



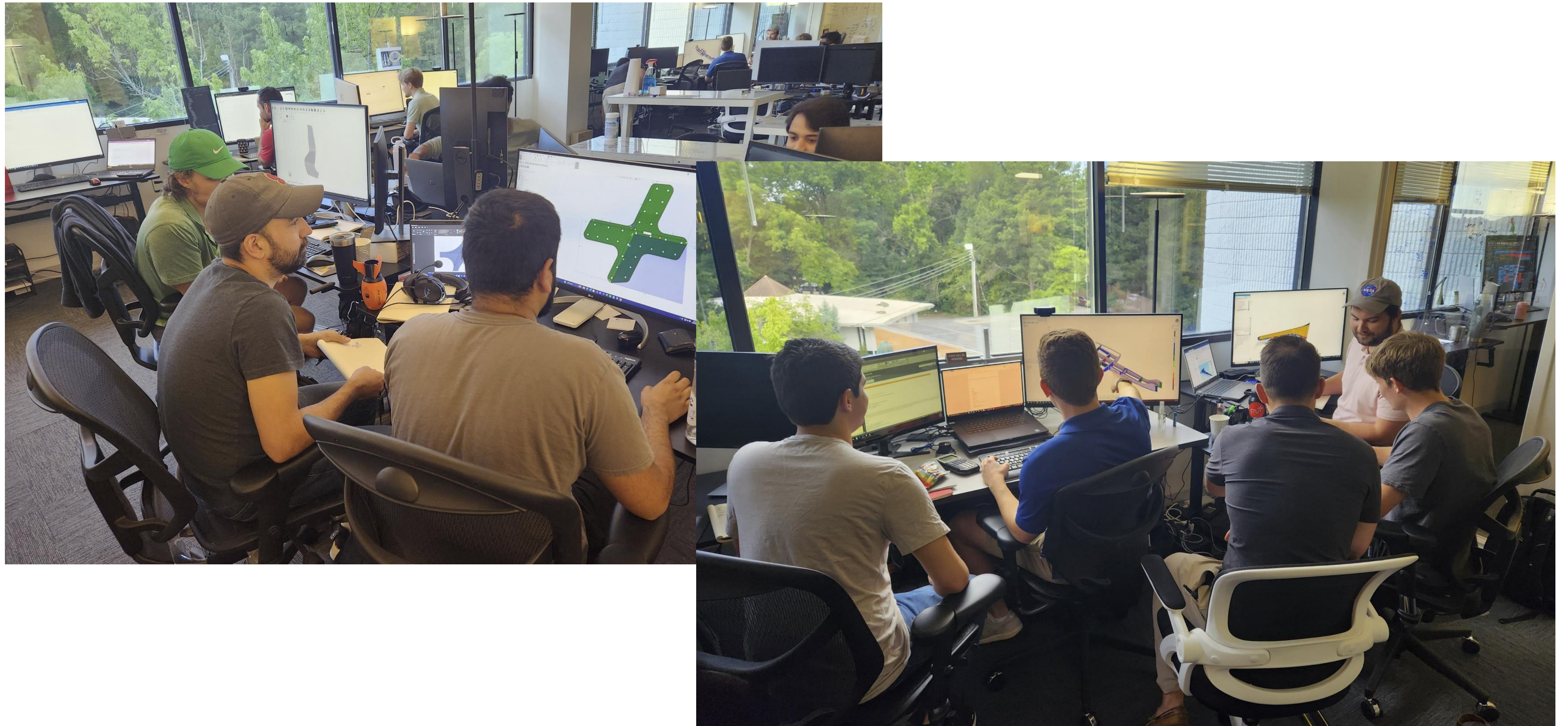
Engineering Services, value to the HyperX user community

Presenter: James Ainsworth

Contact us: www.collieraerospace.com

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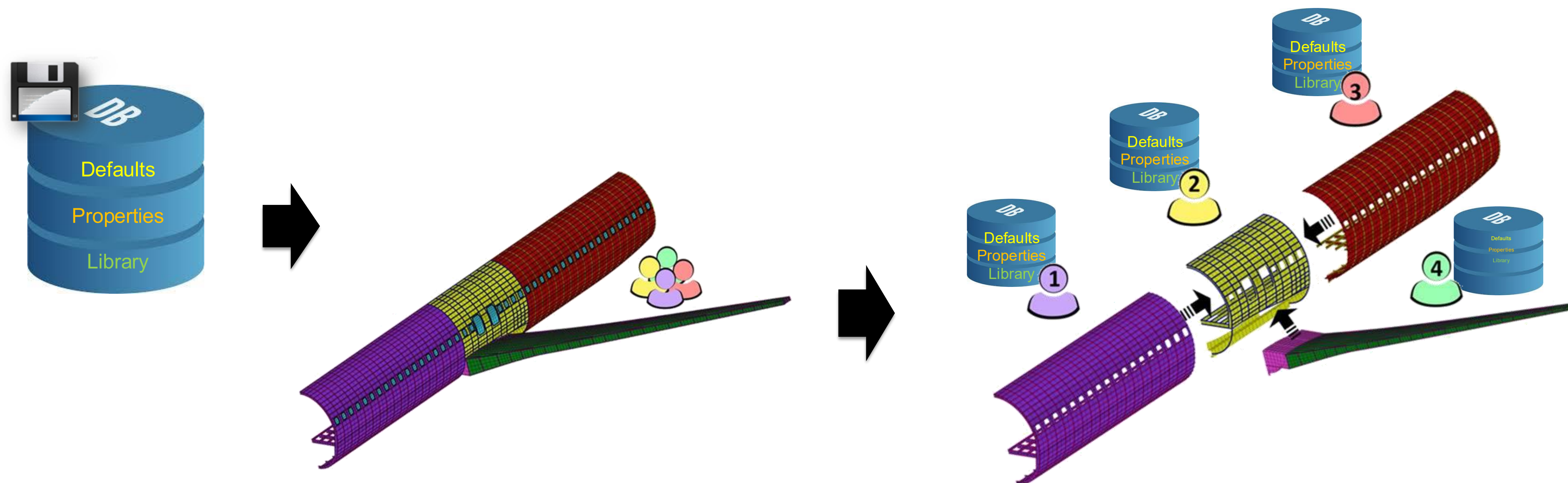


Just say what you want to say..

