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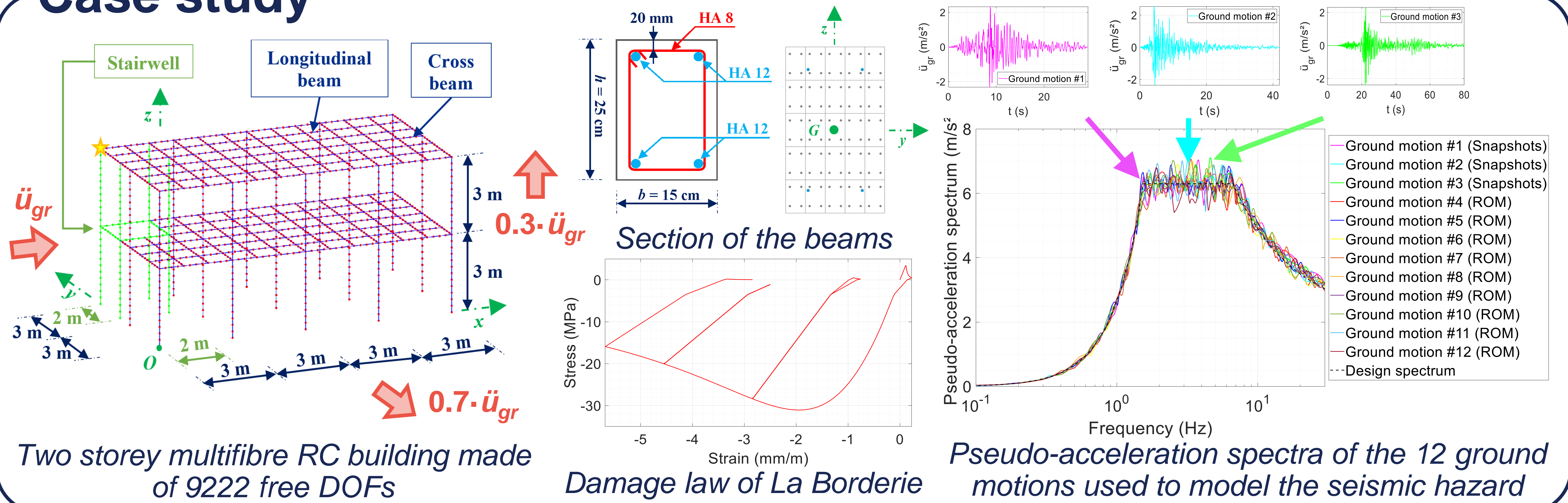
POD-DEIM MODEL ORDER REDUCTION IN THE CASE OF DAMAGING RC STRUCTURES SUBJECTED TO EARTHQUAKES

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Earthquake Engineering, Reinforced Concrete, Multifibre Beam Elements, Proper Orthogonal Decomposition (POD), Discrete Empirical Interpolation Method (DEIM)

In this work, a POD-DEIM reduced order model is used with a non-iterative α -OS time-integration scheme to speed up FEM analyses on a two-storey RC structure made of damaging multifibre beam elements subjected to a seismic hazard modelled by a set of 12 earthquakes.

