Firstly, why do we need manufacturing constraints?

Topology Optimization results sometimes give design which cannot be manufactured economically. At this stage we need some constraints to apply on the design so that the end design results can be manufactured within the available tools and costs.

OptiStruct offers few such manufacturing constraints to apply for the base design and get an output design which can be easily manufactured. Few such manufacturing constraints are minimum and maximum member size, Draw direction (Dv’s with PSOLID), Extrusion (Dv’s with PSOLID), pattern grouping and pattern repetition.

In this tutorial we will discuss about pattern repetition manufacturing constraint using modelled in HyperMesh and solved using Altair OptiStruct.

**Setting up the model:**

Pattern repetition enforces same topology layout on different parts that can be scaled or Overlap only partially. For instance I have two different components for a model with different loads and boundary conditions and I need a similar topology layout for both the components. In such cases pattern repetition comes in handy.

In this example, I have two plates with different thicknesses, BCs and loading conditions. The outer boundary shells are made as non-design space and the remaining is made as designable volume for optimization.

Bottom plate has a thickness of 1 mm and upper plate has a thickness of 0.5mm. Material used for both the plates is same.
Loads and boundary conditions are defined as shown in above picture:

Create a linear static load case with the above loads and boundary conditions.

Create topology design variable and manufacturing constraints for the model:
Create two design variables for top and bottom plate designable spaces with type as PSHELL
First, let us not create any pattern repetition manufacturing and check how the topology changes for a given set of responses (objective and optimization design constraints)

**Create responses, optimization objective and design constraints:**

I have two responses. One is compliance and the other is volume fraction. My objective for this model is to minimize the compliance with a constraint on volume fraction of 0.3.

Run the analysis and post process the results.

**Toggle the result to final iteration and look at the element density change.**
Let’s add pattern repetition manufacturing constraint and see how the topology changes for both the components.

**Pattern repetition manufacturing constraint:**
Go to the topology panel and create pattern repetition manufacturing constraint.

We have created two DTPL cards (design variables) one is master and the other is slave. You can have more than 1 slave DTPL card.

Switch to Pattern repetition in Topology panel and select master DTPL under devsar and select anchor node and click update:

Similarly select slave for devsar and select anchor as shown:

The master and slaves are related through local coordinate system associated to master and slave DTPL cards.

Scaling factors can be specified to slave components. For more information on pattern repetition manufacturing constraints, please refer to OptiStruct user’s guide:

**Altair OptiStruct > User’s Guide > Design Optimization > Manufacturing Constraints > Manufacturability for Topology Optimization:**

Update and run the analysis. If the run is successful you should see the following

OPTIMIZATION HAS CONVERGED.

FEASIBLE DESIGN (ALL CONSTRAINTS SATISFIED).
Post-process the topology results in HyperView and observe the changes in the topology of the model.

Pattern repetition manufacturing constraint can be used for both solid and shell elements and also this can be clubbed with other manufacturing constraints in topology optimization.