Article, Published Version

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DESIGN OF AN ARTIFICIAL SURFING REEF AT SOMO-LOREDO BEACH

BY JARED ORTIZ-ANGULO CANTOS

Surfing has been increasing in popularity over the last few decades. In order to have good conditions for surfing, several factors must simultaneously coincide. These include swell waves, off-shore winds and the optimum bathymetric configuration. Beach profiles and reefs that yield suitable waves for surfing are difficult to find in nature. This drives coastal engineers to construct reef like artificial submerged structures to improve the interaction between the wave and the sea bed and enhance the quality of the waves for surfing. The design of these reefs is inspired by natural reefs with perfect surfing waves. The aim of this research is to provide a novel numerical approach for the design of submerged structures that improve surfing conditions and to study the economic viability of an artificial surfing reef in Somo-Loredo, northern Spain.

The Cantabrian Coast in northern Spain, has many locations with good potential for surfing. Ribamontán al Mar is one such location. It is a coastal town that has undertaken some interesting initiatives in the area of surfing resource management. One of these is a project to explore the possibility of constructing an artificial surfing reef to improve conditions in the area.

Ribamontán al Mar is demonstrating how a local economy can be rapidly improved by the growth of tourism. Surf tourism attracts over 15,000 visitors a year and generates 4.2 million euros for the local economy as well as it provides 720 jobs. The local area has been transformed with the establishment of 22 hotels, 20 rural accommodations, 10 tourist apartments, 4 campsites, 32 restaurants, 34 pubs, 8 surf shops, 9 surf houses and 2 shaping workshops. All this development has attracted interest from overseas in the business model with visitors coming from Chile, Morocco and Guinea over the past two years. The area, including Somo-Loredo, Langre and Galizano beaches, has been recognized as a "Natural Surf Reserve" due to its attempts to promote surf tourism[1].

The construction of a reef-type submerged structure at the beach of Somo-Loredo could improve the surf quality in the area, increase tourist appeal while at the same time provide protection to the dune system behind.

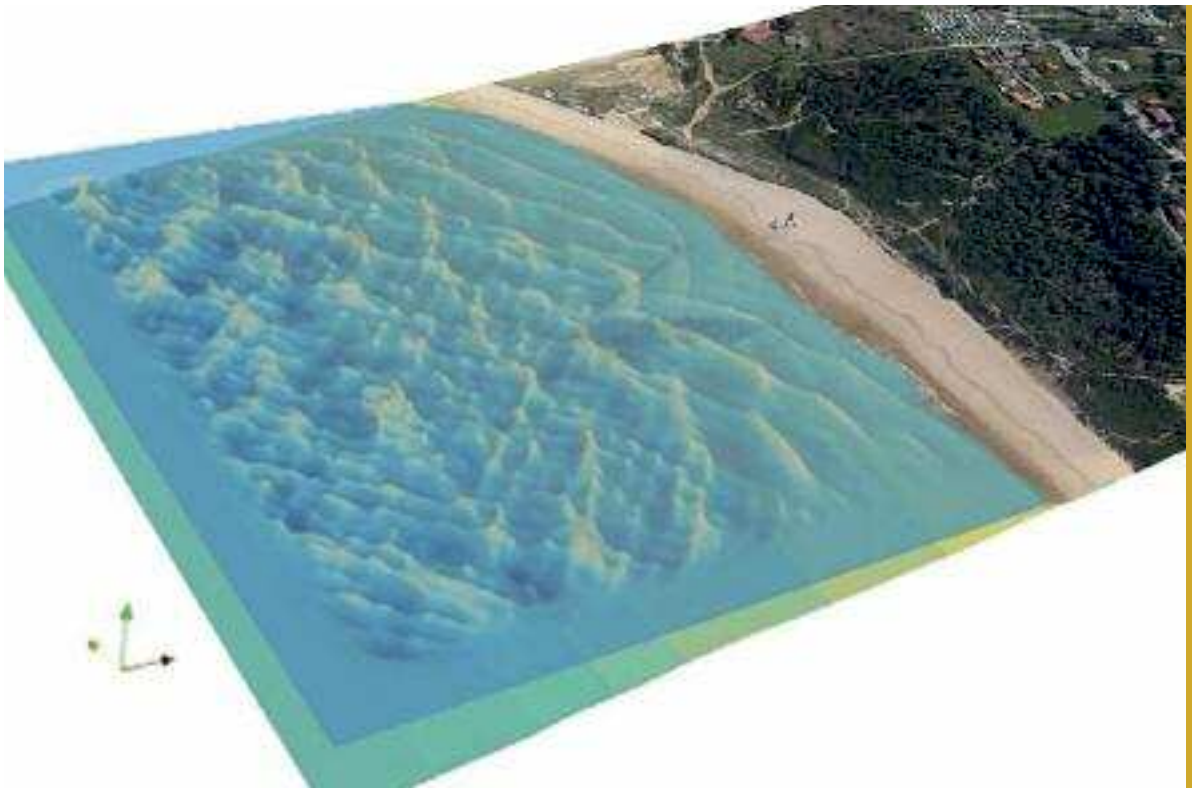

Figure 1. Graphic representation of the results obtained from the Somo-Loredo Beach simulations carried out with the numerical model IH-Bouss

Jared Ortiz-Angulo Cantos has a MSc in Coastal Management Sciences and Technologies from the University of Cantabria and a M.Sc. in Civil Engineering from the University of Granada. Since 2017 he has been working at MCVALNERA as consultant, specializing in computational fluid dynamics applied to coastal hydrodynamics processes. His final master's project, "Design of an artificial surfing reef at Somo-Loredo beach" , was awarded the III Edition of IIAMA award given to the best Academic National Work in the field of Water Engineering. He also regularly collaborates with the prestigious Spanish surfing magazine "Surfer Rule".

