Fixed Blocks Tutorial

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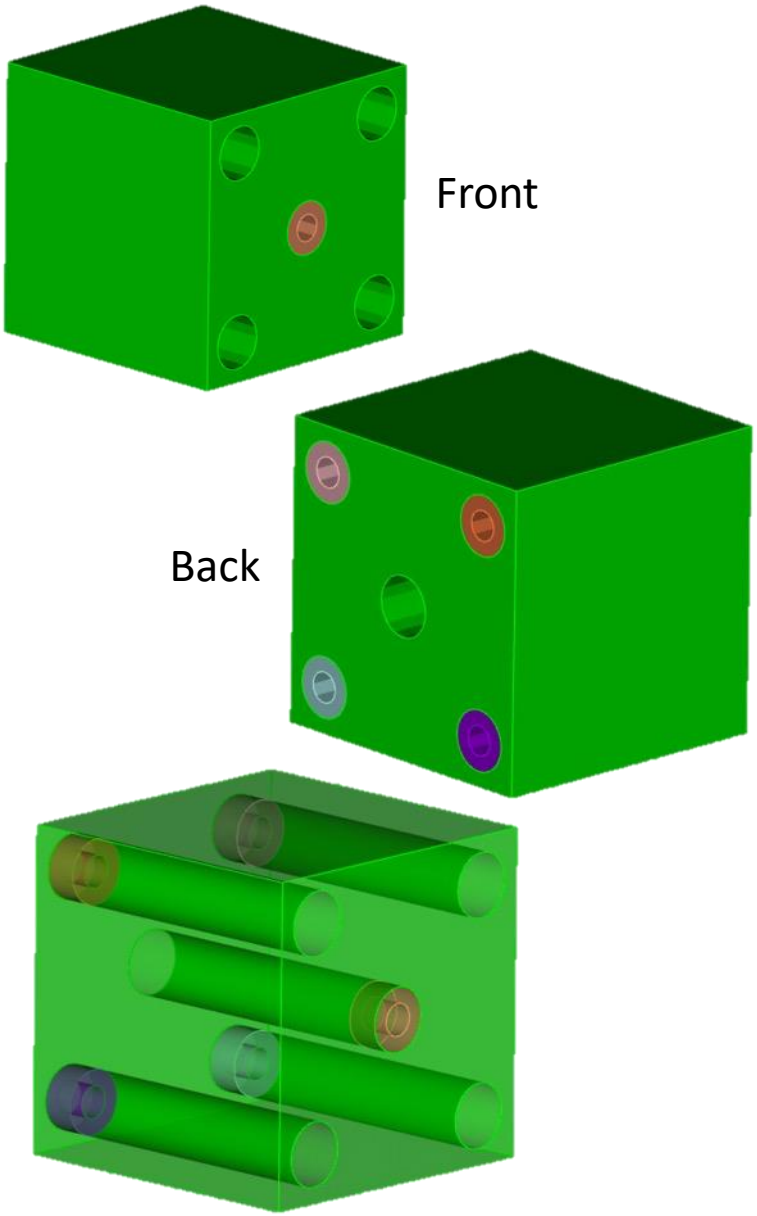
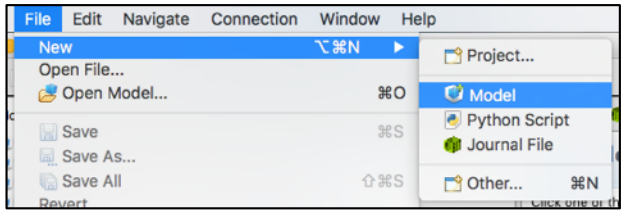
Problem Description

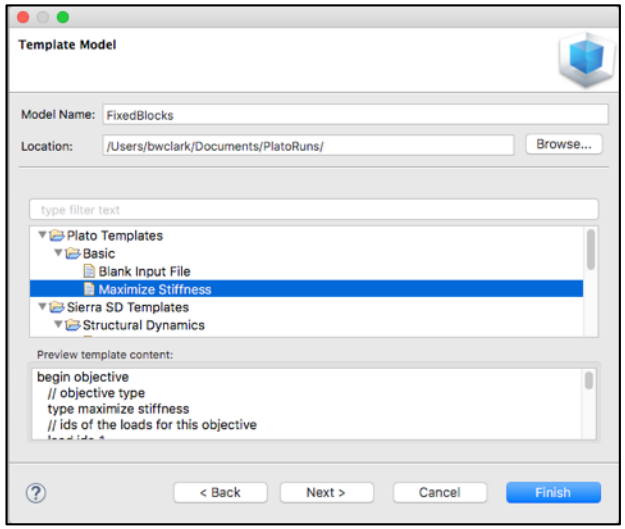
- We will be designing a bracket that will be bolted to a wall using the 4 cylindrical collars on the back side of the model and will support a load applied on the single cylindrical collar on the front of the model.
- We have hollowed out part of the design domain so that there will be access to the bolt-down locations.



