RAMDO HyperStudy & OptiStruct Example



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HyperStudy Model Setup

The first step to using HyperStudy with RAMDO is to setup the HyperStudy model to use a DOE Approach to connect to RAMDO. It is assumed that the user is familiar with how to setup a HyperStudy model. This example only provides the details specific for using HyperStudy with RAMDO.

Instructions

- 1. Following the typical process, create a HyperStudy model that links to the OptiStruct model.
- 2. Add a DOE Approach to the HyperStudy model.
 - a. The Varname for the approach needs to be named RAMDO_DOE_Plugin
 - i. This is DOE approach is how RAMDO is linked to HyperStudy. Thus, setting the variable name correctly is critical.

1	HyperStudy	- Add		×
La	bel: RAMD	O_DOE_Plugi	in	
Va	rname: RAMD	O_DOE_Plugi	in	
	Select Type			
	Doe	1	Fit	
	Optimizat	2 ion s	Stochastic	
	OK	Cancel	Apply	

- 3. Note that in RAMDO all variables defined in the HyperStudy model are used, even if defined as in active in HyperStudy. Thus, the HyperStudy model should only include the variables that are to be used in RAMDO. In a future release the active state of the variable will imported into RAMDO.
- 4. The HyperStudy DOE approach should show the Varname as in the figure below.

plate_v14 - HyperStudy v14.0 (88.872435) File Edit View Tools Applications Help 1 Explorer 🙀 Approach Details E Directory Label Varname Comment 셼 Plate 1 RAMDO_DOE_Plugin RAMDO_DOE_Plugin 🗸 🗓 Setup ••• Define models Define design variables Specifications Evaluate ✓ Define responses Post processing 🗹 Report > 🙀 Optimization 1 RAMDO_DOE_Plugin Select design variables Select responses Specifications Evaluate Post processing Report

5. The Specifications node in the RAMDO_DOE_Plugin (DOE approach) needs to be configured as a Run Matrix as shown in the figure below.

plate_v14 - Hyperstudy v14.0 (88.872435)							
File Edit View Tools Applications H	lelp						
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🗸 🛃 Plate							
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> 🙀 Optimization 1	l i i	0	Lisses	**	Listen		
RAMDO_DOE_Plugin	 /	0	Hammersley	⊕	Hammersley		
Select design variables	8	0	User Defined		User		
Select responses	9	۲	Run Matrix		RunMatrix		
Specifications	10	0	None		None		
Evaluate							
Post processing							
Report							

6. The Perturb File Value for the Run Matrix can be set to any CSV in any location.

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a. RAMDO will use the same name for the CSV file when it runs HyperStudy. It will not modify the original CSV. RAMDO creates a new CSV file in a new location when running HyperStudy.



7. On the Report node of the RAMDO_DOE_Plugin make sure the HyperStudy PostProcessing is checked as shown in the figure below.

Study_1_v14 - HyperStudy v14.0 (88.872435))			
File Edit View Tools Applications H	Help			
Explorer Directory	Report			
✓ ₫ Study_1	Browse files			
🗸 🗓 Setup				
Define models	Active	Label	Varname	Description
Define design variables	1	HyperStudy PostProcessing	hst_dssdata	Generate the input for HyperStudy post processing module (*.data)
Specifications	2	HyperStudy HTML	hst_html	Generate HTML report (*.htm)
💌 Evaluate	3	HyperWorks Session	hst_hwmvw	Generate HyperWorks report (*.mvw) - (Not available in batch)
Define responses	4	HyperStudy Spreadsheet	hst_xls	Generate Spreadsheet report (*.xls, *.xlsx)
Post processing				
Report				
V 🙀 Optimization 1				
Select design variables				
Select responses				
Specifications				
Evaluate				
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Keport				
KAMDO_DOE_Plugin				
Select design variables				
Specifications				
V Evaluate				
Post processing				
Report				

- 8. The final step is going to select the Study in the tree and go to the Batch Tasks tab.
 - a. For each listed approach in the list, uncheck all the checkboxes that are not required. Note that this is required, because when RAMDO runs HyperStudy in batch mode to evaluate the DOE, it will run every step for every approach that is checked. Thus, if an Optimization approach is checked, HyperStudy will run the full optimization approach in addition to the RAMDO_DOE_Plugin approach.
 - i. Note, this does allow for linking multiple approaches together. Therefore, if multiple approaches need to run, in order, to evaluate the RAMDO_DOE_Plugin approach, then the HyperStudy model can be setup accordingly.
- 9. Save the HyperStudy model.
 - a. Make a note of where the HyperStudy file is saved, so that in RAMDO you can browse to the HyperStudy file and find the HyperStudy XML file.

