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U.PORTO

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Assessment of seismic design methodologies for steel moment frames

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Earthquakes and Steel Structures

- Earthquakes can induce significant levels of **damage** in steel structures, eventually leading to local/global **collapse**.

- Damage should not be a concern on itself! It is actually implicit in seismic design when one adopts a behaviour factor (q).
- Critical is to control the level of damage for a pre-defined seismic intensity level (e.g., return period).

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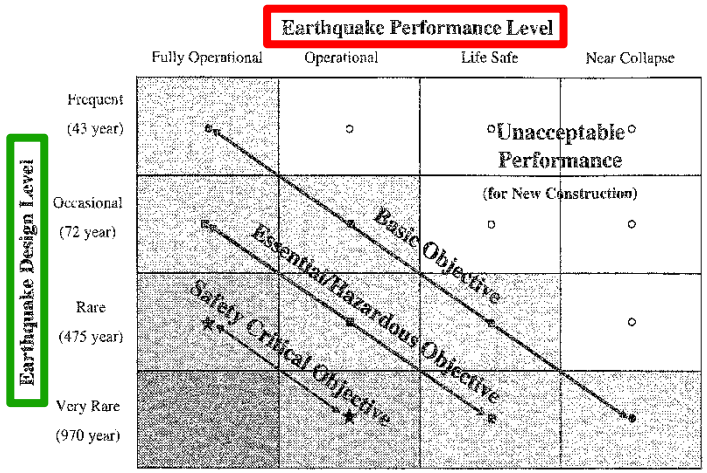
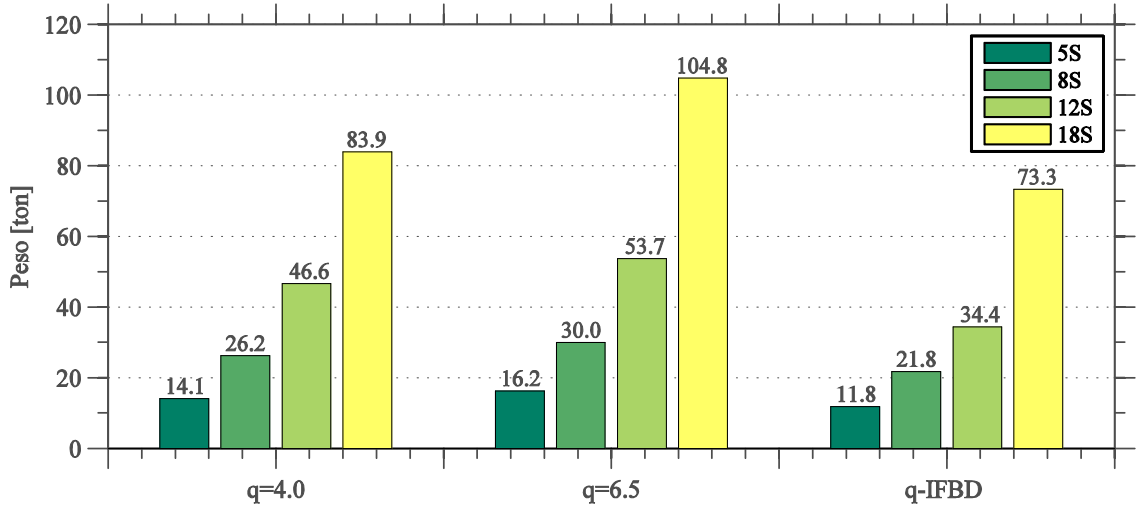
Performance-Based EQ Engineering

- This concept was introduced during the 1990s after the occurrence of the 1994 Northridge and 1995 Kobe earthquakes.
- Main idea is to define performance objectives which basically consist of specifying performance level for a given level of seismic hazard.