- HyperX is a tool built for stress engineers—by professional software developers, informed by stress engineers, supporting relevant aerospace programs.
- Our engineering team uses cutting-edge HyperX features and develop custom workflows to solve problems with HyperX, that other companies may develop in-house tools to solve. HyperX is our in-house stress tool
- We, HyperX users, are a community that benefits from each other's use of HyperX. The Collier Engineering Services team provides value to all HyperX users.

4 | Even if you don't contract ES, you benefit

A great 'for example' is the enterprise use case, which you've already seen..

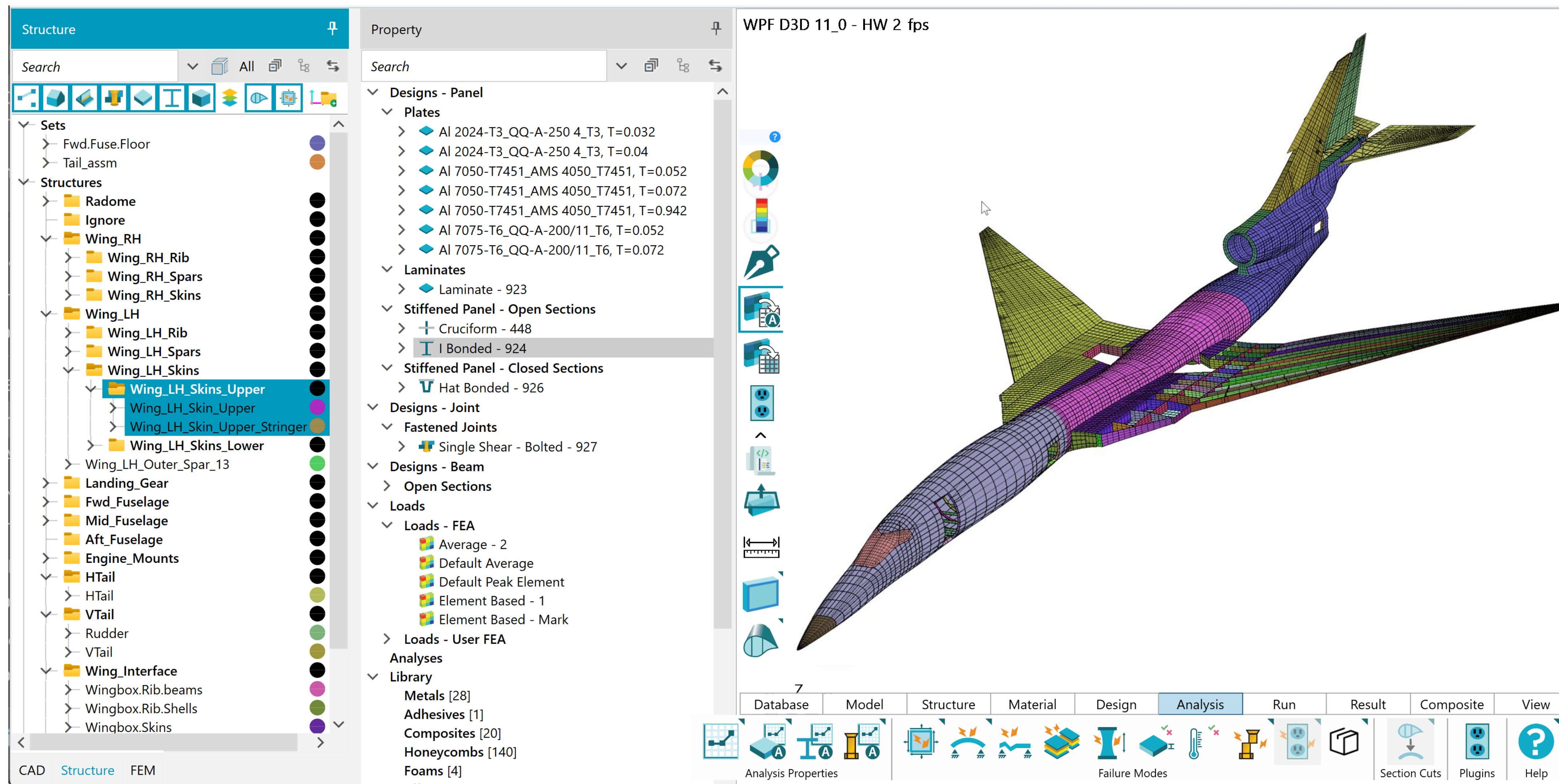


The 'Enterprise' workflow

How do we use HyperX?

