REMTECH EXPO

GEOSISMICA

20 Settembre 2018

LIQUEFAZIONE E INSTABILITA' DINAMICA DEI TERRENI

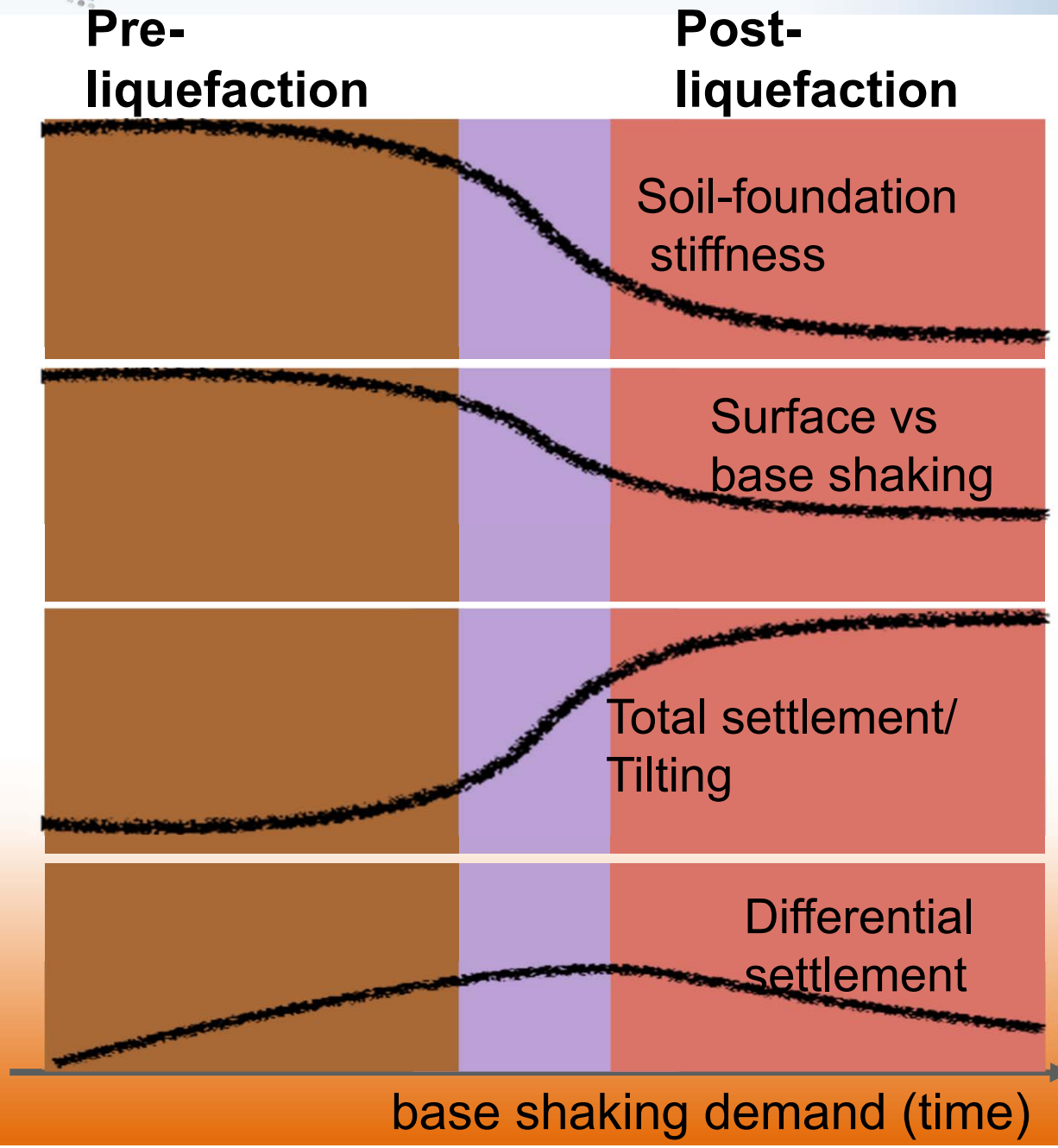
Liquefaction vulnerability of structures and infrastructures

Sara Rios – *University of Porto*

RemTech Expo 2018 (19, 20, 21 Settembre) FerraraFiere

www.remtechexpo.com

System changes due to liquefaction



Consider as two systems:
Pre-liquefaction
Post-liquefaction

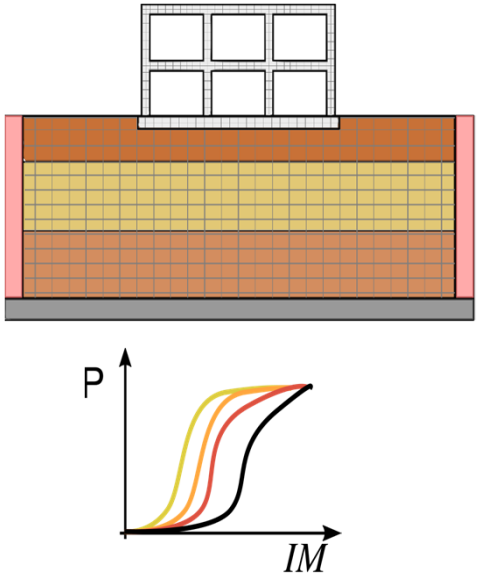
Work Package 3 objectives

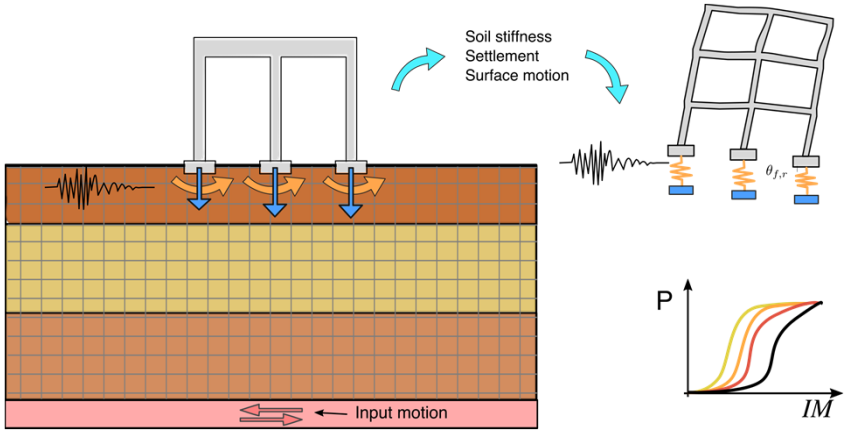
1. Develop an efficient numerical procedure for the simulation of liquefaction-induced damage in critical structures and infrastructures.

