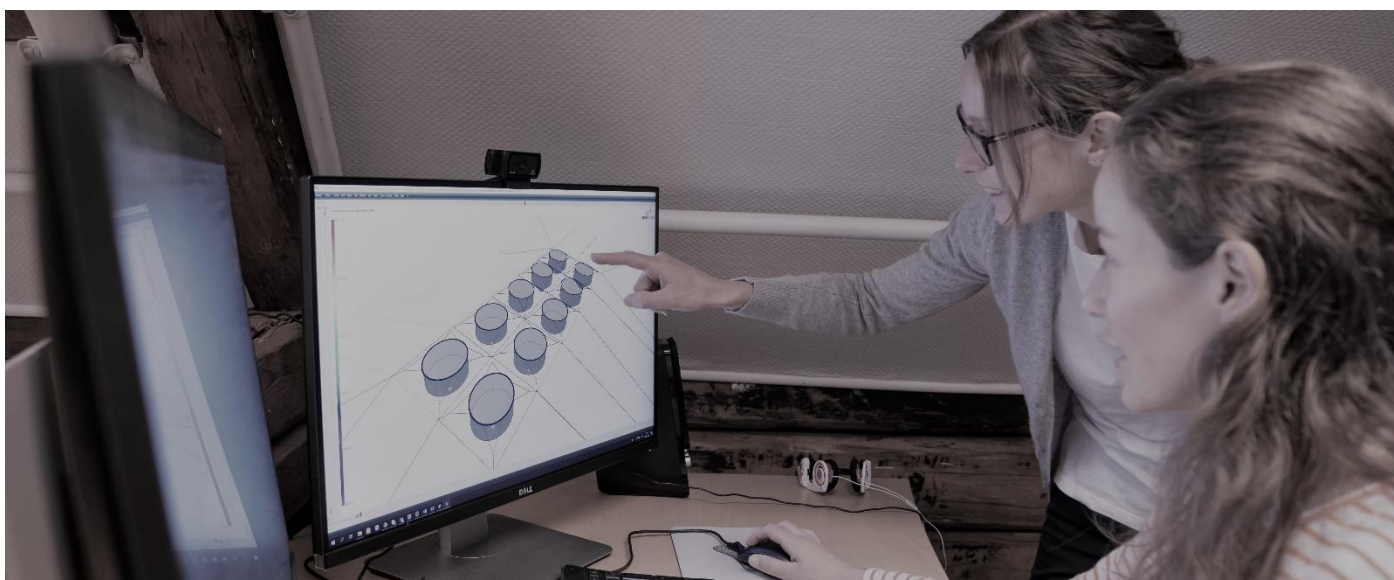


AquaSim training courses

- Moving bracket of floating collar



Revision: 1.0

AquaSim version: 2.18

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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 – Moving bracket of floating collar

2.1 Learning objectives

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

- How a bracket in an aquacultural floating collar can be modelled in AquaSim
- How to account for motion of the bracket along floater pipes

2.2 Introduction

Conventional floating collars of PE consist of three main parts – floater pipes, brackets and railing. The purpose of the brackets is to position and hold the floater pipes together. The brackets are in various degrees, depending on the design, free or restrained to slide along the floater pipes. The figure below presents the case that should be modelled in AquaSim.