10. After setting up the HyperStudy model, proceed to start RAMDO and follow the example below.

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Evaluate	3	RAMDO_DOE_Plue	gin	RAMDO	_DOE_Plugin	HstApproach_D	oe 👫	2	•	\checkmark	\checkmark				\checkmark
Define responses															
Post processing															
Report															

Note

The HyperStudy model can be setup to connect to any simulation solver.

HyperStudy & OptiStruct Plate Example

Problem Formulation



 $Cost(\mathbf{d}) = mass of plate$ $G_1(\mathbf{X}) = Displacement of top right corner \le 0.002$

Lower Bounds of Design $\mathbf{d} = [0.05, 0.05, 0.05]$ Upper Bounds of Design $\mathbf{d} = [0.15, 0.15, 0.15]$

Initial Design $\mathbf{d}_{initial} = [0.096, 0.15, 0.082]$ Target Reliablity = 95%

Random Variable	Marginal Distribution	Mean	Variance	Туре
<i>t</i> 1	Normal	d_1	0.3 ²	Design Variable
<i>t</i> 2	Normal	d_2	0.3 ²	Design Variable
t3	Normal	d_2	0.3 ²	Design Variable

Problem Definition

The plate example is a simple FE model that uses HyperStudy and OptiStruct in connection with RAMDO. There are three thickness variables. The objective is to minimize the mass of the plate and the constraint is the top right corner of the plate should have a displacement less than 0.002.

Instructions

Follow the following steps to set up and run the HyperStudy & OptiStruct Plate Example tutorial. This example will show to use HyperStudy and an existing HyperStudy model as the Simulation Solver in RAMDO. In this example OptiStruct is used as the FEA solver.

The basic process follow is RAMDO, launches HyperStudy, which in turn runs the OptiStruct simulations. HyperStudy then extracts the results from the OptiStruct simulations.

Methods and Options

Filling out the Methods and Options page.

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To fill out the Methods and Options form do the following:

- 1. Under the Method section select the **Optimization** and **Sampling-Based** methods.
- 2. Under the Sampling Based Options section select the **Reliability-Based Design Optimization (RBDO) from Current Design** option.

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(Sensitivity-Based (coming soon)

Sampling-Based Options

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Reliability Analysis at DDO Design (coming soon)
Reliability-Based Design Optimization (RBDO) from Current Design
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Generate Output Distribution at RBDO Design (coming soon)

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	Reliability Analysis at Current Design		
	Optimization		
	Sampling-Based		
	Sensitivity-Based (coming soon)		
	Sampling-Based Options		
	 Deterministic Design Optimization (DDO) 		
	Generate Output Distribution at DDO Design (coming soon)		
	Reliability Analysis at DDO Design (coming soon)		
	Reliability-Based Design Optimization (RBDO) from Current Design		
	Generate Output Distribution at RBDO Design (coming soon)		
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	Generate Output Distribution at RBDO Design (coming soon)		
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4. Click the **Next** button to continue to the next page.

Simulation Solvers

Filling out the Simulation Solvers page.

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To fill out Simulation Solvers form do the following:

- 1. Select the HyperStudy (Altair) option.
- 2. Upload the solver:
 - a) Click the Import Model button to choose the solver file.
 - b) Browse to the installation location of RAMDO and find the 'plate_v14.xml' HyperStudy file in the 'dense_Study_1_v14' folder in the 'Examples' folder in the RAMDO program folder.
 - c) Click the **Open** button to import the HyperStudy model.

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Study_1_	v14.xml
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3. You should see the following in the figure below.

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4. Click the **Next** button to continue to the next page.

Statistical Information

Importing the HyperStudy model adds the variables defined in the HyperStudy model to Random Design Variables (RDV) table in RAMDO. The HyperStudy variable name is shown in the last column of the table to provide a reference back to the variable as defined in HyperStudy.

