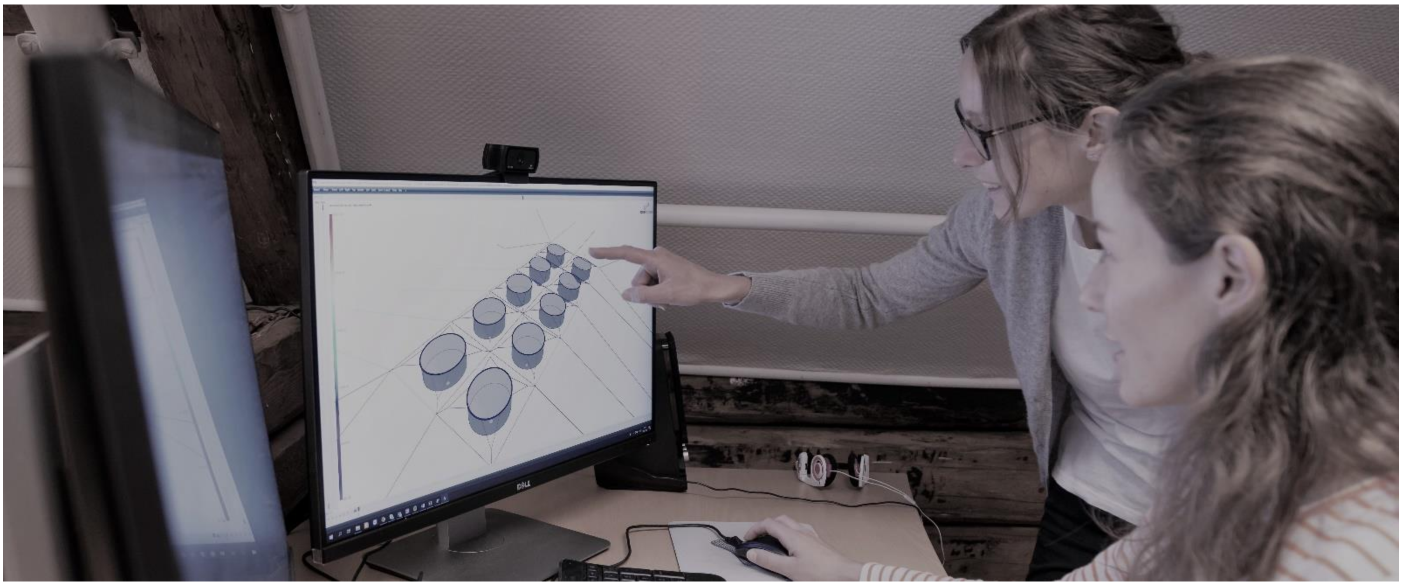
AquaSim training courses

- **Roller**



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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 – Roller

2.1 Learning objectives

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

- Understand the fundamentals of a roller in AquaSim
- Specify roller parameters
- Run static analysis with roller

2.2 Introduction

In this case study you will establish a system with a roller. Attached to the roller is a rope with mass. Due to gravitational forces, the roller will slide along the cable. Further, you are going to assess the forces in the cable when adjusting the key-parameters for a roller.

