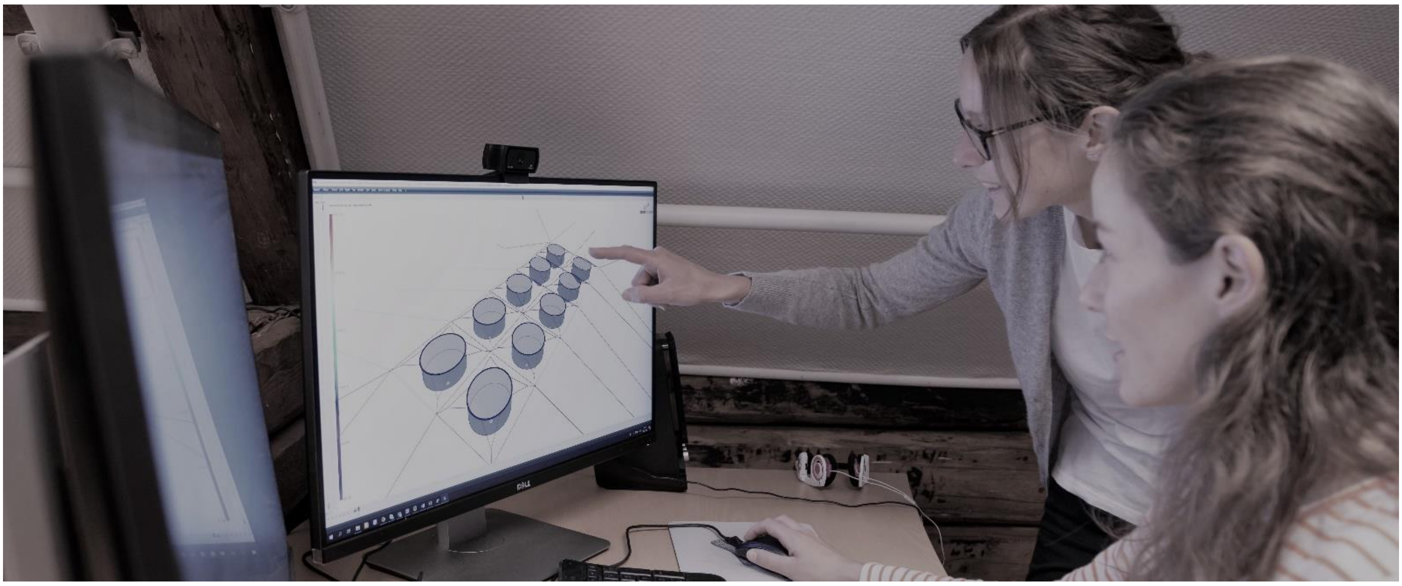
AquaSim training courses

- **Bottom contact, Feces**



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AquaSim version: 2.18

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Content

1 Prerequisites

The tutorial presents a simple case study with the purpose of demonstrating functionality in AquaSim.

It is assumed that the user is familiar with the basic principles of modelling and specifying material parameters in AquaEdit, as well as conducting analyses. If you are looking for an introduction to AquaSim we advise you to start with the Basic program tutorials.

2 Case study – Bottom contact

2.1 Learning objectives

Upon completion of this case study, you will be able to:

- Model an element that represents fish feces falling to the seabed
- Understand the possibility to import terrain and apply bottom contact
- Know parameters in bottom contact and dynamic friction

2.2 Introduction

In this tutorial you should model a small object that falls down on to the seabed. The seabed could either be flat, or you can import a terrain model. Whether the object should slide or bounce on the bottom strongly depends on the properties of the seabed and the object. If the seabed consists of rock, the object will bounce more than if it is mud.

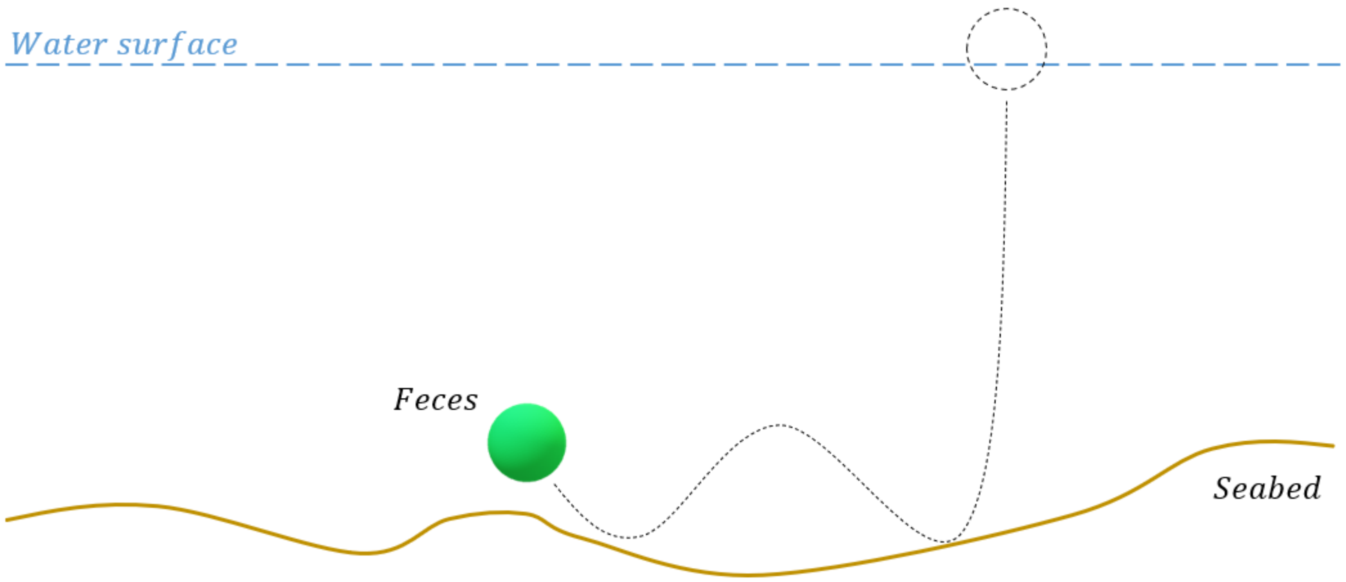

Figure 1

2.3 AquaEdit

Load the AquaSim model *Feces.amodel* that comes with this tutorial.