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1	t1	Normal	0.096	0.003	0.050	0.150	Brows	ə					m_1	_varname_1		
2	t2	Normal	0.150	0.005	0.050	0.150	Browse	ə					m_1	_varname_2		
3	t3	Normal	0.082	0.002	0.050	0.150	Browse	ə					m_1	_varname_3		
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Hyper:	Study Versi	n 14.0 will be used.														

Review the Statistical Information:

Random Design Variable Table

The table should look like the table in the figure below.

Rand	om Design Vari	ables (RDV)									
ID	Name	Distribution Type	Mean	Standard Deviation	Lower Bound	Upper Bound	Attach Data File	Data File Name	Description	HyperStudy Varname	
1	t1	Normal	0.096	0.003	0.050	0.150	Browse			m_1_varname_1	
2	t2	Normal	0.150	0.005	0.050	0.150	Browse			m_1_varname_2	
3	t3	Normal	0.082	0.002	0.050	0.150	Browse			m_1_varname_3	
											L
											V
	C Add Row	🖾 Delete Ro	w(s)	↓ Convert to RP							

Note (Random Design Variable Description)

The Description column is for user convenience. The user can enter any description of the random design variable they want. This is so that when a model is opened later the user can remember what are the random design variables in the problem.

1. The RAMDO window should now look like the window in the figure below.

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Rand	dom Design Va	riables (RDV)													
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2	12	Normal	0.150	0.005	0.050	0.150	Browse					m_1_ m_1	varname_2		
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Corr Con Con Con Con	Add Row elated Pairs related Pair 1st Add Row ed new model on Study Version 1	Variable/Parameter	tow(s)	b Convert to RDV	fype	Kendali's Tau	Clayt Frank Gaus AMH Gum A12 A14	Kendali's Tau opulas Lower on 0 -0.95 -0.222 -0.181 bel 0 0.333 0.333	Range <pre></pre>	Upper 0.95 0.222 0.95 0.333 0.95 0.95 0.95	← Bac	Distributions Normal Log Normal Weibuli Gumbel Gamma Extreme Extreme II	tribution St Lower -∞ 0 -∞ 0 -∞ 0 t→	<pre>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>></pre>	Upper © © © © © © © © © © © © ©

2. Click the **Next** button to continue to the next page.

Performance Measures

Filling out the Performance Measures page.

C F	RAMI	00 t Window Help										-	. 🗆	×
ſ	Model													
	Meth	ods and Options	Simulation Solvers	Statistical Information P	erformance Mea	asures A	nalysis Setting	s Optimization Settin	gs Review and Execute	Results				
	Perf	ormance Measu	ıres (PM)											
	ID	Name	Objective Function	Working Constraints	Feasibility	Target Cons	traint Value	Target Reliability (%)	Description	HyperStudy Va	arname			
	1	Mass								r_1	<u> </u>			
	2	Displacement	Delete Ro	w(s)						<u>τ_2</u>	Ţ			
									🛛 🐻 s	ave 🔶 E	Back	Next \rightarrow	⊘ Exec	ute
	* *						_							
	Creat Hyper	ed new model on Study Version 14	Thu Jan 25 12:32:1	4 CST 2018										

To fill out the Performance Measures page do the following:

1. Responses defined in the HyperStudy model are imported into the Performance Measure Information table. The last column of the table shows the HyperStudy name of the response, this is for a reference back to the original HyperStudy model.

Perio	rmance weasu	res (PNI)							
ID	Name	Objective Function	Working Constraints	Feasibility	Target Constraint Value	Target Reliability (%)	Description	HyperStudy Varname	
1	Mass							r_1	
2	Displacement							r_2	T
									٦.
									1
_	C								
	Add Row	Delete Ro	W(S)						

Performance Measures (PM)

2. Fill out the table with the following.

Performance Measures Table

ID	Name	Objective Function	Constraints	Feasibility	Target Constraint Value	Target Reliability	Description
1	Mass	x					Cost Function
2	Displacement		х	≤	0.002	95	Constraint

The table should look like the table in the figure below.