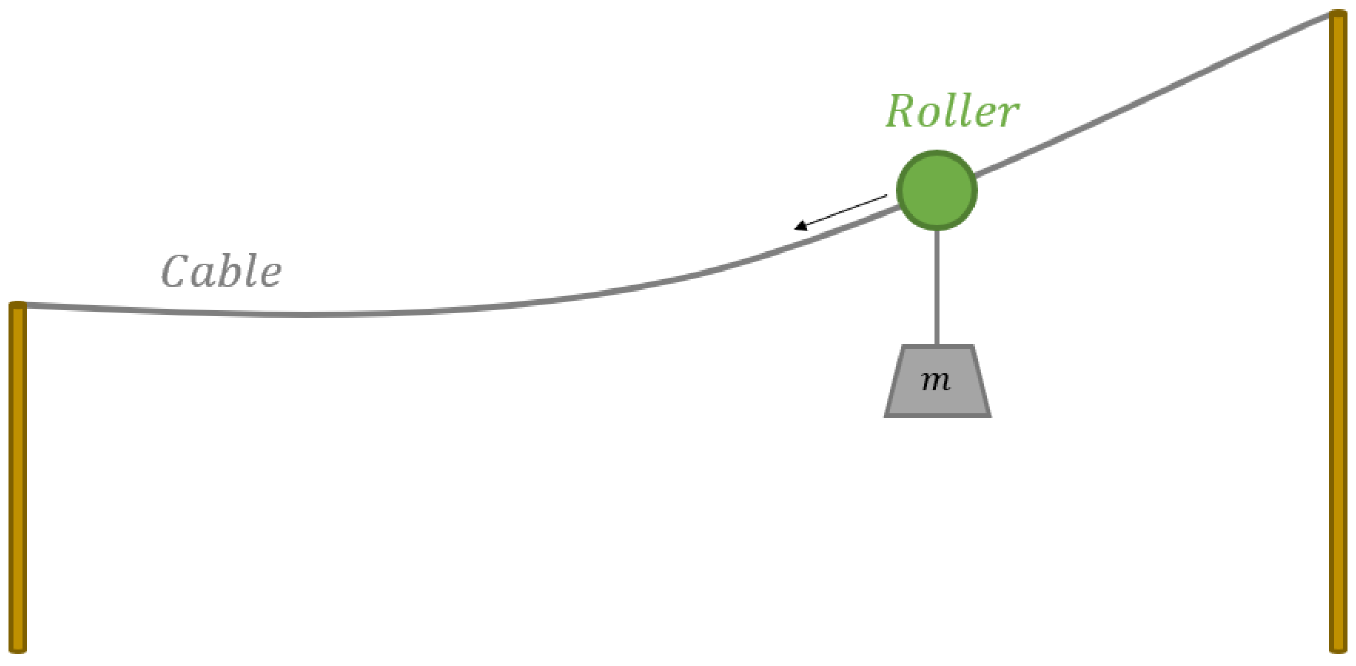

Figure 1

2.3 Principles of roller

In this section, the principles of roller in AquaSim are explained. Rollers are typically applied for ropes to slide along other ropes. A principle sketch of how roller is defined is given in the figure below.

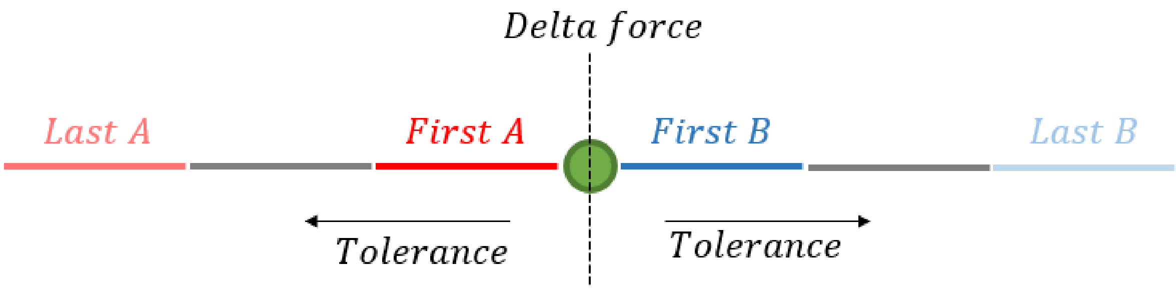

Figure 2

In AquaSim, rollers are applied to nodes as a node decorator. To define the range where the roller can slide a first- and last-element is defined on each side of the roller. The first-elements A and B are automatically selected by AquaSim. The last-elements are where the roller will stop and can be edited by the user. When an analysis is run, AquaSim will compare the axial forces between A and B and adjust the length of the elements so that the forces are within the defined criteria. The analysis timestep will not converge until one or more of these criteria are satisfied.

The Delta force may be interpreted as a frictional resistance in the roller. When Delta force is assigned positive values, element A should have higher axial force than element B. When Delta force is assigned negative values, element B should have higher axial force than element A.

Having defined a value for both Delta force and Tolerance, the timestep will not converge until the axial forces are within the Tolerance of the defined Delta force. If Delta force is 0, then the timestep will converge when the axial force between element A and B are lower than the defined Tolerance.

2.4 Pre processing

2.4.1 Establish the model in AquaEdit

The model is based on the sketch given in the introduction. Create three component groups; one for supporting beams, one for a rope the roller should slide along and one for the rope attaching the weight.