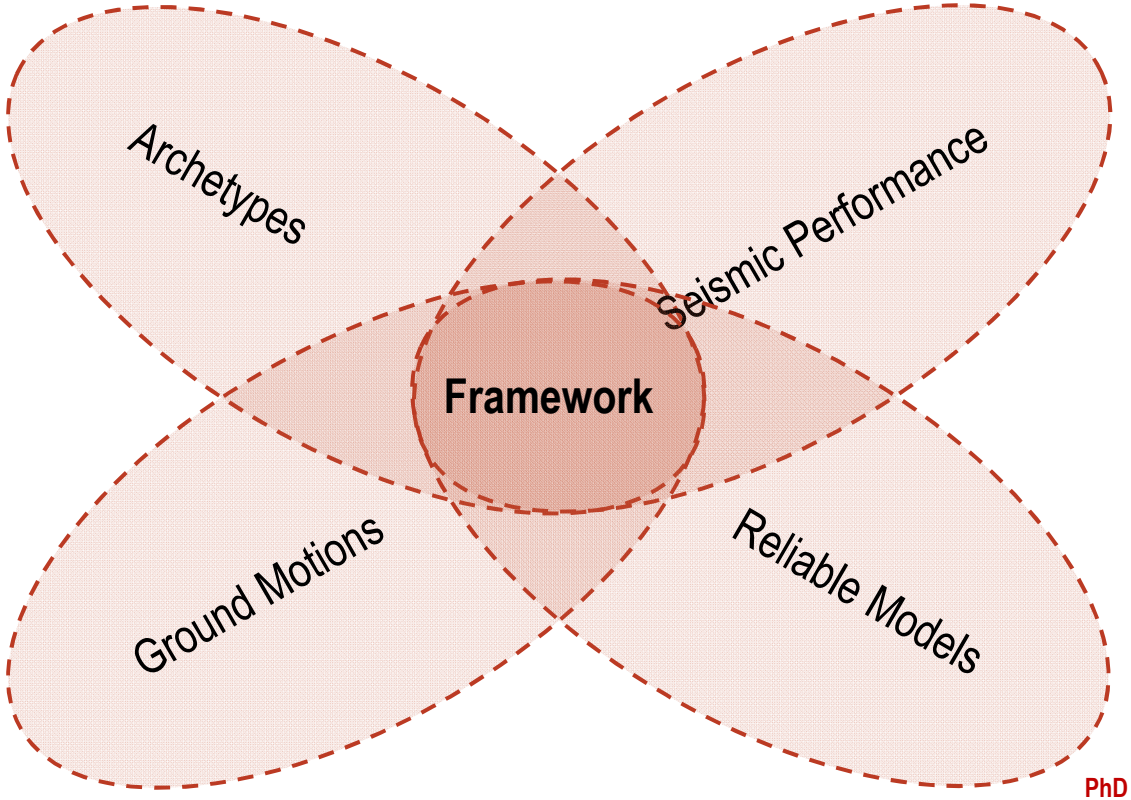
Assessment of seismic design methodologies

- Eurocode 8
  - Performance requirements (No-collapse & Damage Limitation)
  - Compliance criteria (ULS & SLS)
- However some problems have been identified:
  - Same structure in different seismic zones (eg. Porto and Lagos)
  - Contrary to expected, higher behaviour factor results in heavier structures



Assessment of seismic design methodologies

- Available assessment methodologies
  - **FEMA P695** – Quantification of building seismic performance factors
  - **FEMA P58** – Loss assessment methodology
- Key Elements



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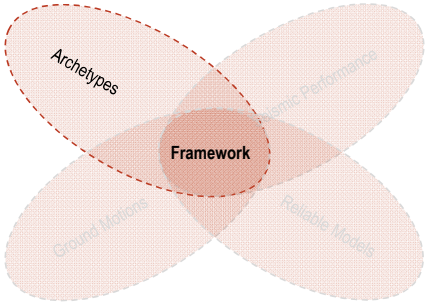
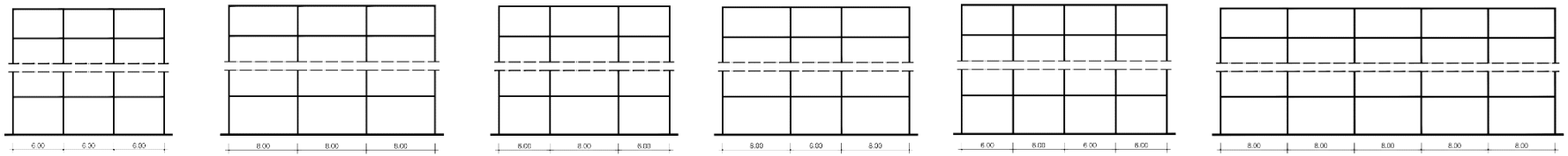
Archetypes



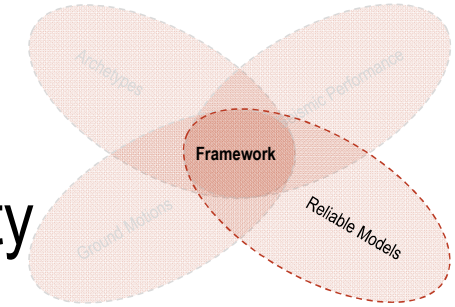
- Six different layouts (2, 3, 4, 5 and 8 storeys)