Create a New Model

- Choose **File->New->Model** in the menu
- Choose **New Model** then **Next**
- Choose **Create From Template** then **Next**
- Enter **FixedBlocks** as the **Model Name**
- Choose the **Plato Templates->Basic->Maximize Stiffness** template and then **Finish**

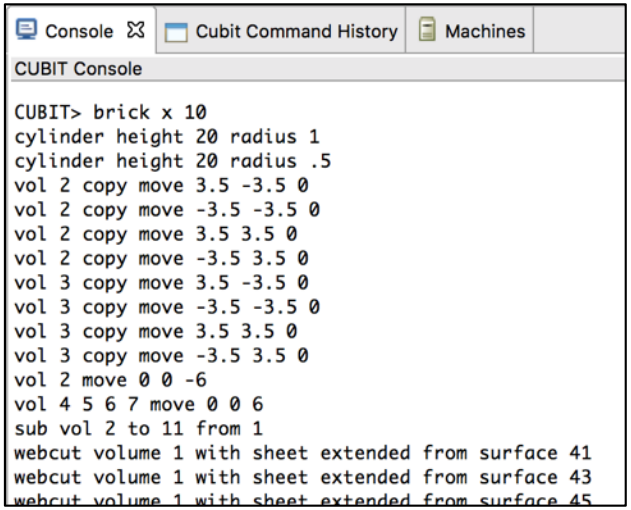


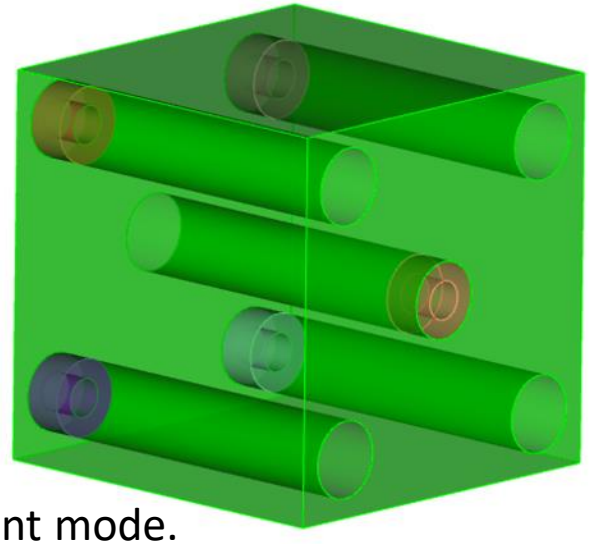


Create the Design Domain

- At the **CUBIT** command prompt copy and paste the following commands (see Hint on next slide):

```
brick x 10
cylinder height 20 radius 1
cylinder height 20 radius .5
vol 2 copy move 3.5 -3.5 0
vol 2 copy move -3.5 -3.5 0
vol 2 copy move 3.5 3.5 0
vol 2 copy move -3.5 3.5 0
vol 3 copy move 3.5 -3.5 0
vol 3 copy move -3.5 -3.5 0
vol 3 copy move 3.5 3.5 0
vol 3 copy move -3.5 3.5 0
vol 2 move 0 0 -6
vol 4 5 6 7 move 0 0 6
sub vol 2 to 11 from 1
webcut volume 1 with sheet extended from surface 41
webcut volume 1 with sheet extended from surface 43
webcut volume 1 with sheet extended from surface 45
webcut volume 1 with sheet extended from surface 47
webcut volume 1 with sheet extended from surface 50
imprint all
merge all
```