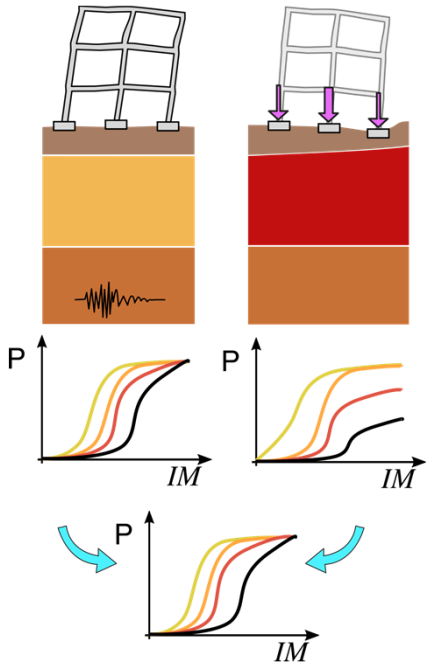
2. Develop an efficient probabilistic framework for liquefaction vulnerability analysis of critical structures and infrastructures.

3. General framework procedure for, in view of subsoil properties, the public authorities to give the necessary approaches for users and owners of critical infrastructures to increase their resilience.

Evaluation of options







Full model approach

- Interactions implicitly dealt with
- Performance obtained from a single model

- Not efficient
- Limited structural modelling options
- Difficult to evaluate uncertainties

Macro-mechanism approach

- Modular so can include multiple methods
- Uncertainties can be evaluated at each step

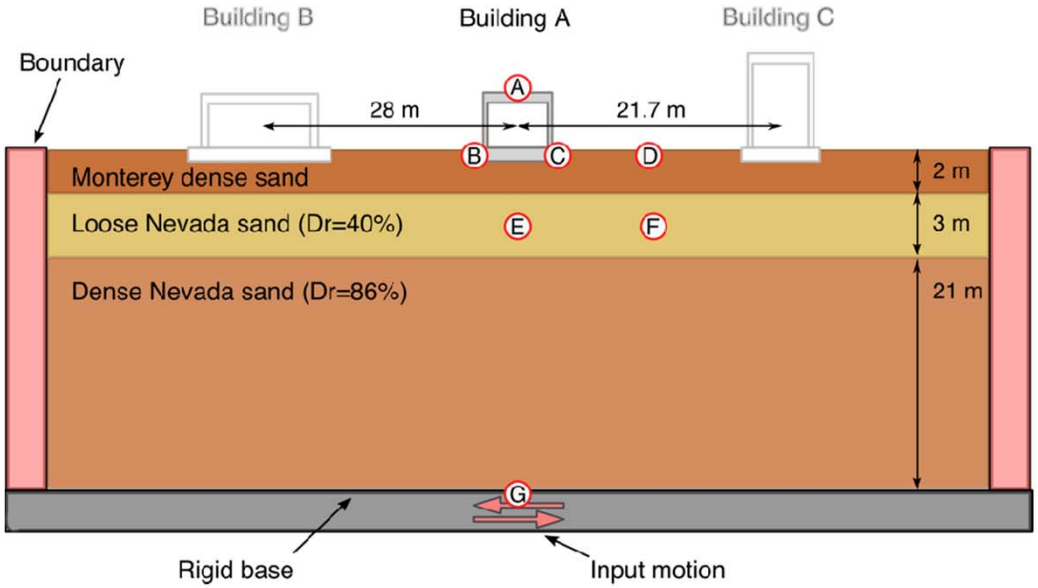
- Difficult to deal with nonlinearities appropriately
- Some aspects had not been quantified for immediate use

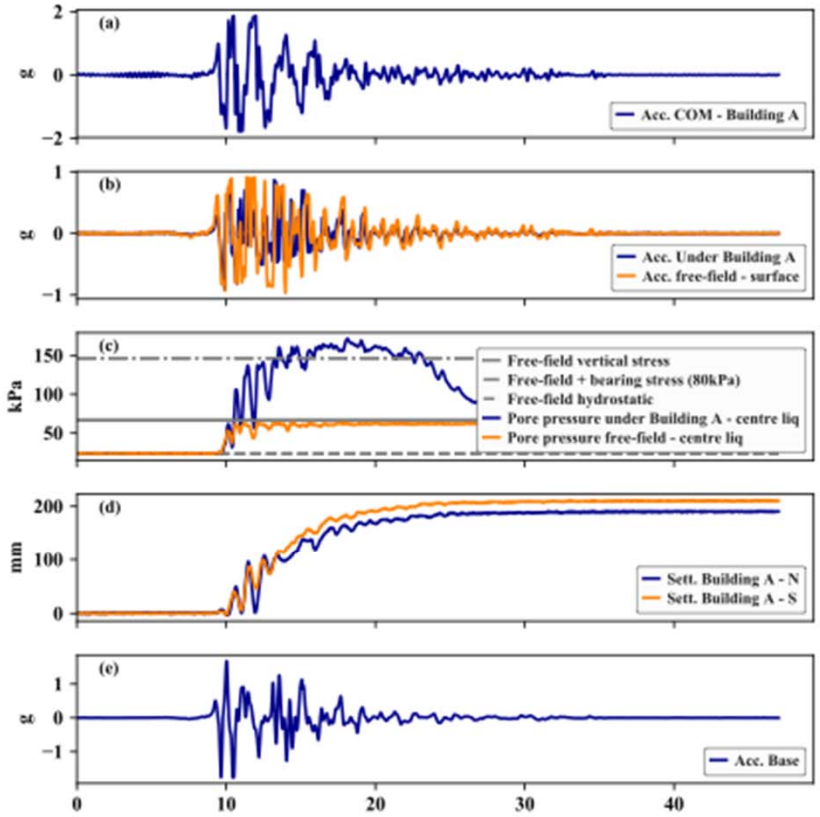
Separate hazards approach

- Fast to apply
- Can use existing shaking damage fragility curves

- No interaction between soil and structure
- Difficult to evaluate settlements
- Requires multiple intensity measures

