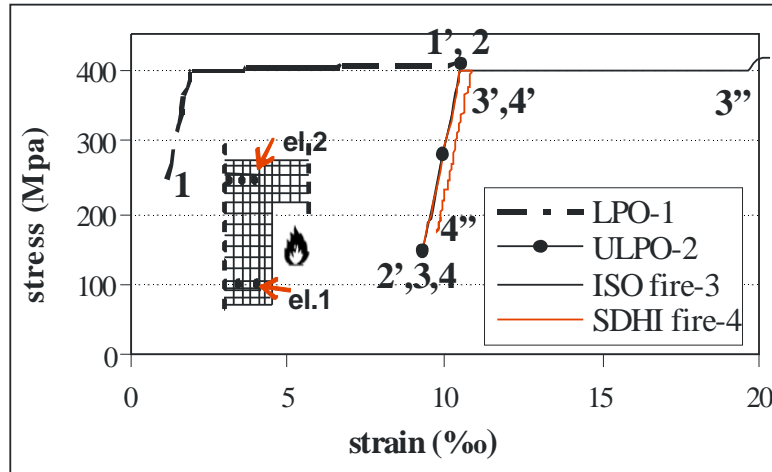
| node | Displac. (cm) | only "g" and fire action |                 |        |       | "g"+ seismic action + fire action |       |                      |                             |             |       |
|------|---------------|--------------------------|-----------------|--------|-------|-----------------------------------|-------|----------------------|-----------------------------|-------------|-------|
|      |               | g                        | g+ISO<br>t=2.0h | g+SDHI |       | g                                 | g+LPO | residual<br>displac. | residual +<br>ISO<br>t=2.0h | resid.+SDHI |       |
|      |               |                          |                 | t=1.1h | t=5h  |                                   |       |                      |                             | t=1.1h      | t=5h  |
| 4    | Δx            | -0.12                    | -1.62           | -1.22  | -0.70 | -0.12                             | -2.34 | -0.72                | -2.16                       | -1.79       | -1.27 |
| 7    | Δx            | -0.13                    | -2.62           | -1.98  | -1.89 | -0.13                             | -4.23 | -1.09                | -3.31                       | -2.67       | -2.25 |
| 9    | Δy            | -0.43                    | -3.67           | -2.68  | -1.53 | -0.43                             | -0.64 | -0.78                | -4.18                       | -3.23       | -2.46 |
| 12   | Δy            | -0.56                    | -5.34           | -3.29  | -4.26 | -0.56                             | -0.59 | -0.73                | -5.41                       | -3.27       | -4.29 |

Fire scenario 1 and 2

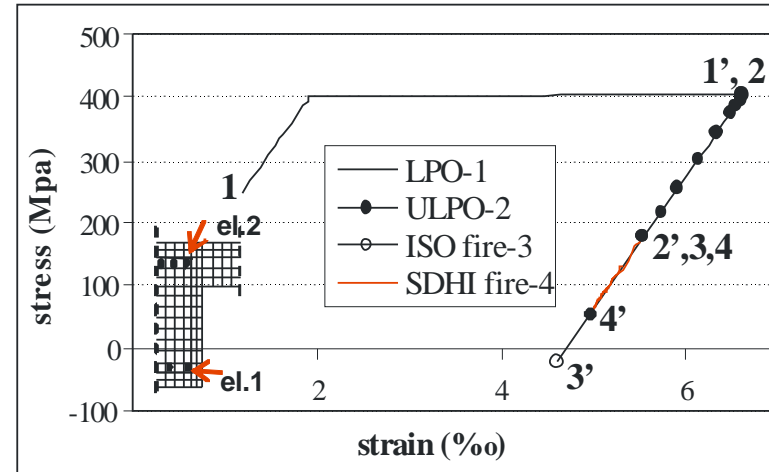
| node | Displac. (cm) | "g"+ seismic action in two directions+ fire action |        |                       |        |                       |                               |                               |  |
|------|---------------|--|--------|-----------------------|--------|-----------------------|-------------------------------|-------------------------------|--|
|      |               | g  | g+L1PO | residual<br>displac.1 | g+L2PO | residual<br>displac.2 | residual<br>fire 1<br>t=3.54h | residual<br>fire 2<br>t=2.43h |  |
| 4    | Δx            | -0.12  | -2.34  | -0.72                 | +1.12  | -0.42                 | -2.31                         | -1.60                         |  |
| 7    | Δx            | -0.13  | -4.23  | -1.09                 | +3.05  | -0.30                 | -0.36                         | -1.55                         |  |
| 9    | Δy            | -0.43  | -0.64  | -0.78                 | -0.87  | -0.96                 | -3.70                         | -4.20                         |  |