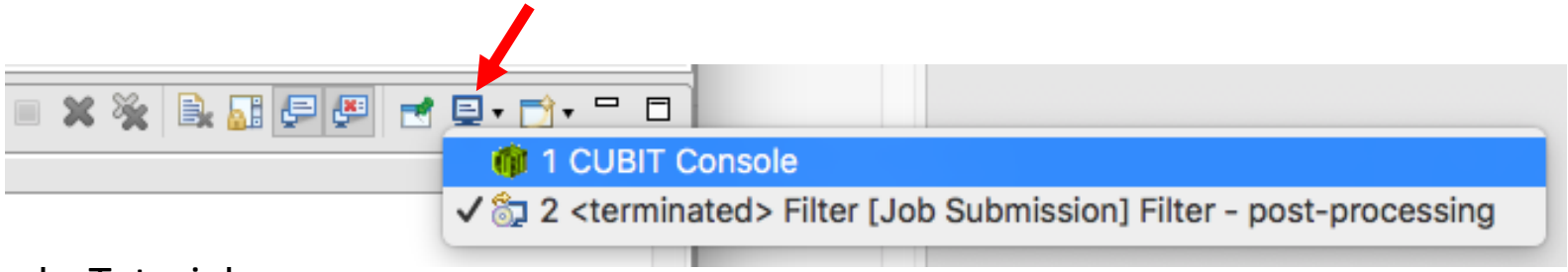




Model shown in transparent mode.

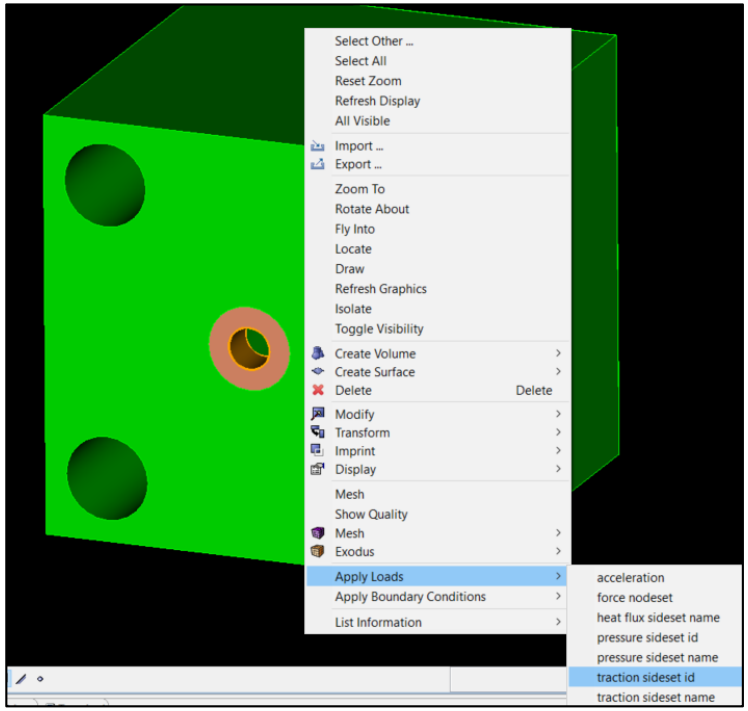
Hint: Cubit Console

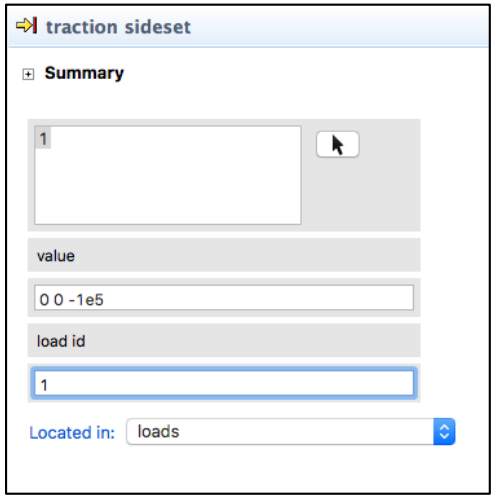
- If you don't see the **CUBIT>** prompt in the console window you are just looking at the wrong console (there may be multiple to choose from loaded in Plato that use the single console window). Click on the icon at the top right of the console window that looks like a computer screen to toggle through the different consoles that are currently loaded. Or you can click on the down arrow next to the computer screen icon to see all of the currently loaded consoles and choose one from the list.



Apply a Traction Load

- Select and right-click the inner surface (see Hint on next slide) of the middle cylindrical collar and choose **Apply Loads->traction sideset id** (Surface is highlighted in orange).
- In the **Settings** panel enter **“0 0 -1e5”** in the **value** box then hit the tab key. Then enter **“1”** in the **“load id”** box and hit the return key.



