SIMBAD PRE-PROCESSING PROGRAM

Foreword

The SIMBAD pre-processing program provides, from the PDSTRIP calculation results, all the necessary parameters to solve the linear hydrodynamic model in the time domain (Cummins equation), namely:

- The "infinity" added masses
- The impulse response functions ("IRF") of radiation damping values
- The impulse response functions ("IRF") of wave excitation and drift forces
- Random wave time series, according to different options:
  - With random phase, on the basis of Hs, Tp and different spectrum density models
  - With the Fast method, on the basis of Hs, Tp and diferent spectrum density models
  - With random phase, on the basis of Hs, Tp and a specific density spectrum
  - Other options for wave time series: input as a specific file, regular waves
- Time series of wave excitation forces
- Time series of drift forces, on the basis of the following options:
  - No drift forces
  - Mean-drift forces
  - Slow-drift loads ("Molin" variant)

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The input data are read from the file "pdstrip.out".

Results are written into different output files, that are further used by the SIMBAD program:

- "Houl_irr.txt", for main characteristics of ship (length, draught, position of centre of gravity, masses and inertia, hydrostatics, "infinity" added masses…)
- "rad_IRF.txt", for the radiation damping impulse response functions
- "wave_for.txt" and "drift_for.txt" respectively for the wave excitation and drift forces time series

(Two other files "FreqDir.txt" and "Rad_Fit.txt" are also generated, as intermediate data files)

These files are described in details hereafter.

All the inputs are specified in the coordinate systems such as required in the SIMBAD program (see documentation of this program). These coordinate systems have the x axis pointing forward, y to port and z upward. The first coordinate system (R1) has its origin located at the intersection of rear section, midship plane and waterline plane. The second coordinate system (R2) has its origin located at the position of the centre of gravity (with its x, y and z values specified as per the first coordinate system).

RUNNING THE SIMBAD PRE-PROCESSING PROGRAM: AN EXAMPLE OF RUN IS GIVEN HEREAFTER

C:\acadata\SIMBAD\DOSSIER_INTERNET\SIMBAD\SIMBAD_Pre_Processing\Exe\RUN.exe

```
Reading the PDSTRIP results in the pdstrip.out file

Reading the PDSTRIP results in the C:\acadata\SIMBAD\DOSSIER_INTERNET\SIMBAD\SIMBAD_Pre_Processing\Exe\pdstrip.out file
body1:
   * Setting added mass at infinite frequency to added mass at omega = 5.002
   * Setting added mass at zero frequency to added mass at omega = 0.013
   * Setting real and imaginary excitation components.
   * Setting drift forces.
Do you want plots of Added mass coefficients?: Yes or No (default: No)

Plots of Radiation damping coefficients with smoothing or fitting (default: 1):
1: Fitting to an exponential curve,
2: Smoothing with hamming method,

Enter the value of frequency limit in rad/s (Default value: 1.75 rad/s):

Do you want plots of Radiation damping coefficients?: Yes or No (default: No)

Replace the Radiation damping values by the fitted ones?: Yes or No (default: No)

Do you want plots of Excitation force real and imag. values?: Yes or No (default: No)

Do you want plots of Drift force?: Yes or No (default: No)
```

RECALL OF SOME PARAMETERS OF "PDSTRIP.OUT" FILE

POSSIBILITY OF PLOTS OF DIFFERENT PARAMETERS: ADDED MASSES, RADIATION DAMPING VALUES, EXCITATION AND DRIFT FORCES. AT THE SAME TIME AS THE PLOTTING OF THE PARAMETERS, IT IS PROPOSED A SMOOTHING OF THE VALUES AND POSSIBLY A REPLACEMENT BY THE SMOOTHED VALUES. FOR THE RADIATION DAMPING VALUES, TWO OPTIONS ARE PROPOSED : A SMOOTHING OF VALUES OR A FITTING TO AN EXPONENTIAL CURVE (FROM A FREQUENCY LIMIT : 1.75 RAD/S BY DEFAULT). SEE NOTE ON VALUES REPLACEMENT HEREAFTER.