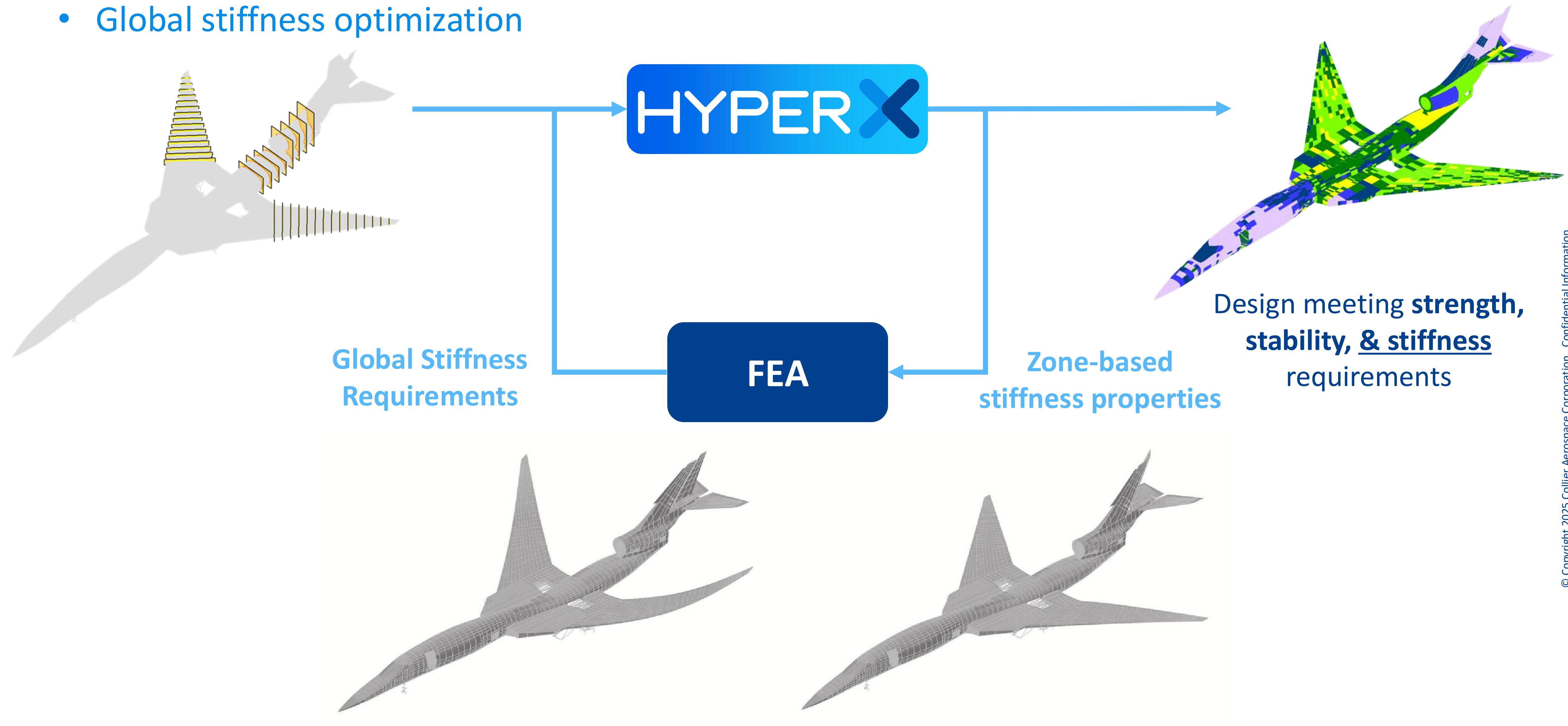
6 | How do we use HyperX?

