Operating of TALOS wave energy converter in different wave climates

Charikleia L.G. Oikonomou¹, Wanan Sheng², Gerasimos Korres¹, George Aggidis²
¹Hellenic Centre for Marine Research, Institute of Oceanography, Greece
²Renewable Energy Group, Energy Engineering, Lancaster University

ABSTRACT

TALOS wave energy converter is a point absorber proposed at Lancaster University (UK), with its main advantage being its ability to absorb energy from all motion modes (i.e. multi-axis Power-Take-Off system). Following previous computational studies in the frame of device development (including frequency-domain modelling), here we present a motion study response for the TALOS wave energy converter for selected wave climates. The analysis applies to realistic irregular wave conditions, assuming a semi-empirical spectrum representative of chosen wave climates, and hydrodynamic modelling is combined with Copernicus Marine Service wave reanalyses data. After scatter plots of significant wave height and energy period are prepared, future considerations are discussed for the device size adjustments under different wave climates.

KEY WORDS: Multi-axis wave energy converter; Wave climate; Point absorber; Motion response; Gaussian Sea; Wave reanalysis.

INTRODUCTION

Even from the first numerical studies on Wave Energy Converter (WEC) hydrodynamics, it became profound that bodies with small characteristic dimensions (compared to typical incident wavelengths) could capture the energy in a wave crest length larger than their diameter (Falnes, 1980). Since then, many "point absorber" WEC concepts have been suggested, with the majority extracting energy from the vertical mode (heave). Nevertheless, point absorbers designed to operate in surge (Bhinder et al., 2009), pitch (McCabe et al., 2006), roll, yaw or a combination of these modes have also been conceived and developed through advanced numerical and experimental methods. Following such advancements, currently, TALOS WEC, a multi-axis device designed by Professor Aggidis, is being further developed at Lancaster University (UK) (Fig. 1). This octagonal-shaped floating structure (Fig. 1) consists of a solid outer hull encompassing all moving parts, securing the device’s survivability during severe wave conditions (Sheng et al. 2022b). The internal Power-Take-Off (PTO) system test rig (Sheng et al. 2022b) embodies a heavy ball supported by springs and dampers. The structure’s response to the waves in various Degrees-of-Freedom (DoF), will induce a relative motion between the floater and the nearly stationary internal heavy ball, driving the PTO system.

Due to the complexity of multi-axis point absorbers (i.e. high non-linearity of the employed PTO system and coupling between modes), comprehending the hydrodynamic response of the device in multiple DoF can provide a first insight into the modes that are more likely to contribute to power capture, as well as the frequency range within which energy extraction can take place. Typically, this is done by examining the motion response of floating bodies, first under regular waves and subsequently under irregular wave conditions (to provide a more realistic perspective). Here, by building on existing work on the regular-wave motion response of TALOS WEC, the numerical method is extended to account for random waves, considering typical wave climates. In this first optimisation analysis, by detecting the most probable sea states of the studied wave climate, suggestions are presented concerning the char-