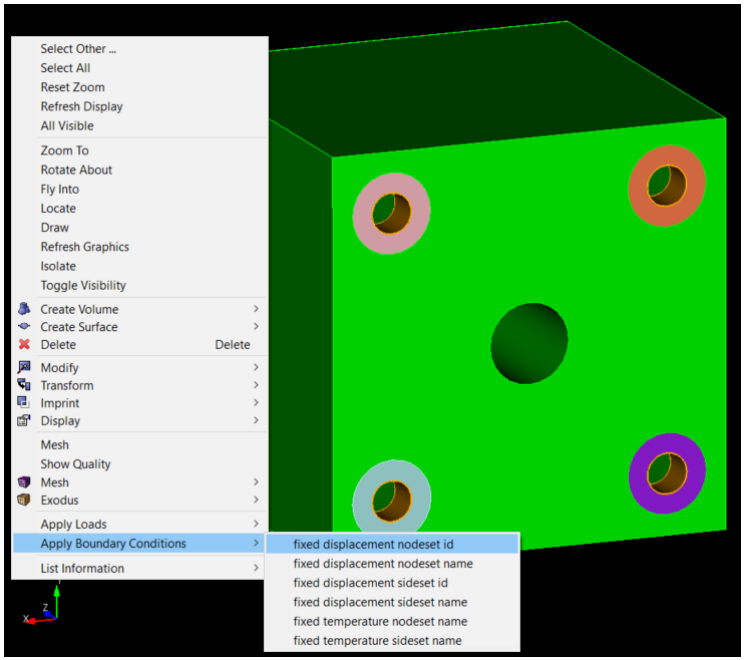


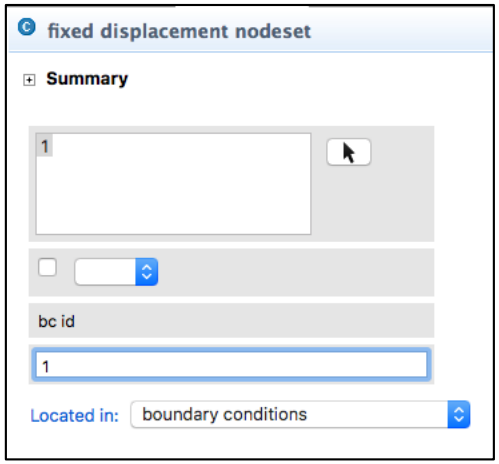
Hint: Entity Selection

- The selection filter toolbar is at the bottom left of the graphics window.
- There are 3 high level modes: Geometry, Mesh, and Exodus
- Within each high level mode there are various options for filtering what will get selected by clicks in the graphics window.

Create a Fixed BC

- Select the inner surfaces of all 4 of the cylindrical collars on the back side of the model (Ctrl-select on Windows/Linux, Command-select on Mac). Right-click and choose **Apply Boundary Conditions->fixed displacement nodeset id**
- In the **Settings** panel enter **"1"** in the **"bc id"** box and hit return.





Define Blocks and Mesh Domain

- At the **CUBIT** prompt copy and paste the following commands:

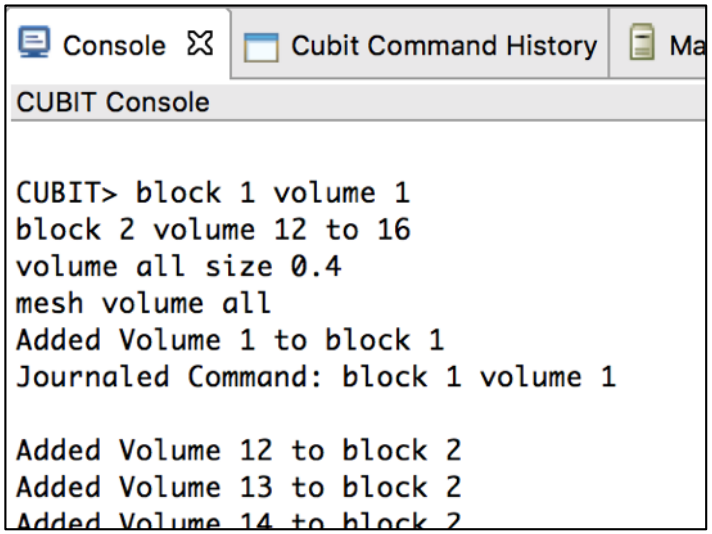
  block 1 volume 1

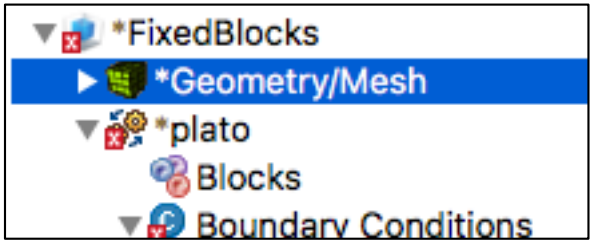
  block 2 volume 12 to 16

  volume all size 0.4

  mesh volume all

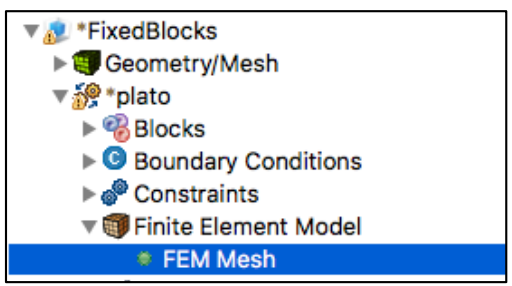
- Click on **Geometry/Mesh** node in the tree and then click the **Save** icon in the toolbar to save the model

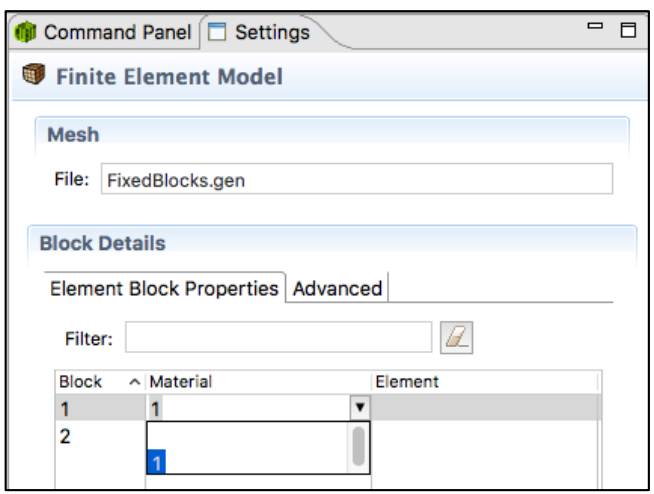


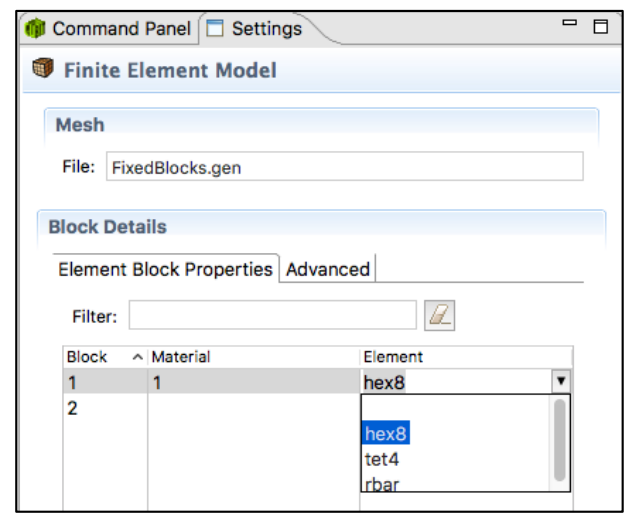


Assign Material and Element Type

- Click on the **FEM Mesh** node in the tree under **plato->Finite Element Model**
- In the **Settings** panel click in the **Material** area next to Block 1 and select **"1"** from the dropdown list
- Then click in the **Element** area next to Block 1 and select "**hex8"** from the dropdown list
- Repeat this process for Block 2