Running the SIMBAD pre-processing program:

Note about the smoothing or fitting of the parameters:

The smoothing of fitting of the different parameters was initially intended to improve the resolution of the linear hydrodynamic model in the time domain.
However, at the time of the comparisons with the results published in the literature, it could not be shown that these smoothing or fitting could improve the results of the SIMBAD calculations.
This is undoubtedly due to the fact that for the added mass, we use a value called at "infinity" and to some extent, for the radiation damping values and the wave excitation and drift forces, we use the impulse response functions which would tend to smooth the results.
The plot of the values of the parameters is therefore mainly used to check that the results of the PDSTRIP program do not present a strong inconsistency.

RUNNING THE SIMBAD PRE-PROCESSING PROGRAM (FOLLOWING): AN EXAMPLE OF RUN IS GIVEN HEREAFTER

C:\acadata\SIMBAD\DOSSIER_INTERNET\SIMBAD\SIMBAD_Pre_Processing\Exe\RUN.exe

```
Do you want a Simbad file for irregular wave?: Yes or No (default: Yes)

Wave directions:
 [  0.  30.  60.  90. 120. 150. 180. 210. 240. 270. 300. 330.]
Wave direction chosen (default value: 90): 135
Wave frequencies:
 [0.013 0.078 0.142 0.205 0.267 0.326 0.384 0.44  0.493 0.544 0.593 0.641
 0.686 0.731 0.775 0.818 0.861 0.904 0.947 0.991 1.036 1.083 1.129 1.176
 1.225 1.273 1.323 1.372 1.422 1.472 1.523 1.573 1.623 1.674 1.724 1.774
 1.825 1.875 1.926 1.976 2.026 2.077 2.127 2.177 2.228 2.278 2.329 2.379
 2.43  2.48  2.53  2.581 2.631 2.682 2.732 2.783 2.833 2.884 2.934 2.984
 3.035 3.085 3.136 3.186 3.236 3.287 3.337 3.388 3.438 3.488 3.539 3.589
 3.639 3.69  3.74  3.791 3.841 3.891 3.942 3.992 4.043 4.093 4.144 4.194
 4.244 4.295 4.345 4.396 4.446 4.497 4.547 4.598 4.648 4.697 4.748 4.8
 4.851 4.898 4.95  5.002]
Wave frequency chosen (default value: 0.5): 0.52

Wave height Hs in m (default value:0.001 m): 1.0
Do you need to change the irregular wave parameters?: Yes or No (default: No)

Interpolation of coefficients in frequency
Interpolation of coefficients in direction
Excitation force IRF for body1:100%|##########################################
1: No wave drift forces,
2: Mean wave drift forces,
3: Calculation with Molin formulation,
Default: 2

Drift force IRF for body1:100%|###############################################
Do you want plots of Wave excitation IRF?: Yes or No (default: No)

Do you want plots of drift force IRF?: Yes or No (default: No)

Calculation range for the radiation damping IRF (default value: 95s):
Radiation damping IRF for body1:100%|#########################################
Do you want plots of Radiation damping IRF?: Yes or No (default: No)
```

*DEFINITION OF DIRECTION, FREQUENCY (2*PI/T) AND SIGNIFICANT HEIGHT OF THE WAVE TIME-SERIES*

INTERPOLATION IN FREQUENCY AND DIRECTION

DETERMINATION OF EXCITATION AND DRIFT FORCES IRFS, AS WELL AS RADIATION DAMPING IRF. FOR THE DRIFT FORCES, A CHOICE IS TO BE DONE, ACCORDING TO 3 OPTIONS.: NO DRIFT FORCES; MEAN WAVE DRIFT FORCES (DRIFT LOADS ARE DERIVED ONLY FROM THE DIAGONAL TERMS OF THE QUADRATIC TRANSFER FUNCTIONS (QTFS)); SLOW DRIFT LOADS , THAT ARE COMPUTED ON THE BASIS OF NEWMAN'S APPROXIMATION AND ACCORDING TO THE MOLIN FORMULATION (SEE : MOLIN B., "SECOND-ORDER HYDRODYNAMICS APPLIED TO MOORED STRUCTURES", BRITISH MARITIME TECHNOLOGY, 1994)

Running the SIMBAD pre-processing program (following): An example of run is given hereafter

