High strength steel for seismic resistant building frames

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Introduction

- High strength steels HSS with yield stress of 420-690 MPa or greater have been available for many years.
- There are many applications of HSS in bridge construction,
- In Europe, steel grades S460-S690 are considered "new materials" for seismic applications.
- In US and Japan HSS - more applications. Structural configurations using HSS:
  - Dual frame configurations – MR frames + braced frames with dissipative braces or low-yield dissipative panels - for high-rise buildings
  - MR frames with composite steel (HSS) - concrete columns, partially encased, with controlled dissipation in beams with reduced section (dog-bone) and/or column panel zones, for buildings of intermediate height
HSS applications to buildings in seismic areas

- In seismic areas, the building design is usually controlled by specific design requirements (proper criteria for strength, stiffness and ductility).
- Steel building frames are designed as dissipative structures and plastic deformations are allowed to develop in specific members.
- The members designed to remain in elastic range during the earthquake, as the columns in multi-storey frames, are usually characterized by high demands in strength.
- For such kind of members the use of HSS represents a real and effective opportunity.
- Ongoing projects
  “High-Performance Steels for Buildings Located in High Seismic Areas – STOPRISC”, funded by the Ministry of Education and Research of Romania.
HSS applications to buildings in seismic areas

- S235, S355 and high resistance S460 steel grade
- Study of the possibility of using HSS in seismic resistant buildings:
  - numerical analyses on different frame typologies
  - experimental/numerical simulations on connection details
  - experimental/numerical simulations on MR joints
- Frame typologies
  - Moment Resisting Frames (MRF) of 5 and 11 storeys
  - Dual Frames with Eccentric inverted V-Bracing and short horizontal link (EBF), of 8 and 16 storeys
  - Dual Frames with Concentric inverted V-Bracings (CBF), of 8 and 16 storeys
HSS applications to buildings in seismic areas

Frames were designed according to Eurocode 8 and the Romanian seismic code P100-2006
HSS applications to buildings in seismic areas

Base shear force vs. top displacement in the pushover analysis

Plastic hinges in the elements for the corresponding target displacements
HSS applications to buildings in seismic areas

- MRF structures are generally designed by SLS criteria, thus the use of HSS may not be economical.
- However, for low-rise MRF structures with larger spans, strengthening of columns by using HSS may be necessary to avoid column failure in case of “near-collapse” state.
HSS applications to buildings in seismic areas

- Ongoing research activities
  - experimental/numerical simulations on connection details
  - experimental/numerical simulations on MR joints