> **Note** that a terrain model (.obj) is associated with this case study. Upon down-loading this tutorial, this file should be stored in the same folder as the AquaSim model. This to make sure it is available in your model.

The key to model feces is to model an object having the correct relation between drag, weight and buoyancy, so that it has the same relation as feces. Both a truss and a beam element can be applied to resemble this.

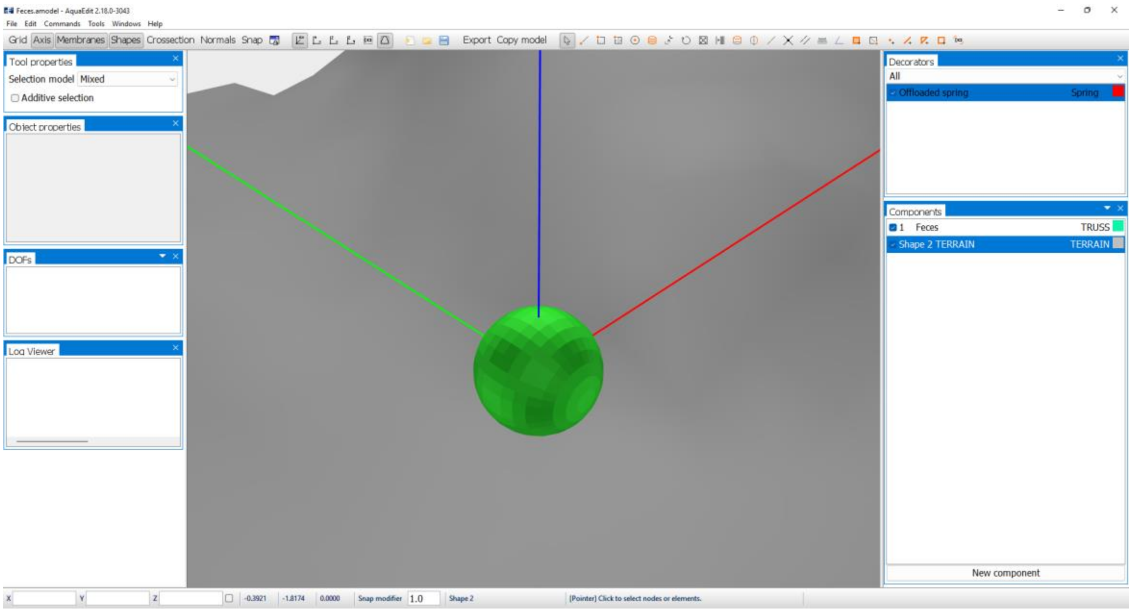

Figure 2

In AquaEdit, a small truss element has been modelled. Double click component **1 Feces** in the component window to view the properties.

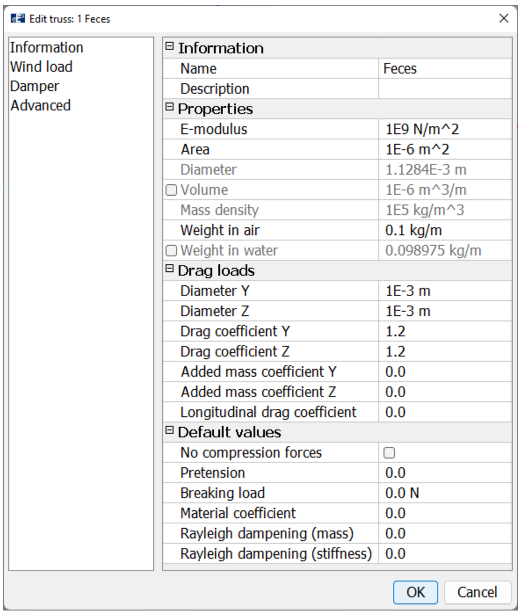

Figure 3

The feces is modelled as a Truss component. A small area of 1.0E-06 m2 and weight of approximately 0.1 kg/m is applied. Drag is applied, this is seen by the values in the **Drag loads** section. We are satisfied with these values and select **OK**.

The purpose of the case study is to let the feces fall freely to the bottom and see how it slides along the seabed. This will lead to large initial vertical translation in the analysis. Large response over a short period of time may induce numerical challenges, and to make the start of the analysis more stable a spring is assigned to the Truss component. This is seen in the **Decorators window** in AquaEdit.

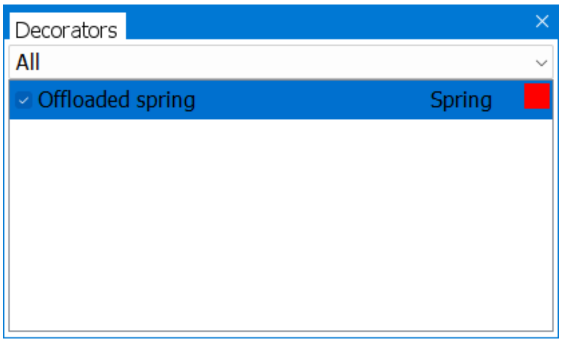

Figure 4

Double click this to enter the Edit spring-dialogue.