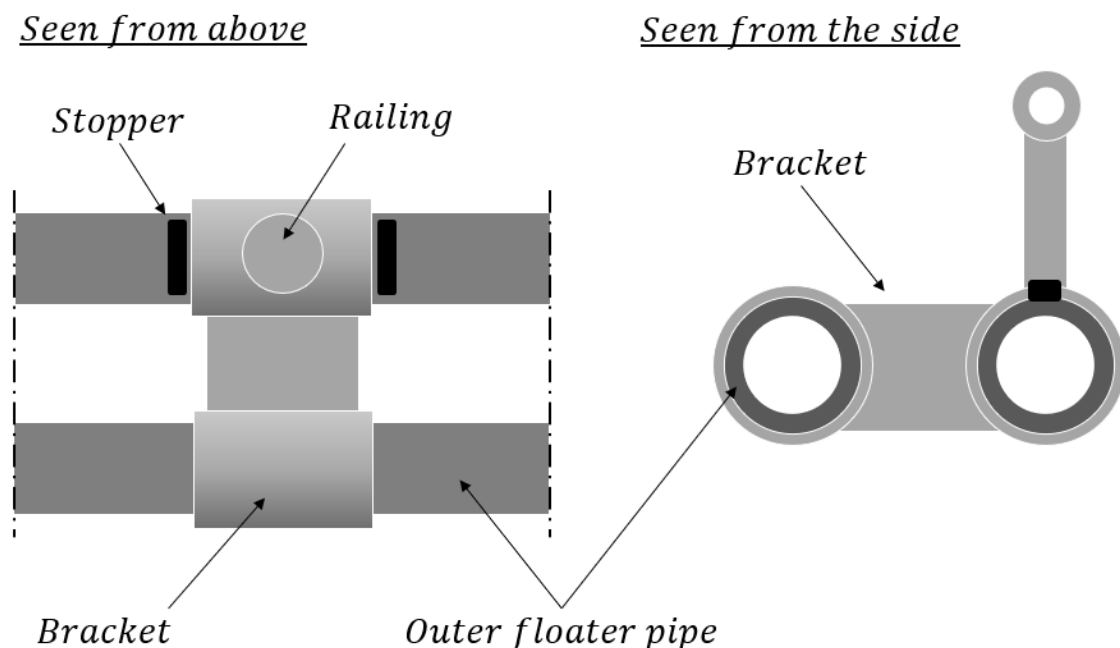


Figure 1

The bracket is free to slide along the outer floater pipe. Stoppers are introduced on both sides of the bracket on the side with railing. The bracket is free to rotate about both floater pipes.

2.3 Modelling principles

2.3.1 Bracket

This section presents one way to model brackets in AquaSim. Other solutions may be applied but is not covered by this tutorial.

The floater pipes, brackets and railing are components that will be exposed to axial forces, shear forces and bending moments. Therefore, they are modelled as component type Beams. Beams are in AquaSim based on drawing elements connected with two nodes: node A and node B. Each element in AquaSim has its own local coordinate system, this is illustrated in the figure below. The local x-axis runs from node A to B, and y- and z-direction is perpendicular to this. You should have this in mind to later in this tutorial.

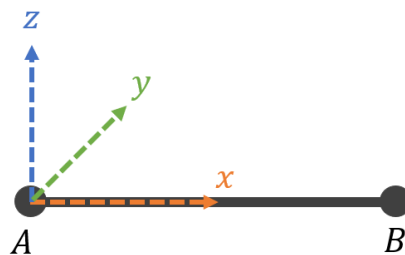


Figure 2

The stiffness of beam element is given by the element length and cross-sectional properties. So, since the stiffness is not solely given by the modelled geometry, one will need to make use of excentre elements to bind together the different structural components of the bracket. The chosen solution is presented in the figure below.

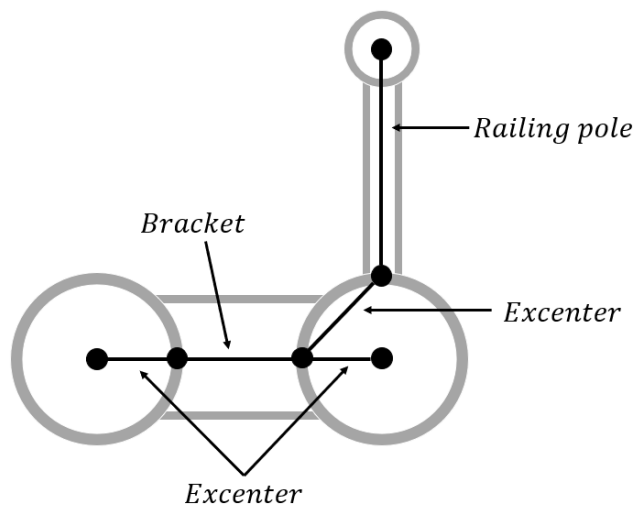


Figure 3

2.3.2 Accounting motion of bracket

The brackets should be able to slide, or be restrained, with respect to the floater pipes. How much the bracket should move is dependent on friction between the floater pipe and the bracket. To account for this, the motions must be determined with respect to local coordinate system of the element. This can be resolved in several ways, for example:

- with the use of the element decorator Roller,
- or with the use of the element decorator Hinge.

This tutorial demonstrates the use of Hinge. This enables the user to define which local degrees of freedom to be free or restrained. In addition, you can add friction with the use of damping. Hinges are available for beam elements and is found by **right** click on an element > **Elements** > **Hinge**.

2.4 AquaEdit

Load *Moving-Bracket.amodel* that comes with this tutorial in AquaEdit.

