Altair

HyperWorks

Altair HyperStudy 2019 Tutorials

HS-4415: Optimization Study of a Landing Beam Using Excel

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This tutorial demonstrates how to perform an optimization study in which the input variables are entered and the output responses are calculated in a Microsoft Excel spreadsheet. The Excel spreadsheet `LandingBeamCalc_Public.xls` file can be found in `<hst.zip>/HS-4415/` and copied to your working directory. To watch a demonstration video of this tutorial, click here.

The objective is to find the cross-sectional dimensions of a tapering I- beam at its three sections that minimize the total cross-sectional area while meeting the margin of safety requirements for buckling, crippling, and combined bending and shear under ten loadcases.

The spreadsheet used here contains a page with the initial design and separate pages for crippling, buckling, and combined bending and shear calculations.

Step 1: Create a Matrix Input that HyperStudy Can Evaluate

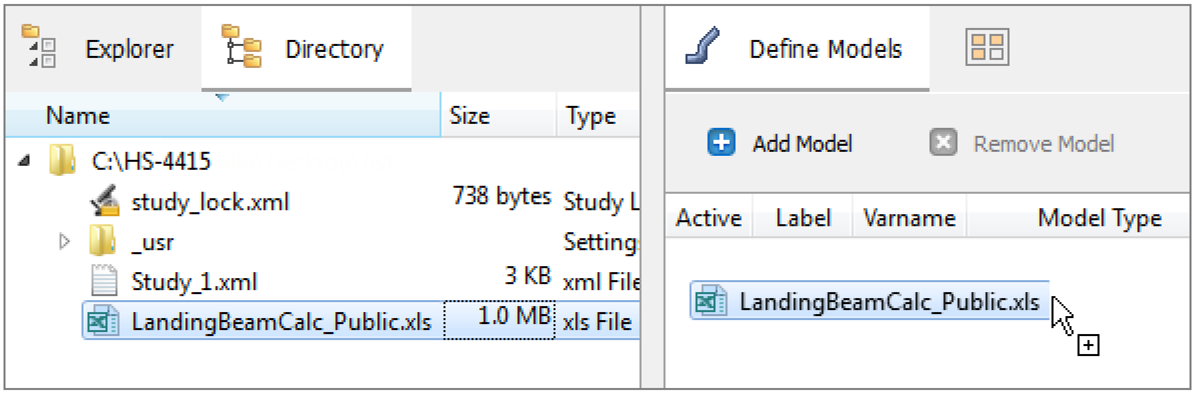
1. In Excel, open the `LandingBeamCalc_Public.xls` spreadsheet.
2. Review the information, and locate the columns that contain the input variables and output responses.

   Note: When creating a Spreadsheet model for HyperStudy on a Mac or Windows platform, variable labels should only contains English characters, or a combination of English characters and numbers.

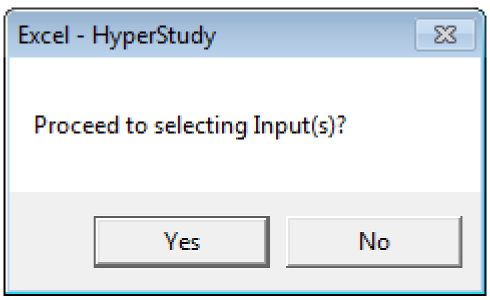
Step 2: Perform the Study Setup

1. Start HyperStudy.
2. To start a new study, click ***File*** > ***New*** from the menu bar, or click  on the toolbar.
3. In the **HyperStudy – Add** dialog, enter a study name, select a location for the study, and click ***OK***.
4. Go to the **Define models** step.
5. Add a Spreadsheet model by dragging-and-dropping the `LandingBeamCalc_Public.xls` file into the work area.

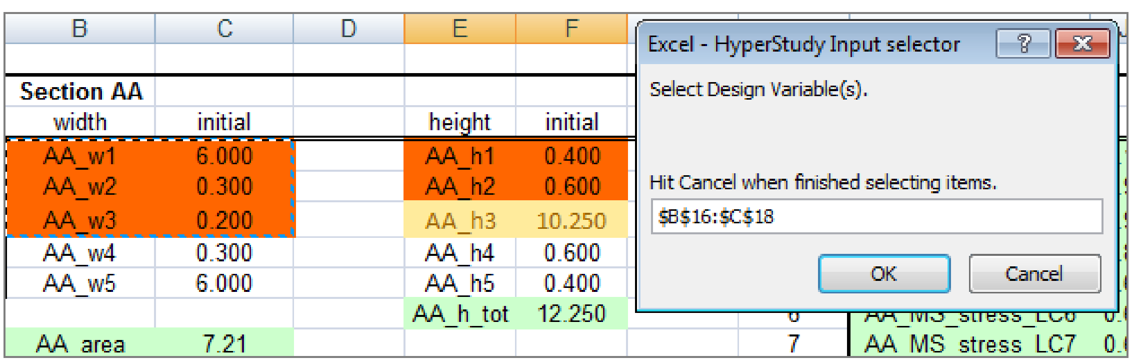
   The **Solver input file** column displays `hst_input.hstp`, this is the name of the solver input file HyperStudy writes during any evaluation. The **Solver execution script** column now displays **SpreadSheet_HST**.