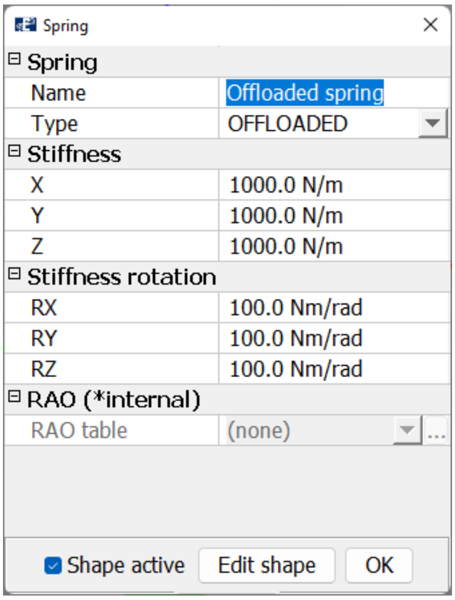

Figure 5

The spring is of type **Offloaded**. This type of spring has a constant spring stiffness in the static initial steps (defined by Preincrement in the Export menu) of the analysis. When the dynamic part starts, the spring stiffness is removed. Both, translatory and rotational stiffness is applied to the feces.

Shapes can also be added to springs, in the lower section you find options for this. By toggle on **Shape active** and **Edit shape** you can add custom shapes. Shapes are object-files without any properties, meaning that it does not contribute to any hydrodynamical properties. The sphere you see in the 3D window of AquaEdit is a type of shape that is assigned to the spring. **Exit** the shape- and spring window.

A bottom can be added through Import terrain. This is found by selecting **Commands** > **Import terrain**.

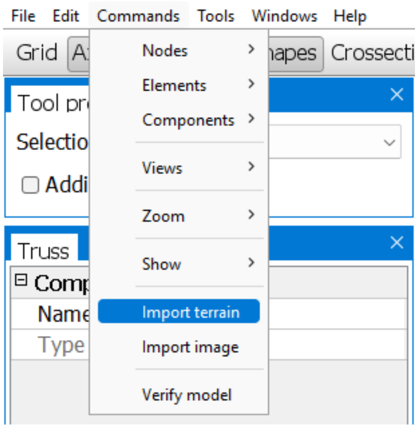

Figure 6

For AquaEdit to be able to use the terrain, it needs to know where to put it. This is defined in the **Center (location of <0,0,0>)** section. Further, one can adjust the **Projection plane**, **Map size** and other options to customize the terrain model. In the lower section, you have **Additional datasets**. This is where you import the terrain model through selecting **Add**. You may add one or more datasets.

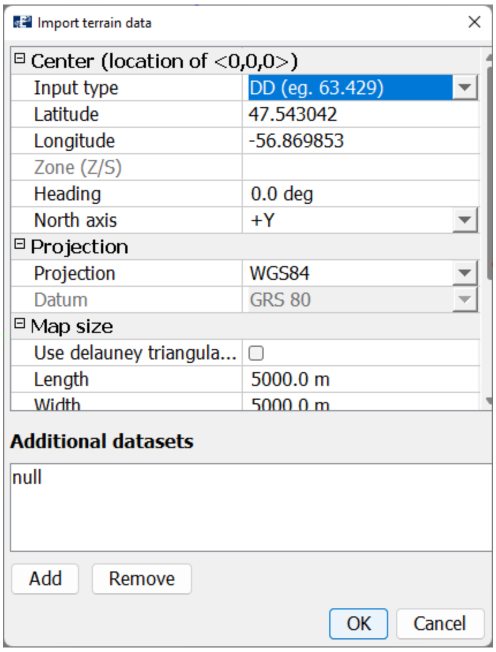

Figure 7

When the terrain is imported, it will appear as a shape in the Components window. The visibility of this can be toggled on and off.

Figure 8

As mentioned, shapes are object-files without any properties. So, the terrain will need to be assigned some bottom properties. If the analysis had been conducted only on the basis of the terrain shape, the feces would have just fall through the terrain. Bottom properties are found in the **Export** menu.

2.4 Analysis

Select **Export** and go to the **Normal**-tab. Let us consider the parameters found in **Time series**: the number of time steps needed depends on the time it takes for the feces to reach the bottom. We run the analysis with 5 initial steps (**Preincrement**) and a total of $4000/200 = 20$ wave cylces, having a wave period of 9 seconds (see **T[s]** in the load condition line) this will result in an analysis of 180 seconds.

