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PROSERVE LTD

CFD Investigation of Deflection Bucket Jet Flows and the Bed Scouring Loads

Produced by Ro Ro Fast Ferries

1 INTRODUCTION

This document details a computational fluid dynamics (CFD) study with the aim of determining the fluid behaviour at the sea-bed caused by water jets representative of those used by roll-on roll-off (Ro Ro) fast ferries during mooring. Two geometries representative of deflection bucket geometries currently in active service were simulated, with the internal geometry of the deflection buckets modelled in order to achieve a high level of accuracy. Mesh requirements were determined first, by performing a mesh sensitivity study, before conducting a series of simulations of deflection bucket flows with varying sea-bed depth. As well as providing pressure and velocity data at the sea bed, the simulations provided insight into the behaviour of the jet flow within the deflection buckets themselves. The study was commissioned by Mr Martin Hawkswood, representing Proserve Ltd, in their purchase order 2012/P43/92, and broadly follows the work programme listed in Wolfson Unit proposal 3963.

2 BACKGROUND

In December 2012 the Wolfson Unit conducted a programme of work at the request of Mr M. Hawkswood of Proserve Ltd, to determine the forces upon the sea bed resulting from the impingement of water jets representative of those used during mooring by fast ferries (Wolfson Unit report number 2413). The reverse jet configurations investigated consist principally of two parts; a circular water jet and a square deflection bucket (Figure 1). The circular water jet is driven by an impeller, and is directed into the square deflection bucket. Ordinarily the jet is free to continue through and exit the rear of the bucket, providing forward thrust. During reversing and 'push on' however, a deflection plate deploys within the bucket and acts to turn the flow downwards from the horizontal plane, onto a further turning plate or blades, which further deflect the jet flow further until it is directed as much as 150 degrees from the original circular jet axis.

For this earlier programme of work the internal geometry of the deflection buckets was not simulated; instead the jet flow was modelled as originating from flat, rectangular inflow 'sources', the same size as the bucket exit plane. The validation study showed that results are very sensitive to the velocity profile specified at the jet inflow source and unfortunately the velocity profile here is not known (i.e. it has not been measured experimentally). It is expected that the velocity profile is unlikely to correspond to any simple known velocity profile (e.g. pipe flow) due to the complexity of the deflection bucket geometry, and the dramatic change in flow direction before exiting the bucket (approx. 145 degrees). The purpose of this programme of work was therefore to

- Model the internal flow through deflection bucket geometries in order to determine the effect of the deflection bucket on the outflow velocity profile and subsequent jet behaviour,
- Provide more accurate prediction of the pressure loads at the sea-bed.