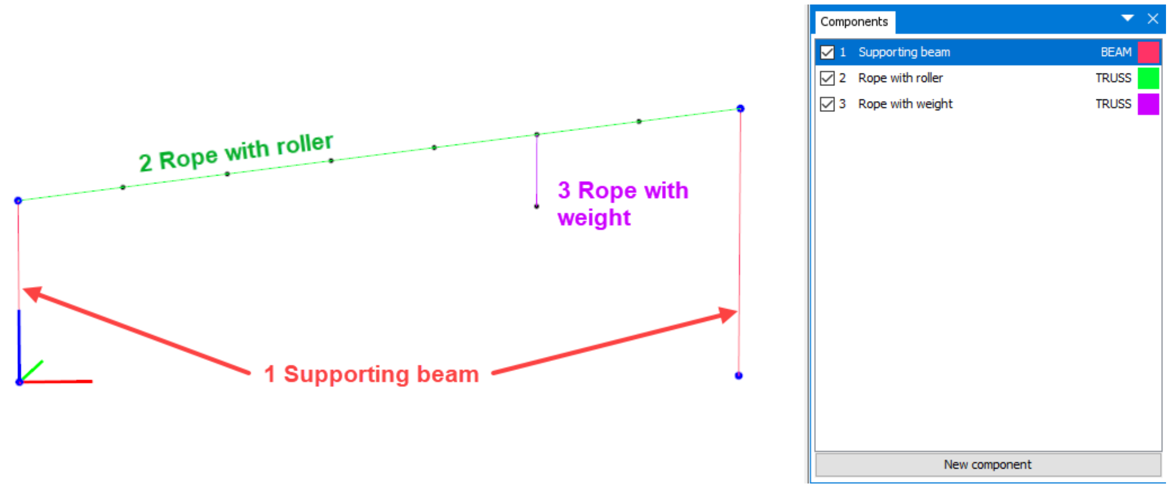

Figure 3

The main dimensions of the roller system are provided in the figure below.

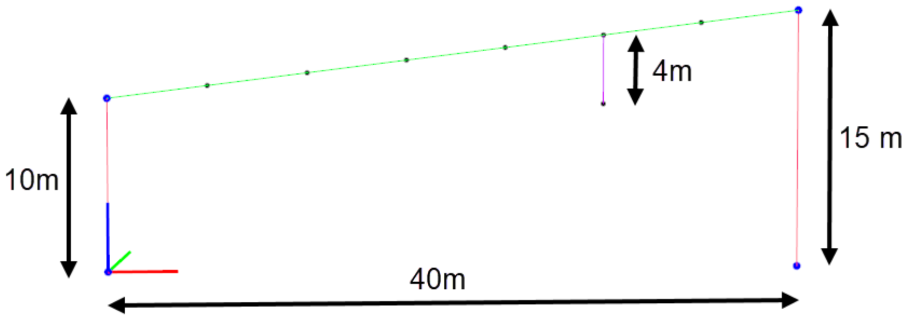

Figure 4

Discretize the component *Rope with roller* into 7 elements with equal lengths. The top- and bottom nodes of Supporting beams should be restrained from translation in x-, y- and z-direction.

2.4.2 Component properties

Suggested cross sectional properties for the three component groups are provided in the table below. Cross-sectional properties of the beam can easily be generated applying the Wizard found in the Edit-beam window.

1 Supporting beam	
Type	BEAM (Morison submerged)
Data source	Tube
Outer diameter	100 mm
Thickness	3 mm
Material	Steel
2 Rope with roller	
Type	TRUSS
E-modulus	2.1E9 N/m2
Area	1.45E-4 m
Weight in air	0.257 kg/m
Diameter Y & Z	0.014 m
3 Rope with weight	
Type	TRUSS
E-modulus	2.1E9 N/m2
Area	1.45E-4 m
Weight in air	0.257 kg/m
Diameter Y & Z	0.014 m

The window for input cross sectional properties is accessed by **double click** the component group or, **right click component group** > **Edit**.

2.4.3 Add Pointload to rope (weight)

The purpose of the Pointload is to start the roller, so that it slides along the rope. **Right click** the lower node of *Rope with weight* > **Nodes** > **Pointload** > **Create new**.