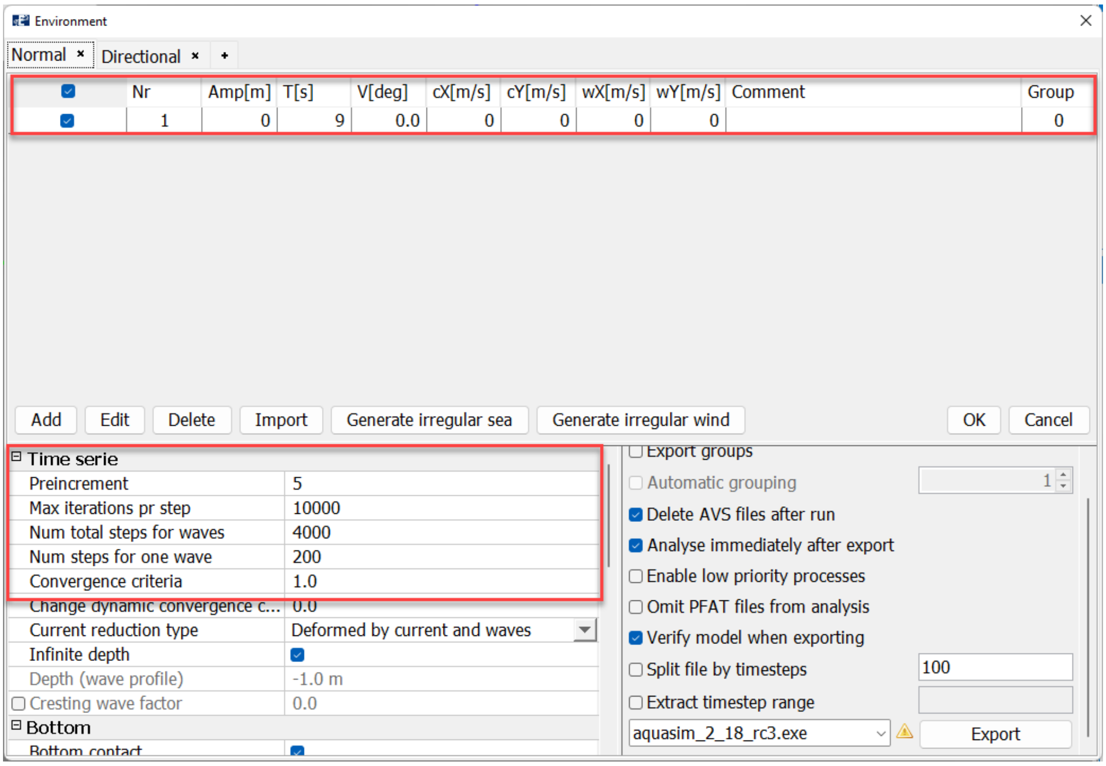

Figure 9

The properties of the bottom should now be decided, go down to the **Bottom** section:

⊟ Bottom	
Bottom contact	☑
Bottom depth	-100.0 m
Use terrain as bottom	☑
Bottom parameter	1.0
Bottom friction	0.0
Dynamic vertical friction	0.1
Dynamic horizontal friction	0.0

Figure 10

To tell AquaSim that a bottom should be applied one should activate the checkbox for **Bottom contact**. To apply the imported terrain as the bottom, activate the **Use terrain as bottom**. This will leave the **Bottom depth** as a dummy, meaning that whatever value is inserted here, this is not accounted for in the analysis.

The **Dynamic vertical friction** and **Dynamic horizontal friction** are factors that are proportional to the velocity of the node when it comes in contact with the seabed. In this case, they will influence how much the feces will bounce and slide along the seabed. We set **Dynamic vertical friction** equal to 0.1, and **Dynamic horizontal friction** equal to 0.

We are ready to start the analysis. Select **Export** and save the analysis as suitable place on your computer, **Start** the analysis. The analysis should take a couple of minutes to finish.

2.5 AquaView

When the analysis is finished, you can **Open** the result file from the **Analyse** window.

> **Note:** if you run the analysis in batch-mode, the result file can be found in the folder you saved the analysis. Double click on <*name of analysis*>.avz to load it in AquaView.

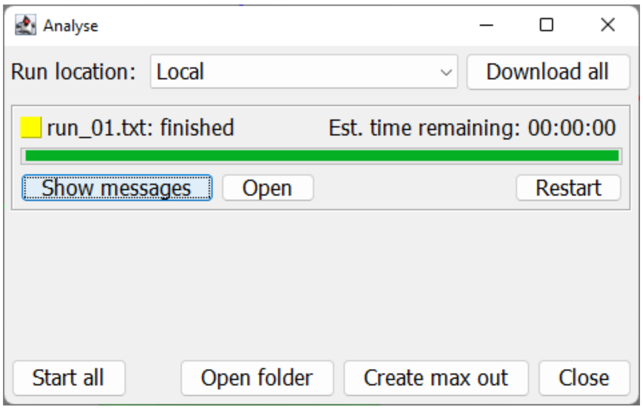

Figure 11

Some steps may not have converged, but that is ok. If the warning appears, just accept it.

The 3D window may be clear without any elements or terrain. To view the shape of the feces, select **Show** > **Shapes** > **Offloaded spring**.

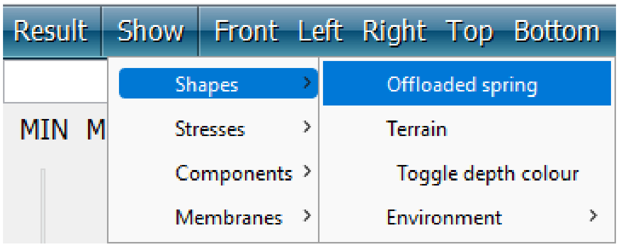

Figure 12

To turn on the view of the terrain select **Show** > **Shapes** > **Terrain**. The terrain may also be coloured be the depth, to view this toggle on **Toggle depth colour**.

The displacement in horizontal- (**Displacment X [m]**) and vertical direction (**Displacement Z [m]**) is plotted, this is seen in the two succeeding figures.