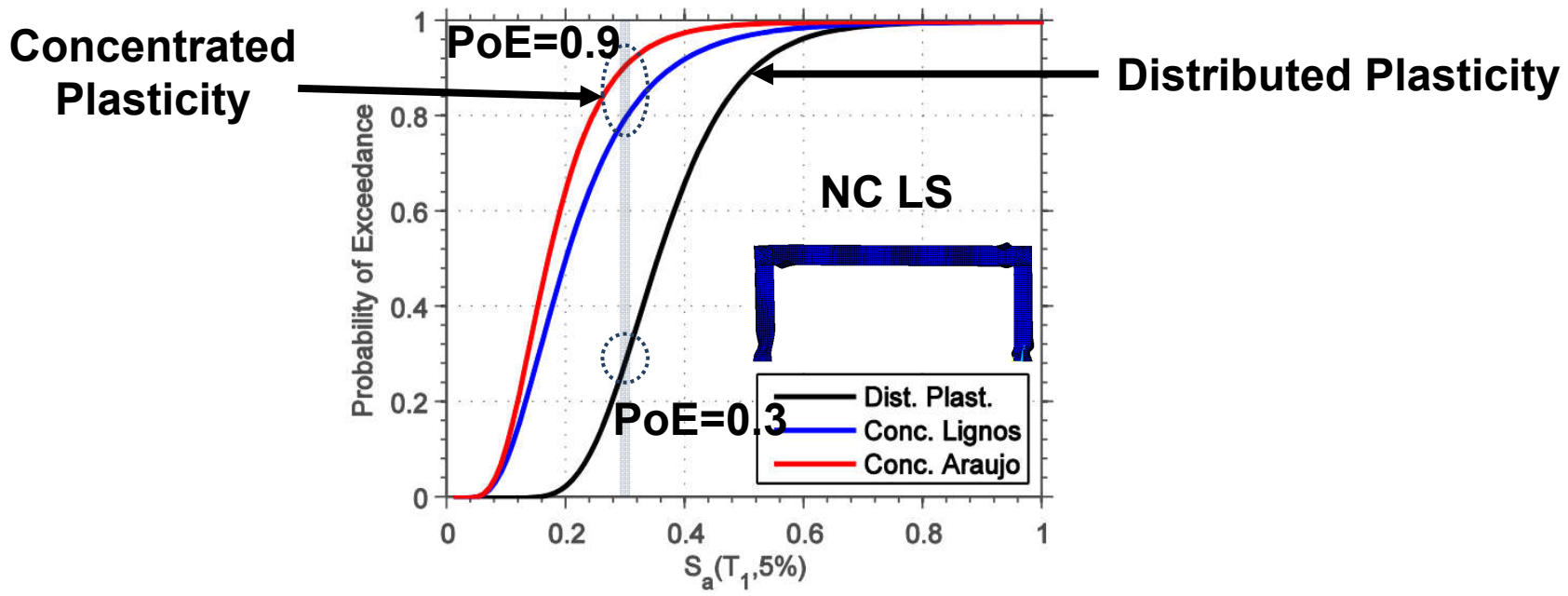
- Three different locations: Porto, Lisbon and Lagos
- Designed according to EC8 using three different behaviour factors: 4, 6.5 and IFBD