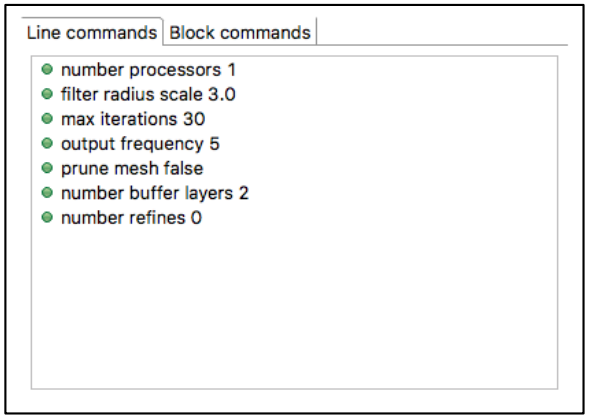


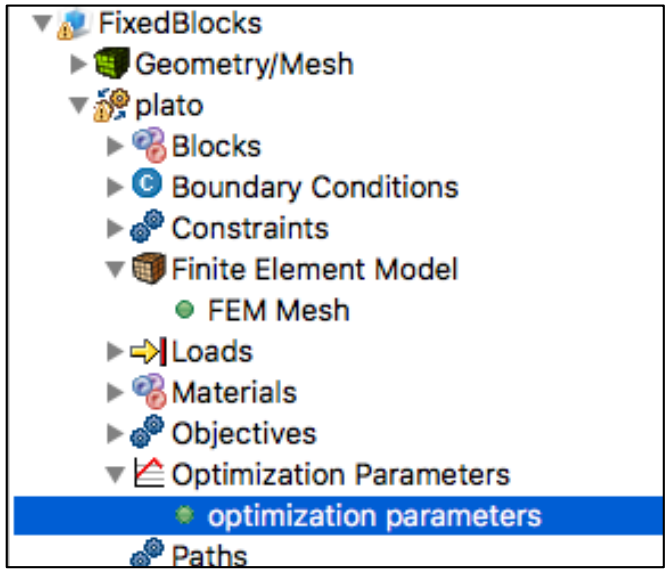




Set the Top. Opt. Parameters

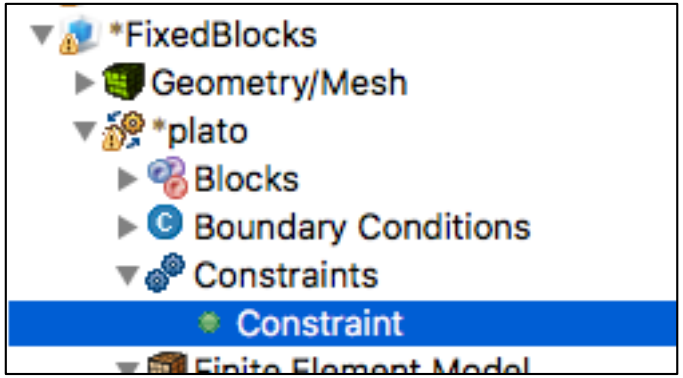
- Click on the **Optimization Parameters->optimization parameters** node in the tree
- In the **Settings** panel set the following parameters to the indicated values. These parameters will specify 1) how much filtering or smoothing will take place (see Filter tutorial for more on filtering), and 2) and how many iterations we want Plato to run, respectively.
  - **filter radius scale** = **3.0**
  - **max iterations** = **30**

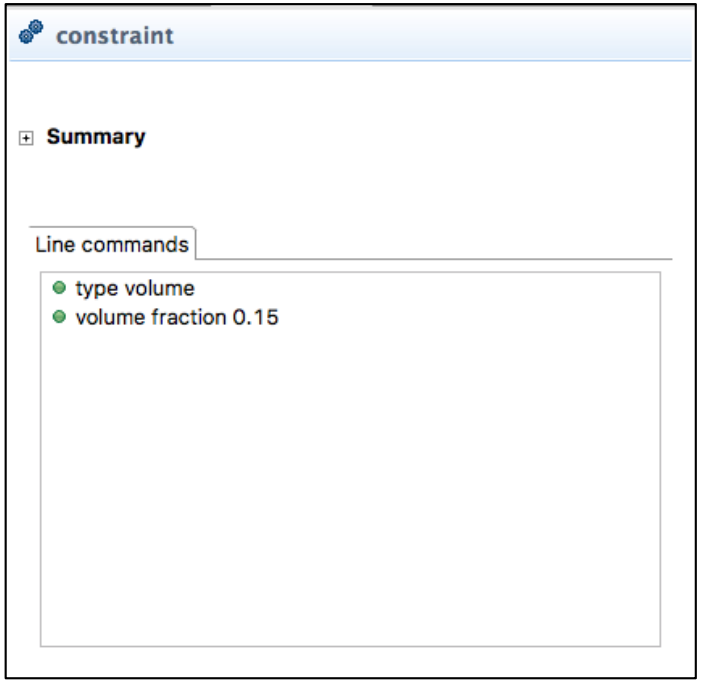




Set the Volume Constraint

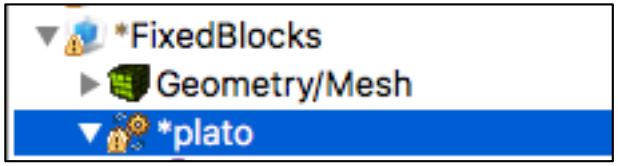
- Click on the **Constraints->Constraint** node in the tree.
- In the **Settings** panel set the **volume fraction** parameter to be **0.15**. This will indicate that we want the final design to only use 15% of the original volume.