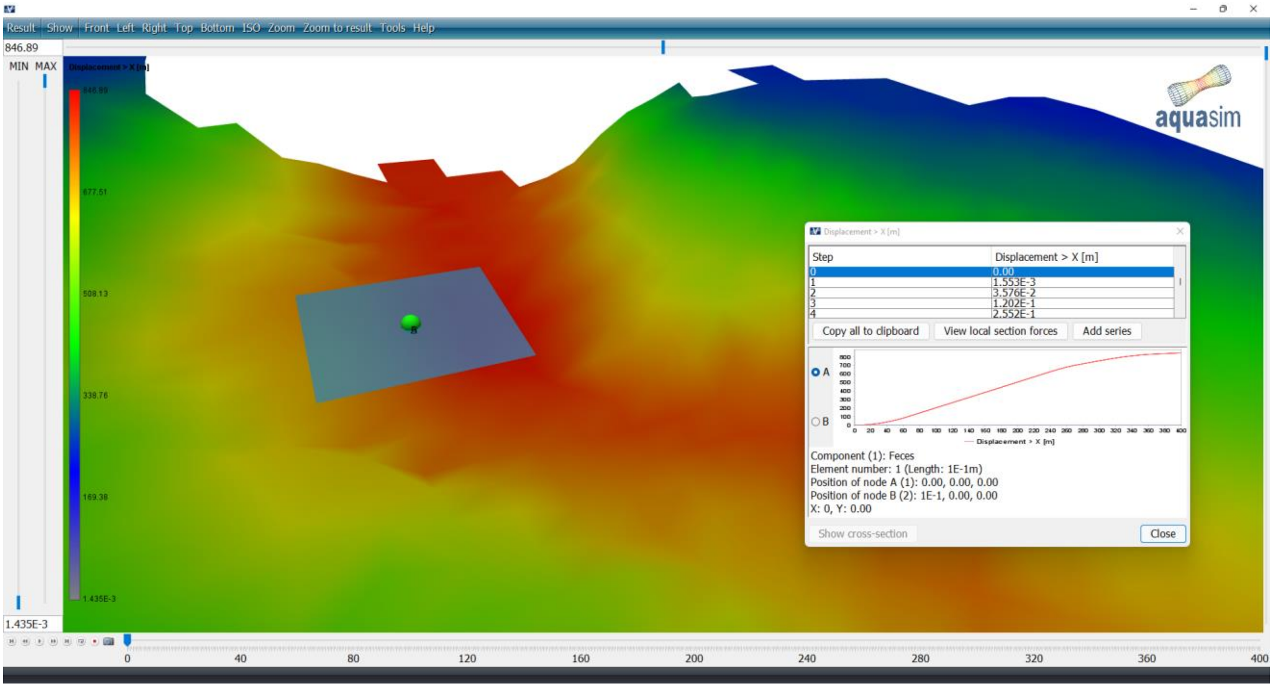

Figure 13

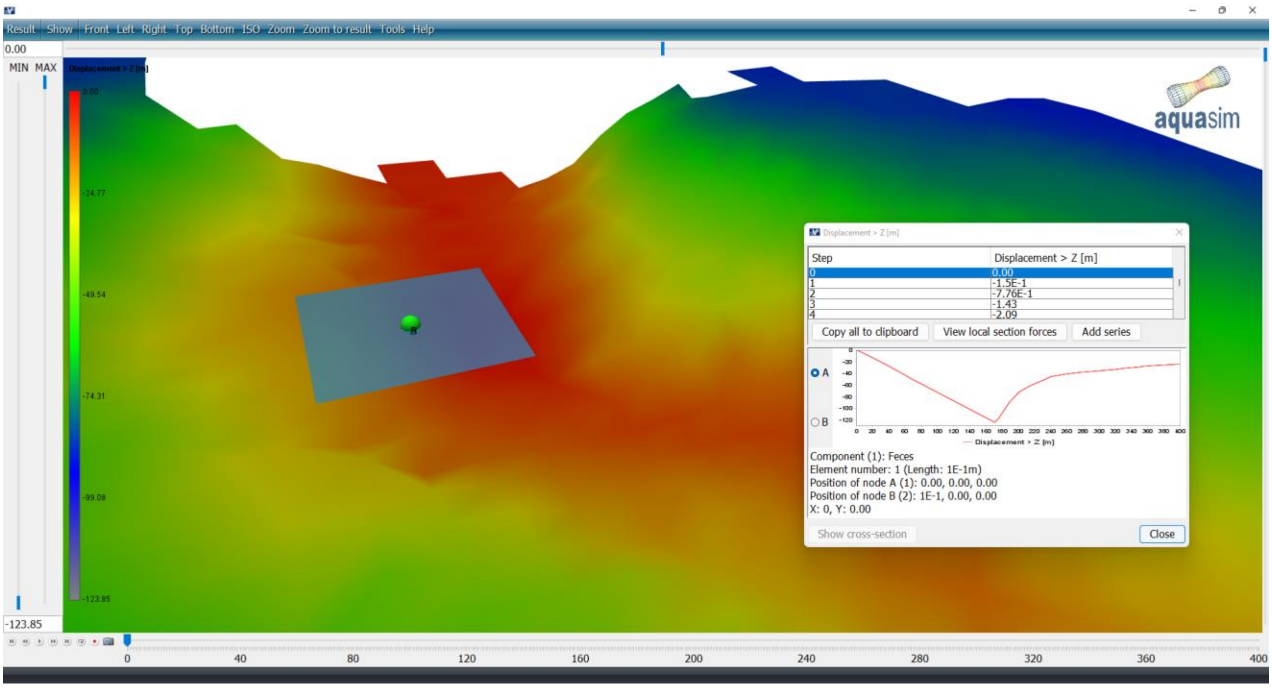

Figure 14

The size of the Offloaded spring-shape can be adjusted by using the rightmost bar in the AquaView window.

The horizontal displacement of the feces wills tart to decrease when it hits the bottom. This is seen where the curve starts to flatten out. The feces hit the bottom when the curve of the vertical displacement gets a sharp break, then it will slide along the bottom and follow the terrain curvature.

2.6 AquaEdit

Regardless of what kind of properties the feces have, it can be of interest to see the landing place and let the falling object ‘stick’ to the landing place. Having more than one object, one can easily compare landing as a function of environmental parameters such as waves and current.