Performance Measures (PM)

ID	Name	Objective Function	Working Constraints	Feasibility	Target Constraint Value	Target Reliability (%)	Description	HyperStudy Varname	
1	Mass	\checkmark						r_1	۸
2	Displacement		\checkmark	×	0.002	95.000		r_2	
									1
									T.
_	C		- (-)						
	C Add Row	Delete Rov	W(S)						

Note (Inequality Sign)

The inequality sign defines if the constraint value should be less than or greater than the allowable/target value defined. In the above figure, the inequality sign is < and the allowable/target value is 0. This means that the constraint would be defined as g < 0, where g is the constraint value.

Note (Performance Measure Description)

The Description column is for user convenience. The user can enter any description of the performance measure they want. This is so that when a model is opened later the user can remember what the performance measures are for the problem.

3. You should see the following in the figure below.

0) RAMDO)									-	D X
	le <u>E</u> dit Model 1 (
	Method	s and Options	Simulation Solvers	Statistical Information	Performance Me	asures Analysis	Settings Optimization S	Settings Review and	Execute Results			
	Perfo	mance Measu	ires (PM)									
	ID	Name	Objective Function	Working Constraints	Feasibility	Target Constraint Va	alue Target Reliability (%) Description	on HyperStud	ly Varname		
	1	Mass	V						r_1			
	2	Displacement		\checkmark	≤	0.002	95.000		r_2			
		Add Dow	The Delete Pa	sude						Ļ		
							_		Save (Back	Next → (S Execute
	Created	new model on	Thu Jan 25 12:32:1	4 CST 2018								
	HyperSt	udy Version 14	4.0 will be used.									

4. Click the **Next** button to continue to the next page.

Analysis Settings

Filling out the Analysis Settings page.

Ø RAMDO	- 0 ×
Elle Edit Window Help	
Model 1 📉 🖓	
Methods and Options Simulation Solvers Statistical Information Performance Measures Analysis Settings Optimization Settings Review and Execute Results	
Sampling Based Analysis Options Surrogate Modeling Options Number of Initial Sample Points: 5 MSE for Sequential Sampling: 0.001	
Number of Samples for Each Sequence: 5 Number of Regions in Window: 15	
Statistical Analysis Options	
Number of MCS-Points: 1,000,000	
Calculate Mean and Standard Deviation of Responses	
Reset to Default Values	
$\boxed{3} \text{ Save } \boxed{\leftarrow \text{Back}} \boxed{\text{Next} \rightarrow}$	🕑 Execute
Created new model on inu dan 25 12:32:14 CST 2018	
Remarks Handler 14 0 will be used	
hyperstudy version 14.0 will be used.	

To fill out the Analysis Settings page do the following:

1. The default options can be used for this example.

ampling Based Analysis Options	
Surrogate Modeling Options	
Number of Initial Sample Points:	5
MSE for Sequential Sampling:	0.002
Number of Samples for Each Sequence:	5
Number of Regions in Window:	15
Statistical Analysis Options	
Number of MCS-Points:	500,000
Calculate Mean and Standard Deviation	n of Responses
	Reset to Default Values

Note

The Users can set their own values or use the default values.

2. You should see the following in the figure below.

⊘ RAMDO –		I X
Eile Edit Window Help		
Methods and Options Simulation Solvers Statistical Information Performance Measures Analysis Settings Optimization Settings Review and Execute Results		
Sampling Based Analysis Options		
Surrogate Modeling Options		
Number of Initial Sample Points: 5		
MSE for Sequential Sampling: 0.001		
Number of Samples for Each Sequence: 5		
Number of Regions in Window: 15		
Statistical Analysis Options		
Number of MCS-Points: 1,000,000		
Calculate Mean and Standard Deviation of Responses		
Reset to Default Values		
Save ← Back Next→	⊗ Ex	ecute
AV		
Created new model on inu Jan 25 12:32:14 CST 2018		
HyperStudy Version 14.0 will be used.		

3. Click the **Next** button to continue to the next page.

Optimization Settings

Filling out the Optimization Settings page.

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Methods and Ontions Simulation Solvers Statistical Information	Performance Measures Analysis Settings	Ontimization Settings Review and Execute Results	
	·		
	RBDO Optimization Tolerances		
	Tolerance for Objective Functions:	1E-4	
	Tolerance for Constraint Functions:	0.001	
	Tolerance for Design Variables:	1E-4	
		Reset to Default Values	
		Save ← Back Next → Secure	
**	_		
Created new model on Thu Jan 25 12:32:14 CST 2018			
HyperStudy Version 14.0 will be used.			