A TOTAL OF 270 STRUCTURES

Modelling Strategies



- Distributed Plasticity vs Concentrated Plasticity



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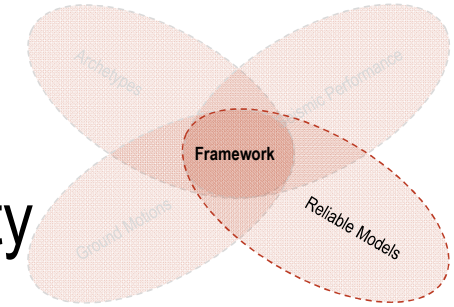
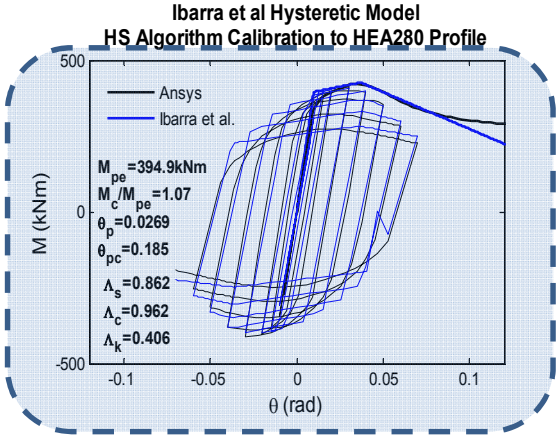
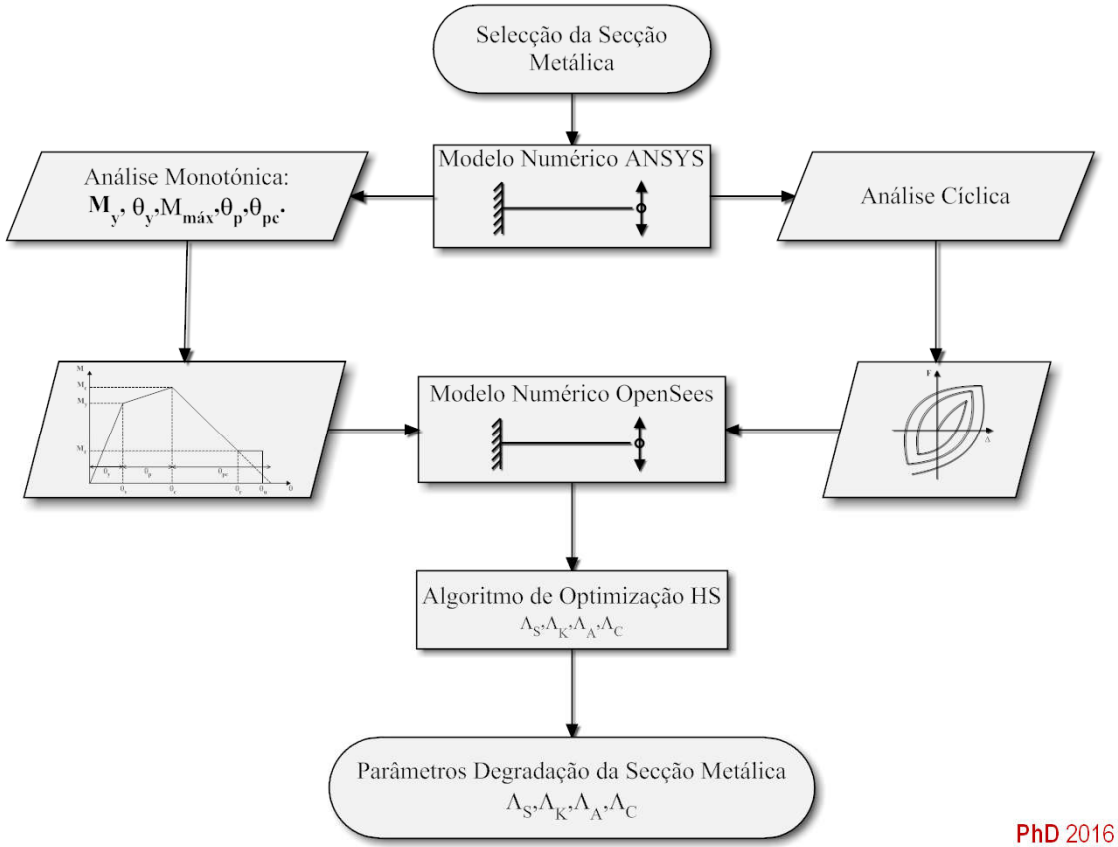


- Distributed Plasticity vs Concentrated Plasticity
- Calibration procedure for european shape profiles