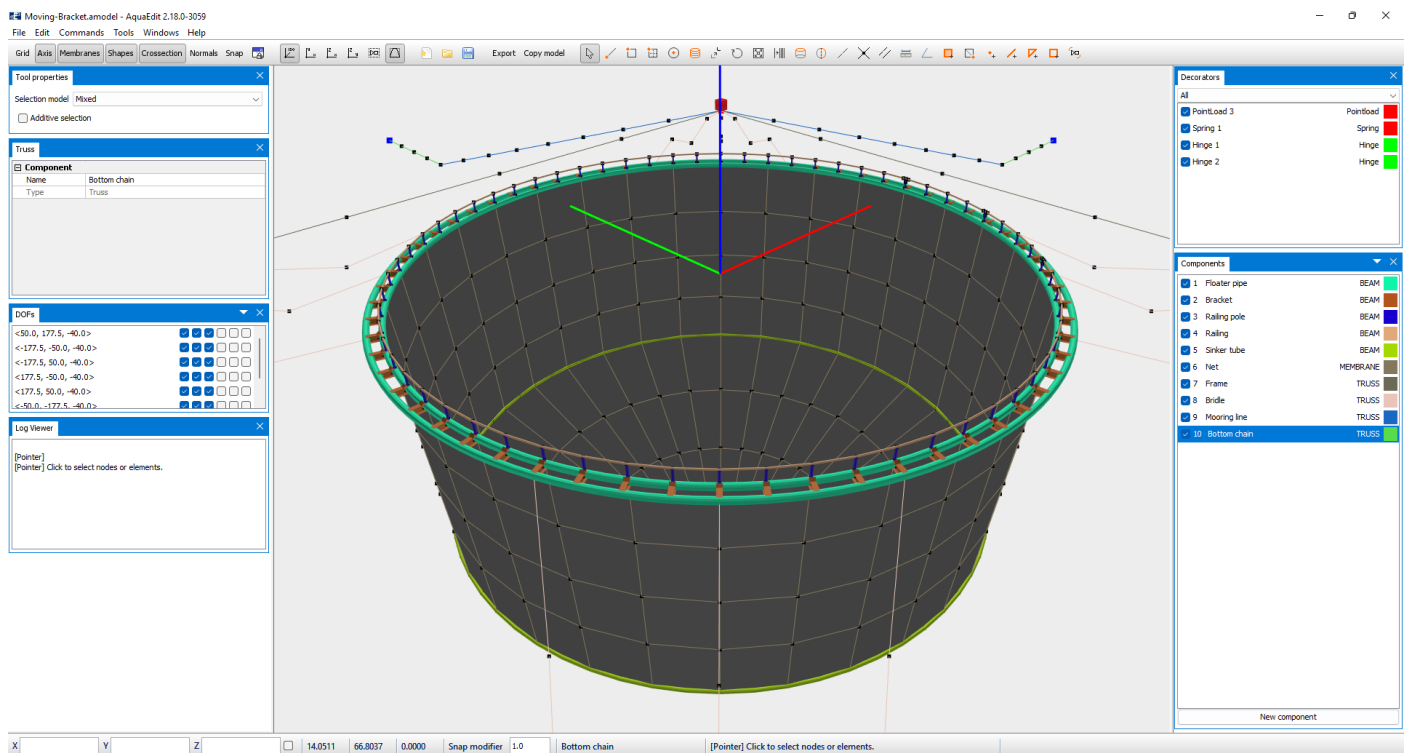


Figure 4

The model shows a conventional floating collar in PE modelled in a frame mooring configuration. This model is finished with Hinge on the brackets.

In the figure below you can see a section of how the floater pipes and brackets are modelled, and where the hinges are placed.

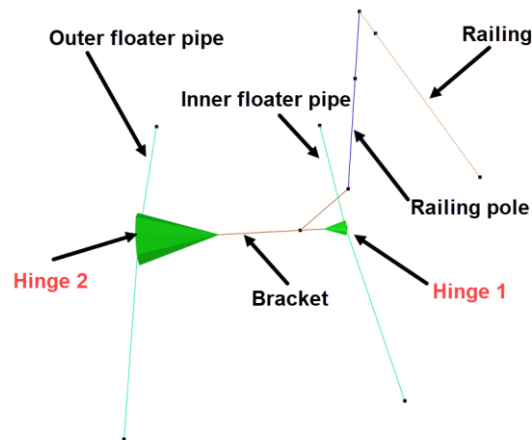


Figure 5

Recall the stoppers, preventing the bracket from moving, is situated on the same side as the railing. Have this in mind when we in the next section should investigate the properties of the hinges.

2.5 Hinge properties

The hinges are seen as element decorators in the Decorators window.

2.5.1 Hinge 2

Double click *Hinge 2* to enter the Edit hinge-dialogue.

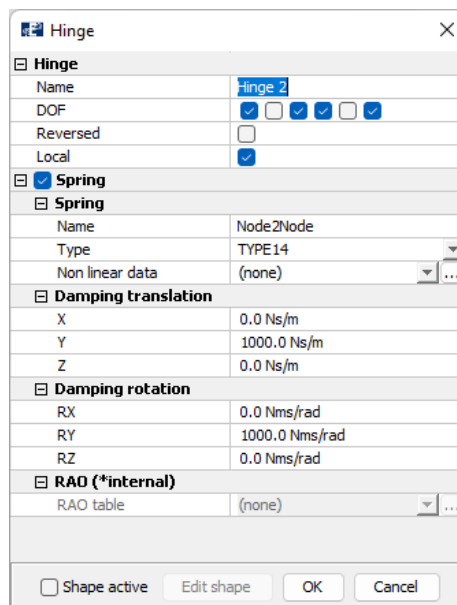


Figure 6

- DOF: here you can select which degrees of freedom that should be restrained or free. The first three checkboxes are translations in x-, y- and z-direction respectively. The three last boxes are rotations about x-, y- and z-direction respectively. By checking a box, the DOF is restrained.