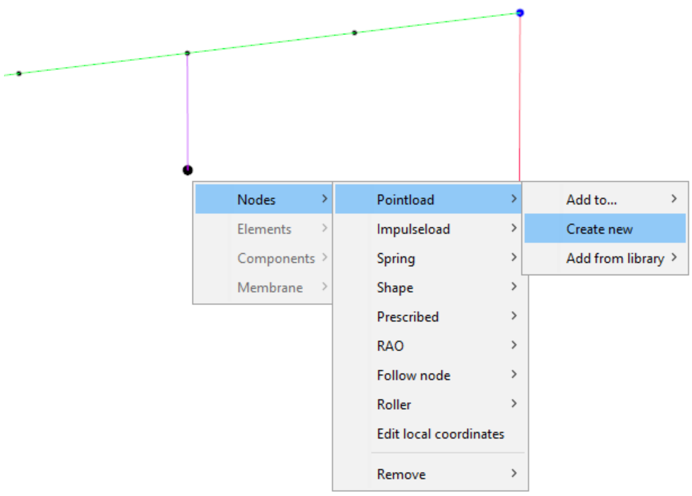

Figure 5

The Pointload should be a conservative node load of 100kg pointing in negative z-direction. Select **Load type 0** and Force **Z = -981.0 N**.

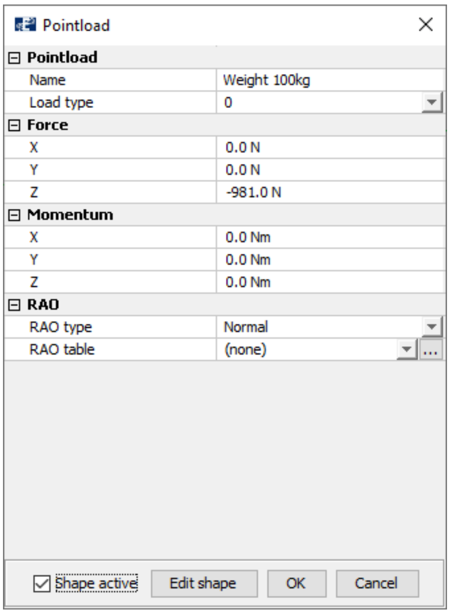

Figure 6

2.4.4 Add roller

The roller should be assigned to the node intersecting *Rope with roller* and *Rope with weight*. **Right click** this node > **Nodes** > **Roller** > **Create new**.

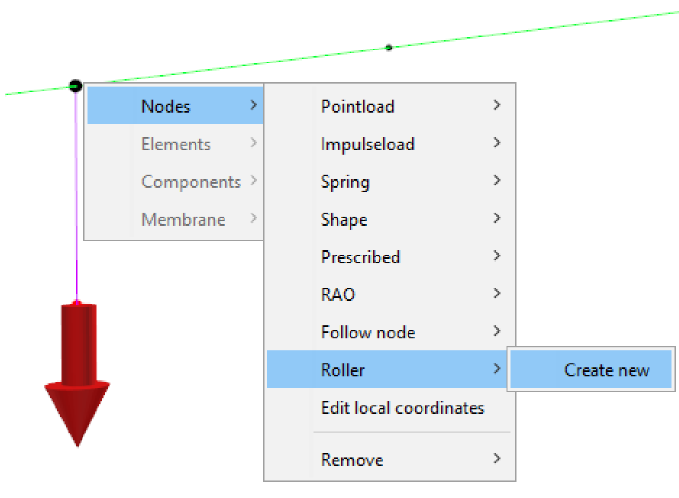

Figure 7

The Roller decorator-window will open, and by default AquaSim have made some selection for you. This concerns especially what is regarded as the first-element of A and B, see figure below.