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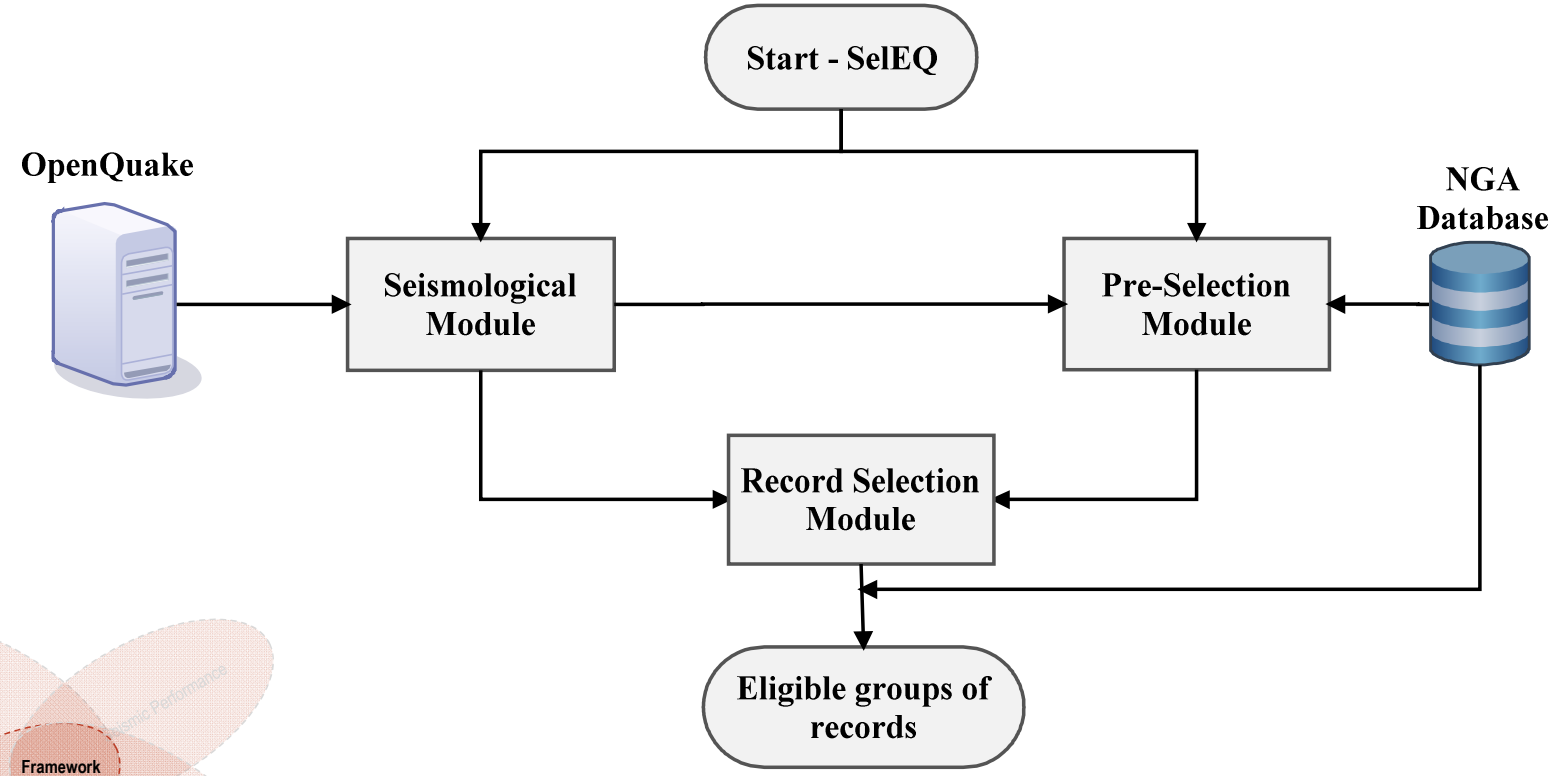
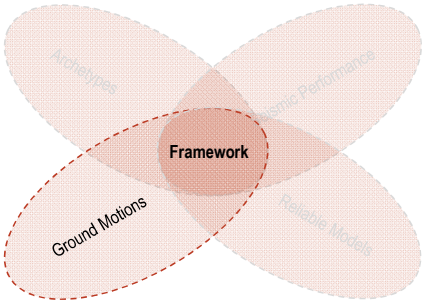
Ground Motion Selection