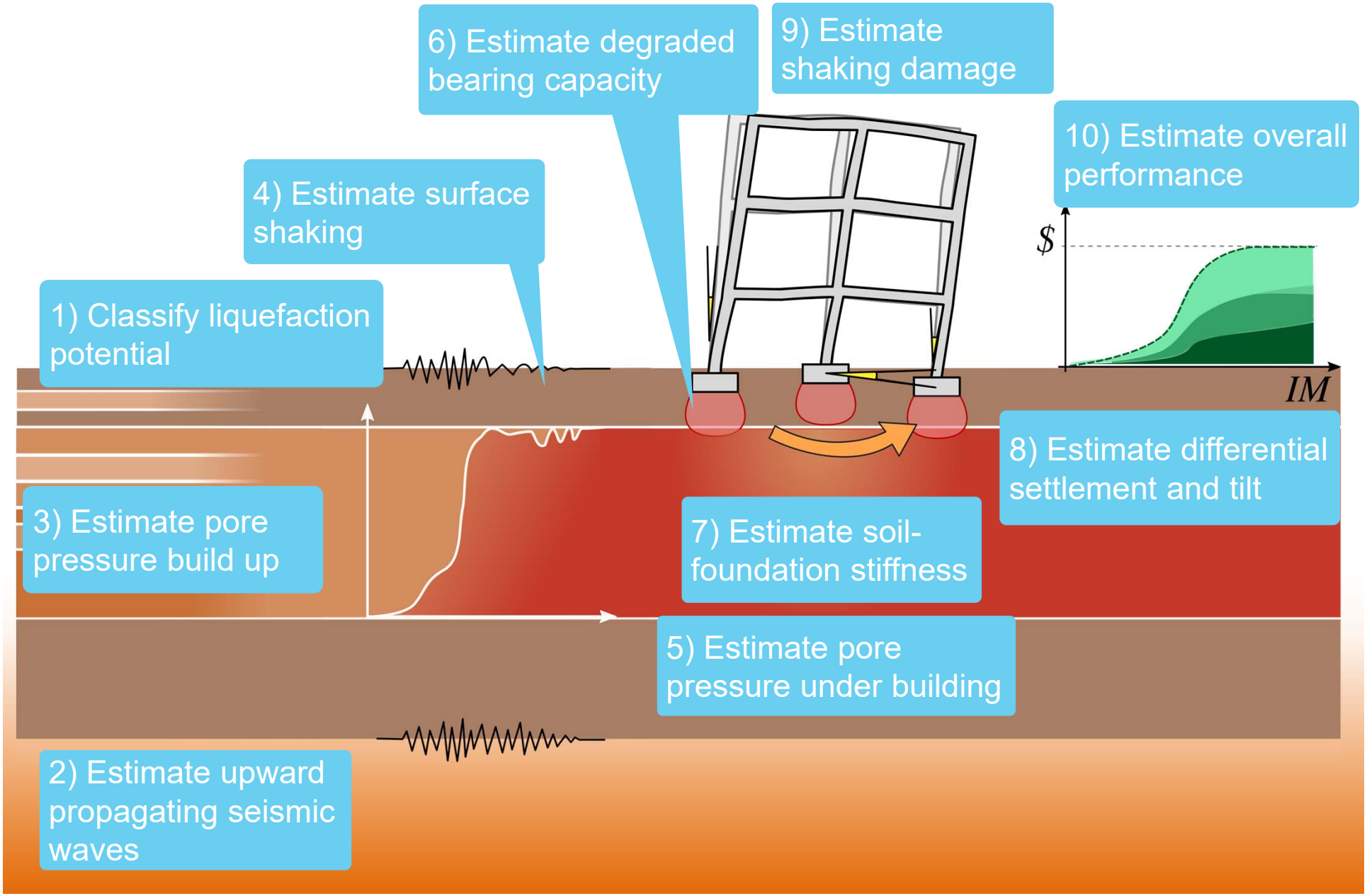
Dashti (2010) centrifuge tests

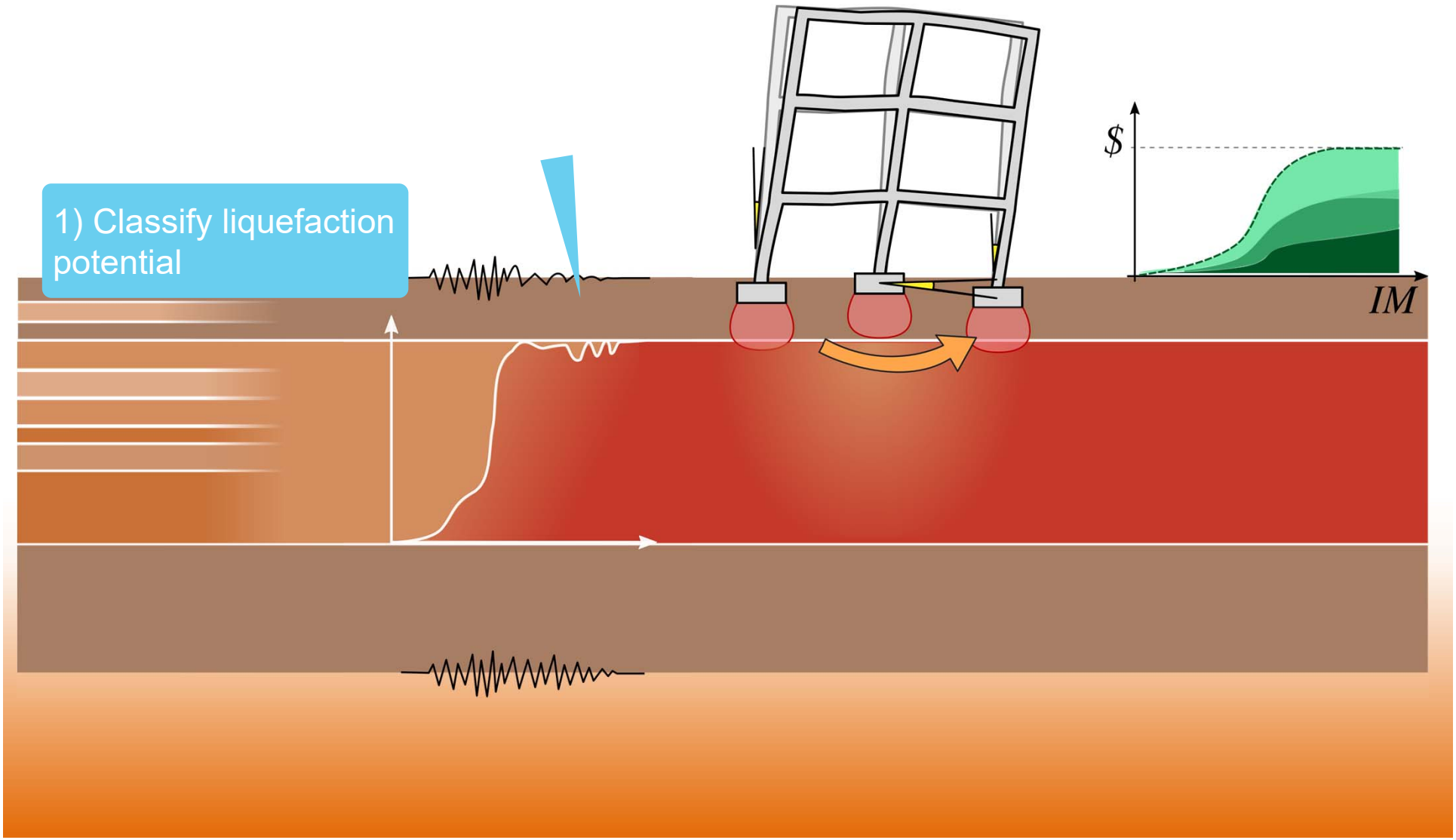




Liquefaction causes a change in the behaviour in terms of surface ground motion, system stiffness, and settlements