Case study



Full order FEM analyses with ground motions #1 to #3

Snapshots

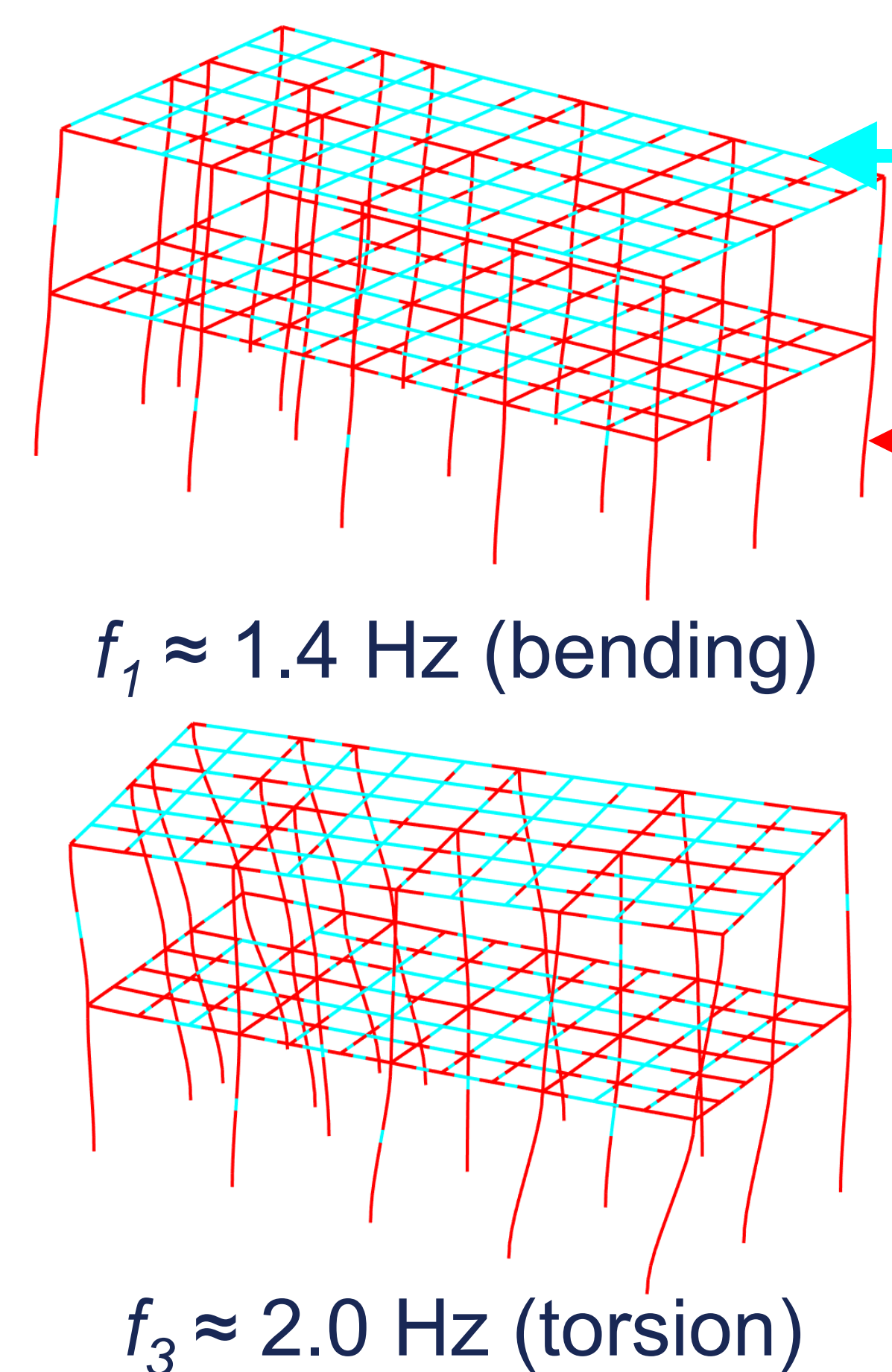
Non iterative α -OS time scheme

$$M \cdot \ddot{u} + C \cdot \dot{u} + K_E \cdot u + \tilde{r}_{NL}(\tilde{u}) = -M \cdot \Gamma \cdot \ddot{u}_{gr}(t)$$