- SelEQ: An advanced ground motion selection and scaling tool





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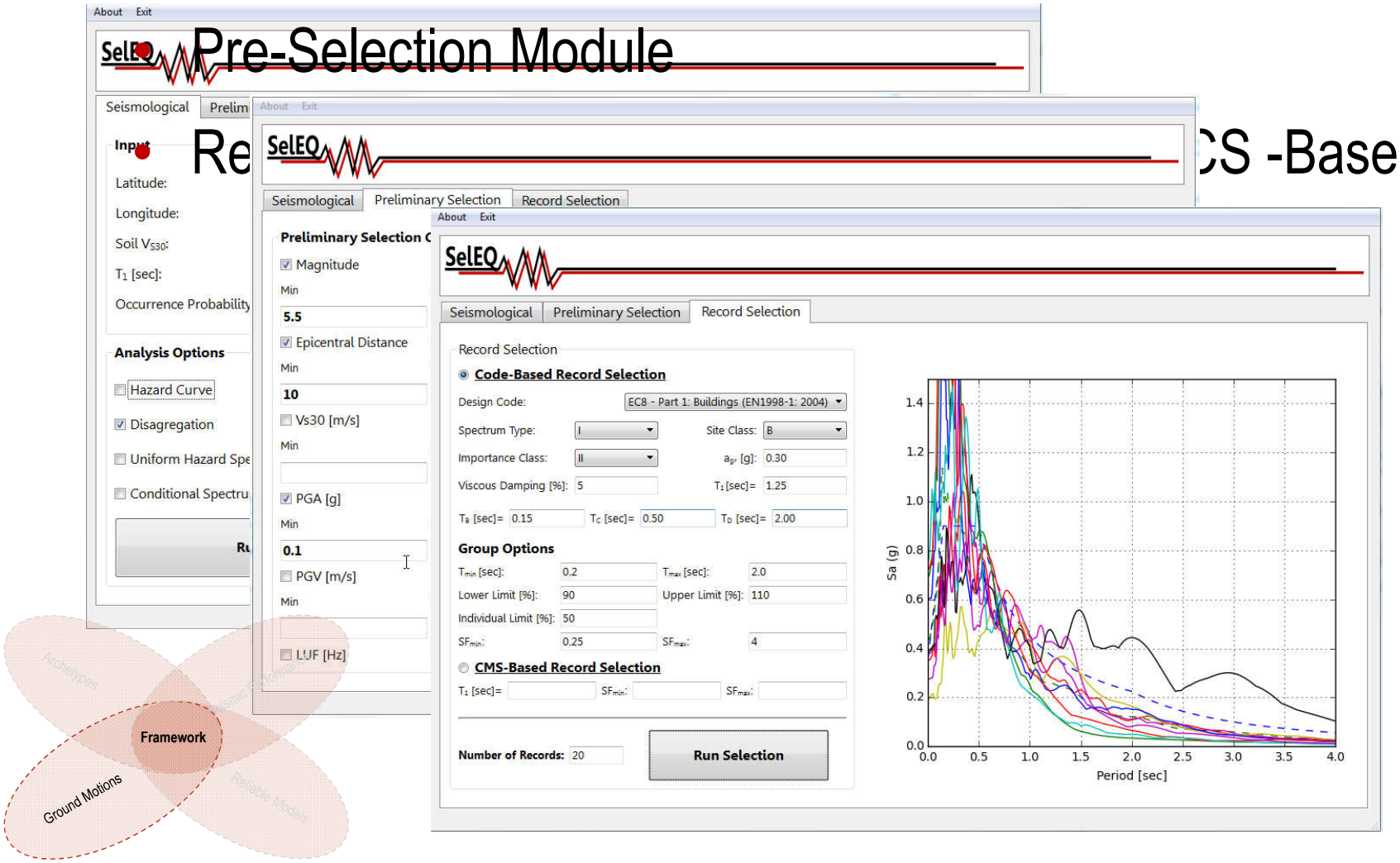
Ground Motion Selection

- Seismological Module (Conditional Spectrum generation)



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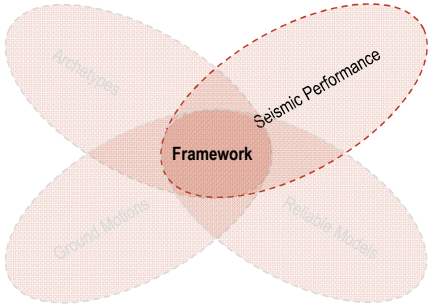
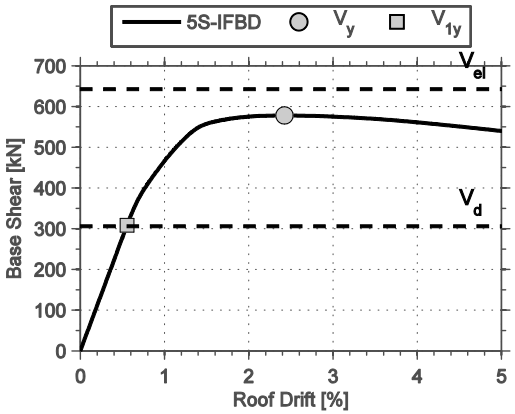
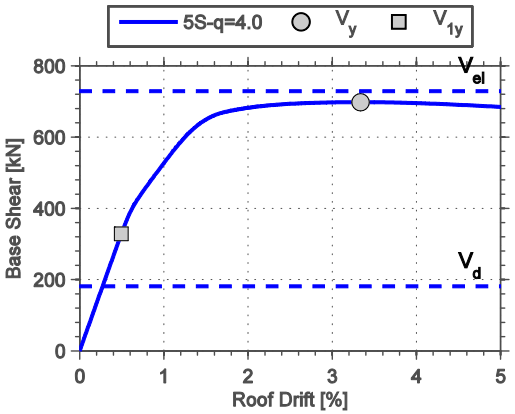
Seismic Performance Assessment