Key steps - macro-mechanism approach



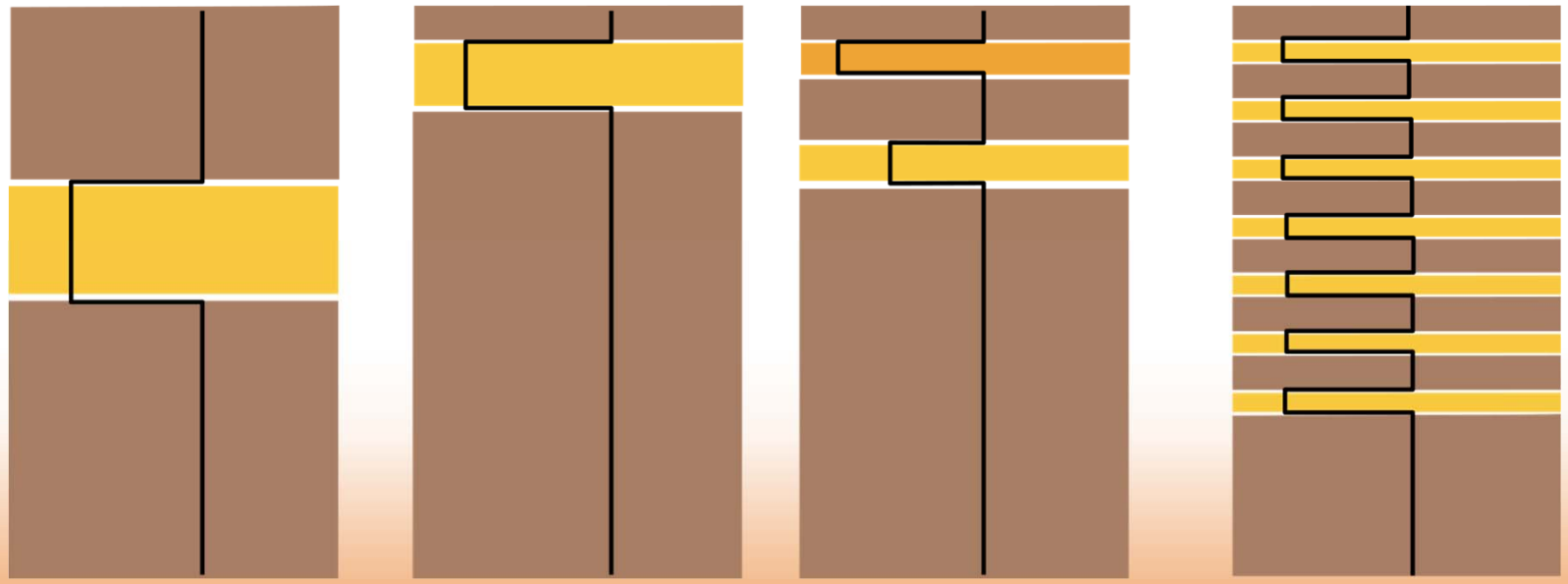

1) Classify liquefaction potential
$
IM

Classifying liquefaction potential

Need to answer:

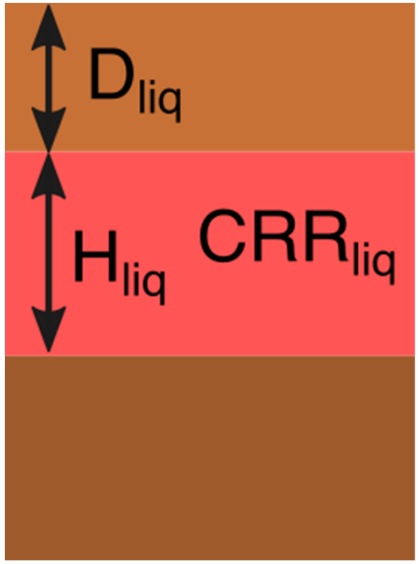
- What level of differential settlement could be expected in the structure?
- What level of shaking could be expected in the structure?
- What level of soil-foundation stiffness could be expected?

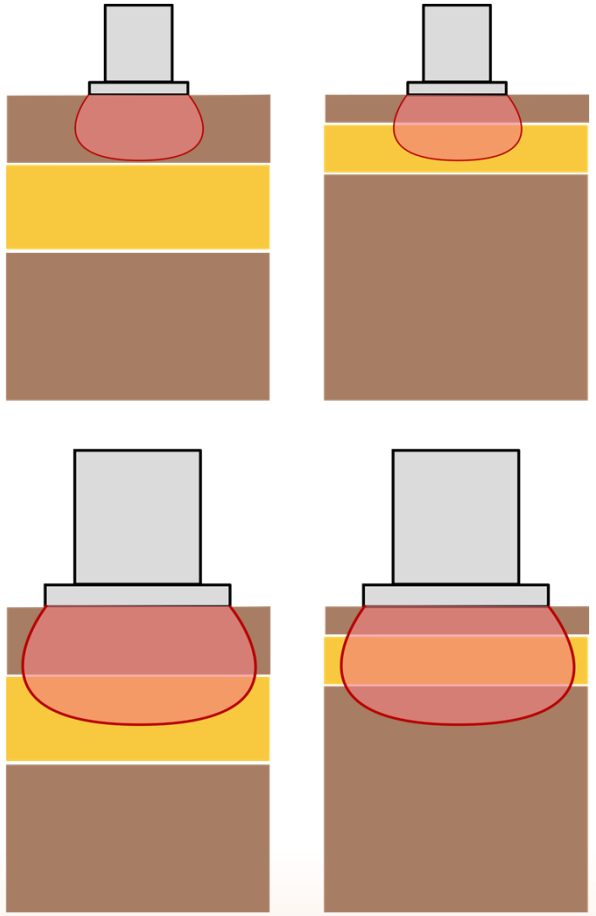
CRR profile for LSN = 20 @ PGA = 0.15g



Existing methods provide non-unique soil profiles and do not account for the presence of the building and the time to liquefaction.