In the previous analysis, we did not include any horizontal friction in the seabed. Let us include this in a new analysis. Go back to your AquaEdit model and the **Export** menu. Navigate to the **Bottom** section and set **Dynamic horizontal friction** = 1.

⊟ Bottom	
Bottom contact	☑
Bottom depth	-100.0 m
Use terrain as bottom	☑
Bottom parameter	1.0
Bottom friction	0.0
Dynamic vertical friction	0.1
Dynamic horizontal friction	1.0

Figure 15

2.7 Analysis

Export the analysis and save it a suitable place, we have named the analysis *run_horizontal_frict_*. **Start** the analysis.

When the analysis is finished, **Open** it in AquaView.

2.8 AquaView

Turn on the view for the Offloaded spring, Terrain and toggle on depth colour again; **Show** > **Shapes**.

The figure below show the horizontal- (**Displacement X [m]**) and vertical (**Displacement Z [m]**) displacement.

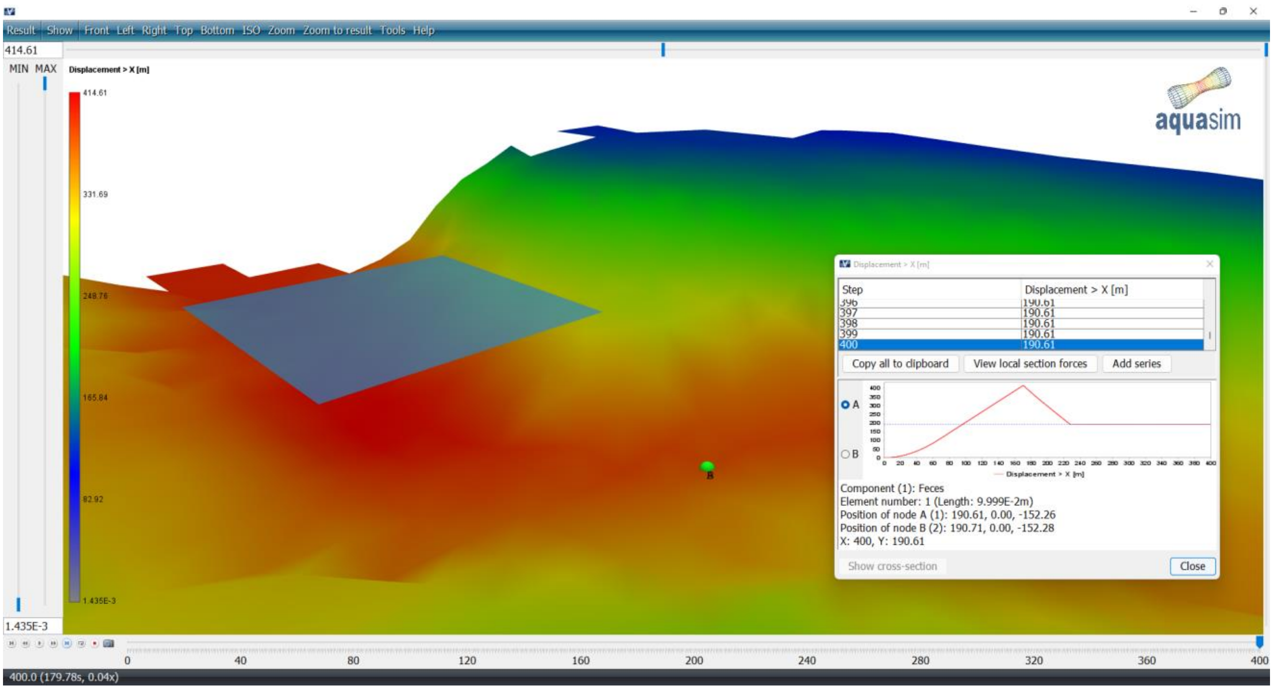

Figure 16

The feces will impact the bottom where the curve breaks. Then it will slide and downwards to a location where it finally will stop. If one would like the falling object to stop at the impact point, one can further increase the dynamic horizontal friction.