Figure 2. IH-Bouss 3D representation of 2 different sea states iteracting wiith a V-shape artificial reef

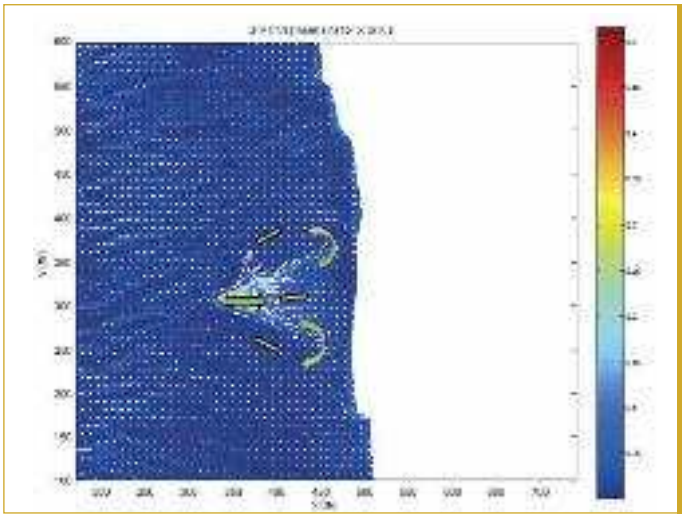

Figure 3. Graphic representation of the currents results obtained from the simulations carried out with the numerical model IH-Bouss

A study was undertaken for the technical design and the assessment of the economic feasibility of an artificial surfing reef to be located at Somo-Loredo beach. The study included the following steps.

Study of wave-reef interaction

In this first phase, the study determined the correct geometry of the reef bathymetry for surfing from the parameters involved in the wave-reef interaction process. One of the starting points was the 2012 study of Mendonça et al [2], wherein two types of artificial reefs were designed with the use of a numerical tool and were analysed for different wave conditions. The study of Mendonça et al was based on the results of the 2009 work of Voorde et al[3] and allowed the development of basic design guidelines for a V-shaped artificial reef. In this study a Boussinesq equation-based numerical model was used (IH-Bouss). This model can handle wave propagation and interaction (including wave breaking) with the submerged V-shape artificial under any real wave forcing (random waves). The use of this numerical tool made it possible to determine the geometry, size, orientation, freeboard, etc. of the reef based on the wave climate statistics in the study zone.

The results for the different simulations include: wave height maps at some relevant cross sections, surf similarity parameters for different incident wave spectra, wave breaking induced currents and wave breaking line plots. Most of the results obtained can be easily used to identify surfing suitable areas.

Optimization of the reef design

After numerically analyzing the wave-reef interaction with different V-shaped structures, taking into account the whole wave climate, a tailored fit structure was designed for Somo-Loredo beach. The final design was optimized following the hierarchy of surfing levels proposed by Espejo Hermosa[4], as follows:

Level 3 – Optimum conditions:

1.2 m ≤ Hs ≤ 2 m; 12 s ≤ Tp < 16 s;

Level 2 – Appropriate conditions:

0.5 m ≤ Hs < 1.2 m; 8 s ≤ Tp < 12 s;

Level 1 – Adequate conditions:

0.3 m ≤ Hs < 0.5 m; 6 s ≤ Tp < 8 s;

Level 0 – Unsurfable conditions:

Rest of conditions.

where Hs is the significant wave height, and Tp is the peak wave period.

In the optimization procedure, two basic studies were performed. The first one dealt with the variation of the average energy flux at four locations on the structure. From these results, it was noted that the variation in energy flux across the structure was minimal and it would not have any significant effect on the morphodynamics of the beach. The second analysis was a sensitivity study of the percentage variation in the surfing levels[4] after the construction of the artificial reef. The most relevant result was that the percentage of occurrence of level 2 (Appropriate conditions) was tripled.

Surfing-reef construction

The proposed construction procedure is innovative, environmentally friendly and economically feasible. It is proposed to use part of the sand dredged annually at the Santander Bay's channel to create the V-shape structure. It would be pre-designed for suitable surfing conditions. In order to preserve the reef shape, it would be covered with a thin polyurethane-sand mixed layer (0.1 m).

The cost of the project estimated (without considering the dredging cost) to be about 906,000.00 €, (based on a unit cost of 23,9 €/m³ of artificial reef).

Acknowledgements

The research project reported in this article was completed under the supervision of Prof. Javier L. Lara and Prof. Gabriel Díaz Hernández (both from The Environmental Hydraulics Institute "IH Cantabria" of the University of Cantabria). ■

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