- Large, complex models. Lots of organization/structure



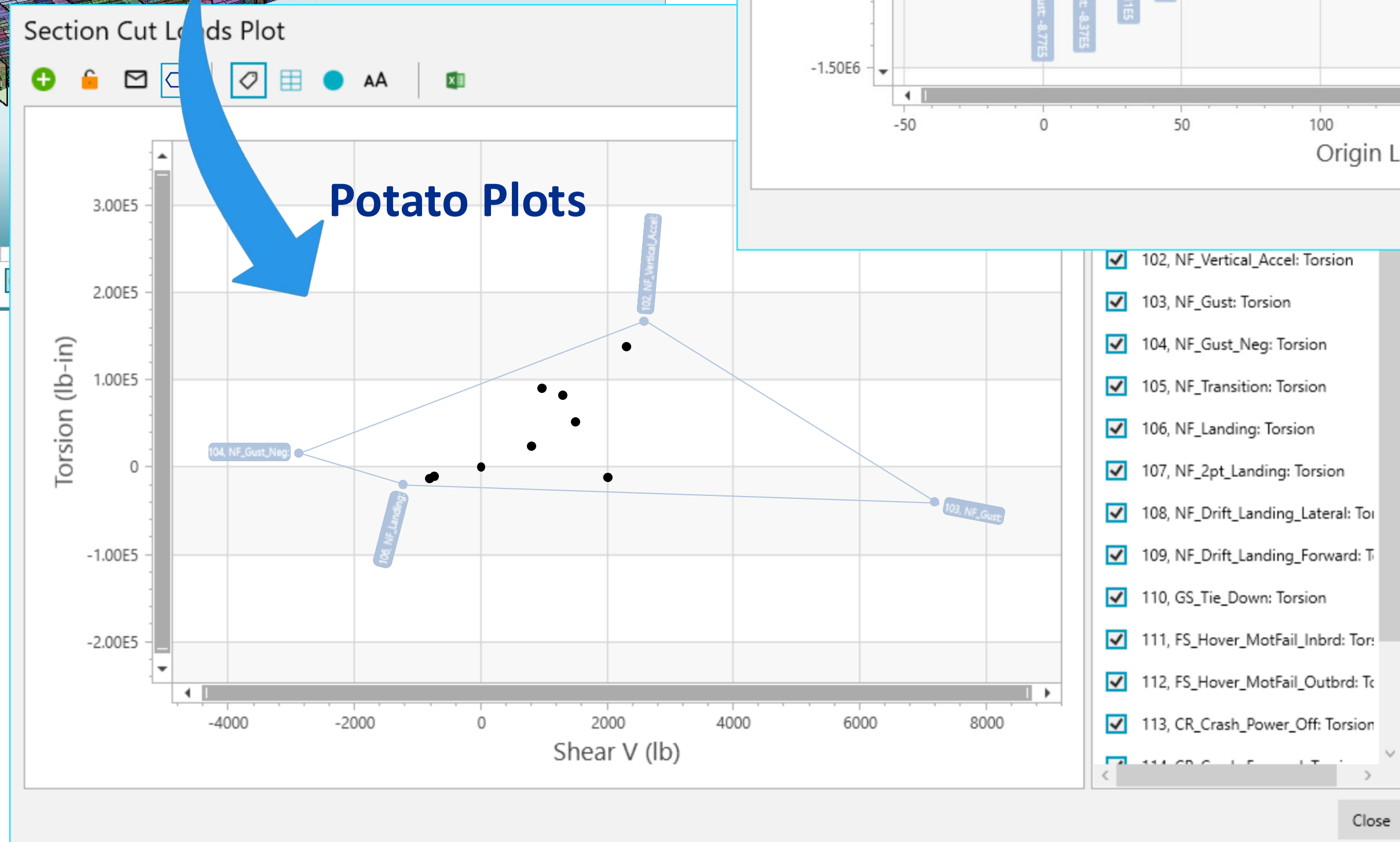
