Benchmark Example No. 52

Verification of Wave Kinematics

SOFiSTiK | 2024

VERiFiCATiON
BE52 Verification of Wave Kinematics

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Front Cover

6th Street Viaduct, Los Angeles   Photo: Tobias Petschke

Overview	
Element Type(s):	
Analysis Type(s):	
Procedure(s):	
Topic(s):	WAVE
Module(s):	SOFiLOAD
Input file(s):	stokes.dat

1 Problem Description

This benchmark is concerned with the validation of wave kinematics of regular nonlinear Stokes 5^{th} order wave theory. In Fig. 1 the properties of a wave can be visualised.

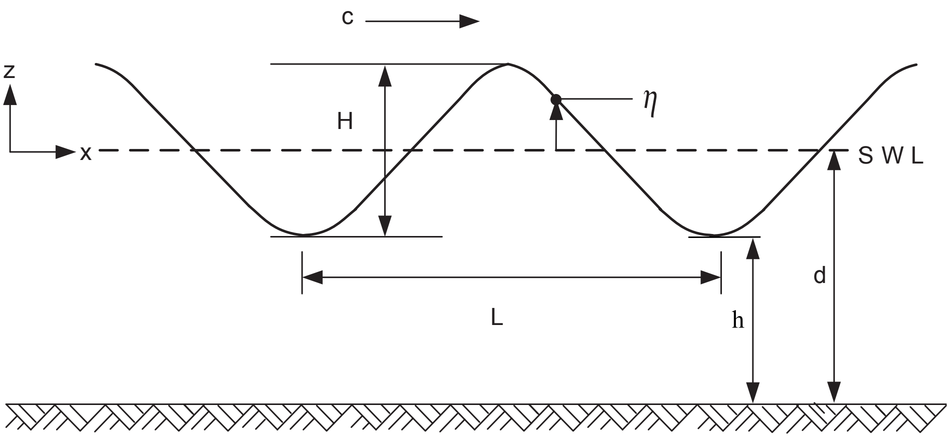

Figure 1: Wave

2 Reference Solution

The reference solution is provided in [1]. This article investigates the solution of the dispersion relation of Stokes fifth order wave theory, which is governed by two coupled nonlinear equations in two variables, through a Newton-Raphson iterative scheme. Different waves are investigated and their wave profile and horizontal velocitiy is computed and plotted. The interest of this benchmark focuses on the provided solution for the corrected coefficient in the original expression for C_2 (the factor $+2592$ should be replaced by -2592), which is employed also from SOFiSTiK. For more information on this correction please refer to Nishimura & al. (1977), Fenton (1985) [2], Bhattacharyya (1995) [1] and SOFiLOAD manual [3].

3 Model and Results

The properties of the considered wave are defined in Table 1.

Table 1: Model Properties

Wave Properties		
$d = 107\,ft$	$H = 70\,ft$	$T = 16.30\,s$

The wave profile, i.e. the phase angle θ versus the surface elevation η, is computed and shown in Fig 2 and the horizontal velocity under the wave crest versus the elevation from the seabed $(z-d)$, in Fig 3. Both results are compared to the reference solution, as peresented in Bhattacharyya (1995) [1].

