THESSALONIKI
16TH EUROPEAN CONFERENCE ON
EARTHQUAKE ENGINEERING
18 - 21 JUNE 2018
www.16ecee.org

SisQuai: A Simplified Method for Seismic Assessment of regular Harbor Wharves Structures

ID: 10157

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Abstract

A simplified method for seismic risk assessment on regular wharves structures (pile supported rectangular concrete slab with back passive steel anchorage studs) called SisQuai has been developed.

This tool aims to provide a fast preliminary evaluation of the seismic risk of a large number of units from a relatively limited number of entry parameters, in order to identify those that require more specific investigations or more detailed numerical analysis.

Issues and objectives

Harbor facilities represent major strategical economical equipment since they ensure a great part of international goods transportation in most countries with maritime border. Moreover they can be devoted to play a fundamental role in case a seismic crises for regional rescue and emergency planning, especially on island territories: supply of food, first-aid and medicines, emergency housing materials, etc.

However, contrary to buildings or bridges, no specific seismic code as yet been published in France to cover the case of harbor wharves structures. The SisQuai method was thus developed by Cerema in order to give a first preliminary evaluation of the seismic resisting capacity of most regular wharves structures, consisting in piles supported concrete slab equipped with rear passive steel studs anchoring.

Method description and calibration

The SisQuai method is mainly based on the calculation of seismic inertial forces from fundamental mode spectral analysis, inspired from Eurocode 8-2 rigid deck model. It also accounts for torsional effects as well as kinematic effects from soil deformation around piles and Mononobe-Okabe dynamic back-fill soil pressure against retaining back-wall.

The method was successfully tested and calibrated on an example of regular wharf unit from the Great Harbor of Nantes Saint-Nazaire on the French metropolitan Atlantic West Coast. On this same application test, parametric comparison with more detail 3D Finite Elements multi-modal spectral analysis model demonstrated a level of precision within a range of plus or minus 35%, which is at this stage considered satisfactory related to the preliminary evaluation objectives of the approach.

Perspectives

Further method upgrading will concentrate on improving precision range by recalibrating some analysis criteria and on making this pre-evaluation method systematically conservative in comparison with results from more sophisticated (and time consuming) models. For this purpose upcoming developments will be mainly inspired from related guidelines concerning Californian harbor facilities and structures (POLA. 2010) (POLB. 2015) as well as other related scientific references (Heidary-Torkamani et al. 2013) (Shafieezadeh. 2011) (Thomopoulos and Lai. 2012) (F. Bozzoni et al. 2010).

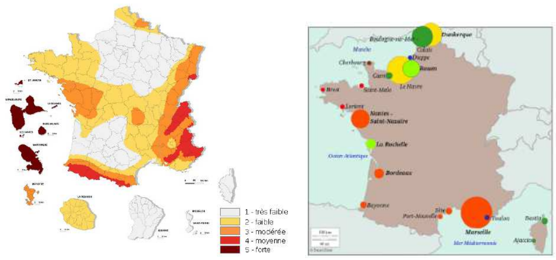

Figure 1. New French national seismic zoning from October 2010, revised in January 2015 and location of main harbor facilities

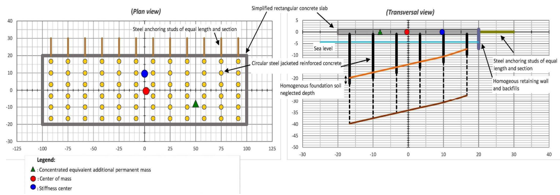

Figure 2. Parametric schematic representation of the simplified model

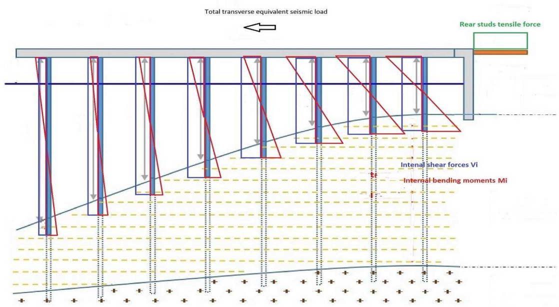

Figure 3. Internal force distribution according to individual elements stiffness

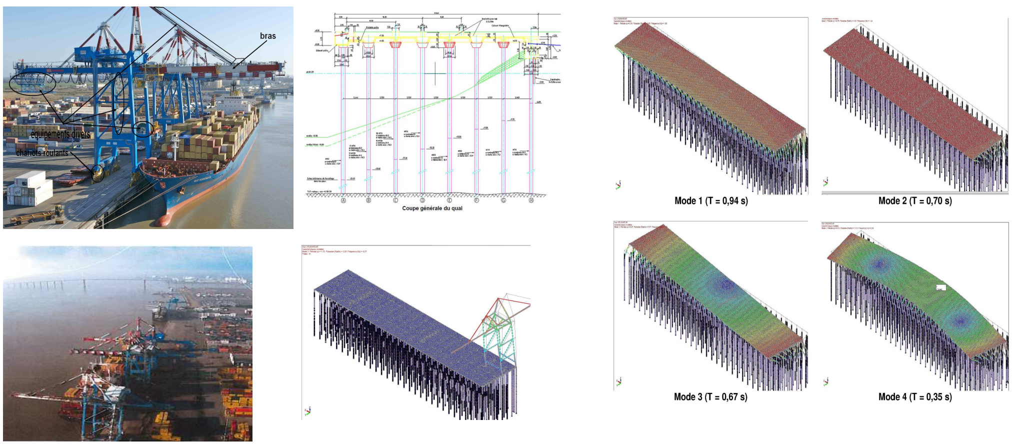

Figure 4. Example of regular wharf unit from the Great Harbor of Nantes Saint-Nazaire and comparison of the method with more detailed 3D Finite Elements model

Table 1. Dynamic characteristics and induced seismic loads evaluation.

	3D model	SisQuai	Deviation
T_{long}	0.94 s	1.01 s	**7%**
T_{trans}	0.70 s	0.73 s	**4%**
$M_{max\ pile}$	4.20 MNm	5.31 MNm	**26%**
$V_{max\ pile}$	1.99 MN	1.44 MNm	**- 28%**
$F_{max\ stud}$	3.05 MN	3.01 MN	**- 1%**

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References

1. CEN/TC250 (2006). Eurocode 8 - Design of structures for earthquake resistance - Part 2: Bridges (EN 1998-2). European Standard, December 2006.
2. POLA (2010). The Port of Los Angeles Code for Seismic Design, Upgrade and Repair of Container Wharves. POLA SEISMIC CODE 2010. City of Los Angeles Harbor Department, May 2010.
3. POLB (2015). Port of Long Beach Wharf Design Criteria. POLB WDC Version 4.0, May 2015.
4. Hamid Heidary-Torkamani, Khosrow Bargi & Rouhollah Amirabadi (2013). Seismic vulnerability assessment of pile-supported wharves using fragility curves, Structure and Infrastructure Engineering, 10:11, 1417-1431
5. Shafieezadeh, Abdollah (2011). Seismic vulnerability assessment of wharf structures. Georgia Institute of Technology, ProQuest Dissertations Publishing.
6. C. Thomopoulos & C. G. Lai (2012). Preliminary Definition of Fragility Curves for Pile-Supported Wharves, Journal of Earthquake Engineering, 16:sup1, 83-106.
7. F. Bozzoni, M. Corigliano, C.G. Lai and L. Scandella (2010). Seismic Risk Assessment of Italian Seaports using GIS and Guidelines for Seismic Design. PIANC MMX Congress Liverpool UK 2010.