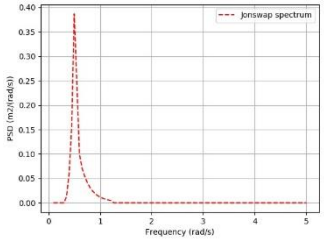
C:\acadata\SIMBAD\SIMBAD_V0.1\DOSSIER_INTERNET\SIMBAD\SIMBAD_Pre_Processing\Exe\RUN.exe

```
       Radiation state space coefficients for body1 were not written.
Wave height Hs in m:  1.0 m
Peak period Tp in s:  12.57 s
Wave directions:
 [  0.  30.  60.  90. 120. 150. 180. 210. 240. 270. 300. 330.]
Wave direction chosen:  90.0 °
Simulation duration in s (default value: 14400):
Time step between 0.1 and 1 s (default value: 0.5):
[0.00000e+00 5.00000e-01 1.00000e+00 ... 1.43985e+04 1.43990e+04
 1.43995e+04]
1: Jonswap spectrum density model,
2: Bretschneider spectrum density model,
3: Torsethaugen spectrum density model,
4: McCormick spectrum density model,
5: OchiHubble spectrum density model,
6: Wallop spectrum density model,
Default: 1
```

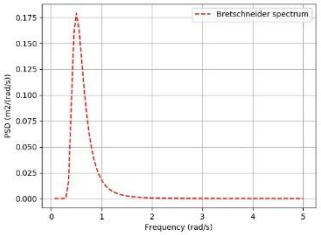
Recall of wave parameters previously chosen

Determination of time series duration and time step. A duration of 4 hours has been taken as default value, as well as a time step of 0.5s. Different options are also possible for the wave time series (see hereafter)

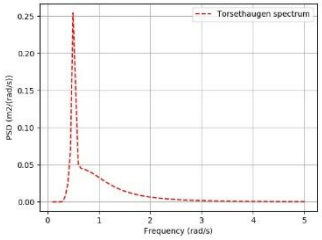
Different types of spectrum density model are available for options 1 and 2 of wave time series



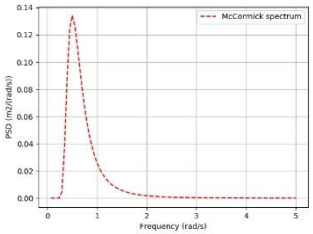
Jonswap spectrum



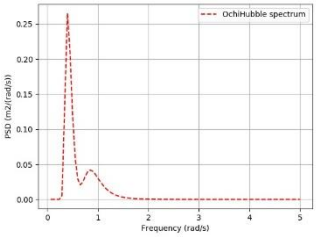
Bretschneider spectrum



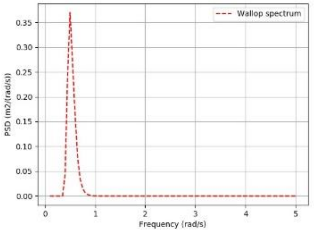
Torsethaugen spectrum



McCormick spectrum



OchiHubble spectrum



Wallop spectrum

Running the SIMBAD pre-processing program (following):
An example of run is given hereafter

```
1: Jonswap spectrum density model,
2: Bretschneider spectrum density model,
3: Torsethaugen spectrum density model,
4: McCormick spectrum density model,
5: OchiHubble spectrum density model,
6: Wallop spectrum density model,
Default: 1

1: Wave time series with random phase,
2: Wave time series with the Fast method,
3: Wave time series from a specific file,
4: Wave time series from a specific density spectrum,
5: Regular waves (Amplitude=0.5*Hs),
Default: 2

Do you want plots of Wave excitation forces?: Yes or No (default: No)

Do you want plots of Drift excitation forces?: Yes or No (default: No)

Press the ENTER key to continue...
```

Different options are possible for the wave time series: option 1 computes a wave elevation with a random phase ; option 2 calculates a Gaussian-distributed wave elevation with a uniformly distributed random phase and also a normally distributed amplitude ; option 3 considers a wave time series as input; option 4 is similar to option 1 but for a density spectrum given as input; Option 5 is for regular waves.
The previous choice of a spectrum density model concerns only the options 1 and 2

Plots of wave excitation and drift forces

Running the SIMBAD pre-processing program:

Note on the choice of options for the wave time –series:

The vast majority of the comparisons made with the results published in the literature were made by taking into account option 2 for the calculation of the time series of waves and forces. It is therefore advisable to take this option into account in the presence of waves, when the Jonswap spectrum is taken into account.