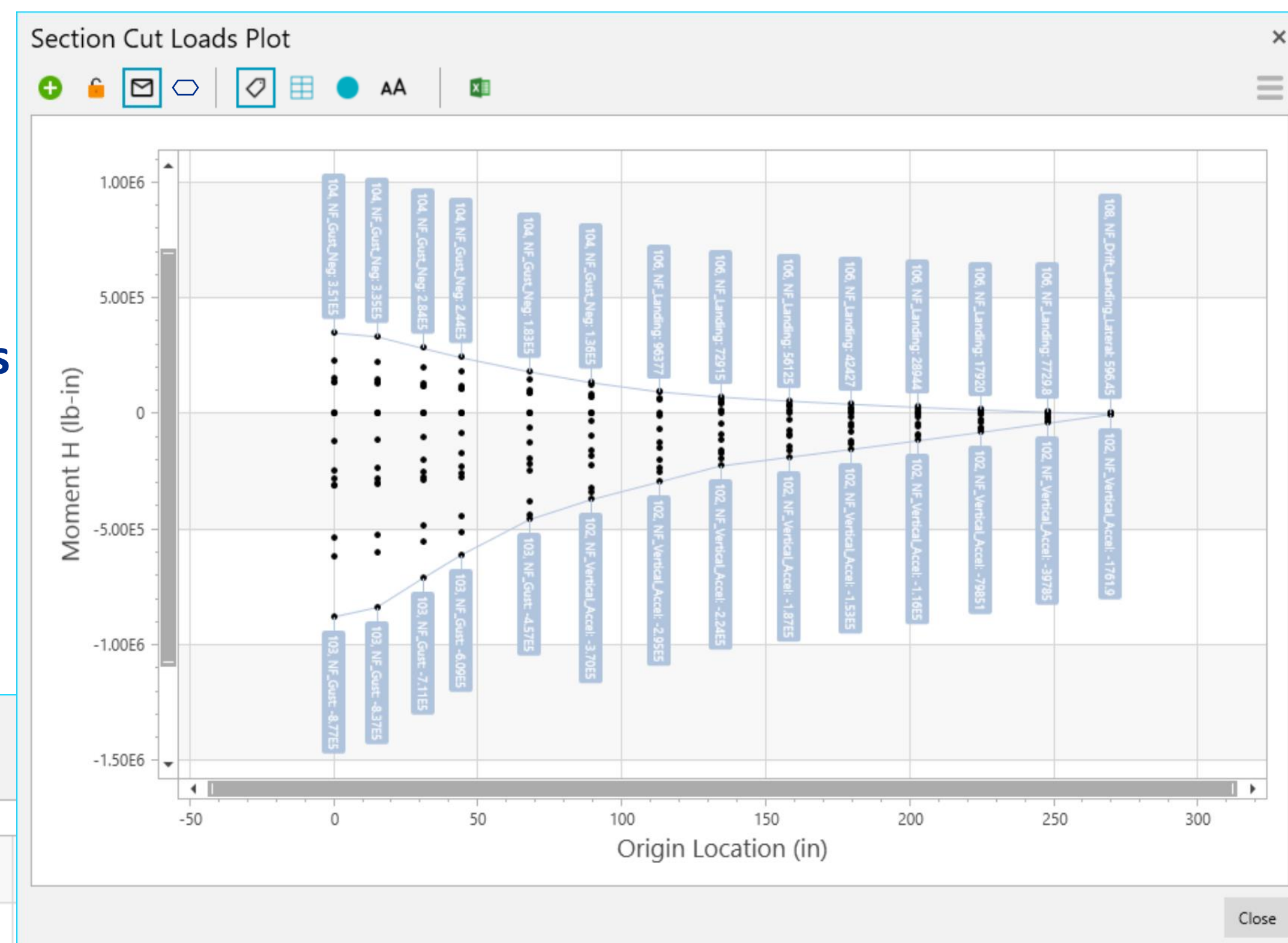
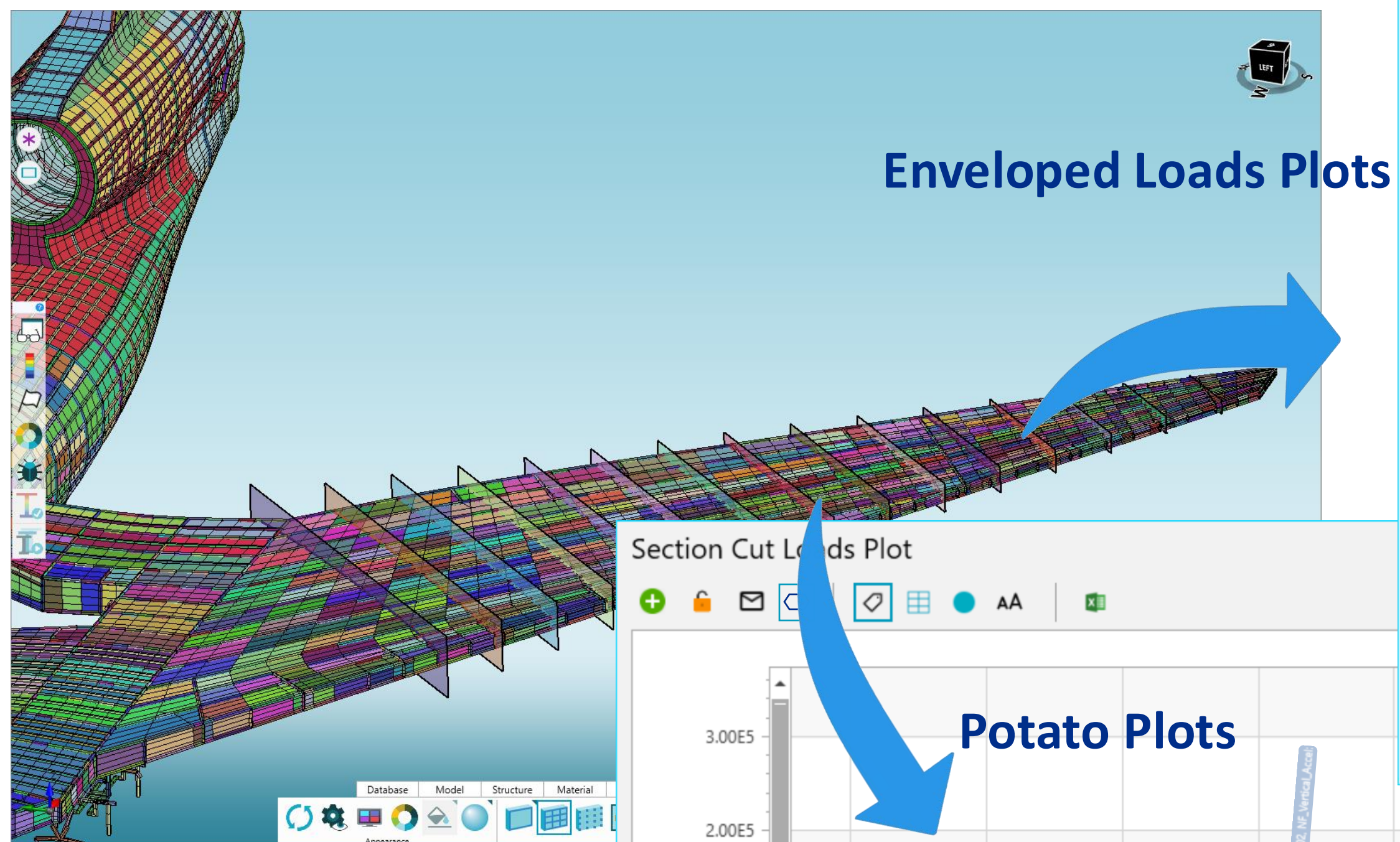
How do we use HyperX?

