**Wave loading on rock lighthouses**

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One page summary:

Observations of wave-impact loading on rock lighthouses during storms are presented. Historical anecdotes from the legendary Robert Stevenson on the Bell Rock lighthouse and John Smeaton, responsible for the third Eddystone lighthouse, are compared with contemporary accounts by Trinity House staff on station at the Bishop and Wolf Rock lighthouses during the storms of February 2014. Strong vibrations were a common theme, worthy of investigation.

Whilst no serious damage has yet been caused to any of the rock lighthouses, with climate change potentially causing sea level rise and more energetic wave climates, the longevity of these heritage structures cannot be taken for granted. To obtain a better understanding of the wave*–*structure interaction, Plymouth University has been working with the General Lighthouse Authorities to develop monitoring and modelling techniques suitable for these isolated masonry structures. Some of the difficulties of conducting monitoring work in these remote locations are discussed, both for the likes of Thomas Stevenson and the current project where available electrical power is at a premium. The modern system, based on remote-controlled video cameras and a geophone system is described.

Details of the field campaign, in which 2978 impact events were recorded during the winter storms of 2013/2014, are presented together with an initial analysis that begins to shed light on the dynamic response of these iconic structures. Two particular events are described with a series of video images and velocity/displacement time histories and frequency spectra. The video data shows that the cylindrical base of the tower may reduce runup but it does not prevent water from jetting up to around the level of the photovoltaic panels (where the cameras become submerged) and possibly even obscuring the light. The results indicate that the response can be sensitive to the type of wave impact and that the overall motion of the Eddystone tower was less than might have been expected.

A structural model of the Eddystone tower was investigated using finite element analysis. A fully representative model of the tower based upon historical drawings was produced. The model was successfully tuned to the first and third modes of vibration measured in the full-scale structure, although the second mode is missing, possibly due to the model being represented as a monolithic structure or because the geophones are picking up the vibrations of the reef or helideck. Finally, preliminary attempts to apply wave loads estimated on the basis of the international standard ISO 21650 ‘Actions from wave and currents on coastal structures’ show reasonable agreement between the model displacements and those measured.

Further work is described, including the replacement of video cameras with those of increased resolution, geophones with a lower operational range and the extension of the monitoring to the more exposed Longships lighthouse.