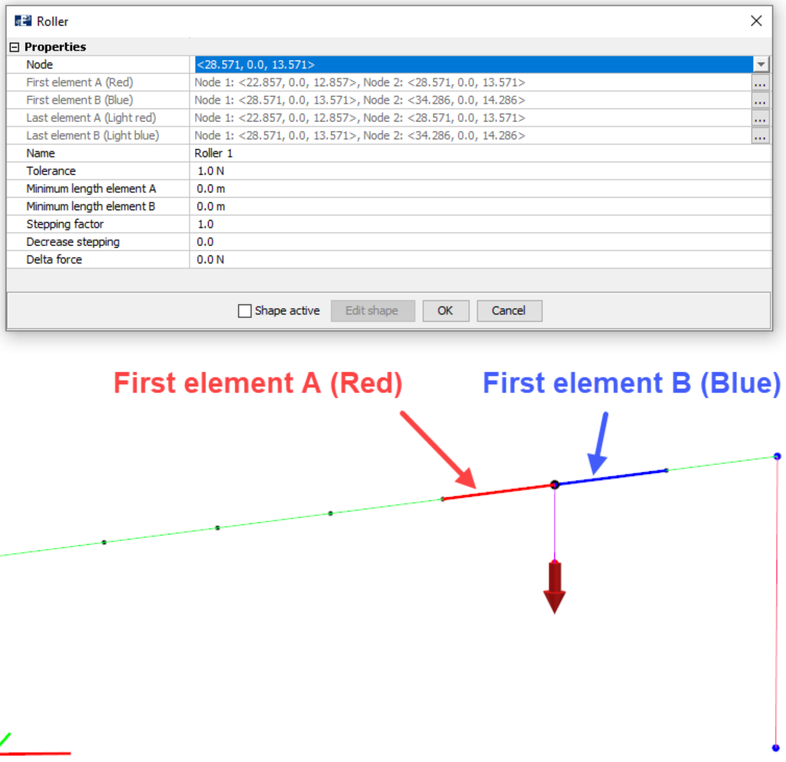

Figure 8

You should now define the last elements of A and B. This is where the roller will stop in each direction. The last element of A should be in the lower end of *Rope with roller* and the last element of B should be in the upper end.

For *Last element A (Light red)*, select **Edit** > **Choose with pointer**.

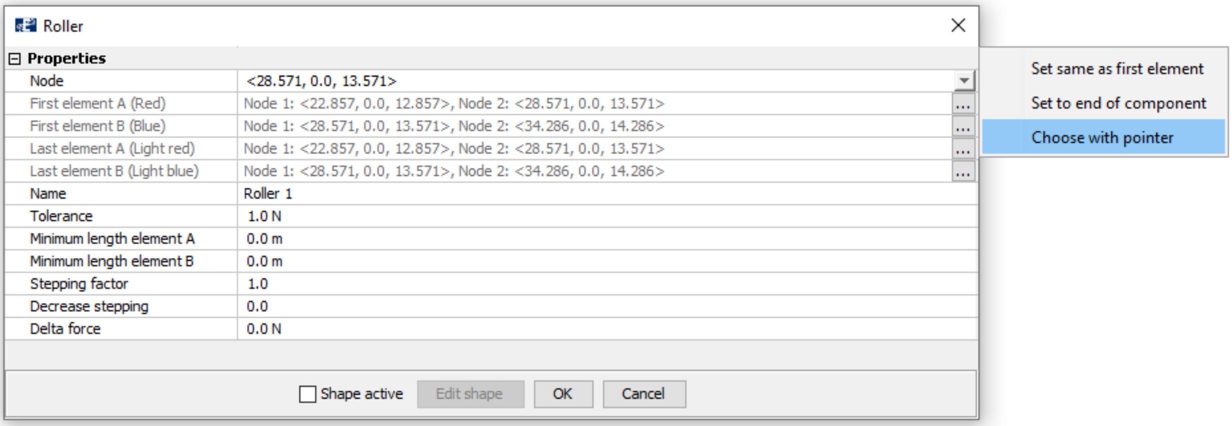

Figure 9

Then press the last element in the lower end of *Rope with roller*, as shown below.

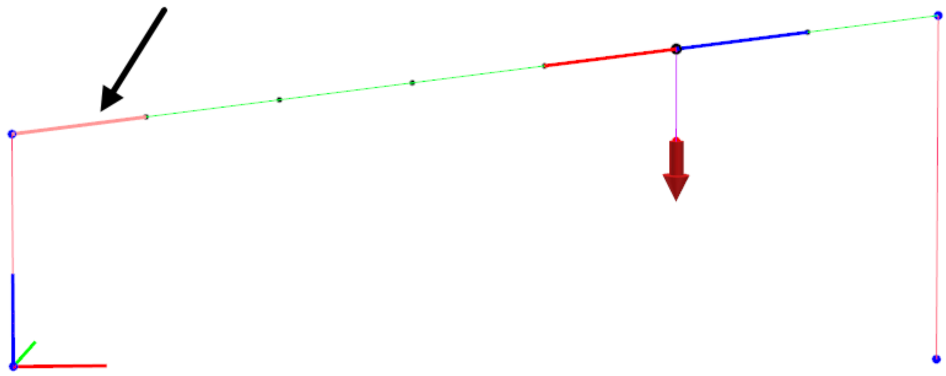

Figure 10

Repeat this for Last element B (Light blue), only now select the upper element of Rope with roller.

