CONTENTS

Uncertainty Analysis Spreadsheet For Sinkage And Trim Measurements

1 PURPOSE OF PROCEDURE

Provide a spreadsheet for calculating the bias and precision limits and total uncertainty using single or multiple test methods for model scale towing tank sinkage and trim tests following the Quality Manual Procedures 7.5-02-01-01 "Uncertainty Analysis in EFD, Uncertainty Assessment Methodology," and Longo, J. and Stern, F., (1998) "Resistance, Sinkage and Trim, Wave Profile, and Nominal Wake and Uncertainty Assessment for DTMB Model 5512," Proc. 25th ATTC, Iowa City, IA.

2 PARAMETERS

The data reduction, bias and precision limit, and total uncertainty equations are given in Longo, J. and Stern, F., (1998) "Resistance, Sinkage and Trim, Wave Profile, and Nominal Wake and Uncertainty Assessment for DTMB Model 5512," Proc. 25th ATTC, Iowa City, IA. The uncertainty analysis spreadsheet for sinkage and trim tests implements this procedure. Spreadsheet inputs and outputs are given in Sections 2.1 and 2.2, respectively, based in the definitions as Longo, J. and Stern, F., (1998) "Resistance, Sinkage and Trim, Wave Profile, and Nominal Wake and Uncertainty Assessment for DTMB Model 5512," Proc. 25th ATTC, Iowa City, IA. Spreadsheet table of contents is as follows:

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2.1 Inputs

Symbol	Units	Definition
		Facility
		Type of ship
		Period of tests performed
		References
D	m	Distance between measuring points
L_1	m	Distance from fore measuring point to forward perpendicular (FP)
L_2	m	Distance from aft measuring point to aft perpendicular (AP)

M		Number of Tests
ΔFP	m	ΔFP measured (single test)
ΔAP	m	ΔAP measured (single test)
σ_σ		Standard deviation of sinkage (single test)
σ_τ		Standard deviation of trim (single test)
ΔFP	m	ΔFP measured (multiple test)
ΔAP	m	ΔAP measured (multiple test)
L_{WL}	m	Length along waterline
g	m/s^2	Model basin gravity
K		Coverage factor for standard deviation
V	m/s	Model speed
U_{trav}		Calibration traverse uncertainty
z_{range}	m	Calibration traverse range
z_{inc}	m	Calibration traverse increment
$(z_{inc})^2$	m^2	Calibration traverse increment sum of squares
θ_M	θ^o	Potentiometer misalignment angle
B_V	m/s	Speed bias
$B_{\Delta FP3}$	m	Data reduction bias of ΔFP
$B_{\Delta AP3}$	m	Data reduction bias of ΔAP

2.2 Outputs

Symbol	Units	Definition
		Statement of purpose
σ		Measured sinkage (single test)
τ		Measured trim (single test)
σ		Measured sinkage (multiple test)
τ		Measured trim (multiple test)
ΔFP	m	ΔFP average (multiple test)
ΔAP	m	ΔAP average (multiple test)
σ		Average sinkage (multiple test)
τ		Average trim (multiple test)
$\sigma_{\Delta FP}$		Standard deviation of ΔFP (multiple test)
$\sigma_{\Delta AP}$		Standard deviation of ΔAP (multiple test)
σ_σ		Standard deviation of sinkage (multiple test)
σ_τ		Standard deviation of trim (multiple test)
Fr		Model Froude number % of speed, V
ΔFP	m	ΔFP measured
ΔAP	m	ΔAP measured
σ		Sinkage
τ		Trim
$B_{\Delta FP1}$	m	Calibration bias of ΔFP % of $(B_{\Delta FP})^2$
$B_{\Delta FP2}$	m	Potentiometer misalignment bias of ΔFP % of $(B_{\Delta FP})^2$ % of $(B_{\Delta FP})^2$
$B_{\Delta FP}$	m	Total bias of ΔFP % of ΔFP
$B_{\Delta AP1}$	m	Calibration bias of ΔAP % of $(B_{\Delta AP})^2$
$B_{\Delta AP2}$	m	Potentiometer misalignment bias of ΔAP % of $(B_{\Delta AP})^2$ % of $(B_{\Delta AP})^2$
$B_{\Delta AP}$	m	Total bias of ΔAP

		% of ΔAP
$\theta_{V,\sigma}$	s/m	Sensitivity coefficient for speed, V, for sinkage
$\theta_{\Delta FP,\sigma}$	1/m	Sensitivity coefficient of ΔFP, for sinkage
$\theta_{\Delta AP,\sigma}$	1/m	Sensitivity coefficient of ΔAP, for sinkage
B_σ		Total bias limit for sinkage % of $(U_\sigma)^2$
$\theta_{V,\tau}$	s/m	Sensitivity coefficient for speed, V, for trim
$\theta_{\Delta FP,\tau}$	1/m	Sensitivity coefficient of ΔFP, for trim
$\theta_{\Delta AP,\tau}$	1/m	Sensitivity coefficient of ΔAP, for trim
B_τ		Total bias limit for trim % of $(U_\tau)^2$
σ_σ		Standard deviation of sinkage, σ
$M_{sinkage}$		Number of tests, sinkage
P_σ		Sinkage precision limit % of $(U_\sigma)^2$
σ_τ		Standard deviation of trim, τ
M_{trim}		Number of tests, trim
P_τ		Trim precision limit % of $(U_\tau)^2$
U_σ		Sinkage total uncertainty % of sinkage, σ
U_τ		Trim total uncertainty % of trim, τ

3 PROCEDURE

3.1 Instructions

The inputs appear as empty white boxes. The outputs appear as grey boxes and are calculated for the user. The user can select single or multiple test method by entering the corresponding number of tests, 1 for single test method, >1 for multiple test method. For single test method, enter average ΔFP, average ΔAP, standard deviation of ΔFP from best available data and standard deviation of ΔAP from best available data. For multiple test method, enter measured ΔFP and ΔAP values from each test. There are 15 ΔFP and ΔAP inputs for multiple test method. If the user does not have 15 ΔFP and ΔAP inputs, use as many as necessary and leave the remaining ΔFP and ΔAP inputs blank, not zero. Upon entering of all inputs, the uncertainty will be calculated for the user at the end of the spreadsheet.

3.2 Spreadsheet

The uncertainty analysis spreadsheet for sinkage and trim tests is provided by attached Sinkage and Trim-blank.xls excel document.

"Sinkage and Trim - blank.XLS"

4 VALIDATION

Example use of the uncertainty analysis spreadsheet for sinkage and trim tests for single and multiple test methods are provided by attached Sinkage and Trim-single test example.xls and Sinkage and Trim-multiple test example.xls excel documents. The examples are based on Longo and Stern (1998).

"Sinkage and Trim - single test example.X

"Sinkage and Trim - multiple test example

5 REFERENCES

Longo, J. and Stern, F., (1998) "Resistance, Sinkage and Trim, Wave Profile, and Nominal Wake and Uncertainty Assessment for DTMB Model 5512," Proc. 25th ATTC, Iowa City, IA.