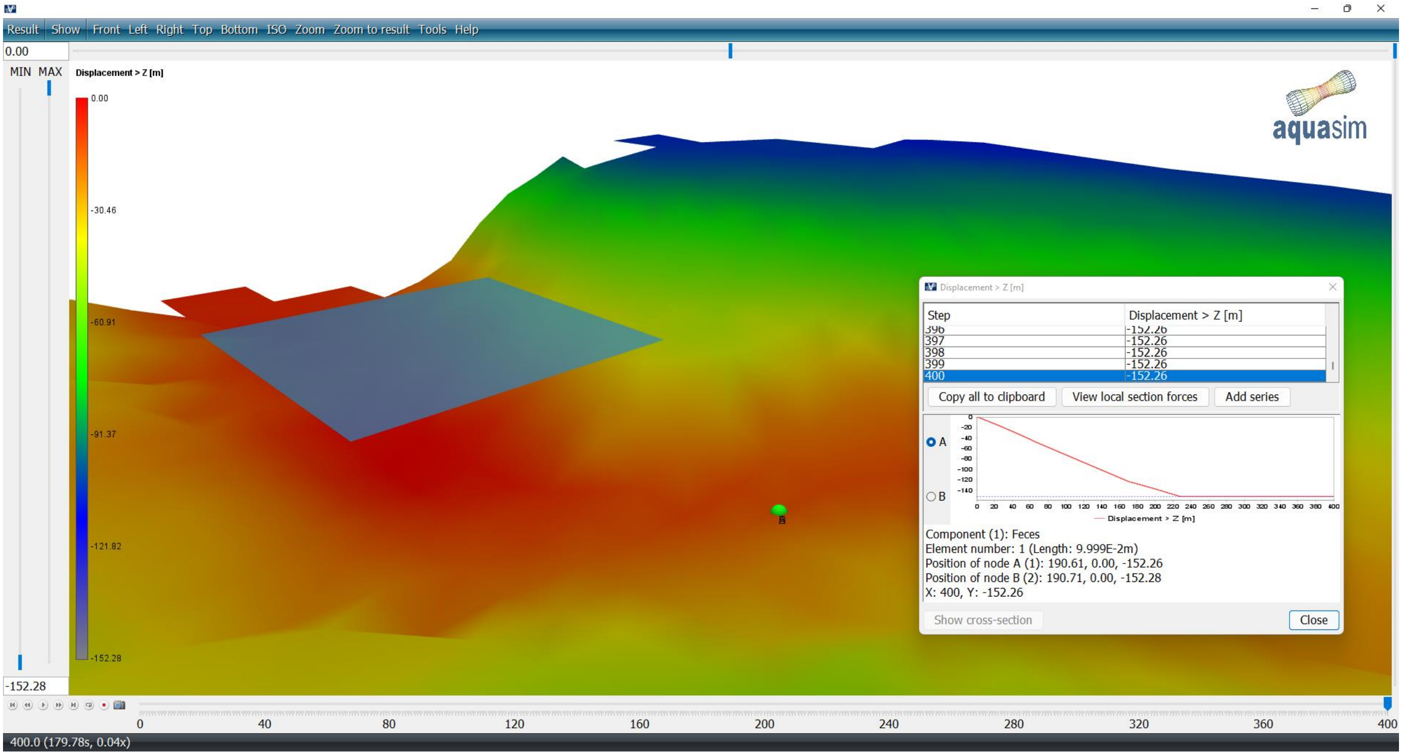

Figure 17

2.9 AquaEdit

It can be of interest to compare landing points for a diverse set of environmental conditions. This can easily be obtained by running sets of analyses and compare these. Let us run a third analysis.

Go back to your AquaEdit model and enter the **Export** menu. In the **Normal-tab**, add a wave amplitude (**Amp[m]**) of 3 meters. Leave the period equal to 9 seconds (**T[s]**). Apply a current in x-direction of 0.1m/s (**cX[m/s]**).

Environment

Normal × Directional × +

☑	Nr	Amp[m]	T[s]	V[deg]	cX[m/s]	cY[m/s]	wX[m/s]	wY[m/s]	Comment	Group
☑	1	3	9	0.0	0	0	0	0		0

Figure 18

2.10 Analysis

The rest of the analysis settings can be as before. **Export** the analysis and save it, then **Start** the analysis form the **Analyse** window. We named the analysis *run_wave_current_*.

⊟ Time serie	
Preincrement	5
Max iterations pr step	10000
Num total steps for waves	4000
Num steps for one wave	200
Convergence criteria	1.0
Change dynamic convergence c...	0.0
Current reduction type	Deformed by current and waves
Infinite depth	☑
Depth (wave profile)	-1.0 m
☐ Cresting wave factor	0.0

⊟ Bottom	
Bottom contact	☑
Bottom depth	-100.0 m
Use terrain as bottom	☑
Bottom parameter	1.0
Bottom friction	0.0
Dynamic vertical friction	0.1
Dynamic horizontal friction	1.0

Figure 19

When the analysis is finished **Open** it in AquaView.

2.11 AquaView

Plot the horizontal- and vertical displacement of the feces again. In this case, it will take longer for the feces to reach the bottom compared with the two other analyses. This happens because the velocity of the water changes the path of the feces.