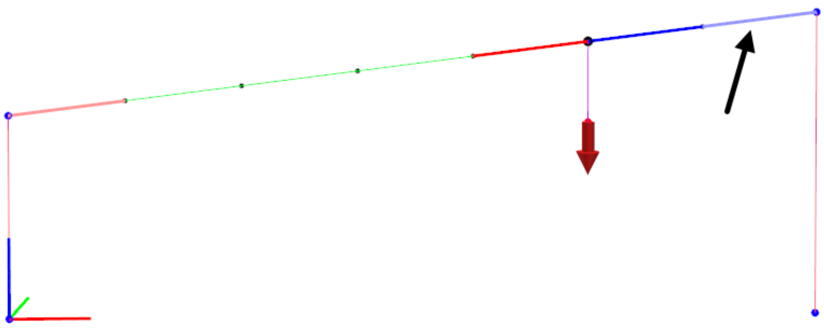

Figure 11

2.4.5 Roller parameters

The input-parameters applied for the roller in this case study is found in the figure below.

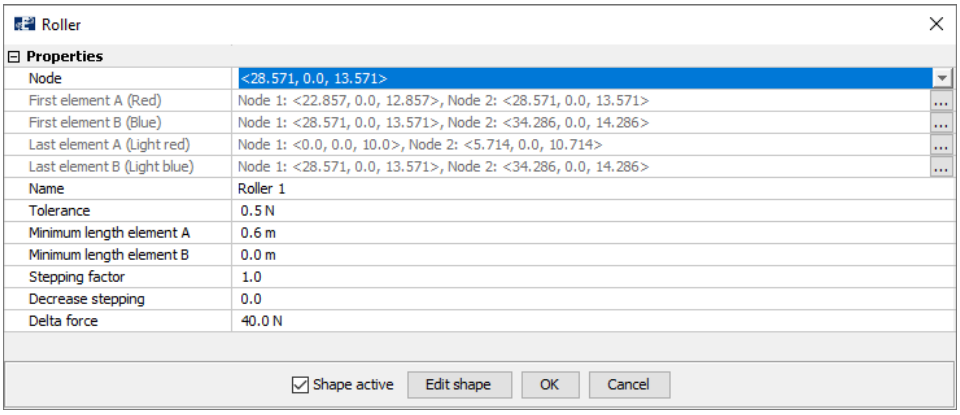

Figure 12

The roller **Name** is by default named *Roller 1*, this can be changed according to your preferences. **Tolerance** is set to **0.5N** and **Delta force** is **40N**, meaning that the element A should have 40N higher axial force than plus / minus a tolerance of 0.5N. So that the difference in axial force between element A should either be 40.5N or 39.5N. The **Minimum length element A / B** specifies the minimum allowed length of the elements on each side of the roller. In this case study, the minimum allowed length of the elements on the A-side of the roller is **0.6m**.

The roller will stop when either the Tolerance / Delta force-criteria is fulfilled, or when the Minimum length element A / B is fulfilled.

Stepping factor and **Decrease stepping** are parameters regulating the iteration of the roller position. If Decrease stepping is larger than zero, the Stepping factor will be reduced during the roller iterations. These can be accelerated from the default values but enhances the risk of divergence.

Select **OK** and save the model.

2.4.6 Verify model

Your model is now complete. To verify that the model is correct and without errors, select **Commands** > **Verify model**.

You might be given a warning **Loose node**, this is due to the end-node of the *Rope with weight* not being attached to other nodes. This is acceptable because we want the Pointload in this node to induce the motion of the roller.

2.5 Calculations static analysis

In this case study, static considerations are made. To set up analysis parameters select **Export** from the Toolbar menu. Select the **Normal** tab in the Environment window and leave the parameters for the load condition with default values. Since we are conducting static analysis, the parameters **Num total steps for waves** and **Num steps per wave** can be set to **0**. To ensure that the roller will find static equilibrium **Preincrement** can be increased to **20** steps.