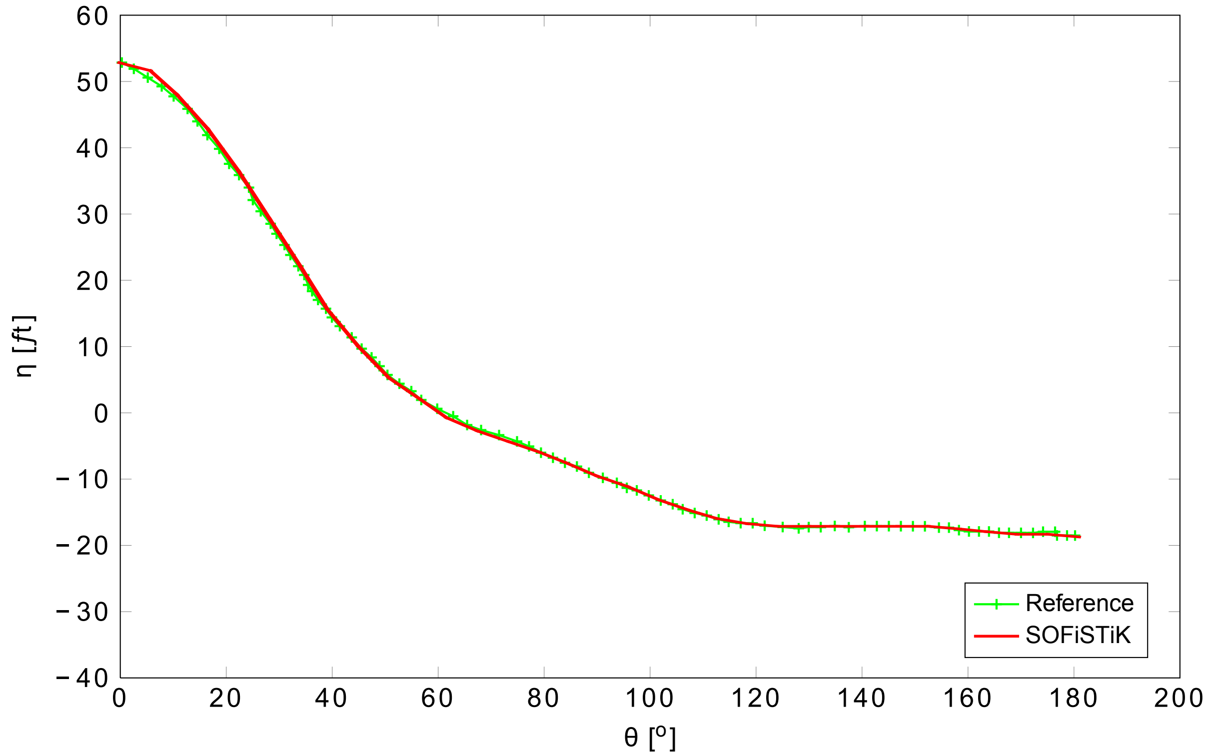

Figure 2: Wave profile

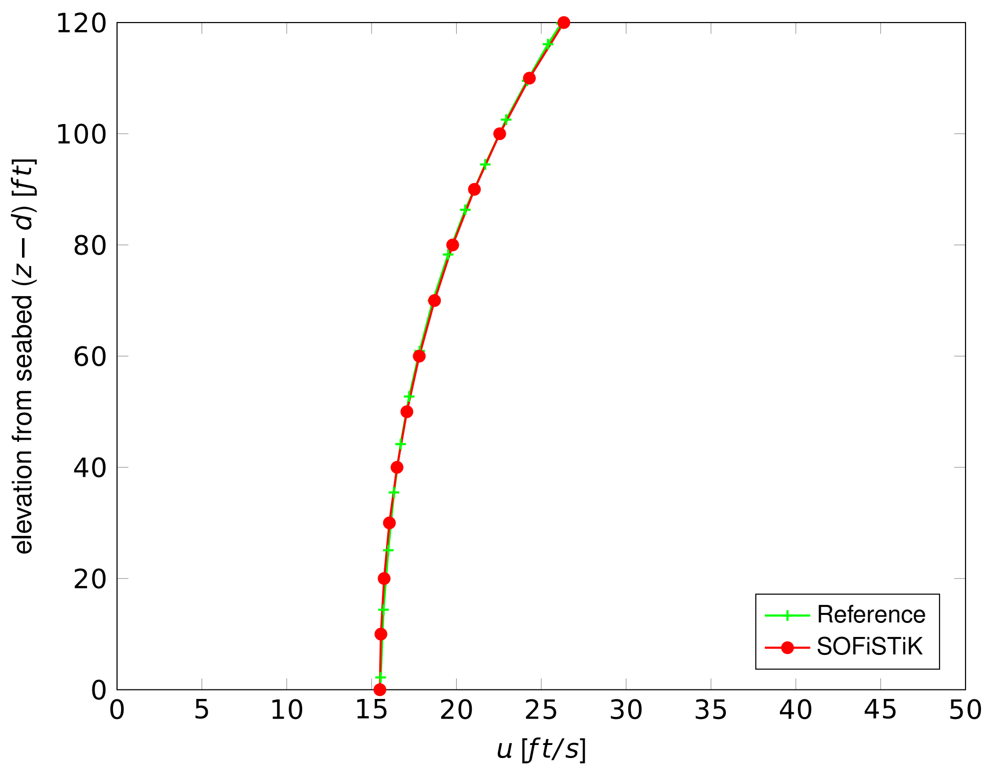

Figure 3: Horizontal velocity under wave crest

4 Conclusion

The very good agreement between the reference and the results computed by SOFiSTiK verifies that the Stokes fifth order wave theory is adequately implemented.

5 Literature

[1] S. K. Bhattacharyya. “On two solutions of fifth order Stokes waves”. In: *Applied Ocean Research* 17 (1995), pp. 63–68.

[2] J. D. Fenton. “A fifth order Stokes theory for steady waves”. In: *J. Waterways, Port, Coastal & Ocean Engineering* 111(2) (1985), pp. 216–234.

[3] *SOFiLOAD Manual: Loads and Load Functions*. Version 2018-0. SOFiSTiK AG. Oberschleißheim, Germany, 2017.