- Reversed: AquaSim has a default node the Hinge is assigned to for each element. If the Hinge is not on the correct side of the element, selecting Reverse will swap the side.
- Local: Hinges can rotate and translate either with respect to the global coordinate system, or the element's local coordinate system. The bracket should move with respect to the floater pipe, hence Local should be toggled on.

Let us go back to the DOF-section again and see why the checkboxes are selected as they are. Remember that the local x-axis of an element runs from node A to B, and that y- and z-axis are perpendicular to the element. The bracket should be able to translate along and rotate about the local y-axis.

Tips! To see where the local axis run, you can select **Normals** from the Toolbar and select the bracket-element as shown below.

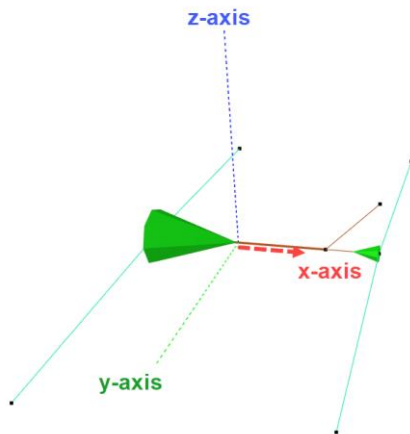


Figure 7

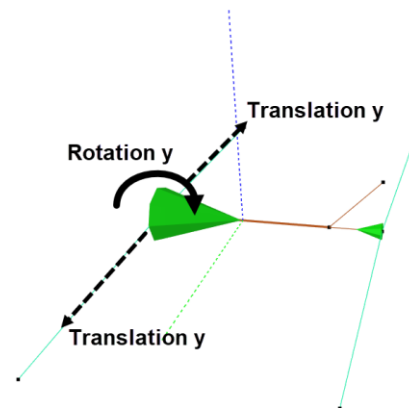


Figure 8

Some friction is assumed between the bracket and the floater. This is included as damping through selecting **Spring** and Type **Type 14**. The damping is proportional to the relative velocity between the node and fluid. A damping of 1000Ns/m is introduced for translation in y-direction, and 1000Nms/rad for rotation about y. The size of the damping depends on the friction, and can be determined through e.g., assessing expected distance the bracket should move.

2.5.2 Hinge 1

Double click *Hinge 1* in the decorators window.

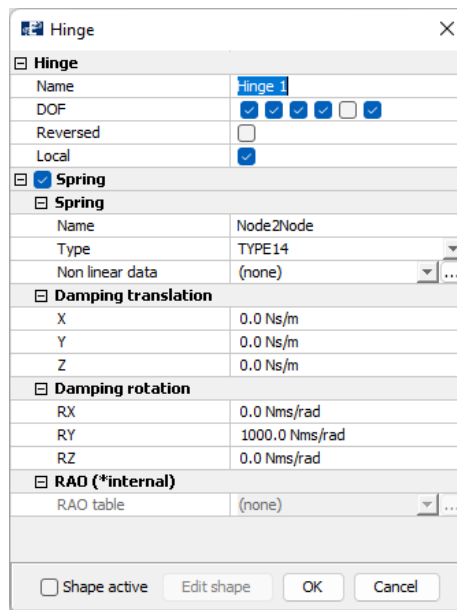


Figure 9

Due to the stoppers, the bracket should only be allowed to rotate about the local y-axis. This is illustrated in the figures below.