- Global stiffness optimization



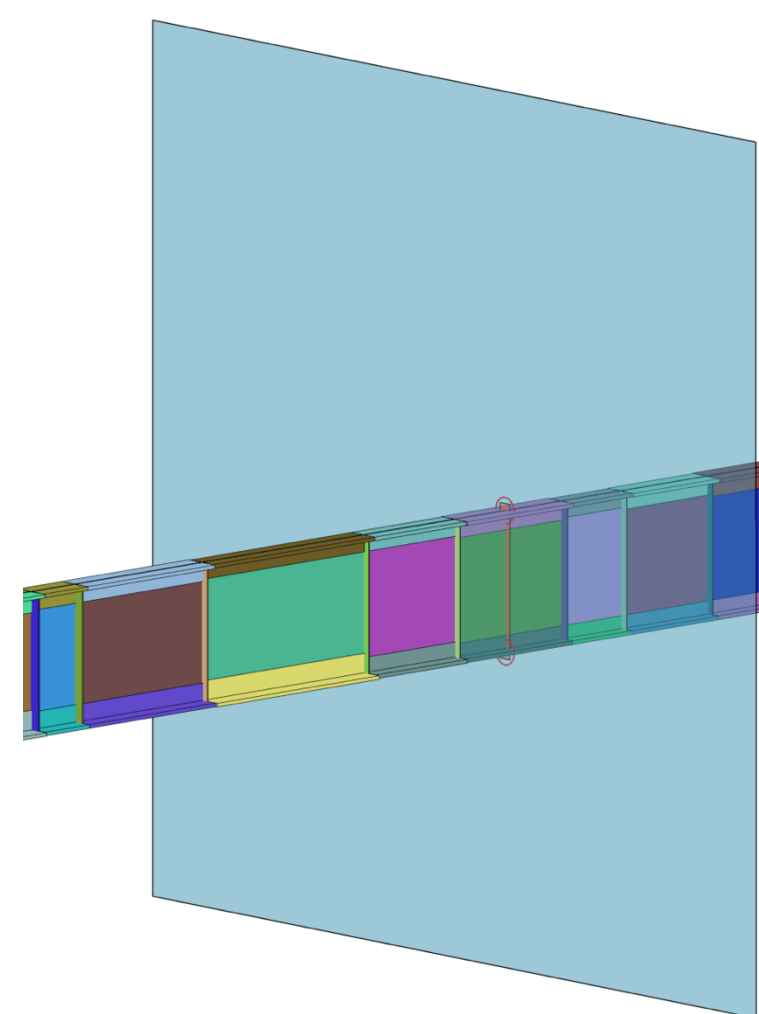
How do we use HyperX?