To fill out the Optimization Settings page do the following:

1. The default tolerances can be used for this example.

RBDO Optimization Tolerances	
Tolerance for Objective Functions:	1E-4
Tolerance for Constraint Functions:	0.001
Tolerance for Design Variables:	1E-4
	Reset to Default Values

Note

Users can set their own values or use the default values.

2. You should see the following in the figure below.

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	File Edit Window Help										
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		Circulation Column	Charlie Line Commention	Defense Manage	Annaharia Cattinana		Deview and Events	Desults			
F	Methods and Options	Simulation Solvers	Statistical information	Performance Measures	Analysis Settings	Opumization Settings	Review and Execute	Results			
				RBDO Optimization Toleran	ces						
				Tolerance f	or Objective Functions:	1E-4					
				l olerance t	or Constraint Functions:	0.001					
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						Reset to Defau	It Values				
\vdash											
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-	Created new model on	Thu Jan 25 12:32:	14 CST 2018		_						
	illadea new model on		2010								
	HyperStudy Version 1	4.0 will be used.									

3. Click the **Next** button to continue to the next page.

Review and Execute

Viewing the Review and Execute page.

⊗ RAMDO	- C	x c											
Eile Edit Window Help													
Model 1													
Methods and Options Simulation Solvers Statistical Information Performance Measures Analysis Settings Optimization Settings Review and Execute Results													
Statistical Information													
Number of Random Design Variables (RDV): 3													
+ Random Design Variables (RDV)													
Performance Measures													
Number of Performance Measures (PM): 2													
L Defermance Macaures (BM)													
Save ← Back Next→	B	recute											
Created new model on Thu Jan 25 12:32:14 CST 2018													
HyperStudy Version 14.0 will be used.													

To use the Review and Execute page you can do the following:

- 1. Click the + icon to expand the drop-down to display the tables you want to view.
- 2. Click the icon to collapse the drop-down.
- 3. Review the tables to make sure they are correct. Go back and edit them if needed.
- 4. You should see the following in the figure below if all the drop downs are expanded.
- 5. Click the **Save** button to save the model.

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<u>File</u> Edit	Windo	w <u>H</u> elp												
Model 1		+)												
Metho	ods and	Options Sim	nulation Solvers St	tatistical Information	Performance Measure	s Analysis S	ettings Optir	nization Settings	Review and Execute	Results				
						Statistica	Informatio	n					ñ	
	Number of Random Design Variables (RDV): 3													
	- Random Design Variables (RDV)													
		Nome	Distribution Turn	Noon	Standard Daviation	Lower Bound	Linner Round	Data File Nom	Description	LhuporCt	udu Voro omo		- 1	
	1	t1	Normal	0.096	0.003	0.050	0.150	Data File Nam	Description	nyperot	n 1 varname 1 🔺		- 1	
	2	t2	Normal	0.150	0.005	0.050	0.150			n	n_1_varname_2		- 1	
	3	t3	Normal	0.082	0.002	0.050	0.150			n	n_1_varname_3		- 1	
						Performan	nce Measur	96					- 1	
					Number	of Performance N	Aescurec (DM): 2	65						
					Number	or Performance is	reasones (Privi), 2							
													- 1	
	- F	Performance M	Measures (PM)										- 1	
	ID	Name	Objective Function	on Working Cons	straints Feasibility	Target Constrai	int Value Tar	get Reliability (%)	Description	HyperStudy	Varname		- 1	
	1	Mass	V			-				r_1	<u>^</u>		- 1	
	2	Displacement		V	≤	0.002		95.000		r_2	×		- 1	
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- Calcado				2010										
Hypers	Study N	Version 14.0 w	rill be used.											
Hyper:	Study N	Version 14.0 w	rill be used.											

1. Click the **Execute** button to execute the simulation of the model.

Note

As shown in the log window it will take a few minutes before you will see the RBDO code start and for information to appear in the log window. This normal so please be patient.

2. The output of the simulation will be printed in the output window. Once the model is finished simulating then the Results page will be shown.