New classification for liquefaction potential





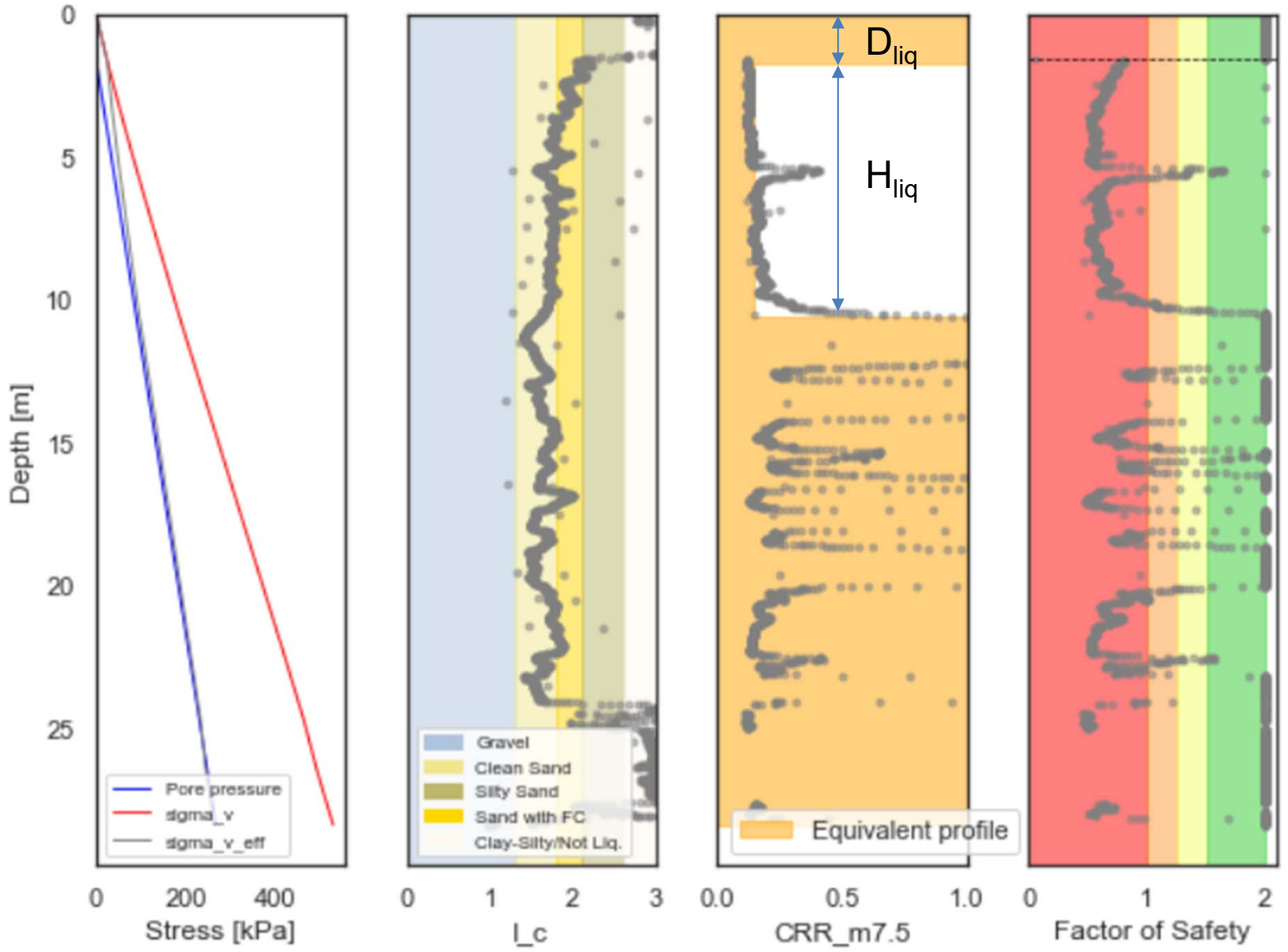
Cyclic resistance ratio: influences timing of liquefaction

Depth to liquefaction: influences ground motion characteristics and bearing capacity/settlement

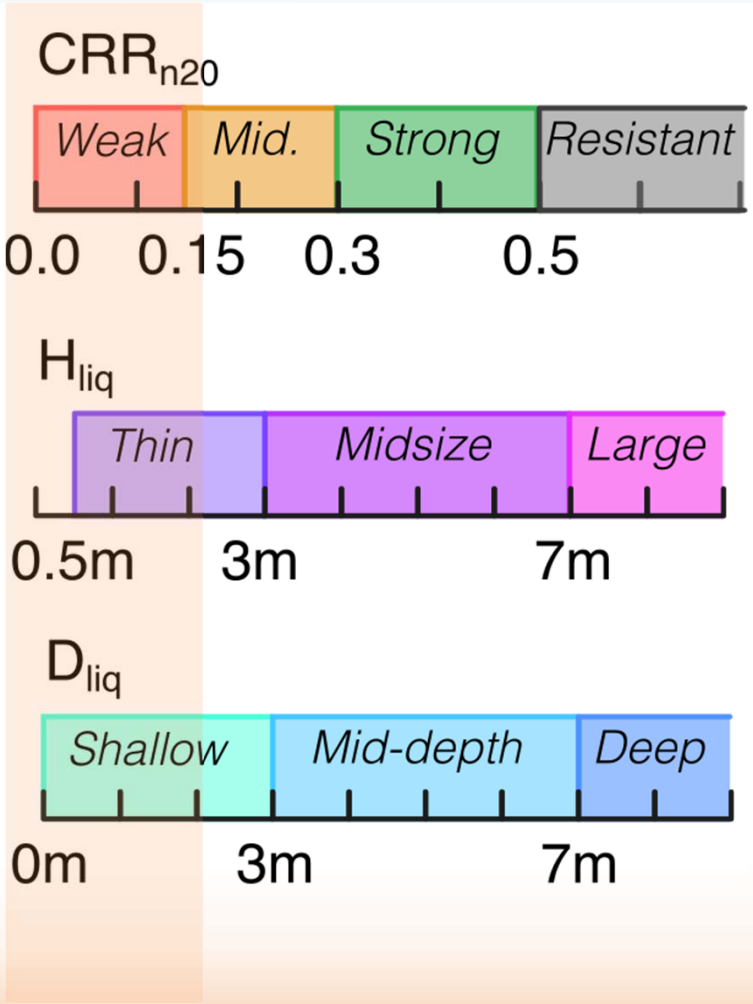
Height of liquefaction: influences ground motion characteristics and bearing capacity/settlement

Simple geometry means the performance of buildings on different soil profiles becomes intuitive.