- FEM & Loads Evaluation

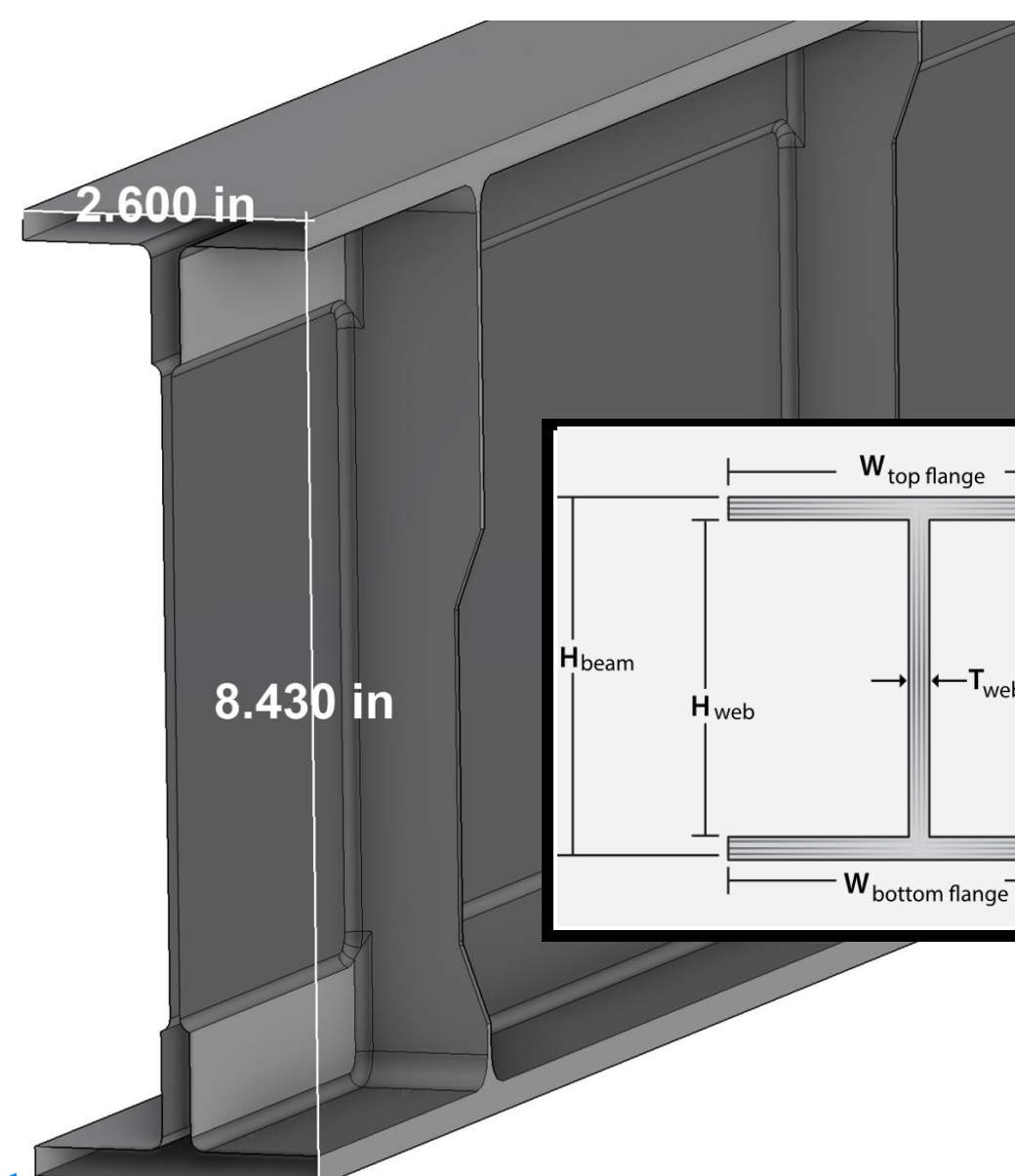
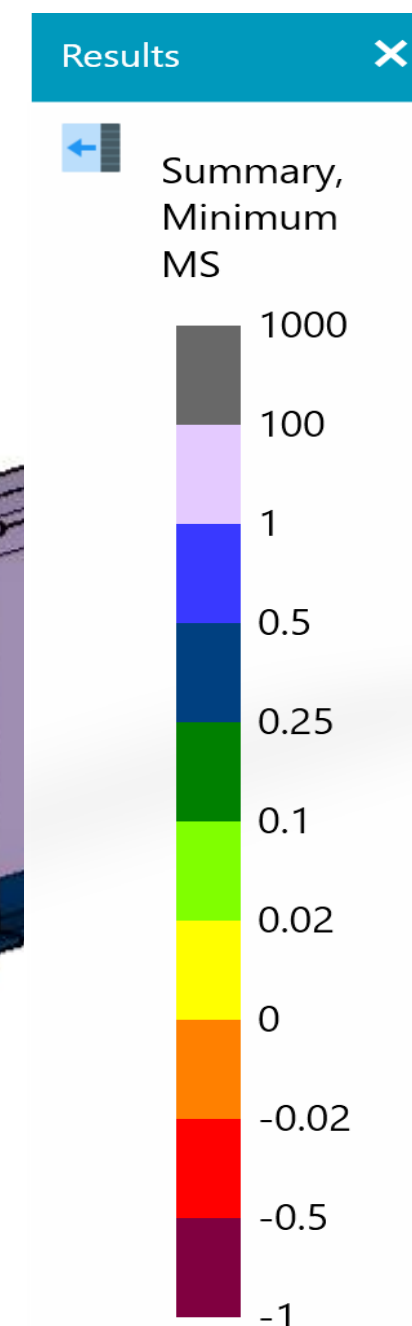
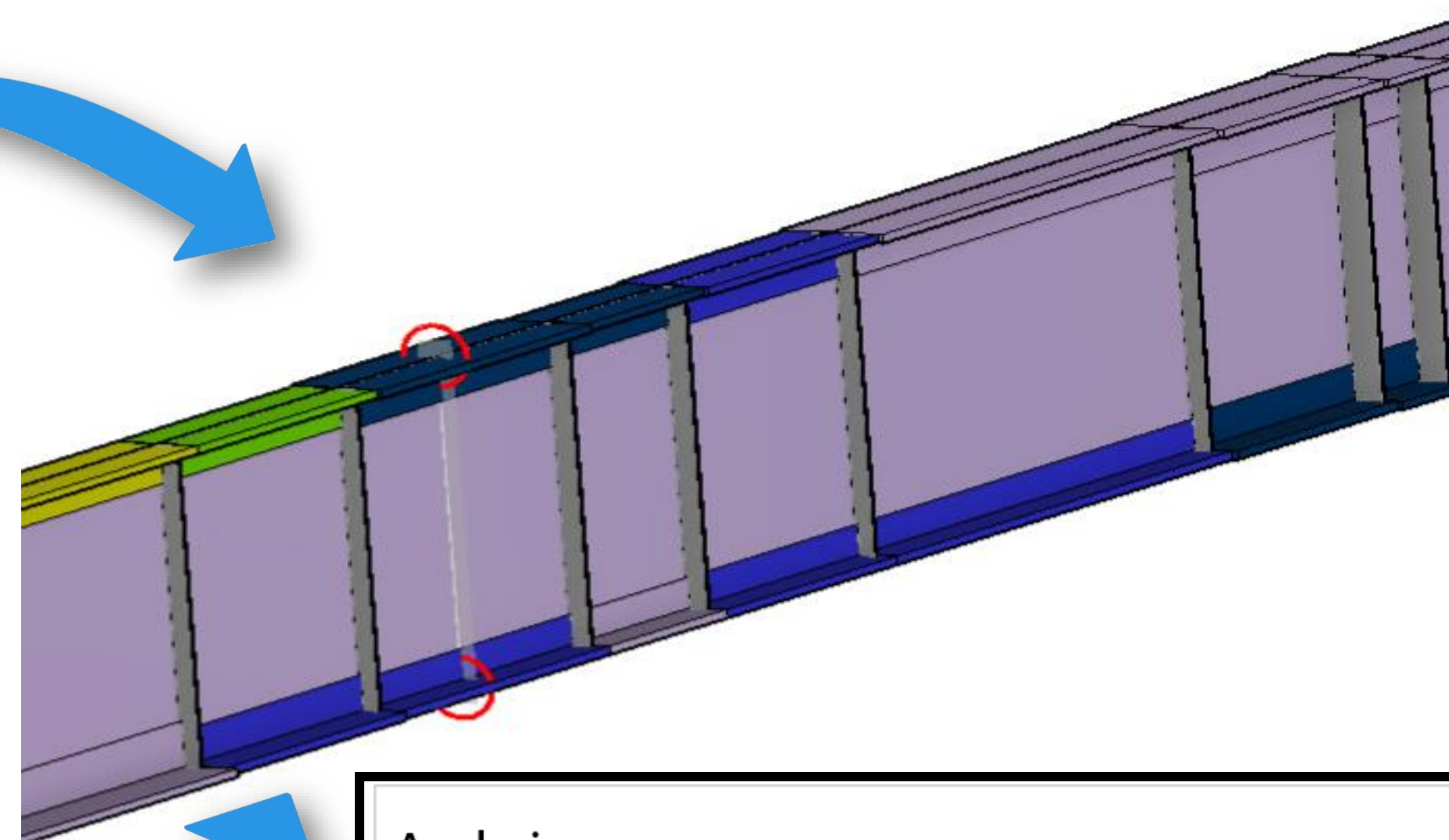