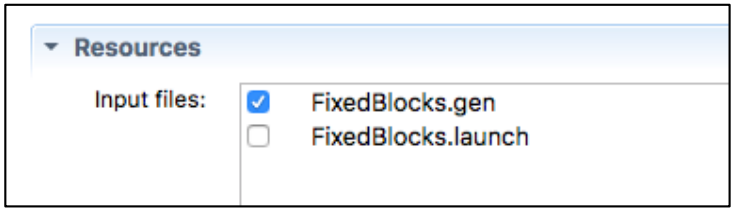




Run the Optimization

- Click on the **plato** node in the tree to bring up the job submission panel in the **Settings** view
- Choose **Plato** as the code and then choose the machine and execution template you want to use

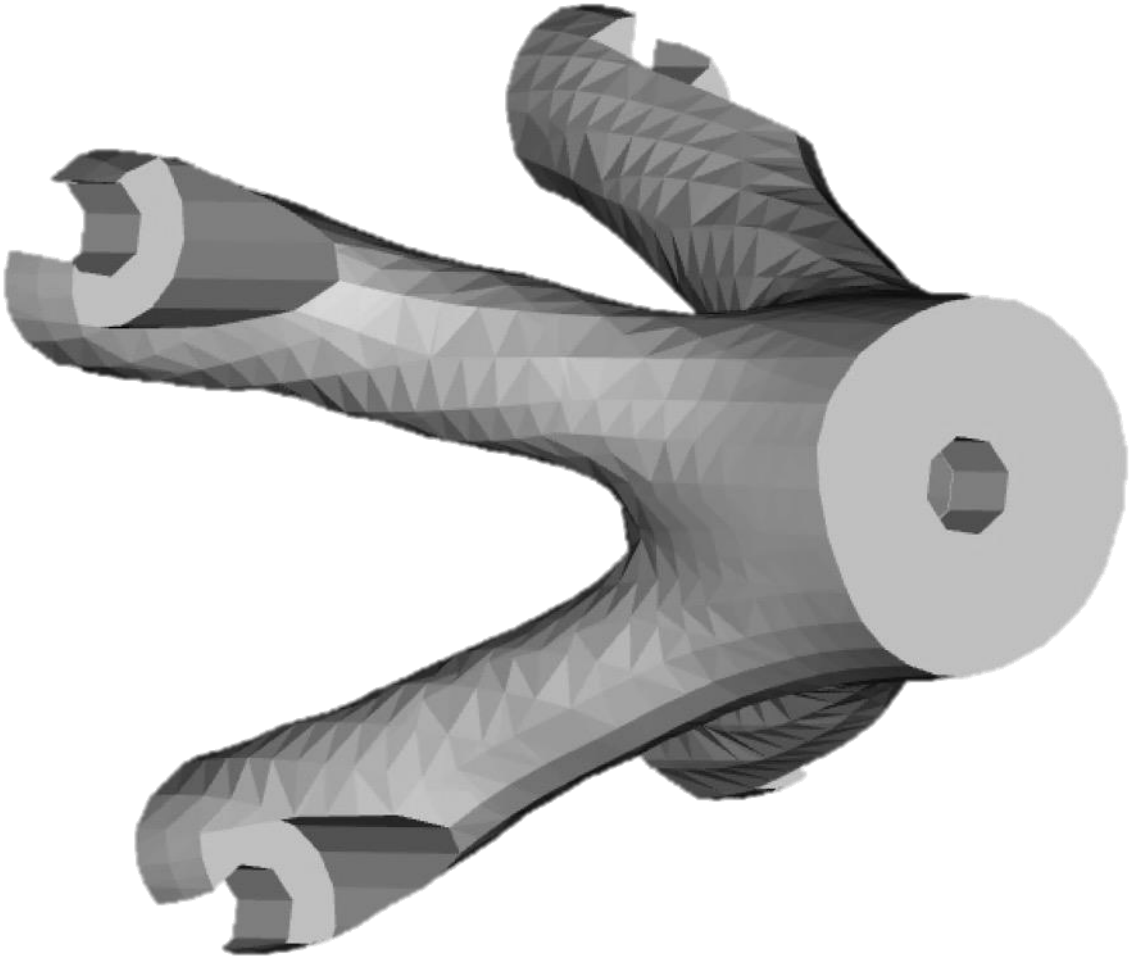




- In the **Resources** area make sure **FixedBlocks.gen** is checked
- In the **Prune and Refine** area make sure **Prune Mesh** is unchecked and **Number Refines** is **0**. We will not use these features in this example.
- Choose any other preferences and launch the job by clicking on **Submit Simulation Job** toward the top of the panel

