PORT RESONANCE MITIGATION MODELED INTRODUCING ARJ-R STRUCTURES

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INTRODUCTION

While port breakwaters typically provide shelter to wind-generated sea waves, they fail to prevent the entrance of the energy of larger oscillations. Dimensions of conventional port basins and small craft harbors make them prone to be excited to resonance by infragravity (IG) period oscillations. However, the small height of the IG oscillations and the lack of continuous measurement of the seawater elevations nearshore make IG oscillations remain unnoticed except when the effects of resonance are high enough to disrupt normal port operation.

Moreover, resonance dependence on availability of IG energy is related to offshore sea wave energy and to sea level, both being expected to increase with the climate change thus increasing the probability of the resonance to occur or its effects to be more noticeable.

If necessary, resonance mitigation may require substantial (and sometimes impractical) changes in harbor layout or the introduction of large or complex dissipative structures that cause friction, turbulence or destructive wave interference. In this paper, the effectiveness of Anti-Reflective Jarlan-type structures for Resonance mitigation (ARJ-R) has been assessed numerically for the port of Denia (Spain). ARJ-R structures are constructible, with similar dimensions as conventional vertical quay caissons and with a similar cost (15% more than conventional vertical caisson).

ARJ-R CAISSON PERFORMANCE

ARJ-R caissons are based on the "*long-circuit*" concept (*Medina et al, 2016*) that allows the extension of the destructive wave interference mechanism to mitigate low-frequency oscillations without enlarging the width of the caisson. The performance of the ARJ-R caissons is referred to its reflection coefficient (C_r) which was obtained through large-scale physical model tests (*Gonzalez-Escriva et al, 2018*). Additionally, an accurate experimental methodology to reproduce the Resonant Response Simulation (RRS methodology) was used to overcome the drawbacks of conventional methodologies when testing long-period oscillations.

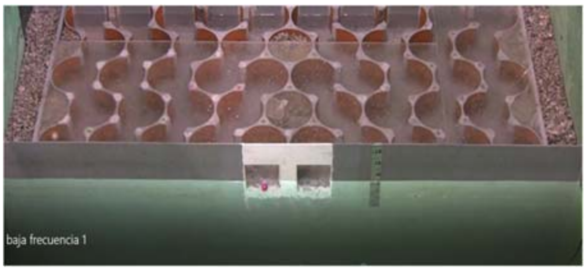

Figure 1 – Scale model example of an ARJ-R structure with long dissipative circuits made of circular cells with two frontal openings to the basin.

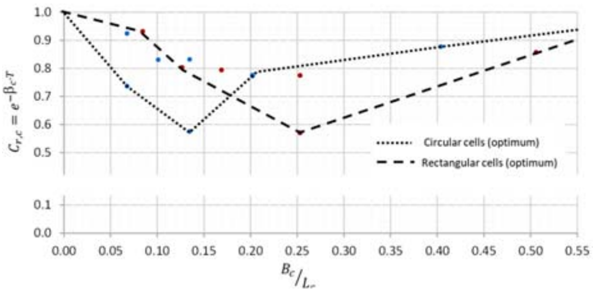

Figure 2 – Reflection coefficient of the ARJ-R structures related to the relative width of the dissipative chamber

MITIGATION OF PORT RESONANCE

The port of Denia (Spain) has been selected as a case study and a numerical model based on the "mild slope equation" was used to reproduce the resonant response of the port basins. The phase-response was used to select the best allocation for the ARJ-R structures (black thick lines on the right of figure 3). The design proposes a conservative C_r of 0.9 for modelling the performance of the ARJ-R structures to consider the variability of the IG frequencies and heights with time in the real world.

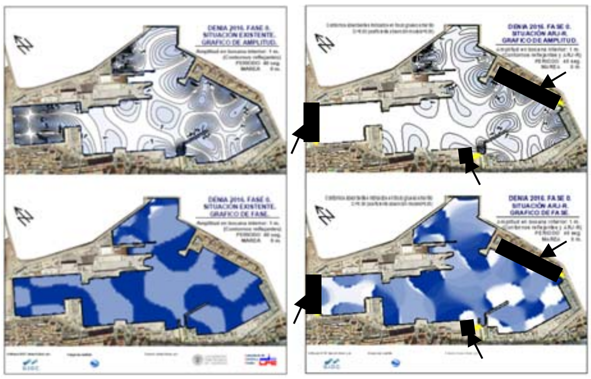

Figure 3 -Example of numerical RRS for external forcing with T= 40 s, without ARJ-R (left) and with ARJ-R (right).

In the example of Fig. 3, the maximum amplification factor is reduced from 5 to less than 1. Similar results has been obtained for other natural resonant modes of the port.

REFERENCES

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