Explicit prediction of the nonlinear part of the restoring force vector

SVD on a set of snapshots of u

POD-modes

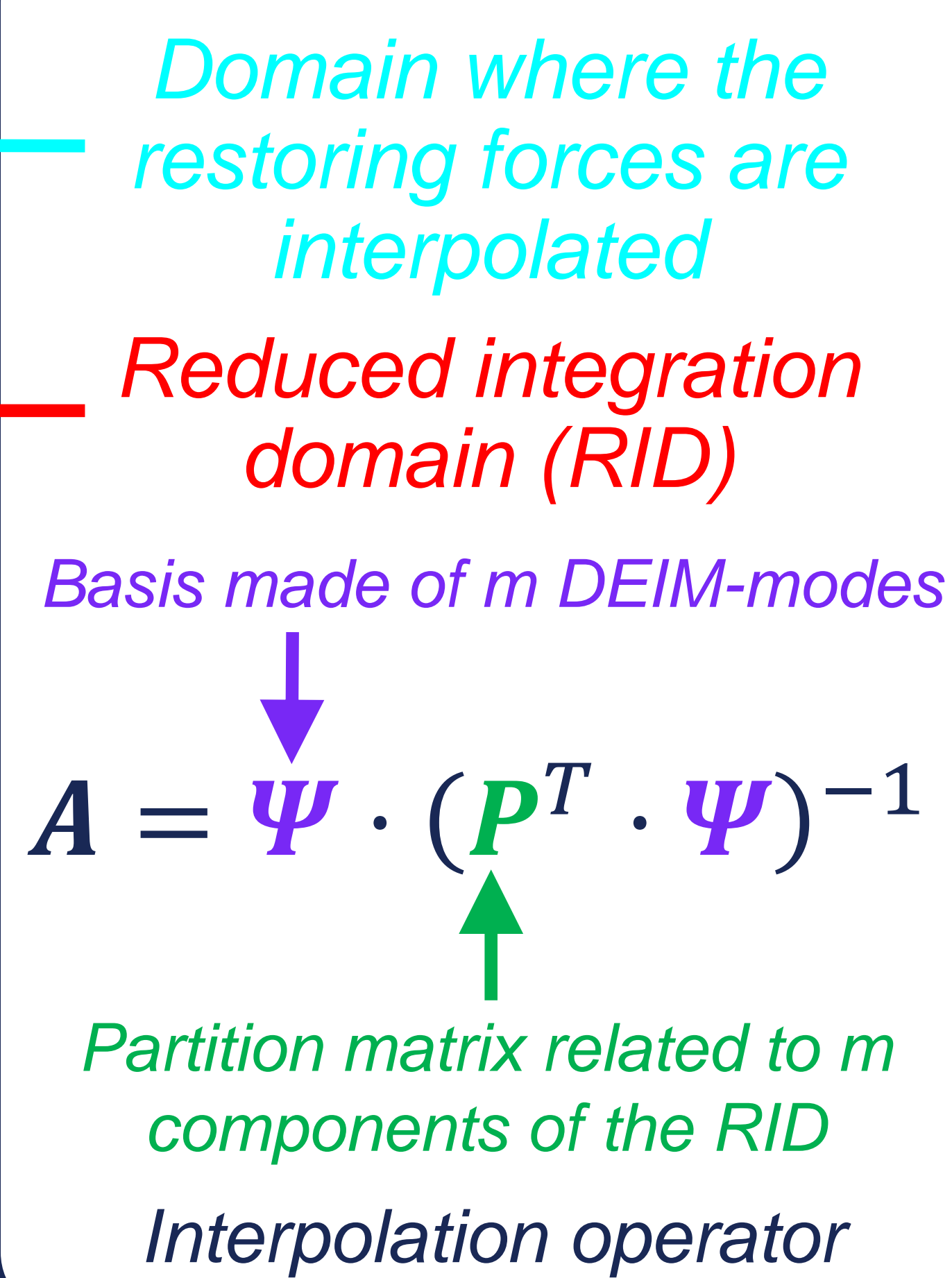


$$u \approx B \cdot q$$

Projection of the displacements on a basis B made of n POD-modes

SVD on a set of snapshots of \tilde{r}_{NL}

DEIM-modes



$$\tilde{r}_{NL} \approx A \cdot \tilde{r}_{NL}^{RID}$$

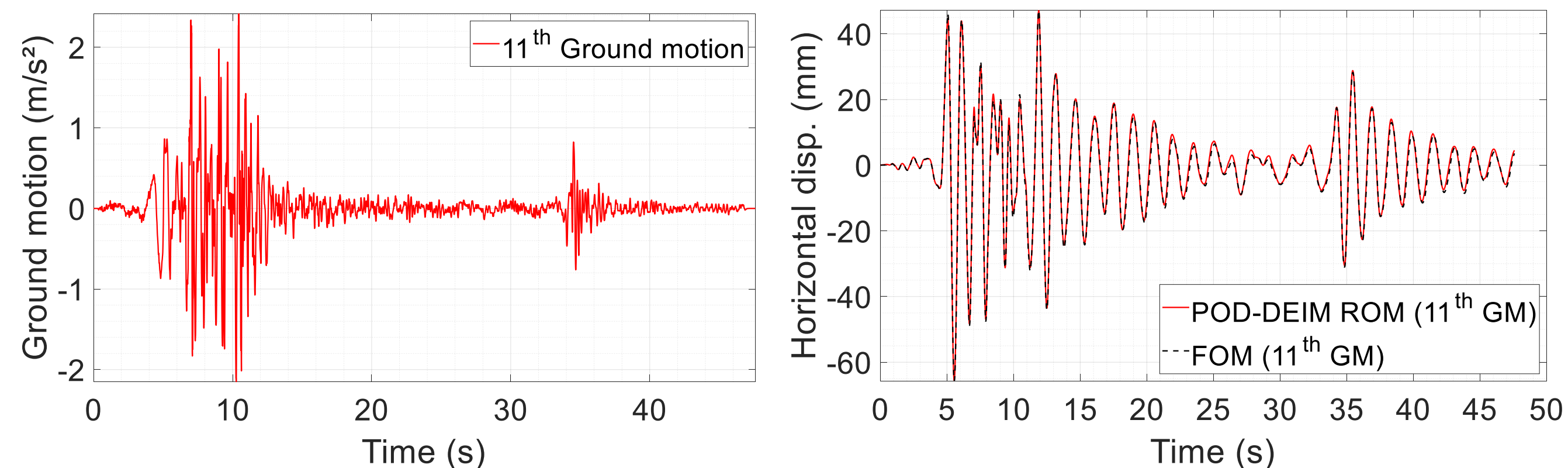
Interpolation of the restoring force vector on the full domain

Online phases

$$1 - \frac{\sum_{i=1}^n \lambda_i}{\sum_{i=1}^N \lambda_i} \leq \epsilon$$