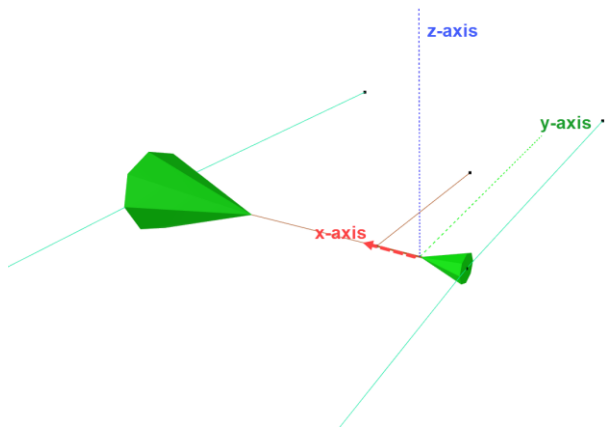


Figure 10

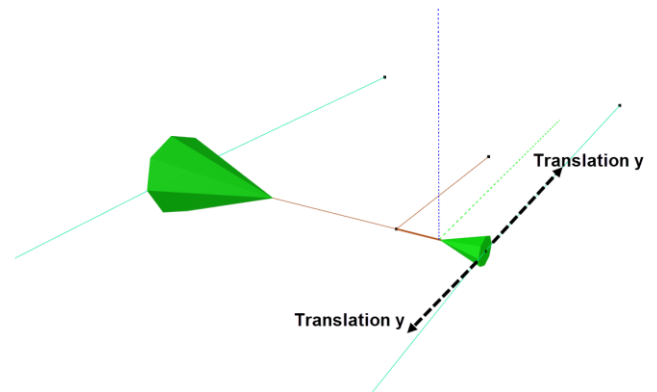
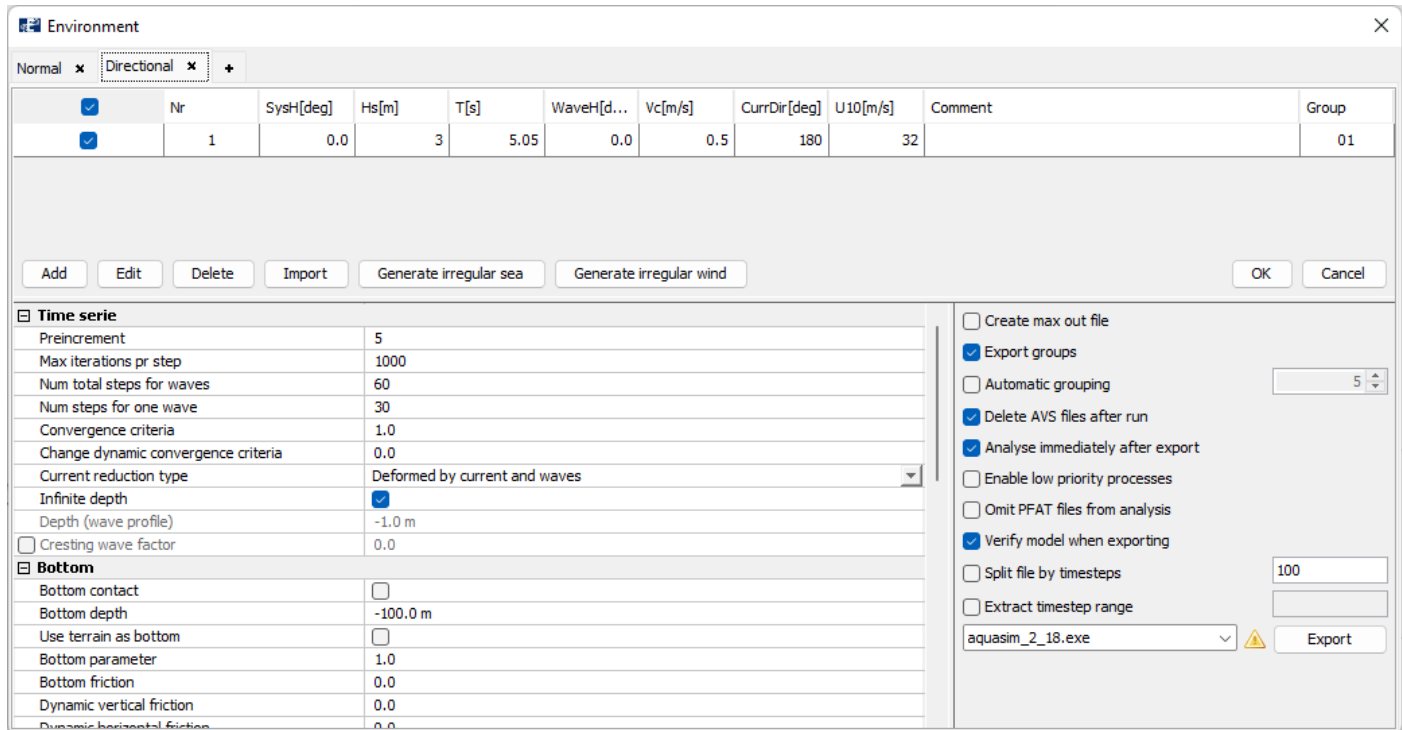


Figure 11

Rotational damping, due to friction, is assigned about the y-axis; 1000 Nms/rad.

2.6 Analysis

A dynamic analysis is prepared that can be run. From the Toolbar menu select **Export** and the tab **Directional**.



Environment

Normal x Directional x +

	Nr	SysH[deg]	Hs[m]	T[s]	WaveH[d...]	Vc[m/s]	CurrDir[deg]	U10[m/s]	Comment	Group
	1	0.0	3	5.05	0.0	0.5	180	32		01

Add Edit Delete Import Generate irregular sea Generate irregular wind OK Cancel

Time series

Preincrement	5
Max iterations pr step	1000
Num total steps for waves	60
Num steps for one wave	30
Convergence criteria	1.0
Change dynamic convergence criteria	0.0
Current reduction type	Deformed by current and waves
Infinite depth	<input checked="" type="checkbox"/>
Depth (wave profile)	-1.0 m
Cresting wave factor	0.0

Bottom

Bottom contact	<input type="checkbox"/>
Bottom depth	-100.0 m
Use terrain as bottom	<input type="checkbox"/>
Bottom parameter	1.0
Bottom friction	0.0
Dynamic vertical friction	0.0
Dynamic horizontal friction	0.0

☐ Create max out file

☒ Export groups

☐ Automatic grouping 5

☒ Delete AVS files after run

☒ Analyse immediately after export

☐ Enable low priority processes

☐ Omit PFAT files from analysis

☒ Verify model when exporting

☐ Split file by timesteps 100

☐ Extract timestep range

aquasim_2_18.exe Export

Figure 12

Select **Export** and run the analysis. Alternatively, you can open the prepared analysis files.

