Paper No. 113

Extreme loading analysis of petrochemical plants and design of metamaterial-based shields for enhanced resilience: The Horizon 2020 Innovative Training Network project XP-RESILIENCE

Oreste S. Bursi[1], Nicola Tondini[2]

[1,2]*Department of Civil, Environmental and Mechancial Engineering, University of Trento, Via Mesiano 77, 38123, Italy*

ABSTRACT

The tremendous impact of natural hazards, such as earthquakes, tsunamis, flooding, etc, which triggered technological accidents, referred to as natural-technological (NaTech) events, was demonstrated by: i) the recent Tohoku earthquake and the following Fukushima disaster in 2011 [1]; ii) the UK's 2015 winter floods which topped £5bn, with thousands of families and businesses that faced financial problems because of inadequate or non-existent insurance. The NaTech problem is quite relevant as up to 10% of industrial accidents, involving the release of Chemical, Biological, Radiological, Nuclear and high-yield Explosives (CBRNE) substances, were triggered by natural hazards [2]. Although the number of lives lost each year to natural disaster is reduced, the recovery costs of major disasters continue to rise. In fact, each year, NaTech disasters cause an estimated $52 billion in damages in the United States in terms of life lost, disruption of commerce, properties destroyed, and the costs of mobilizing emergency response personnel and equipment. Similar figures apply to Europe. To implement and support the Seveso II Directive 2012/18/EU which regulates the control of major accident hazards involving dangerous substances [3], XP-RESILIENCE intends to establish a network of individual research projects working towards Advanced Modelling and Protection –via metamaterial-based isolators/layouts- of Complex Engineering Systems for Disaster Reduction and Resilient Communities. In fact, today there is a stronger need than ever to grow researchers that combine a robust academic foundation in reliability/resilience with practical experiences, technological expertise with awareness of the socio-economical context and conviction to furthering research with an entrepreneurial spirit. Hence, the objective of XP-RESILIENCE is to offer innovative research training ground as well as attractive career development and knowledge exchange opportunities for Early Stage Researchers (ESRs) through cross-border and cross-sector mobility for future growth in Europe. In fact, the ESRs will be seconded to organisations of the consortium with long-standing experience and expertise in the project topics to enrich their skills. XP-RESILIENCE is an inter/multi-disciplinary and intersectoral programme as it includes seven academic partners, one Institute of Applied Science and seven private companies from ten different European countries. It represents international excellence in risk-based simulation/development of "special risk" petrochemical plants, vibration reduction and community disaster resilience subjected to earthquakes, blast, fire, flooding, winterization, etc. Owing to the intense competition from countries such as USA, Japan, Korea, Taiwan, etc., the training of ESRs in such a network is timely and of strategic importance in Europe. The fourteen recruited ESRs will be exposed to all knowledge domains along the risk chain in continuous contact with both the industrial world and community needs. This is part of innovative methods that are not currently offered in Europe. Finally, XP-RESILIENCE will provide training-through-research in: i) controlling resilience planning at the plant level and nearby built environment; ii) designing metamaterial-based vibration shields; iii) quantifying resilience for facility/community performance during and after a hazard event; iv) setting concepts of recovery and functionality; v) interacting with academic and industrial partners.

[1] Professor, oreste.bursi@unitn.it

[2] Assistant Professor, nicola.tondini@unitn.it

[*] Corresponding author

Fig. 1a. Earthquake consequences on a petrochemical plant (Japan, 11/03/ 2011)

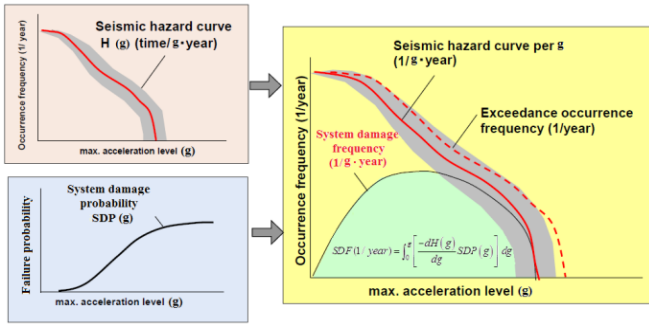

Fig. 1b. Quantitative evaluation of damage frequency of a nuclear power plant.

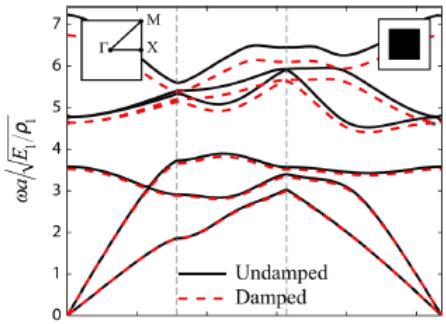

Figure 1c. Frequency dispersion diagram with band gap of a 2D phononic cristal [4].

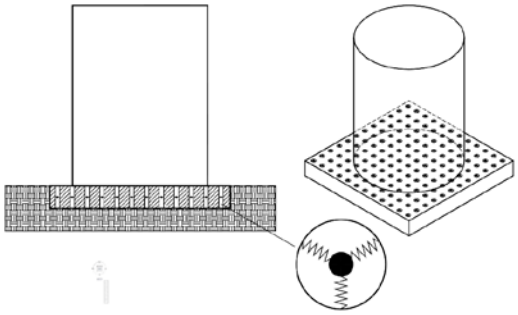

Figure 1d. Schematic of a resonator in a periodic foundation.

Keywords: *Risk-based framework, Special risk facilities, Community disaster resilience, Metamaterial based shields, Second generation of EN Eurocodes*

ACKNOLEDGEMENTS

This work was carried out with the financial grant from the HORIZON2020 research framework of the European Community, within the XP-RESILIENCE project: " Extreme loading analysis of petrochemical plants and design of metamaterial-based shields for enhanced resilience ", Marie-Curie grant agreement number 721816.

REFERENCES

[1] Nakashima, M., Lavan, O., Kurata, M., Luo, Y., (2014), Earthquake Engineering Research Needs in Light of Lessons Learned from the 2011 Tohoku Earthquake, Earthquake Engineering and Engineering Vibration, 13, pp. 141-149.

[2] Campedel, M. (2008), Analysis of Major Industrial Accidents Triggered by Natural Events Reported in the Principal Available Chemical Accident Databases, Report EUR 23391 EN - 2008, JRC42281, Ispra, Italy.

[3] European Parliament, (2012),Directive 2012/18/EU (Seveso II) on the Control of Major Accident Hazards Involving Dangerous Substances, Amending and Subsequently Repealing Council Directive 96/82/EC, Official Journal, L197/2, 24/7/2012, 1-37.

[4] Hussein, M.I., Leamy, M.J., Ruzzene, M., (2014), Dynamics of Phononic Materials and Structures: Historical Origins, Recent Progress, and Future Outlook, Applied Mechanics Reviews, ASME, 66, 040802-38.