COST C26: Urban Habitat Constructions under Catastrophic Events
WG2: Earthquake resistance

Workshop Prague, March 30-31, 2007

Seismic upgrade of non-seismic r.c. frames using steel dissipative braces

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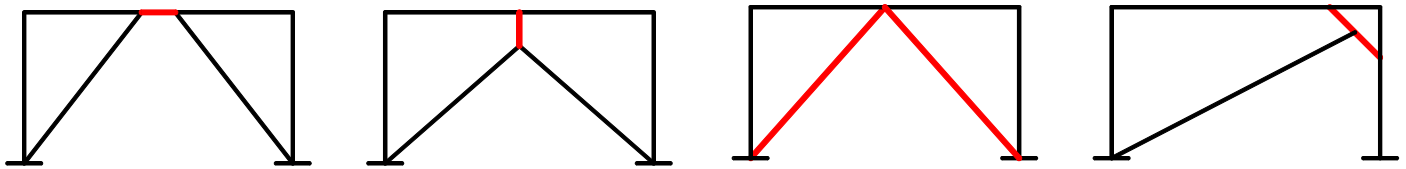
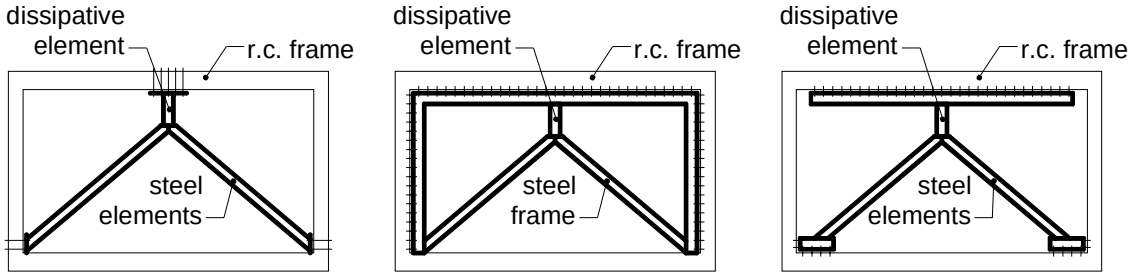
Seismic rehabilitation of existing r.c. structures

- **R.C. structures built before 1970s lack seismic design ⇒ strengthening needed**
- **Approaches for seismic rehabilitation:**
  - **jacketing with steel elements**
  - **added high-strength mortars**
  - **fiber reinforced plastics**
  - **additional earthquake-resistant systems**

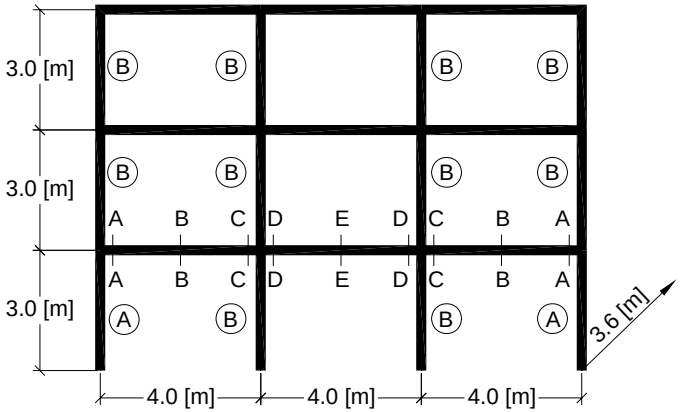


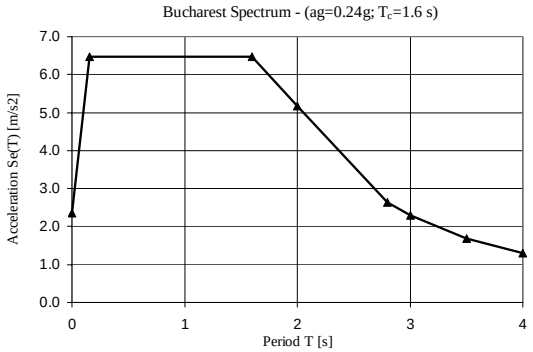
- **Connection between the new and existing system:**