The strip method used for the hydrodynamic calculations can only provide approximate values for the drift forces. Option 3 of calculating the drift forces sometimes gives quite strong results, especially in combination with gusty wind. For now, it is recommended to choose option 3 if the wind is not to be considered and option 2 otherwise.

Note on the choice of time –series duration and time step:

The duration sets the length of the incident wave kinematics time series, but it also determines the frequency step used in the inverse Fourier transform, from which the time series are derived (with option 2). If the total simulation time is more than the duration of the wave time series, there will be a cyclic repeatability of the wave train. The time step for the wave time series determines also the maximum frequency in the inverse Fourier transform. When modelling irregular sea states, it is recommended that the duration be set to at least 3 hours (DNV, BV) and that the time step be a value in the range between 0.1 and 1 s. This time step is specified independently from the time step of SIMBAD program (wave forces are interpolated in time as necessary). In SIMBAD program, the maximum number of time steps is 28800, i.e.: 4 hours at 0.5s time step or 2 hours at 0.25s time step.

Running the SIMBAD pre-processing program: Result file "Houl_irr.txt", for main characteristics of ship

```
   279.00 1     137.00        0.00        3.40
    12.00       90.00        1.25
    10.80        0.00
9.23650e+07 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00
0.00000e+00 9.23650e+07 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00
0.00000e+00 0.00000e+00 9.23650e+07 0.00000e+00 0.00000e+00 0.00000e+00
0.00000e+00 0.00000e+00 0.00000e+00 2.84022e+10 0.00000e+00 0.00000e+00
0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 4.65002e+11 0.00000e+00
0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 4.44996e+11
0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 -1.62470e+07 0.00000e+00
0.00000e+00 0.00000e+00 0.00000e+00 1.62470e+07 0.00000e+00 0.00000e+00
0.00000e+00 0.00000e+00 9.38596e+07 0.00000e+00 -2.91948e+08 0.00000e+00
0.00000e+00 0.00000e+00 0.00000e+00 4.80214e+09 0.00000e+00 0.00000e+00
0.00000e+00 0.00000e+00 -2.91948e+08 0.00000e+00 3.94237e+11 0.00000e+00
0.00000e+00 0.00000e+00 0.00000e+00 -2.06185e+09 0.00000e+00 0.00000e+00
2.658247e+06 0.000000e+00 0.000000e+00 0.000000e+00 -9.085947e+06 0.000000e+00
0.000000e+00 2.292022e+07 0.000000e+00 -9.628294e+07 0.000000e+00 7.543337e+07
0.000000e+00 0.000000e+00 3.171721e+08 0.000000e+00 -8.877196e+08 0.000000e+00
0.000000e+00 -9.673418e+07 0.000000e+00 6.767870e+09 0.000000e+00 -8.627555e+08
-9.085947e+06 0.000000e+00 -8.877198e+08 0.000000e+00 8.642086e+11 0.000000e+00
0.000000e+00 7.543341e+07 0.000000e+00 -8.618248e+08 0.000000e+00 1.319021e+11
```

Ship's Lpp/number of bodies/xg, yg, zg of centre of gravity in coordinate system R1
Wave Tp/direction/Hs
Ship's draft/NA

Masses, inertia

Hydrostatics

"Infinity" Added masses

Running the SIMBAD pre-processing program: Result file "rad_IRF.txt", for the radiation damping impulse response functions

```
476
14
0 0
0.000000e+00 9.525177e+06
2.000000e-01 9.330204e+06
4.000000e-01 8.758139e+06
6.000000e-01 7.846504e+06
8.000000e-01 6.654468e+06
1.000000e+00 5.258109e+06
1.200000e+00 3.744388e+06
1.400000e+00 2.204369e+06
1.600000e+00 7.262819e+05
1.800000e+00 -6.109749e+05
2.000000e+00 -1.743339e+06
2.200000e+00 -2.625655e+06
2.400000e+00 -3.234001e+06
2.600000e+00 -3.566139e+06
2.800000e+00 -3.640122e+06
3.000000e+00 -3.491269e+06
3.200000e+00 -3.167848e+06
3.400000e+00 -2.725932e+06
3.600000e+00 -2.223926e+06
3.800000e+00 -1.717297e+06
4.000000e+00 -1.253971e+06
4.200000e+00 -8.707905e+05
4.400000e+00 -5.913026e+05
4.600000e+00 -4.249882e+05
4.800000e+00 -3.679206e+05
5.000000e+00 -4.046818e+05
5.200000e+00 -5.112609e+05
5.400000e+00 -6.585702e+05
5.600000e+00 -8.161792e+05
5.800000e+00 -9.558627e+05
6.000000e+00 -1.054609e+06
6.200000e+00 -1.096806e+06
6.400000e+00 -1.075434e+06
6.600000e+00 -9.921958e+05
          -
          -
          -
```

