Progetto DPC-ReLUIS 2024-2026 WP 18
task 3

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

Response of soil – structure systems using conditional spectrum and code-based ground motion selection procedures

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1. INTRODUCTION

For time history non-linear analyses, current building code provisions require (or recommend) the selection of input ground motions that are compatible with the target design spectrum over a wide range of periods. The target design spectra are usually defined or derived from uniform hazard spectra (UHS), as it is the case of the Italian Building code NTC18. Alternatively, spectra derived using conditional hazard methodologies (e.g., Baker, 2011; Bradley, 2012) can be used to target a more physically sound description of the expected spectral acceleration at a given site. Advances in digital signal processing and computing power have facilitated the adoption of these procedures, particularly those based on the conditional mean spectrum (CMS).

The objective of this study is to examine the applicability of CMS-compatible input motions for the analysis of non-conventional geotechnical systems, specifically pile-supported wharves. Such systems comprise two interacting components with markedly different dynamic characteristics: liquefiable ground and the wharf structure. This complexity complicates the optimal choice of the CMS conditioning period (Tc). To address this, the study investigates the impact of ground motion selection procedures, based on NTC18 and CMS approaches on the seismic response of a large-diameter pile-supported wharf.

2. CASE STUDY

Large diameter (2m) pile supported wharf in Gioia Tauro, founded on liquefiable ground → **2D Fully coupled dynamic soil – structure (DSSI) Effective stress analyses (ESA)** →

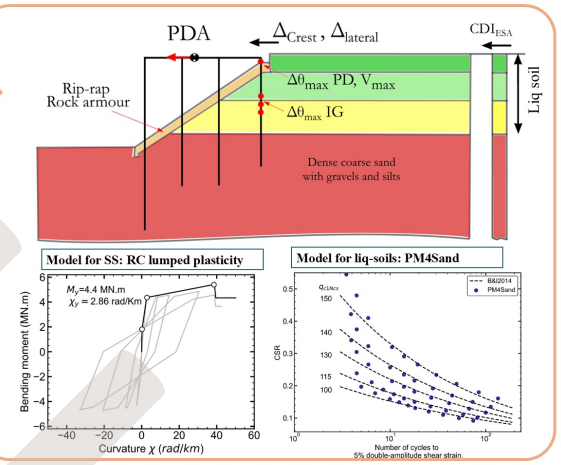
SET 1. 7 single component records compatible with CMS with conditioning period
- T = 0.45s ~ To wharf super structure (SS) (future work)
- **T = 0.6s ~ To 1D free-field (FF) (Current work)**
- T = 0.9s ~ 1.5 × To 1D (future work)

+ **SET 2**. 7 single component records compatible with NTC 2018

2. NUMERICAL MODELLING

Fully coupled 2D, plane strain, effective stress, DSSI ESAs with FLAC 2D.

- Model height = 85 m, down to the seismic bedrock V_s=800m/s
- Max frequency = 18 ÷ 20 Hz
- Non-linear Free-field BCs



3.1 GROUND MOTION SELECTION - CMS

GMPE	Ambraseys and Simpson (1996)
Correlation Model	Akkar et al., (2014)

Screening based on $Vs_{30,Rock}$, **M, and R**

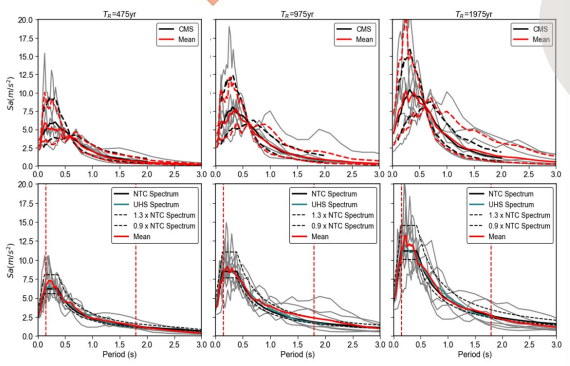
Sa(T): from the rotated horizontal component along θ_{azmth} that produce the maximum Sa(Tc) (Boore, 2010)

GMs scaled at Tc.

Selection based on the SSE method of Jayaram et al. (2011) to target mean and variance of CMS.

3.2 GROUND MOTION SELECTION - NTC18

Screening based on $Vs_{30,Rock}$, **M, and R** → GMs scaled to enforce compatibility between t_1=0.15s and t_2=1.8s

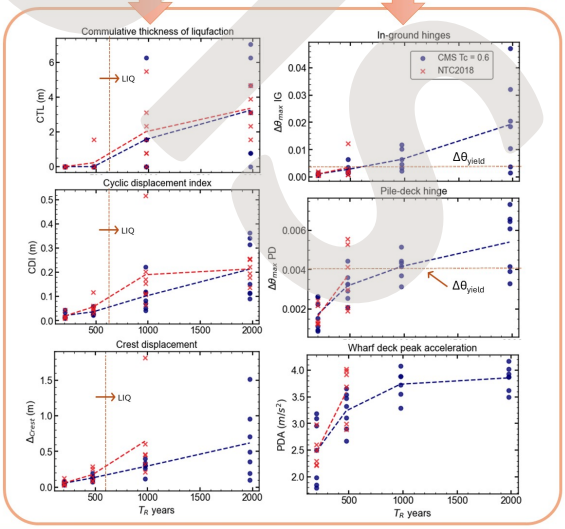


4. RESULTS

Preliminary results are shown for the analyses that employed input motions selected according NTC18 and following a CMS approach with Tc equal to the 1D fundamental period of the ground.

For the 1D column, NTC18 and CMS compatible motions are producing similar ground response in terms of surface manifestation of liquefaction. NCT18 compatible motion produce larger lateral ground displacements for TRs equal to 201, 475 and 975 yrs.

Ground EDPs | Wharf EDPs



4. CURRENT AND FUTURE WORK

1. Currently
- Finalize numerical analyses for NTC18 and CMS Tc = 0.6s

2. Coming next:
- Analyses with CMS for additional Tc
- Analyses with vertical and horizontal input motions – WP18 Task 4

3. Ideas for the future
- Include the requirements of new Gen EC8 for impulsive records
- Test findings for different ground conditions
- Select ground motions rom the NESS2.0 database

5. SELECTED REFERENCES

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- Boulanger RW and Ziotopoulou K (2017) "PM4Sand (version 3.1): *A sand plasticity model for earthquake engineering applications.* Report No. UCD/CGM-17/01. Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA.
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