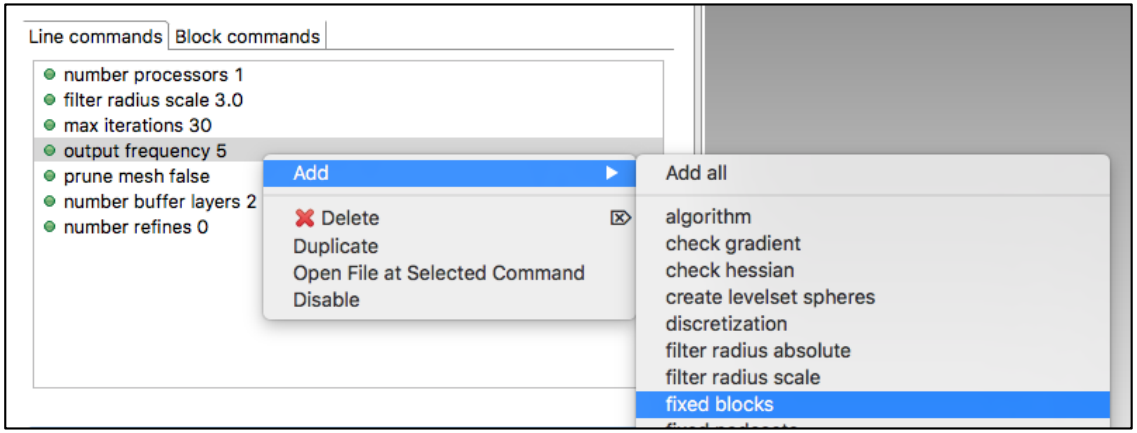
Result with No Fixed Blocks

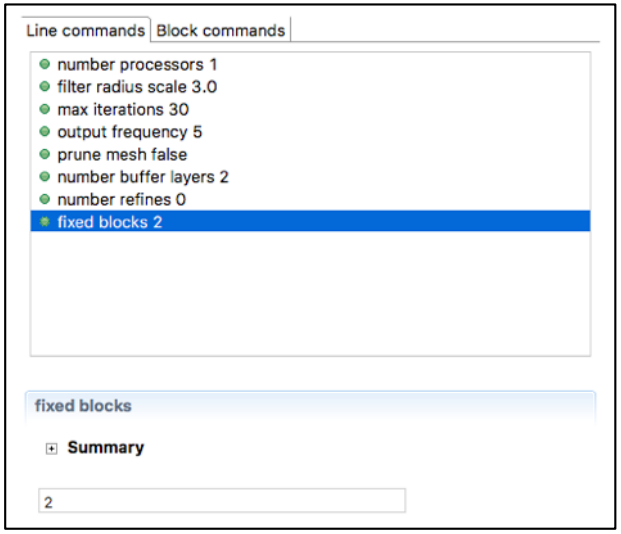
Notice how the optimizer removed parts of the collars that will be used to bolt down the bracket. Obviously, this isn't desirable. By using fixed blocks we can tell the optimizer not to remove material from the collars.



Specify Fixed Blocks and Rerun

- Block 2 in our model contains the collars we want to fix.
- Bring up the topology optimization parameters by clicking on the **Optimization Parameters->optimization parameters** node in the tree.
- Right-click anywhere in the **Parameters** area and choose **Add->fixed blocks.**
- Enter **2** in edit field for the **fixed blocks** value and hit return. If you need to fix multiple blocks you can enter multiple ids separated by spaces.
- Resubmit the job with all of the same parameters by clicking on the **plato** node in the tree and then click on the **Submit Simulation Job** in the job submission area in the **Settings** panel





Result with Fixed Blocks

With fixed blocks specified the result now maintains the collars needed for bolting the bracket down. The coarseness or roughness of the result is related to mesh resolution. See the “Prune and Refine” tutorial to learn how to efficiently generate smooth results.