6. **Optional**. If a firewall prompt dialog appears, click ***Allow***.
7. Click ***Import Variables***. The `LandingBeamCalc_Public.xls` spreadsheet opens.
8. In the **Excel - HyperStudy** dialog, click ***Yes*** to begin selecting input variables.

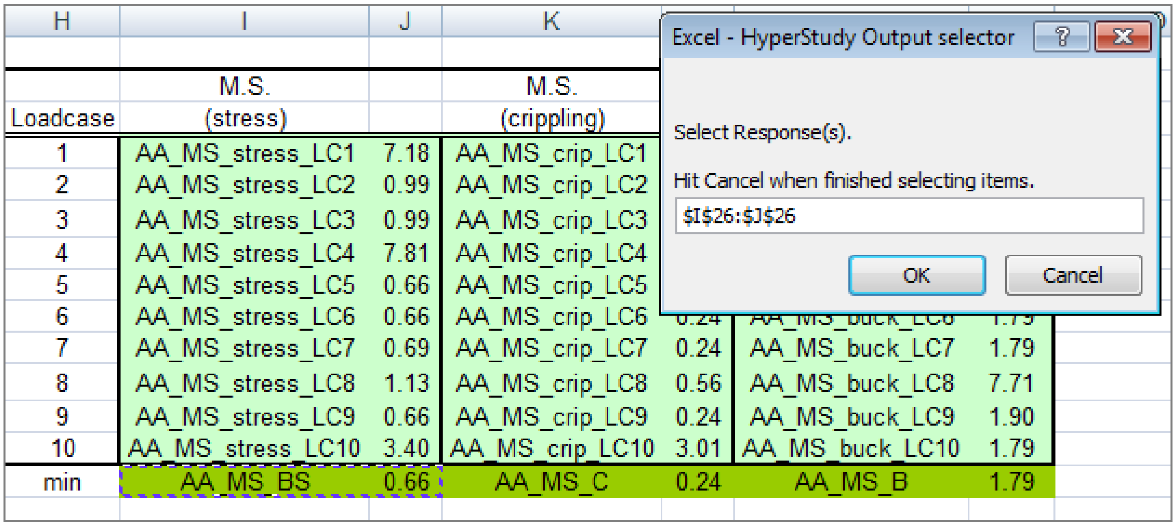


9. In the spreadsheet, select the cells ***AA_w1***, ***AA_w2***, and ***AA_w3*** in **Section AA**, along with their corresponding values.

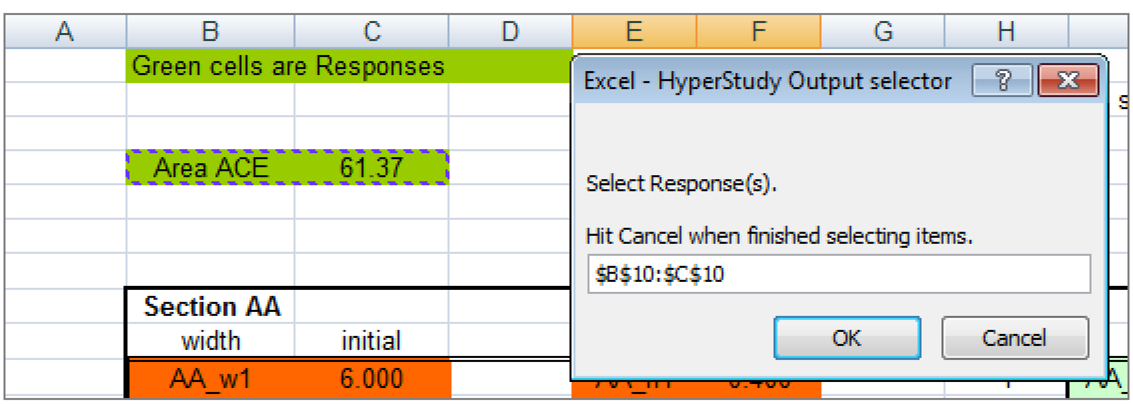


10. In the **Excel - HyperStudy Input Selector** dialog, click ***OK***.
11. Select the following:
    - **Section AA:** AA_h1 and AA_h2
    - **Section CC:** CC_w1, CC_w2, CC_w3
    - **Section CC:** CC_h1, CC_h2
    - **Section EE:** EE_w1, EE_w2, EE_w3
    - **Section EE:** EE_h1, EE_h2

12. Click ***Cancel*** to stop selecting input variables from the spreadsheet.
13. In the **Excel - HyperStudy** dialog, click ***Yes*** to begin selecting output responses.
14. In the spreadsheet, select the cell ***AA_MS_BS*** in **Section AA**, along with its corresponding value.



