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Numerical Estimation for Submersible Drift Forces Evaluated by Experimental Tests

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ABSTRACT

This paper presents a numerical estimation method applied for axisymmetric hulls considering the fineness ratio as parameter. Four models with the following ratios were adopted, 7.0, 8.6, 10.5 and 12.0. The first model is the Series 58, model no.4164 (Landweber and Gertler, 1950), the second model is the DARPA SUBOFF (Groves et al., 1989) and the last two models are 'general hull form' (Heberley, 2011).
Well established formulations were applied aiming to estimate lift force and yawing moment. The formulations are from Allen and Perkins (1951), Safel et al. (1971), Finck (1978) and Granlund (2009).
For the 58 Series and DARPA SUBOFF hulls, experim ental results are presented.
The objective of this work is to present numerical and experimental results intended to be helpful in the early stages of submersible design, avoiding computation costs of CFD codes.

KEY WORDS: lift; drag; axisymmetric hulls; fineness ratio; DARPA SUBOFF; 58 Series; numerical estimation

NOMENCLATURE

L: total length
D: maximum diameter
M: mass displacement
CP: prismatic coefficient
XB/L: percent position of the buoyancy center forward of midship
SP: plan form area

INTRODUCTION

In the early stages of design usually a few parameters are known.
To estimate the magnitude order of some parameters, fundamental principles theory for simplified geometries and flow characteristics can be used.
The results obtained from this method should be validated with experimental results and empirical data for reliability.
Four hull models were chosen for this study: Series 58 model no.4164 (Landweber and Gertler, 1950), DARPA SUBOFF (Groves et al., 1989) and two 'general hull form' models (Heberley, 2011). The parameter considered is the fineness ratio, with the following values: 7.0, 8.6, 10.5 and 12.0, respectively.
Numerical estimation of lift forces, drag forces and yawing moment where obtained for the models mentioned above.
Physical models where built for the DARPA SUBOFF and the 58 Series geometries. They were tested in a towing tank, where the drift forces and yawing moment were measured.

A list of relevant publications is given below, regarding fundamental development and recent application in this field.

A formulation for aerodynamic loads in inclined bodies of revolution which takes into account viscous and potential effects for sub and supersonic flows are presented by Allen (1949).

Allen and Perkins (1951) published experimental results for forces,