Base Shear=393kN  
 t=3.76h ( Fire Scenario 1)  
 $\Delta_{x7}=-7.31\text{cm}$   $\Delta_{x7R}=-3.04\text{cm}$   
 $\Delta_{x4}=-4.19\text{cm}$   $\Delta_{x4R}=-1.98\text{cm}$

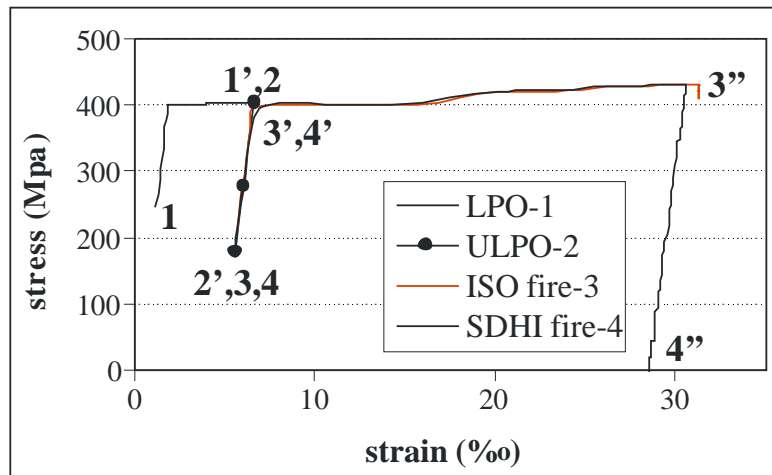
# Stress-strain history



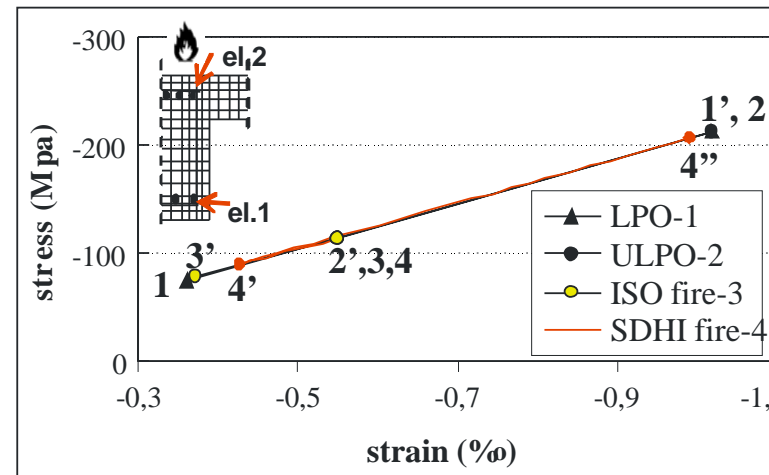
Top bar, Node 4, fire scenario 1



Top bar, Node 7, fire scenario 1

