
Benchmark Example No. 53

# Verification of Wave Loading

SOFiSTiK | 2024

**VERiFiCATiON**
**BE53 Verification of Wave Loading**

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The manual and the program have been thoroughly checked for errors. However, SOFiSTiK does not claim that either one is completely error free. Errors and omissions are corrected as soon as they are detected.

The user of the program is solely responsible for the applications. We strongly encourage the user to test the correctness of all calculations at least by random sampling.

**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):** | wave_loading.dat |

# 1 Problem Description

This benchmark is concerned with the validation of wave loading on a structure. In this example the linear Airy wave theory with Wheeler stretching is applied to one exemplary wave on a monopile, as presented in Fig. 1. The surface elevation and the accumulated forces produced by the wave theory are compared with the results calculated by WaveLoads. WaveLoads is a well-known software developed within the research project GIGAWIND at Hannover University for calculating wave induced loading on hydrodynamically transparent structures [1].

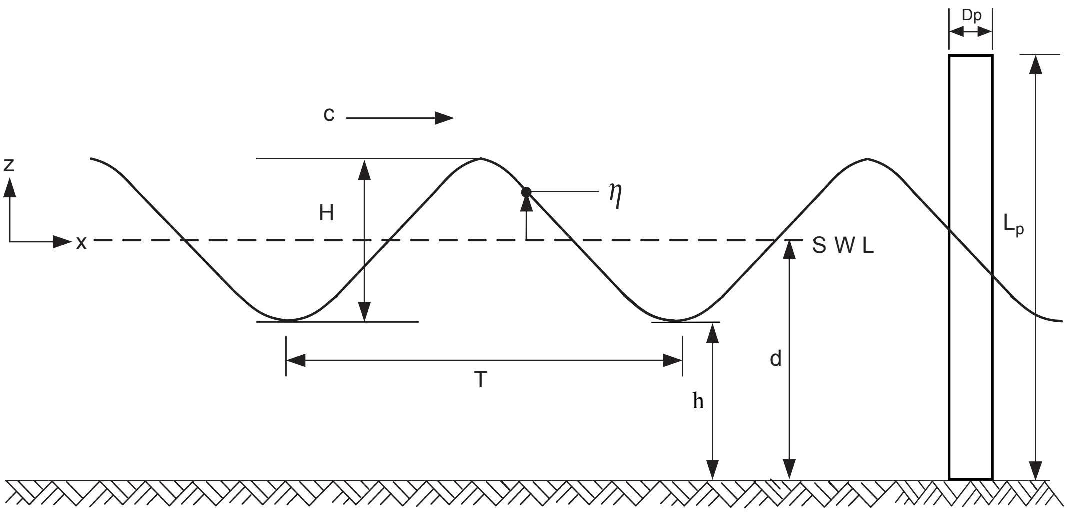


Figure 1: Wave

# 2 Reference Solution

The reference example is calculated with WaveLoads. Further information on the model can be found in the WaveLoads manual [1]. This benchmark aims at verifying three important components: the Airy wave theory, the Wheeler stretching scheme and the Morison equation [2].

# 3 Model and Results

The properties of the considered wave and the structure are defined in Table 1. The wave profile, i.e. the surface elevation $\eta$ over time of one period, is computed and shown in Fig 2 and the accumulated forces over time of one period, in Fig 3. Both results are compared to the calculated reference solution [1].

Table 1: Model Properties

| Wave Properties | Structure Properties |
|---|---|
| $d = 34\ m$ | $D_p = 6\ m$ |
| $H = 17.5\ m$ | $L_p = 54\ m$ |
| $T = 15\ s$ | $C_m = 2.0$ |
| $SWL = 0\ m$ | $C_d = 0.7$ |

The pile is modeled with $500$ elements as in the reference example. The Wheeler stretching is applied. The calculated wave length is $L = 246.013\ m$ and the calculated depth criterion $d/L = 0.138$ indicates that the examined case falls into finite water.