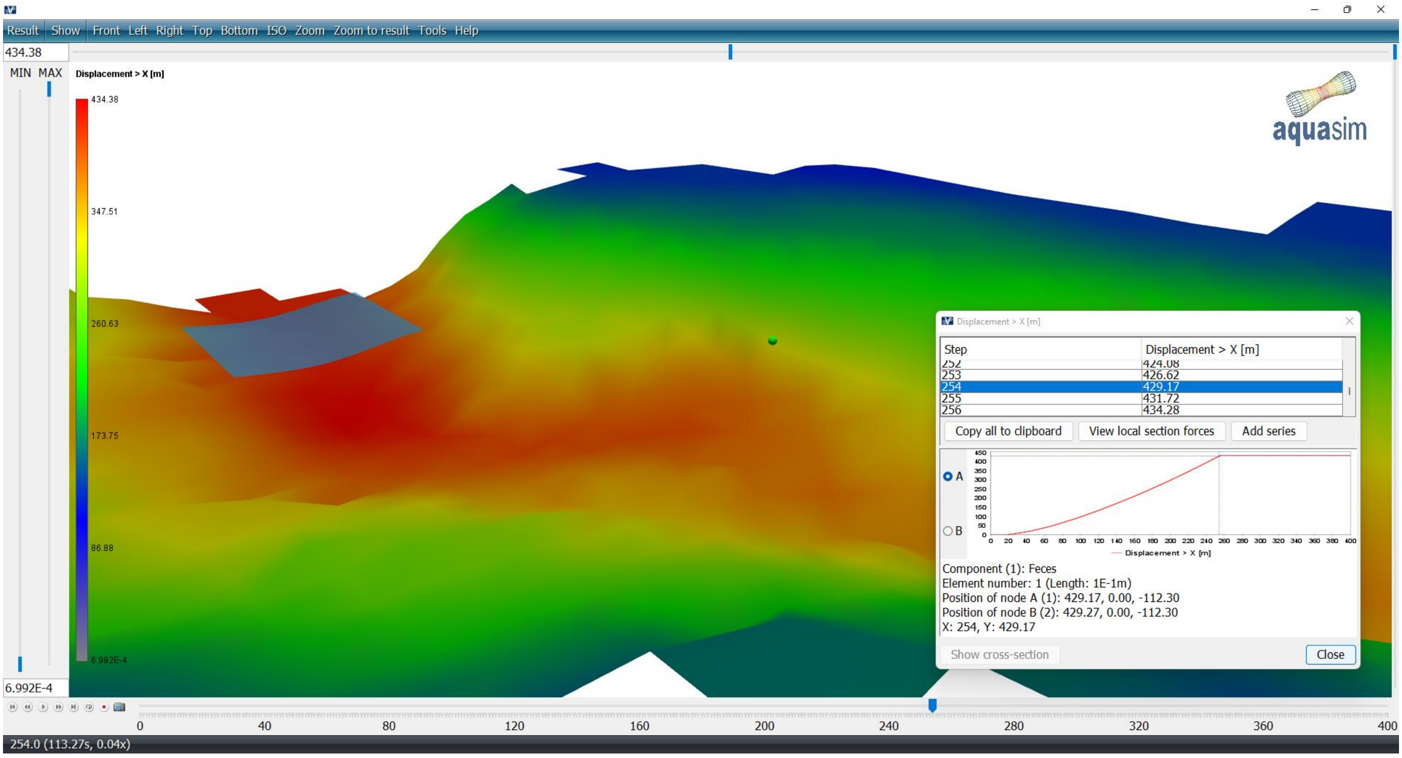

Figure 20

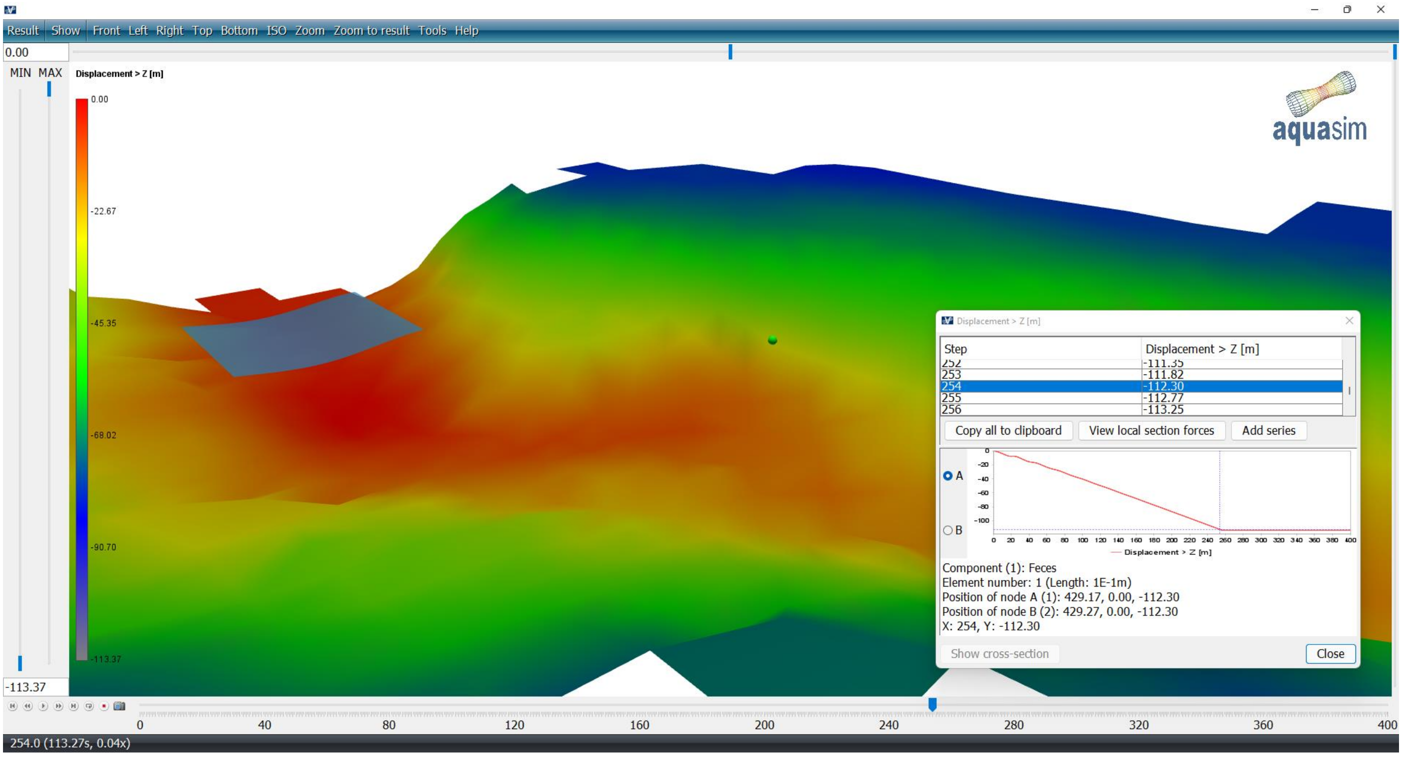

Figure 21

2.12 Summary

In this case study, you have established a model representing objects (e.g., feces) falling from the surface to the bottom. You have been introduced to how to use this as a possibility to investigate where objects lands as a function of environmental conditions. Further, you have been presented how the parameters of the bottom can be varied to obtain a variety of response between a falling object and the bottom.

3 Revision comments

Revision no.	Comment
1.0	First publication

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