2.7 AquaView

The effect of the moving bracket can be seen by comparing shear forces and vertical bending moment for analysis with and without the hinges applied. The prepared file, *locked-bracket01.avz*, show results for analysis without hinges on the brackets. Comparing this with *moving-bracket.avz*, it is seen that forces are reduced.

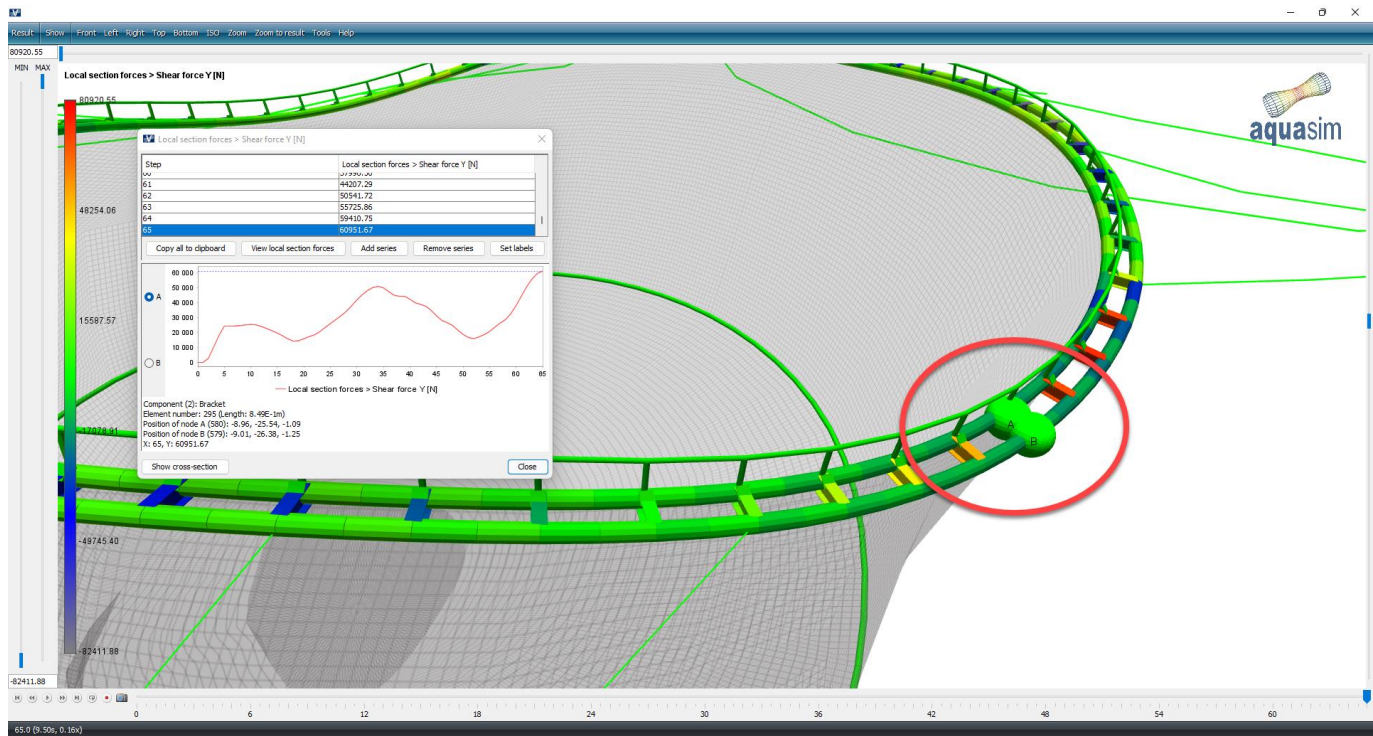


Figure 13 Shear force Y for analysis without hinged brackets

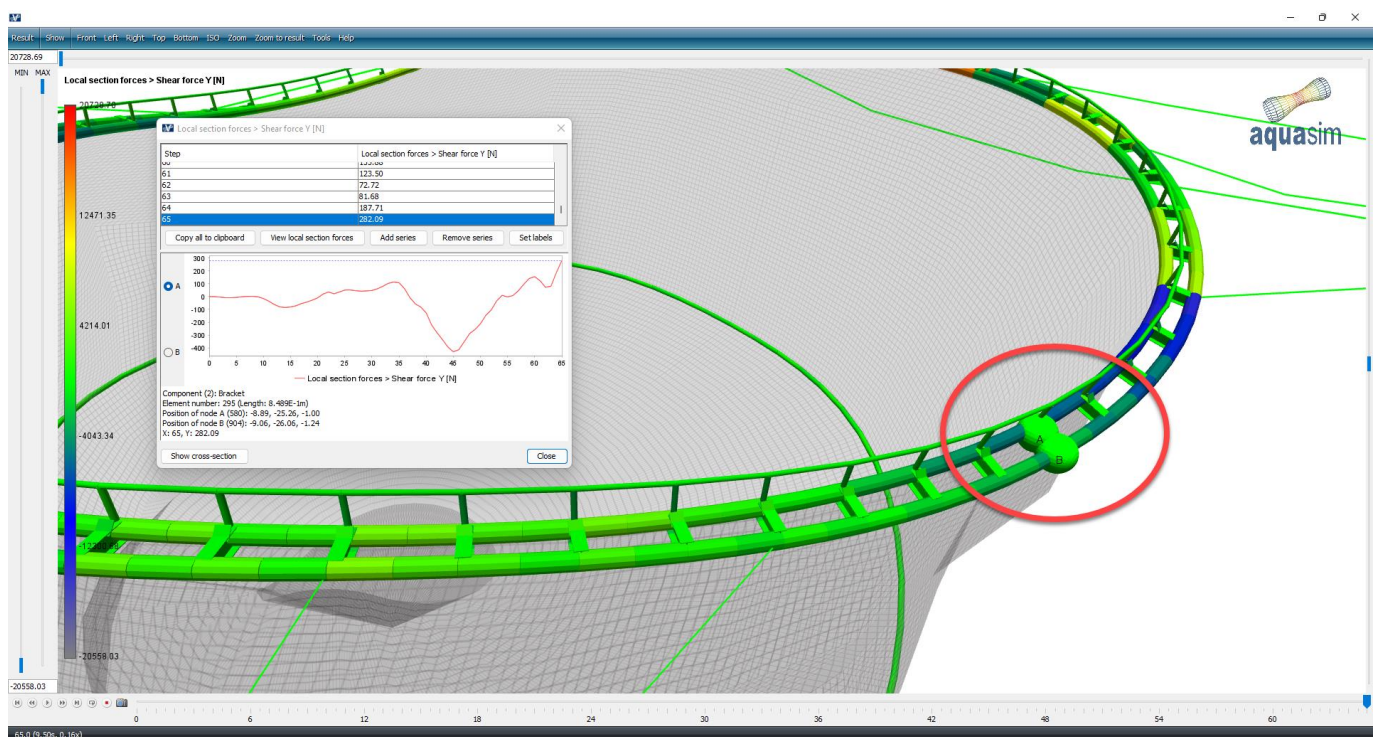


Figure 14 Shear force Y for analysis with hinged brackets

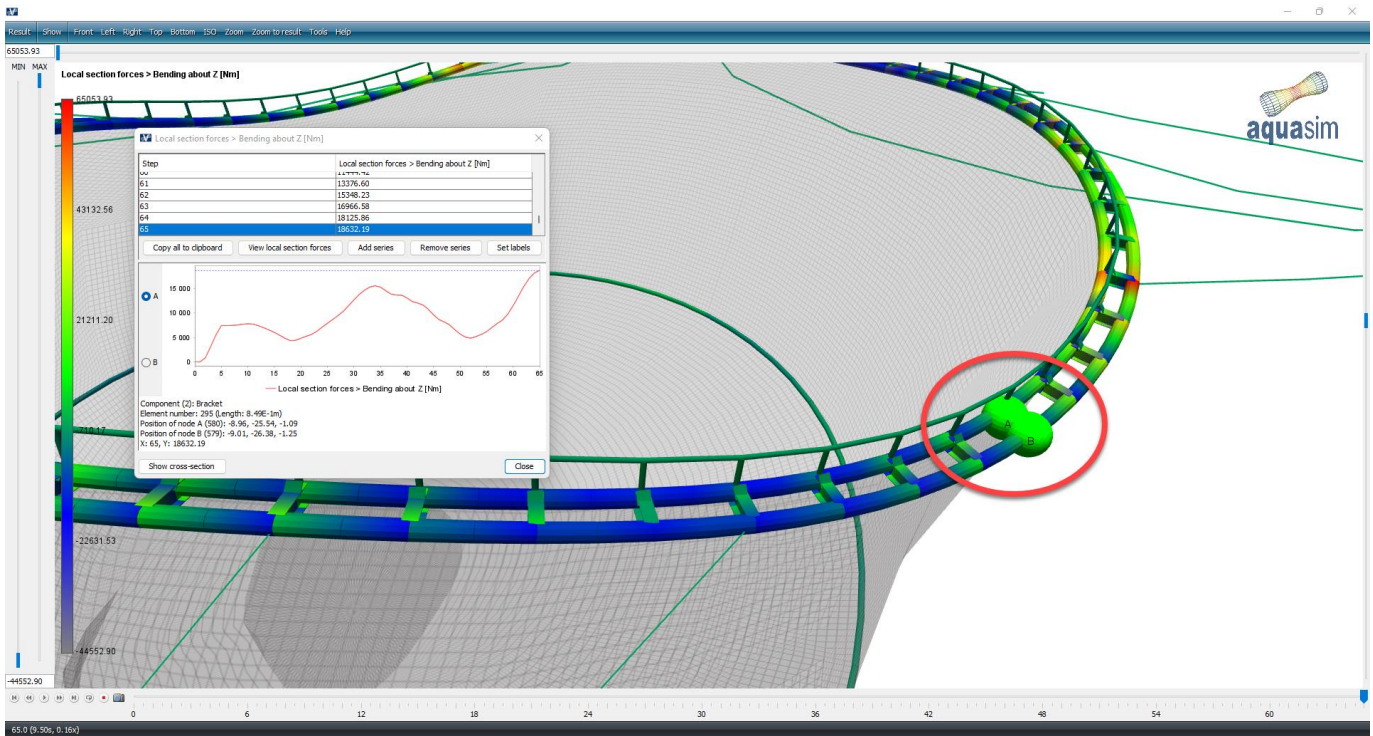