Fitted profile from CPT



Criteria and classes for loss assessment

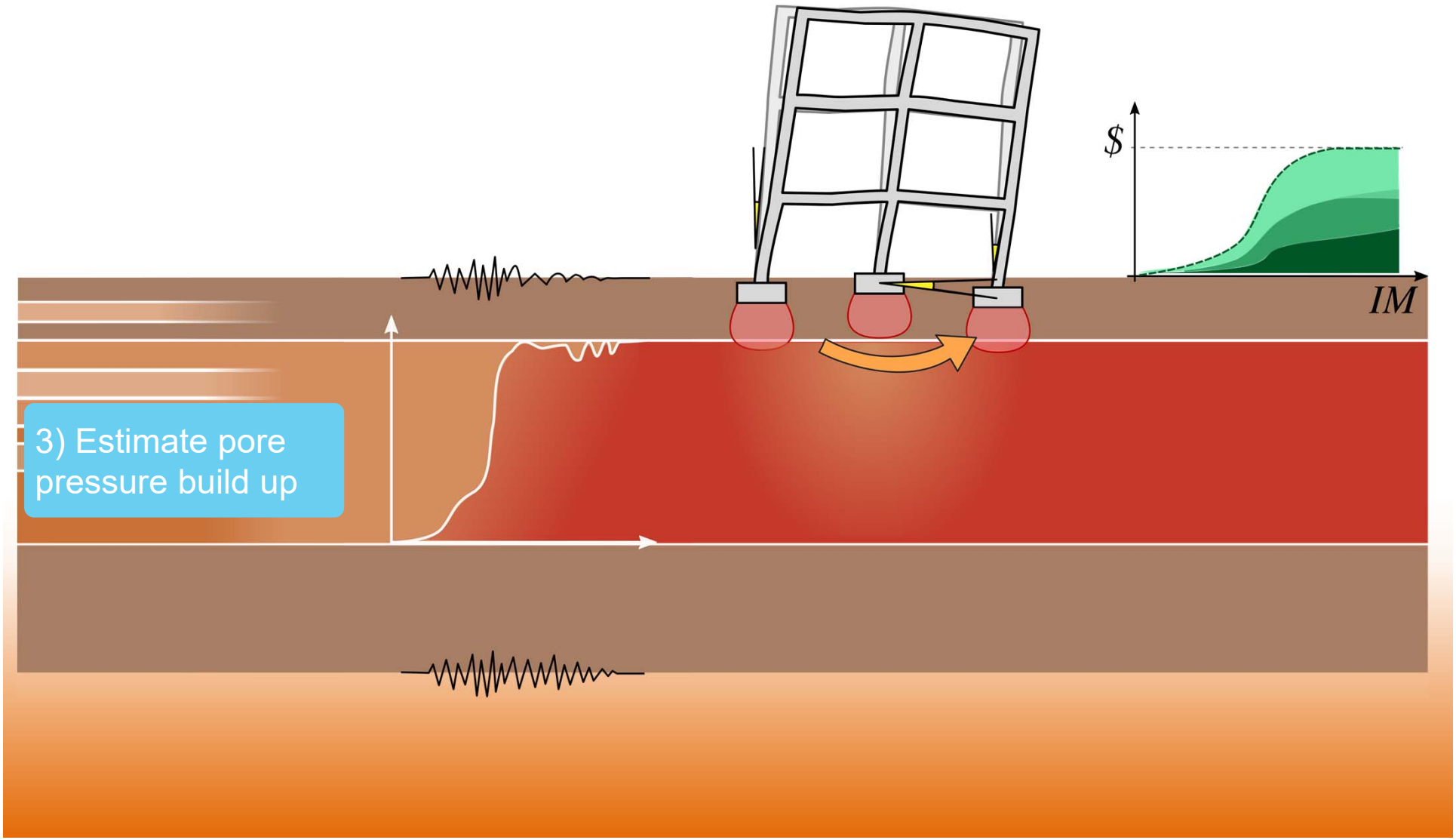


Strength - Size - Position

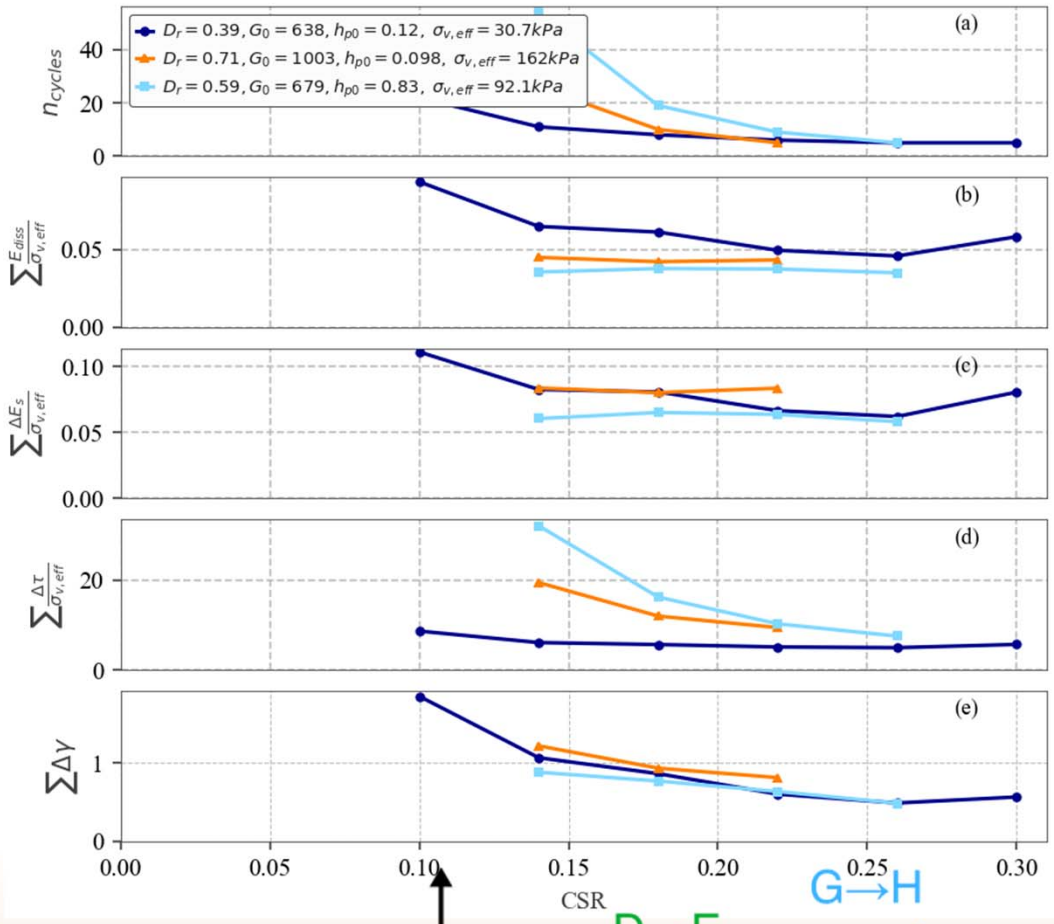
		Weak	Mid.	Strong	Resist
Large	Shallow	WLS	MLS	SLX	RXX
	Mid.	WLM	MLM		
	Deep	WLD	MLD		
Midsize	Shallow	WMS	MMS	SMX	
	Mid.	WMM	MMM		
	Deep	WMD	MMD		
Thin	Shallow	WTS	MTS	STX	
	Mid.	WTM	MTM		
	Deep	WTD	MTD		