15. In the **Excel - HyperStudy Output Selector** dialog, click ***OK***.
16. Select the following:
    - **Section AA:** AA_MS_C
    - **Section AA:** AA_MS_B
    - **Section CC:** CC_MS_BS
    - **Section CC:** CC_MS_C
    - **Section CC:** CC_MS_B
    - **Section EE:** EE_MS_BS
    - **Section EE:** EE_MS_C
    - **Section EE:** EE_MS_B
    - **Area ACE** value from cell C10 (illustrated in the image below):



17. Click ***Cancel*** to stop selecting output responses from the spreadsheet. Fifteen input variables and ten output responses are imported from the `LandingBeamCalc_Public.xls` spreadsheet.
18. Go to the **Define Input Variables** step.
19. Review the input variable's lower and upper bound ranges.
20. Go to the **Specifications** step.

Step 3: Perform the Nominal Run

1. In the work area, set the **Mode** to ***Nominal Run***.
2. Click ***Apply***.
3. Go to the **Evaluate** step.
4. Click ***Evaluate Tasks***. An `approach/nom_1/` directory is created inside the study directory. The `approaches/nom_1/run__00001/m_1` sub-directory contains the `sse_output.csv` file, which is the results file of the nominal run.
5. Go to the **Define Output Responses** step.

Step 4: Add an Optimization Approach and a Run Optimization

1. In the **Explorer**, right-click and select ***Add*** from the context menu.
2. In the **Add - HyperStudy** dialog, select ***Optimization*** and click ***OK***.
3. Go to the **Select Input Variables** step.
4. Review the input variable's lower and upper bound ranges.
5. Go to the **Select Output Responses** step.
6. Click ***Add Objective***.
7. In the **Add - HyperStudy** dialog, add one objective.
8. Define the objective.
   a. Set **Type** to ***Minimize***.
   b. Set **Apply On** to ***Area ACE (r_10)***.

	Active	Label	Varname	Type	Apply On	Evaluate From
1	☑	Objective 1	obj_1	Minimize	Area ACE (r_10)	SOLVER

9. Click the ***Constraint*** tab.
10. Click ***Add Constraint***.
11. In the **Add - HyperStudy** dialog, add nine constraints.
12. Define **Constraint 1** through **Constraint 9** by selecting the options indicated in the image below from the **Apply On**, **Bound Type**, and **Bound Value** columns.

	Active	Label	Varname	Type	Apply On	Bound Type	Bound Value
1	☑	Constraint 1	c_1	Deterministic	AA_MS_BS (r_1)	>=	0.0000000
2	☑	Constraint 2	c_2	Deterministic	AA_MS_C (r_2)	>=	0.2000000
3	☑	Constraint 3	c_3	Deterministic	AA_MS_B (r_3)	>=	0.2000000
4	☑	Constraint 4	c_4	Deterministic	CC_MS_BS (r_4)	>=	0.0000000
5	☑	Constraint 5	c_5	Deterministic	CC_MS_C (r_5)	>=	0.2000000
6	☑	Constraint 6	c_6	Deterministic	CC_MS_B (r_6)	>=	0.2000000
7	☑	Constraint 7	c_7	Deterministic	EE_MS_BS (r_7)	>=	0.0000000
8	☑	Constraint 8	c_8	Deterministic	EE_MS_C (r_8)	>=	0.2000000
9	☑	Constraint 9	c_9	Deterministic	EE_MS_B (r_9)	>=	0.2000000

13. Click ***Apply***.
14. Go to the **Specifications** step.
15. In the work area, set the **Mode** to ***Sequential Quadratic Programming (SQP)***.

    Note: Only the methods that are valid for the problem formulation are enabled.
16. Click ***Apply***.
17. Go to the **Evaluate** step.
18. Click ***Evaluate Tasks*** to launch the optimization.

Step 5: View the Iteration History of the Optimization

1. Click the ***Iteration Plot*** tab to monitor the evolution of the objective function and constraints vs. the iterations.
2. Using the **Channel** selector, select **Constraint 1** through **Constraint 9**. The Optimization iteration history of the constraints is plotted.