POD : $\epsilon = 1 \cdot 10^{-2} \rightarrow n = 20$
 DEIM : $\epsilon = 5 \cdot 10^{-6} \rightarrow m = 2303$

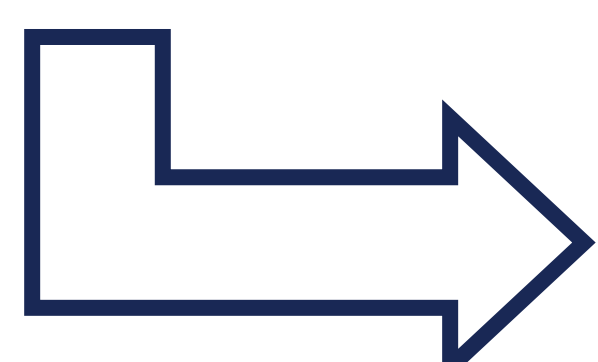
Criterion used to select the number of modes



Time savings with the POD and the POD-DEIM

Ground motion	#4	#5	#6	#7	#8	#9	#10	#11	#12
Error (%)	0.3	0.6	0.2	0.6	0.3	0.7	0.3	0.2	0.6
Time saving POD (%)	22	28	23	27	27	27	23	30	27
Time saving POD-DEIM (%)	46	49	47	48	48	48	48	49	48

The error is less than 1 % with a 50 % time saving during each online phase.



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