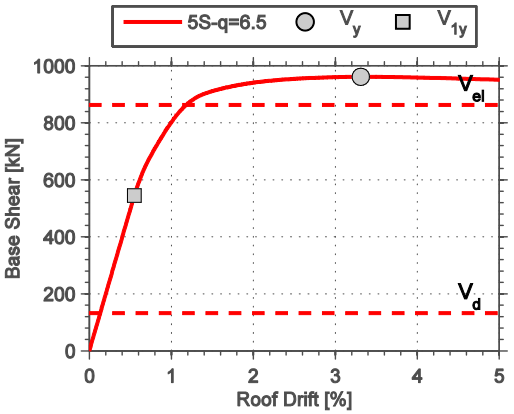


- System overstrength

5 Storeys







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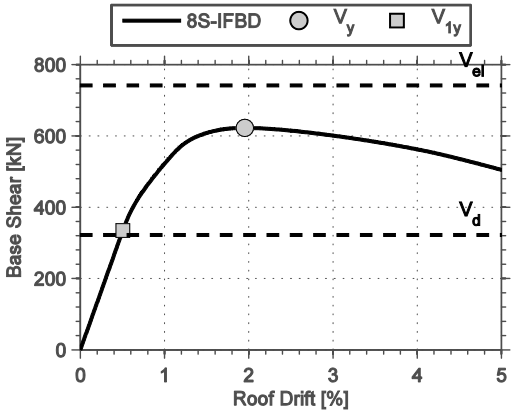

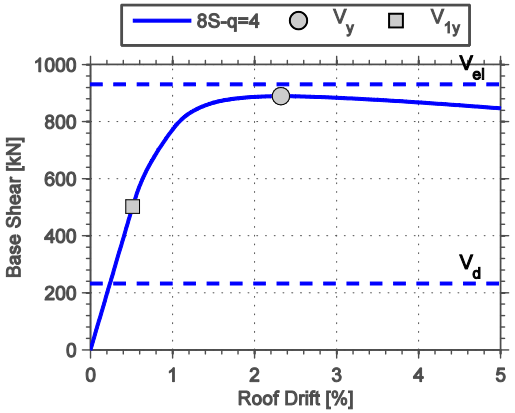

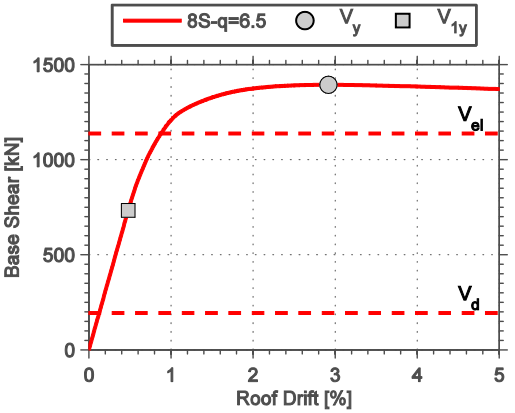

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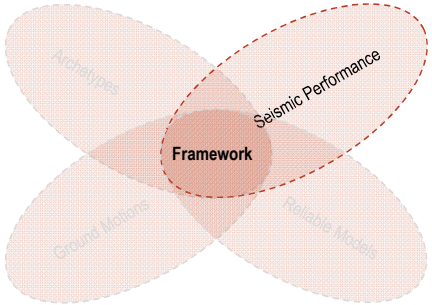
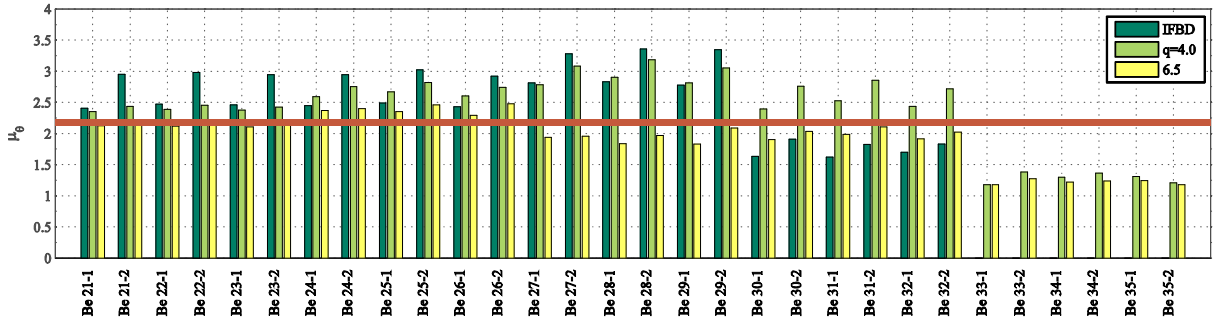