Number of time steps for each IRF
Total number of IRFs
Position of IRF in matrix 6x6 (from 0 to 5)

Values of IRF at each time step

RUNNING THE SIMBAD PRE-PROCESSING PROGRAM: RESULT FILE "WAVE_FOR.TXT" FOR THE WAVE EXCITATION FORCES TIME SERIES

```
28800
0
0.000000e+00 9.046170e+03
5.000000e-01 1.416102e+04
1.000000e+00 1.638136e+04
1.500000e+00 8.982066e+03
2.000000e+00 1.313831e+03
2.500000e+00 -2.700510e+03
3.000000e+00 -3.433519e+03
3.500000e+00 -1.708423e+03
4.000000e+00 -3.694717e+02
4.500000e+00 4.198782e+02
5.000000e+00 -4.272198e+02
5.500000e+00 -3.114241e+03
6.000000e+00 -6.525065e+03
6.500000e+00 -1.040189e+04
7.000000e+00 -1.299836e+04
7.500000e+00 -1.361685e+04
8.000000e+00 -1.190833e+04
8.500000e+00 -7.642256e+03
9.000000e+00 -2.145484e+03
9.500000e+00 3.783757e+03
1.000000e+01 8.680641e+03
1.050000e+01 1.141816e+04
1.100000e+01 1.185590e+04
1.150000e+01 9.767578e+03
1.200000e+01 6.207435e+03
1.250000e+01 2.120632e+03
1.300000e+01 -1.522560e+03
1.350000e+01 -3.635018e+03
1.400000e+01 -4.187335e+03
1.450000e+01 -3.062258e+03
1.500000e+01 -8.605344e+02
1.550000e+01 1.595562e+03
1.600000e+01 3.849691e+03
1.650000e+01 5.114036e+03
1.700000e+01 5.349410e+03
            -
            -
            -
```

NUMBER OF TIME STEPS FOR EACH TIME SERIES

DEGREE OF FREEDOM OF WAVE FORCE (FROM 0 TO 5)

VALUES OF WAVE EXCITATION FORCE AT EACH TIME STEP

Running the SIMBAD pre-processing program: Result file "drift_for.txt" for the drift forces time series

```
28800
0
0.000000e+00 2.325136e+03
5.000000e-01 3.227300e+03
1.000000e+00 4.362367e+03
1.500000e+00 5.317862e+03
2.000000e+00 6.091253e+03
2.500000e+00 6.900416e+03
3.000000e+00 7.698847e+03
3.500000e+00 8.234822e+03
4.000000e+00 8.661215e+03
4.500000e+00 9.040098e+03
5.000000e+00 9.168592e+03
5.500000e+00 9.166338e+03
6.000000e+00 9.132446e+03
6.500000e+00 8.856052e+03
7.000000e+00 8.435268e+03
7.500000e+00 8.003969e+03
8.000000e+00 7.405523e+03
8.500000e+00 6.744639e+03
9.000000e+00 6.156181e+03
9.500000e+00 5.465354e+03
1.000000e+01 4.729771e+03
1.050000e+01 4.136482e+03
1.100000e+01 3.566532e+03
1.150000e+01 2.996157e+03
1.200000e+01 2.549697e+03
1.250000e+01 2.174847e+03
1.300000e+01 1.836923e+03
1.350000e+01 1.594648e+03
1.400000e+01 1.421365e+03
1.450000e+01 1.314731e+03
1.500000e+01 1.286709e+03
1.550000e+01 1.300260e+03
1.600000e+01 1.393819e+03
1.650000e+01 1.556559e+03
1.700000e+01 1.722259e+03
-
-
-
```

Number of time steps for each time series

Degree of freedom of drift force (from 0 to 5)

Values of drift force at each time step