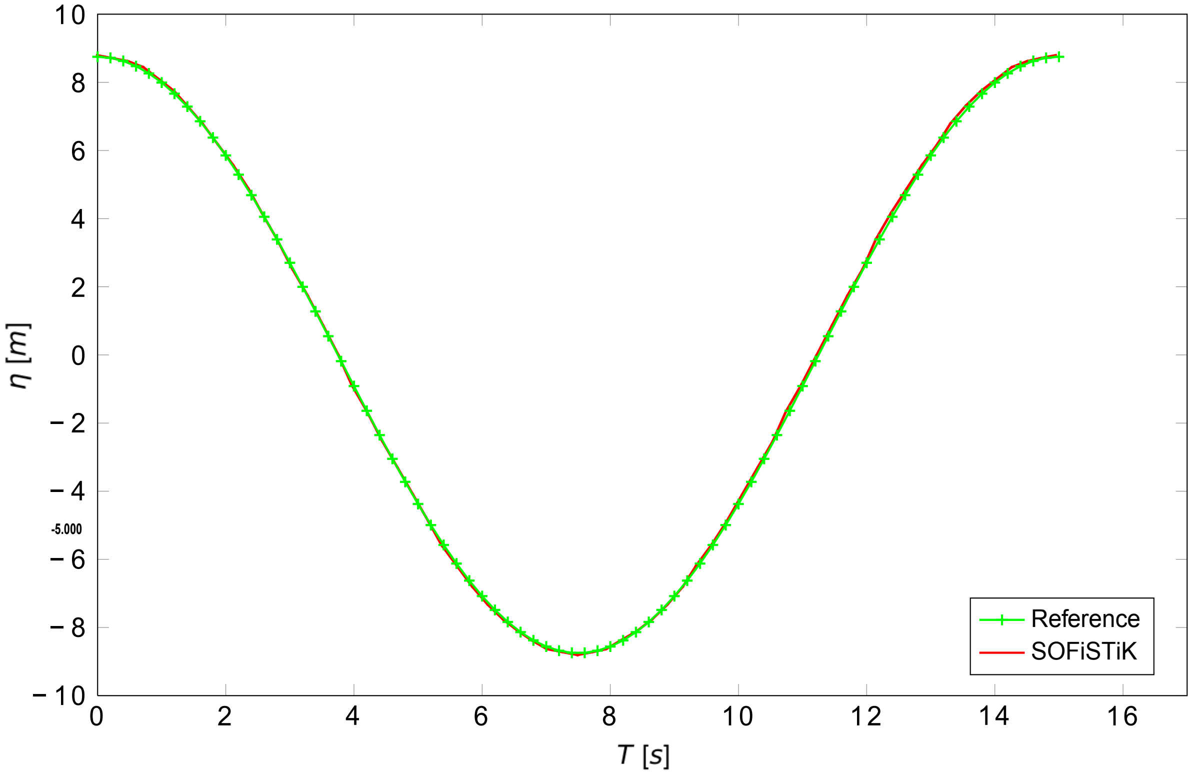


Figure 2: Wave profile

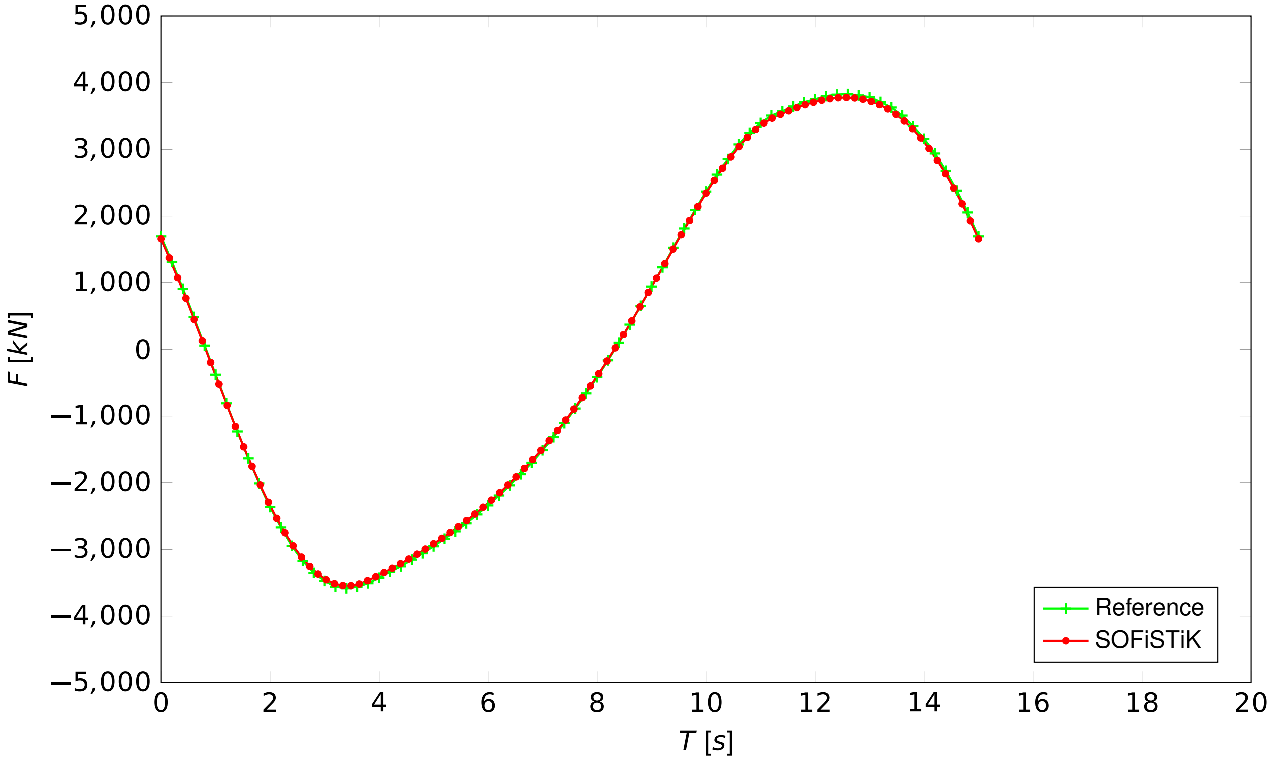


Figure 3: Accumulated Force for Airy linear wave theory in combination with Wheeler Stretching

# 4 Conclusion

The very good agreement between the reference and the results computed by SOFiSTiK verifies that the linear Airy wave theory, the Wheeler stretching scheme and the Morison equation are adequately implemented.

# 5 Literature

[1] K. Mittendorf, B. Nguyen, and M. Blümel. *WaveLoads - A computer program to calculate wave loading on vertical and inclined tubes*. ISEB - Fluid Mechanics Institute, University of Hannover. 2005.

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