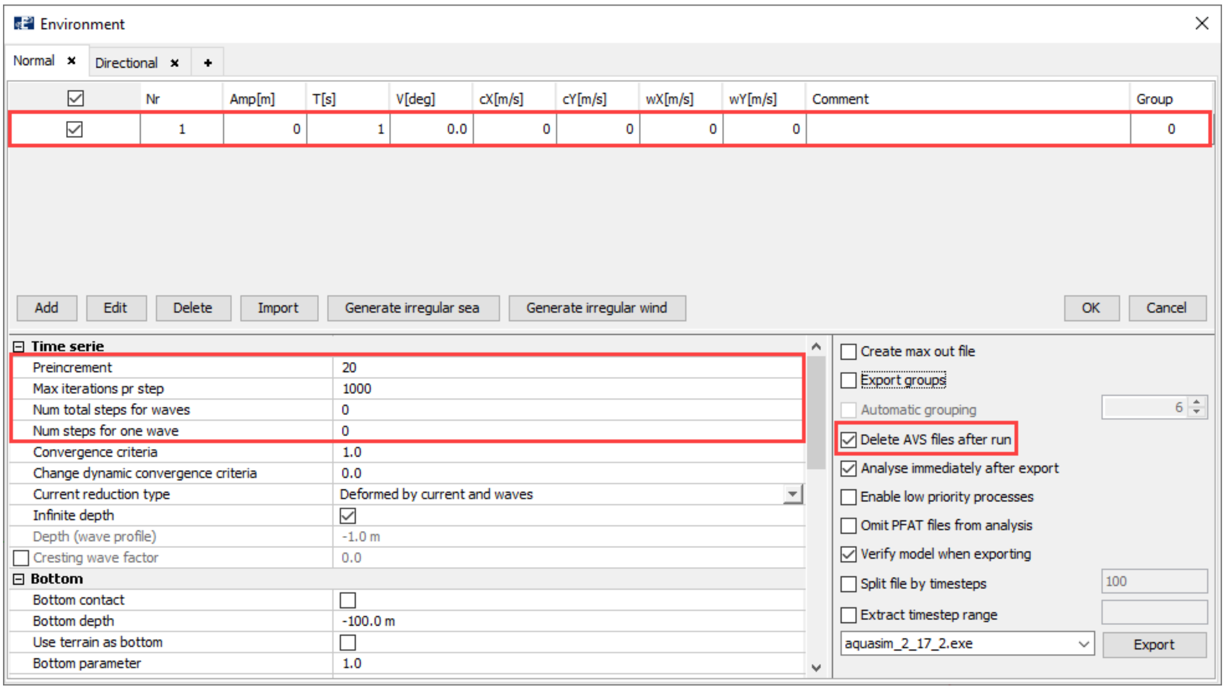

Figure 13

To reduce the amount of data generated check on the **Delete AVS files after run**. The compressed version .avz will still be generated. Select **Export** and save the analysis a suitable place on your computer. **Start** the analysis.

How many steps the analysis needs to achieve convergence in the roller may depend on the version of your solver. If no steps are converged, you may increase the number in Preincrement. In our case, the analysis converged after 16 steps. Meaning that AquaSim managed to fulfil the roller criteria given for the roller after 16 steps.

2.6 Post processing

Open the result .avz-file in AquaView by clicking **Open** from the Analyse-window. **Select Result** > **Local section forces** > **Axial force [N]**. For more visual appearance the shapes for roller and Pointload may be activated in **Show** > **Shapes**.

Start the playback and observe the roller move along the rope.