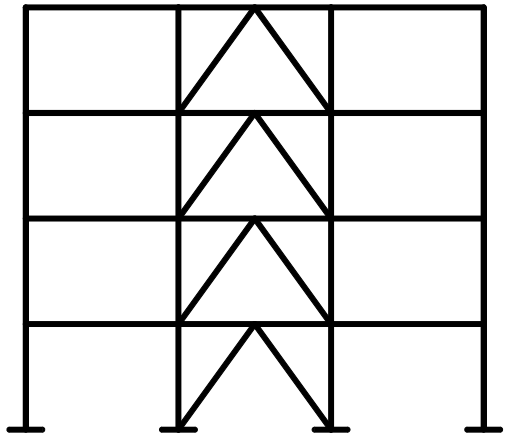
Case study: strengthening of a r.c. frame with BRB

- A r.c. frame was designed with materials and design procedure common in 1950s in Romania
- Performance assessment: pushover analysis + N2 method
- Design earthquake parameters:
  - a_g=0.24 g
  - T_C=1.6 sec



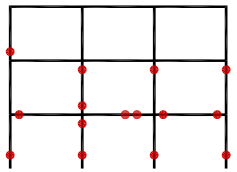


- Strengthening solutions:
  - Buckling restrained braces (BRB)
  - Column confinement by FRP
  - BRB+FRP (q=6)
  - BRB+FRP (q=3)

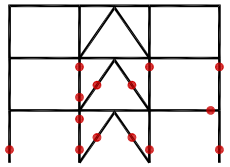


Overview of results

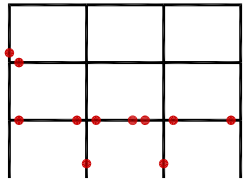
- **R.C. frame: extensive damage**



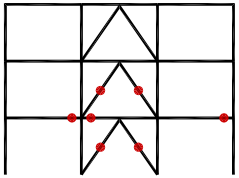
- **BRB strengthened frame:**
  - **increased strength and stiffness**
  - **reduced displacement demand**
  - **extensive damage to columns, beams and BRB**



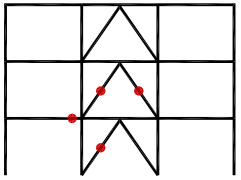
- **FRP strengthened frame:**
  - **similar strength and stiffness**
  - **larger ductility of columns**

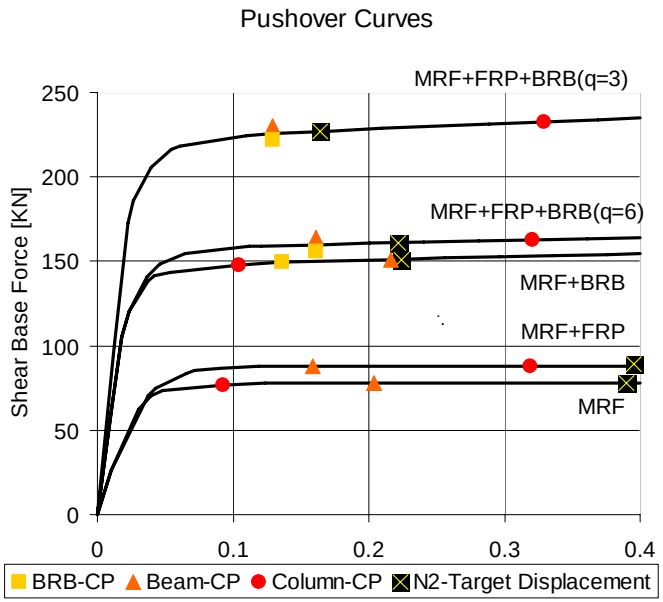


- **BRB+FRP strengthening**
  - **increased strength and stiffness**
  - **large damage to beams and BRB**



- **BRB+FRP strengthening (q=3)**
  - **large strength and stiffness**
  - **moderate damage to beams and BRB**





Conclusions

- **Many r.c. frames designed before 1970s are in need of seismic rehabilitation**
- **Insertion of buckling restrained braces increases global strength and stiffness**
- **Strengthening of r.c. elements (e.g. by FRP) necessary for an adequate seismic performance**
- **Further research**
  - **non-linear time history analysis**
  - **different ground motion characteristics**