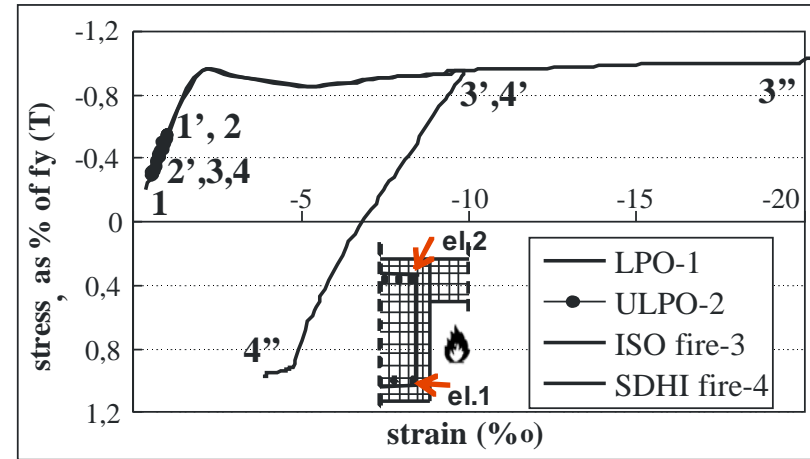
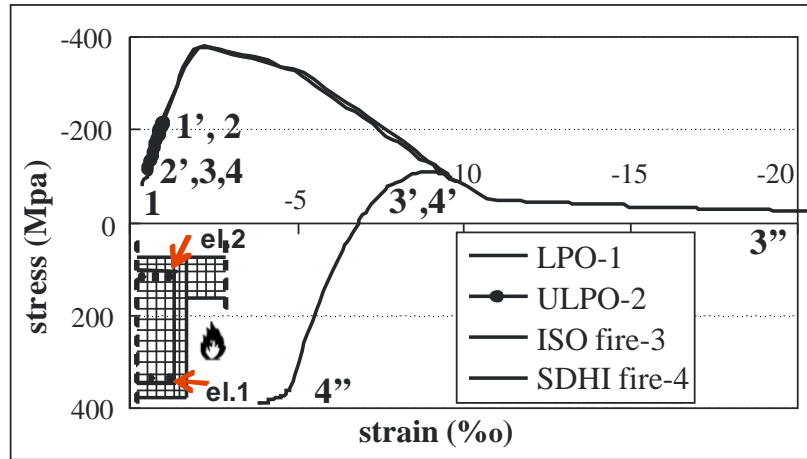


Top bar, Node 7, fire scenario 2

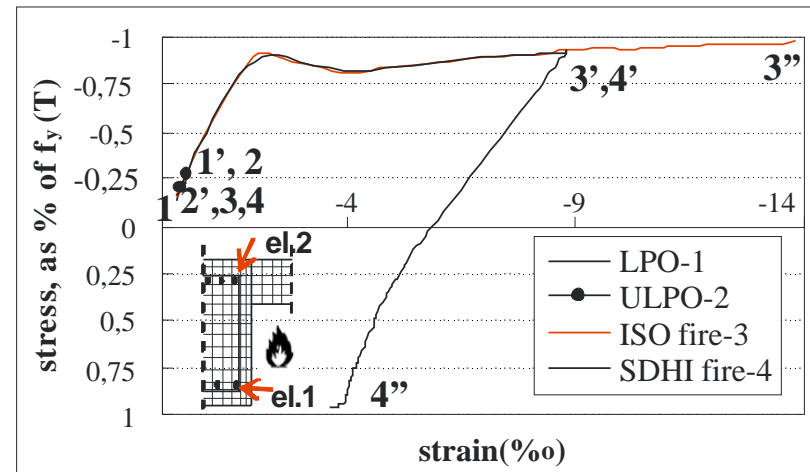
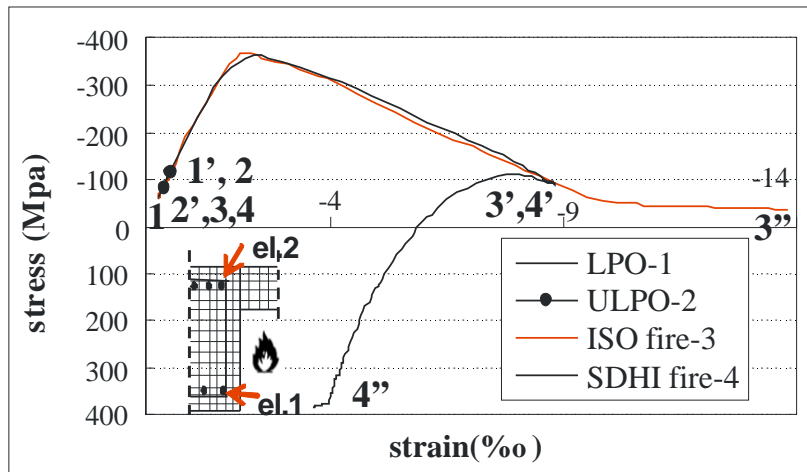


Bottom bar, Node 4, fire scenario 2

# Stress-strain history



Bottom bar, Node 4, fire scenario 1



Bottom bar, Node 7, fire scenario 2