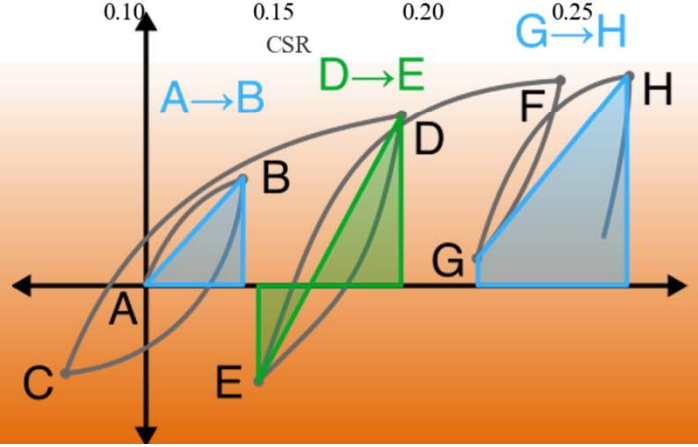
May not be appropriate for estimating lateral spreading damage

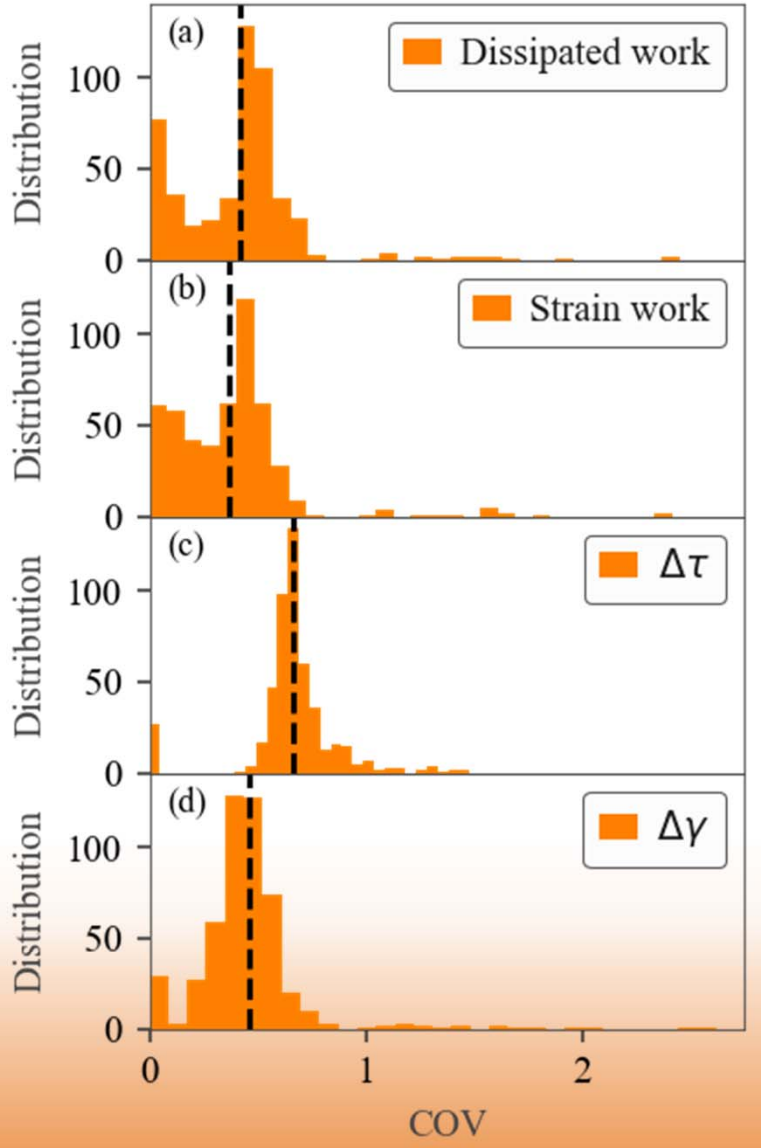
Key steps - macro-mechanism approach



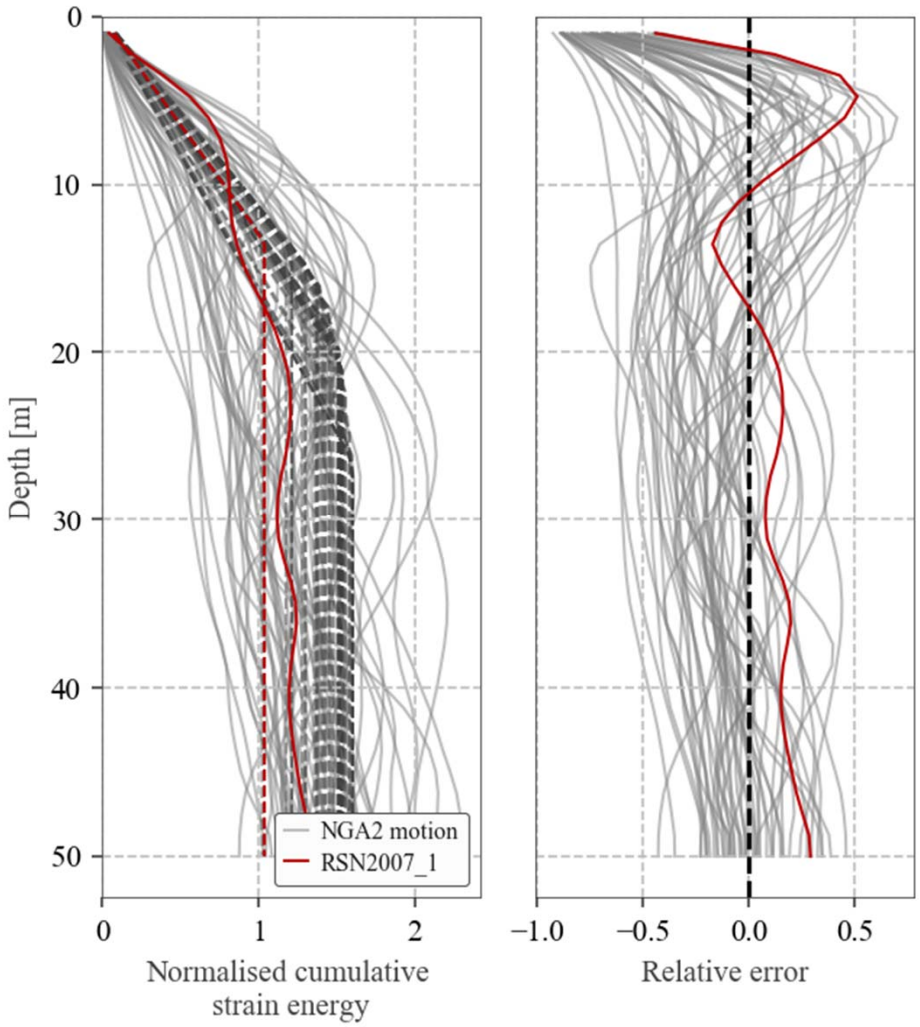
Best measure of liquefaction resistance

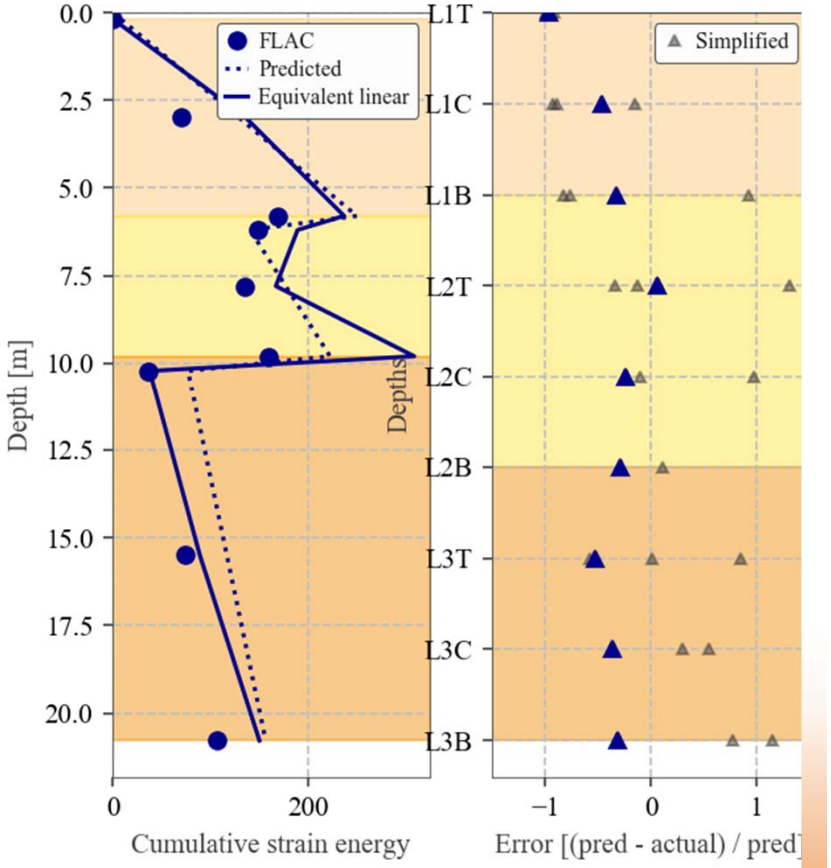




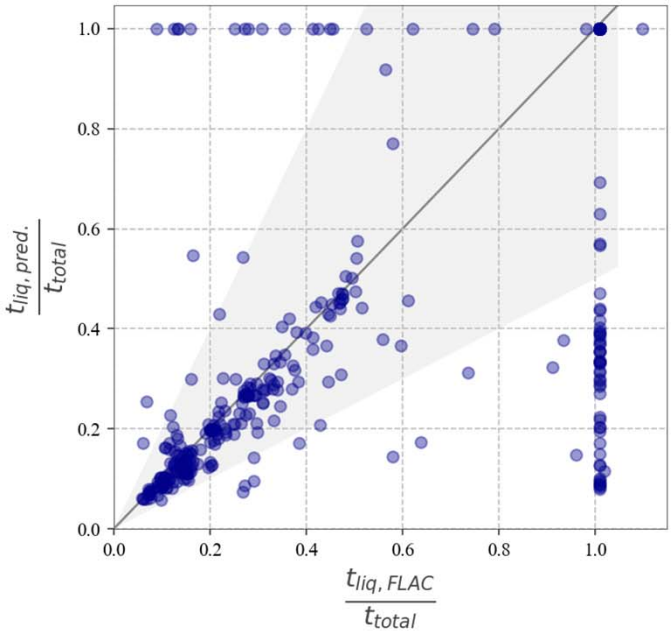


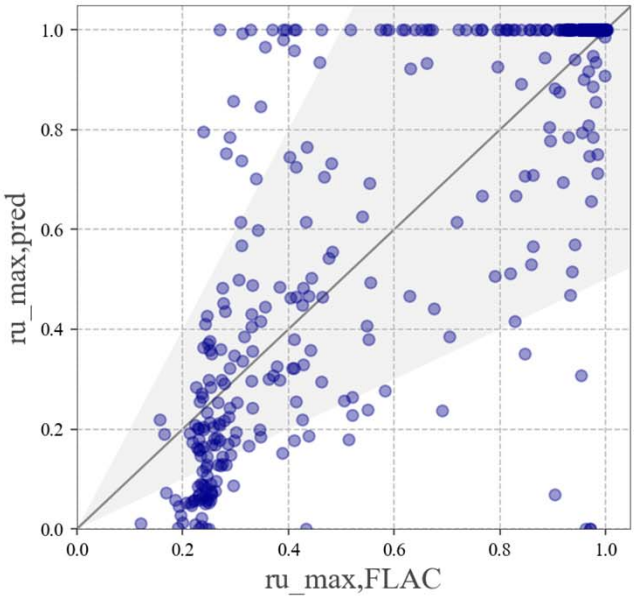
Strain energy evaluation