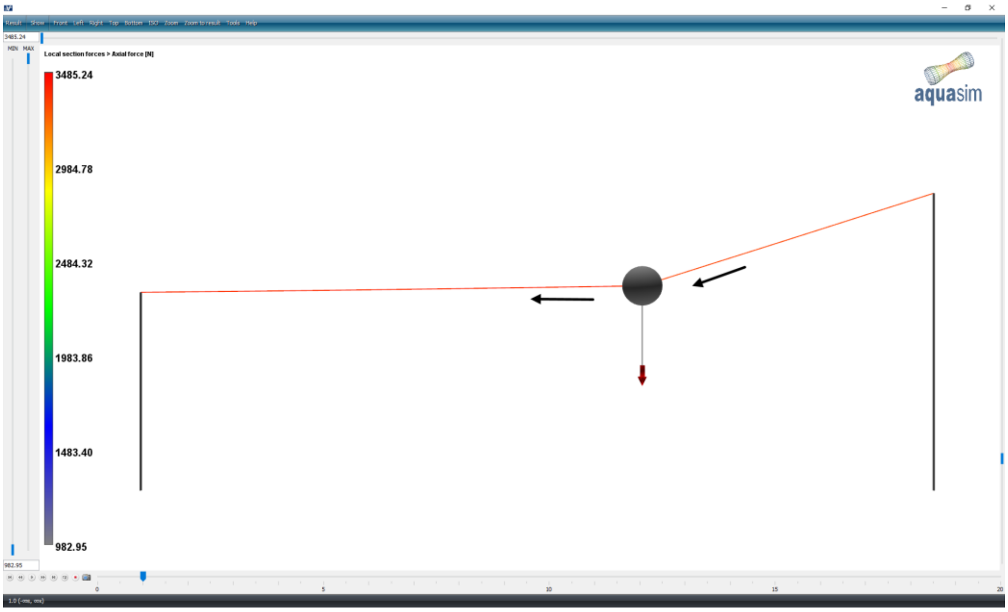

Figure 14

The roller criteria for Tolerance, Delta force and Minimum length element A can be verified by checking the Axial force and length of the elements. This is shown in the figures below for the last step in the analysis.

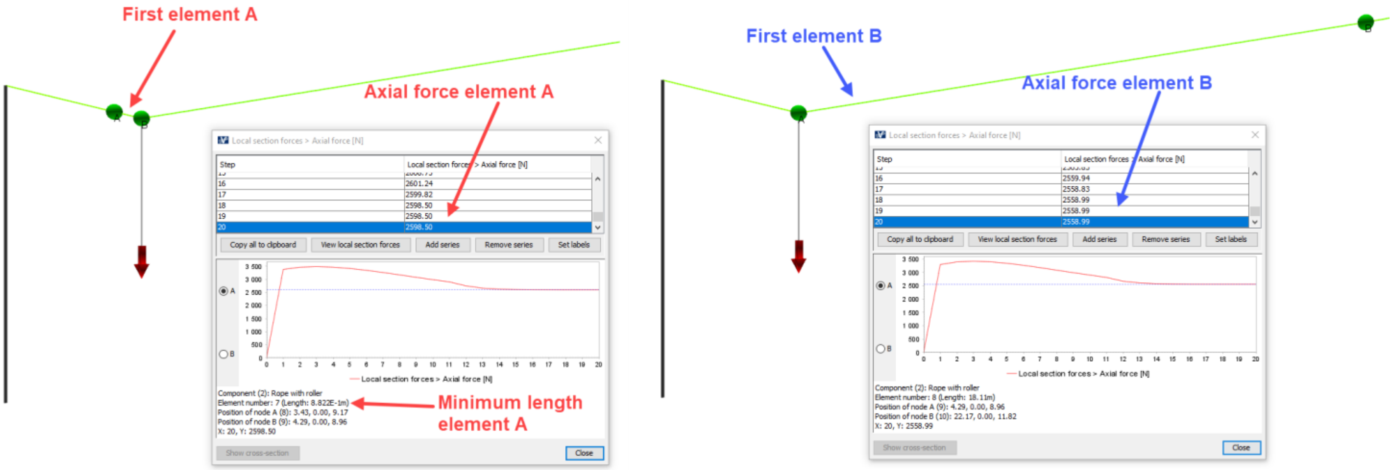

Figure 15

From the results, we have a minimum length of element A of approximate 0.88m. In this case we have axial force in first element A equal to 2598.50N and first element B equal to 2558.99N, which gives a difference of 39.51N. This is according to what was specified for the roller in AquaEdit with Tolerance = 0.5N and Delta force = 40N. Remember that the minimum allowed length of element A was defined to 0.6m. So, the time step converged when the Tolerance / Delta force-criterion was fulfilled.

2.7 Summary

In this case study, you have established a roller system consisting of ropes, weight and a roller through the node decorator Roller. Further, static analysis has been conducted to simulate the roller moving along the rope between the two supporting beams.

You have learned to self-validation the input-parameters in AquaView through consider axial force and length of the elements associated with the roller. Have in mind that the roller criteria depend on the cases investigated, this case study was a simple case established with the purpose of showing the principles.

3 Revision comments

Revision no.	Comment
1.0	First publication

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