Progetto DPC-ReLUIS 2024-2026 WP 11
Task 3 – Metodo del Fattore Globale applicato alle analisi non lineari (G. Monti)

Seismic Assessment of RC Frames Using Nonlinear Pushover and Variability Propagation

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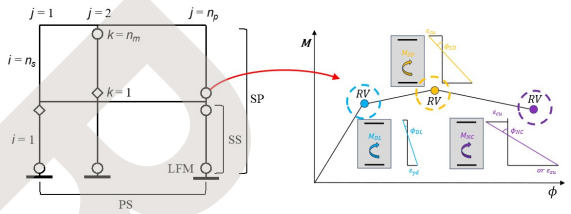
Scope and Motivation

Push-over analysis performed according to current codes **does not provide safe estimates** of structural capacity
Treatment of uncertainties through **Confidence Factors** is oversimplified.
Need for a rational method to determine **design capacity** meeting EN1998-1-1:2024 reliability targets $\beta_{t,LS,CC}$.

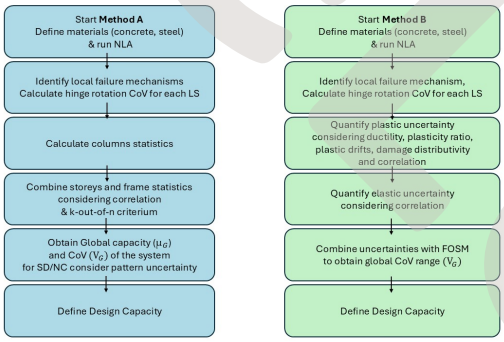


Schematic representation of hierarchical structural system logic:
n_m is the number of local mechanisms in an element regarded as a series system (SS),
n_c is the number of elements in a storey regarded as a parallel system of series subsystems (PS),
n_s is the number of storey where local mechanism develop, regarded as a SS of parallel subsystems (SP).

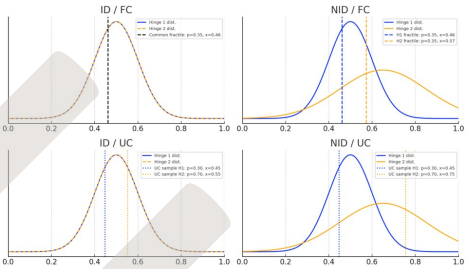
RC frame as a system of interconnected components
arranged in a logical hierarchy, to propagate uncertainty
from hinge-level (local) to frame-level (global) using system logic.

Methodology

Method A – Hierarchical Statistical Propagation: rigorous, bottom-up, uses series/parallel system logic → **for scientists**.
Method B – Simplified FOSM: pragmatic, global displacement model, faster and practical → **for engineers**.



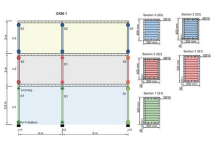
The flowcharts compare the two methodologies for uncertainty propagation in NLA.
Method A (left, blue), a full hierarchical FOSM approach with pattern variability.
Method B (right, green), order statistics from pushover markers,
to provide a simplified engineering-oriented alternative.

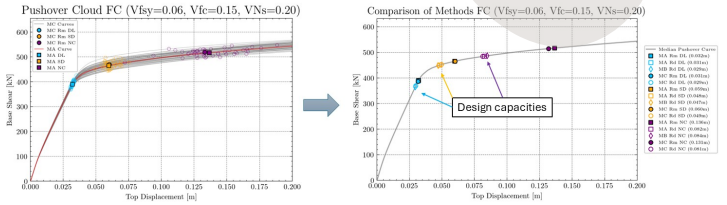


Statistical properties and correlation assumptions for hinge capacities:
ID / FC: Hinges have identical distribution (same mean and dispersion) and are Fully Correlated (same fractile) leading to the same capacity value.
NID / FC: Hinges have non-identical distributions but are fully correlated, so the same fractile yields different capacity values.
ID / UC: Hinges follow the same distribution, but fractiles are sampled independently. This produces different realizations from the same statistical law.
NID / UC: Hinges follow different distributions and fractiles are sampled independently, resulting in distinct capacity values for each hinge.

Results & Insights

1. Both methods are based on **one single** push-over analysis
2. Both methods match Monte Carlo results
3. **Framework bridges reliability theory and engineering practice.**





Comparison of Methods: Comparison of Critical Global Failure Mechanisms and Design Capacities at each LS, calculated using MA (square marker) and MB (diamonds) against the results from MC simulations (circles).
Pushover Cloud: Visualizes the structural response variability by showing the entire "cloud" of pushover curves from the MC simulations.
The pushover curve and performance points from MA are overlaid to compare its deterministic prediction against the full probabilistic distribution.