								_		×
Eile Edit Window Help										
Methods and Options Simulation Solvers Statistical Information Performar	nce Measures	Analysis Settings	Optimization Settings	Review and Execu	te Re	sults				
	5	Statistical Infor	mation							
	Number of	Random Design Variable	es (RDV): 3							
+ Random Design Variables (RDV)										
	_									
	P	erformance Me	easures							- 1
	Number of	Performance Measures ((PM): 2							- 1
										- 1
+ Performance Measures (PM)										- 1
										- 1
										7
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A.V.										
HyperStudy Version 14.0 will be used.										
Saved "Plate RBDO" on Thu Jan 25 13:59:48 CST 2018										
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<pre># @ Copyright 2015-2018 RAMDO Solutions, LLC All Rights Reserved #</pre>	* *									
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STARTING PARALLEL PROCESSING										

Results

Viewing the Results page.



Navigation Table Tree

To use the navigation table tree, make sure it is visible on the page. Change the view of the table tree by dragging right or left the split pane bar or by clicking the right arrow to expand or left arrow to collapse.

To collapse or expand the navigation table tree click the collapse icon \square and expand icon \square button arrows respectively.

The "Name" column is the name of the results or result types. The "View" column is the current view state of the internal frames of the plots and tables if they are visible or hidden. The visible icon ⁽²⁾ means the item is visible and the hidden icon ⁽²⁾ means the item is hidden. To change the viewing state of the plots and tables on the navigation tree table, double-click on the desired item or grouping of items to toggle the view.

Name	View	
E Results	0	
E Sampling RBDO	0	h
🖬 Plots	0	
RBDO Objective Function History	0	
t1 History	0	
t2 History	0	
t3 History	0	
Displacement History	0	
E Tables	0	
RBDO Objective Function Values	0	
RBDO Design Variable Values	0	
RBDO Reliability and Constraint Values	0	
RBDO History	0	

Result Frames

The result windows behave like normal desktop windows. They can be resized and dragged around.

To expand a window to fit the result's desktop, click the Expand button 亘 in the top right-hand corner.

To restore a window to its last size after it has been expanded, click the Restore button 🗐 in the top right-hand corner.

To show an individual result window, double-click on the window's corresponding name or single-click on the view icon in the navigation tree table. Or do the same actions on a group of tables, plots, or results to hide or show them all at once.

To hide an individual result window, click the Hide button 🔯 in the top right-hand corner.

Click the View Options button in the top left-hand corner to use all the viewing options.



The Results

Note

The results in the table may vary a little from the ones shown in the table below. This is to be expected being a sampling-based RBDO method using surrogate models is used for analysis.

RBDO Objective Function Values									
Name	Initial Value	RBDO Value							
Mass	1.976	2.045							

RBDO Design Variable Values										
ID	Name	Initial Value	RBDO Value							
1	t1	0.096	0.105							
2	t2	0.150	0.150							
3	t3	0.082	0.082							

	RBDO Reliability and Constraint Values												
ID	Name	Initial Reliability (%)	RBDO Reliability (%)	Initial Nominal Value	RBDO Nominal Value	Initial Mean Value	RBDO Mean Value						
1	Displacement	48.544	95.036	-5E-5	-0.030	0.001	-0.029						
							<u>, 76</u>						

	RBDO History											
Iteration	t1	t2	t3	Mass	Displacement Reliabilit	Displacement Nominal	Displacement Mean					
0	0.096	0.150	0.082	1.976	48.544	-5E-5	0.001					
1	0.084	0.150	0.101	1.996	50.925	-0.001	2.561E-5					
2	0.120	0.150	0.063	2.046	77.939	-0.014	-0.013					
3	0.096	0.150	0.092	2.032	88.489	-0.023	-0.022					
4	0.102	0.150	0.084	2.037	92.800	-0.027	-0.026					
5	0.104	0.150	0.084	2.044	94.735	-0.030	-0.029					
6	0.104	0.150	0.083	2.044	94.712	-0.030	-0.029					
7	0.104	0.150	0.083	2.045	94.968	-0.030	-0.029					
8	0.105	0.150	0.083	2.045	95.012	-0.030	-0.029					
9	0.105	0.150	0.083	2.045	95.035	-0.030	-0.029					
10	0.105	0.150	0.082	2.045	94.989	-0.030	-0.029					
11	0.105	0.150	0.082	2.045	95.036	-0.030	-0.029					