Figure 15 Bending about Z for analysis without hinged brackets

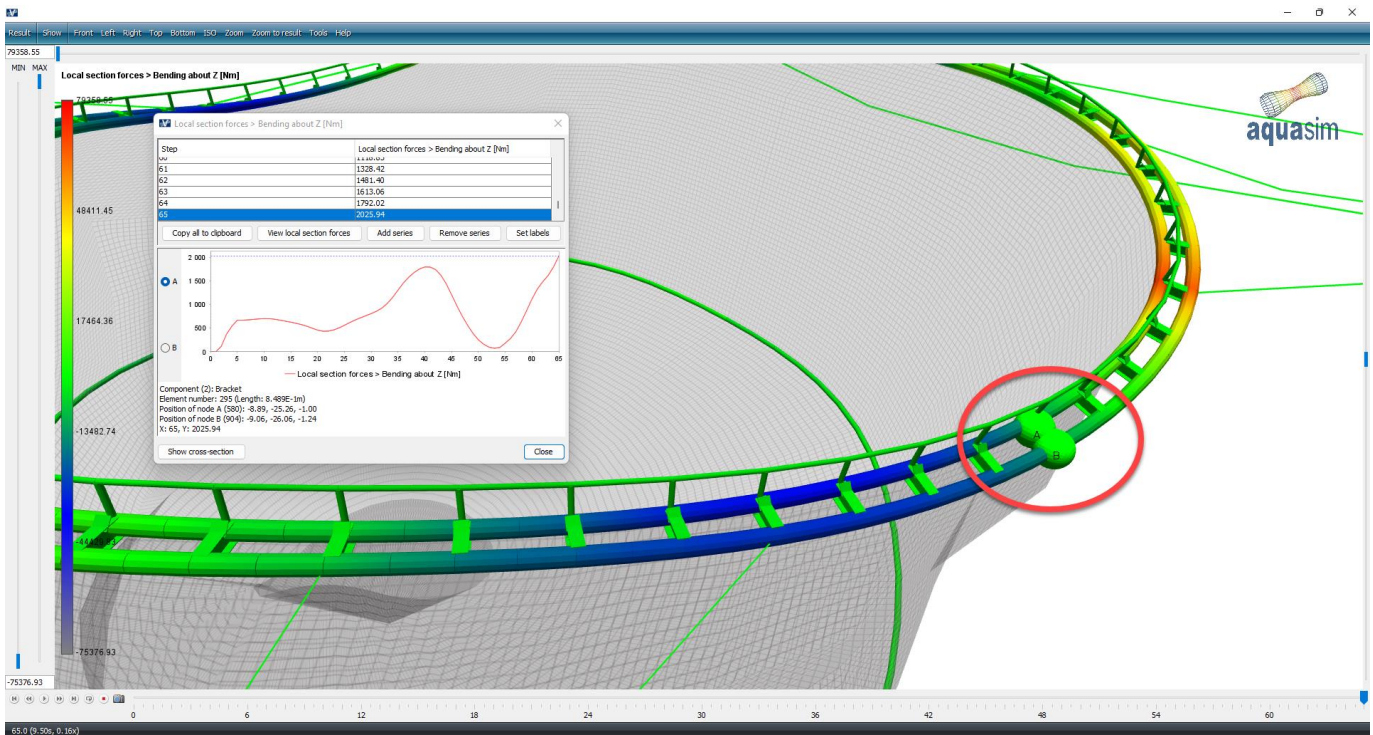


Figure 16 Bending about Z for analysis with hinged brackets

The tutorial case study is finished.

3 Revision comments

Revision no.	Comment
1.0	First publication

--- End of document ---