- System overstrength
- Rotation ductility

5 Storeys



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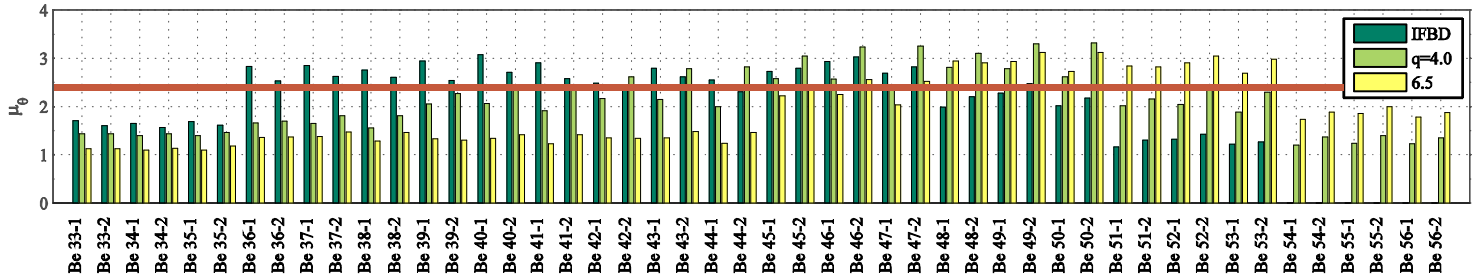

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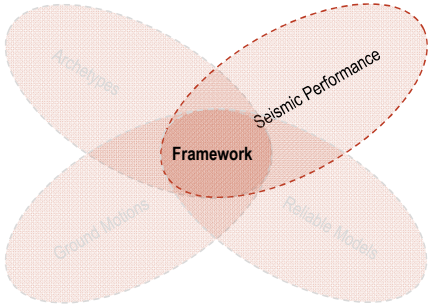
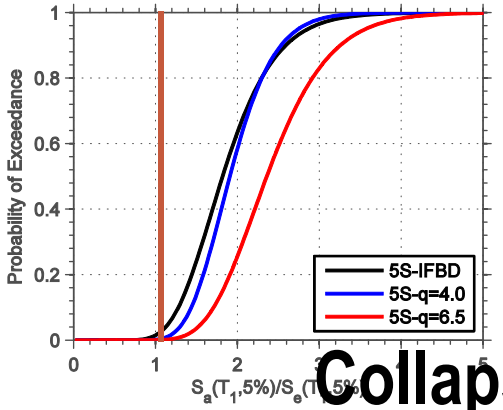
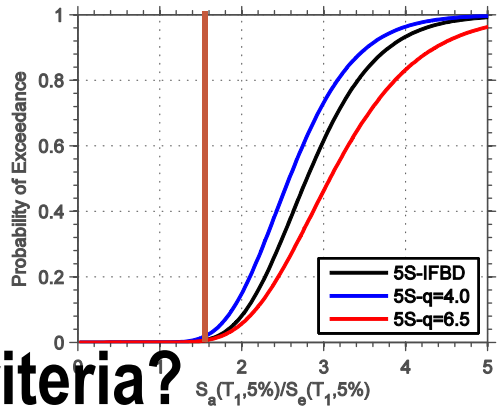


- System overstrength
- Rotation ductility
- Collapse assessment

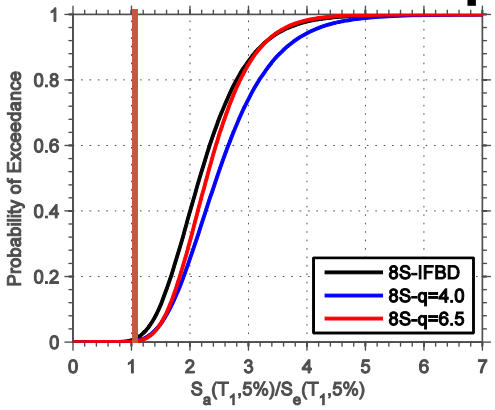
5 Storeys

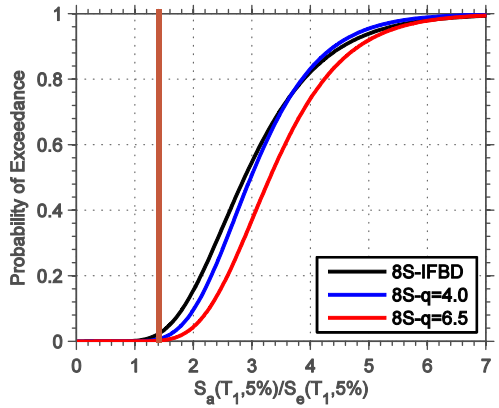




Collapse Criteria?

8 Storeys





Conclusions

- New deterioration parameters of steel members with European profiles have been defined.
- An advanced ground motion selection and scaling tool have been developed
- Application of FEMA P695 validates and demonstrates the advantages of using IFBD procedure
- The developments are fully compliant and could be integrated in EC8.