Accuracy of the pore pressure model



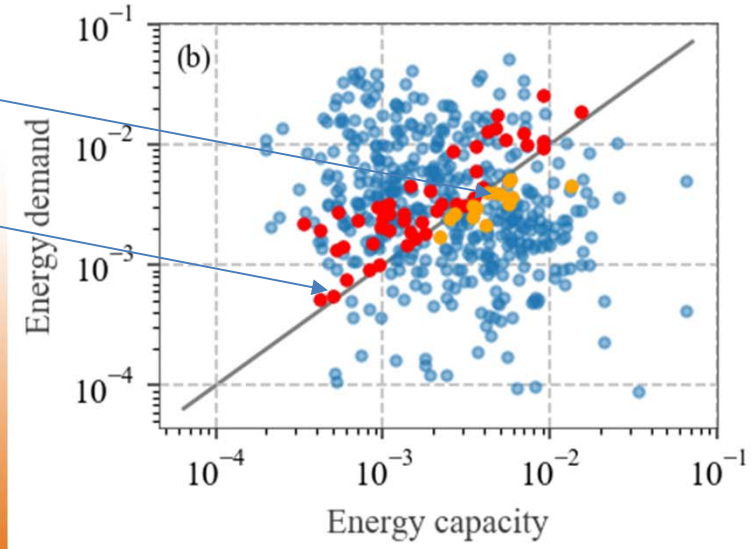


For 500 numerical analysis !!!

False no triggering

False triggering

Accuracy of 87% !



European Commission

Horizon 2020
European Union funding
for Research & Innovation

Grant Agreement n° 700748

liquefACT

www.liquefact.eu

GRAZIE PER L'ATTENZIONE,

Sara Rios

University of Porto – Faculty of Engineering

+ 351 225081728

sara.rios@fe.up.pt