How do we use HyperX?

- Loads model + CAD → Stress analysis



Load Dependent Properties	
Axial Force (lb):	-6731.12
Shear H (lb):	-0.17859
Shear V (lb):	-5810.54
Torque (lb-in):	0.50415
Moment H (lb-in):	-79459.7
Moment V (lb-in):	-0.37509



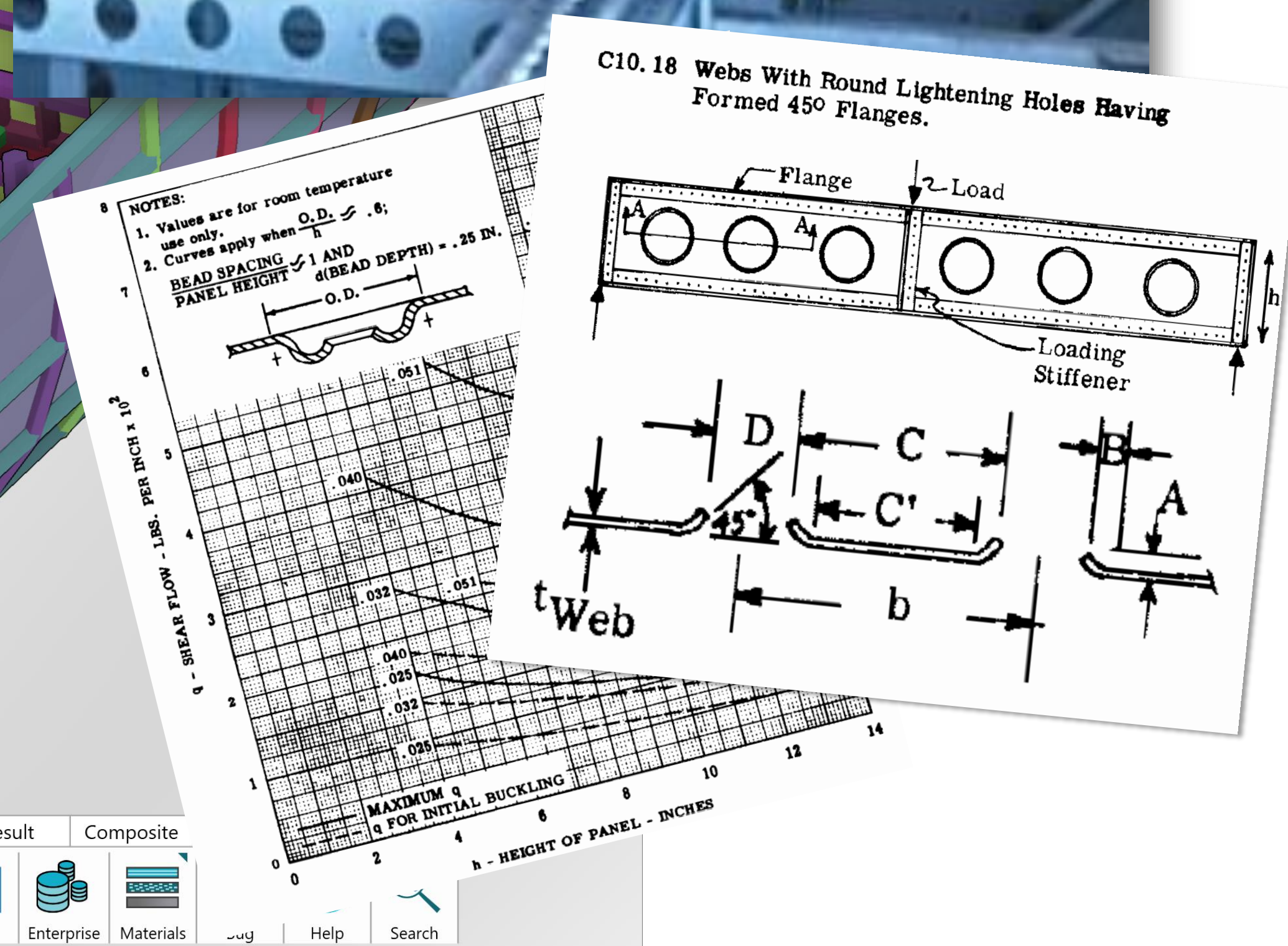
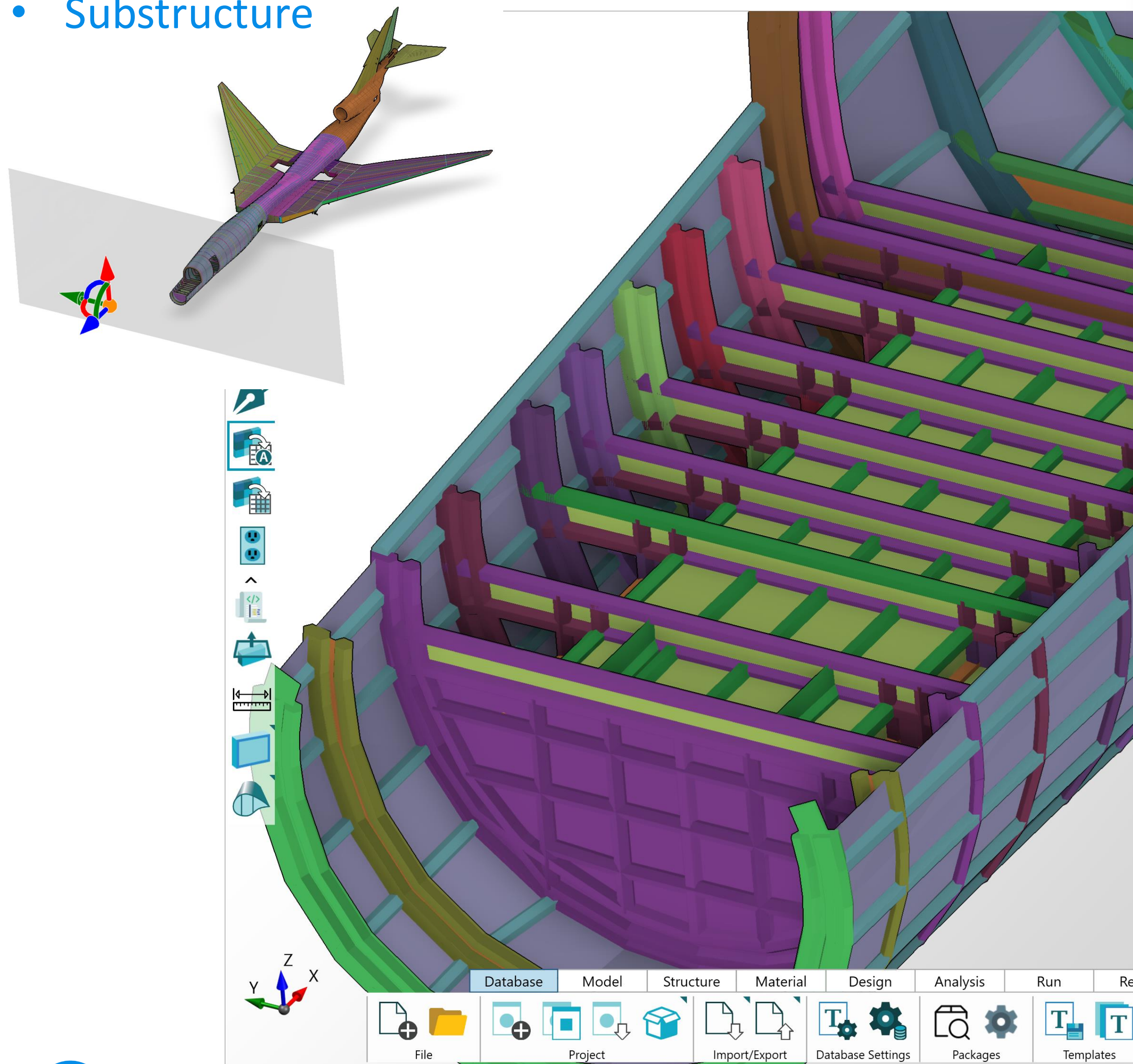
$W_{top\ flange}$	T_{web} (in)	0.095
$T_{top\ flange}$	$T_{top\ flange}$ (in)	0.26
$T_{bottom\ flange}$ (in)	H_{beam} (in)	8.45
$W_{top\ flange}$ (in)	$W_{top\ flange}$ (in)	2.6
$W_{bottom\ flange}$ (in)	$W_{bottom\ flange}$ (in)	2.64

Analysis

	22
Buckling, Beam, I1 (Ultimate)	7.86
Buckling, Beam, I2 (Ultimate)	2.67
Buckling, Beam, Imin (Ultimate)	2.67
Buckling, Beam, Flex.-Tors. (Ultimate)	2.48
Spar - Shear Web Buckling (shear only) (Ultimate)	1.51
Spar - Shear Web Buckling (bending only) (Ultimate)	0.0994
Spar - Shear Web Buckling (shear/bending interaction) (Ultimate)	0.0399
Spar - Cap Crippling (Top) (Ultimate)	0.418
Spar - Cap Crippling (Bottom) (Ultimate)	3.39
Spar - Johnson-Euler (Top) (Ultimate)	0.359
Spar - Johnson-Euler (Bottom) (Ultimate)	0.426

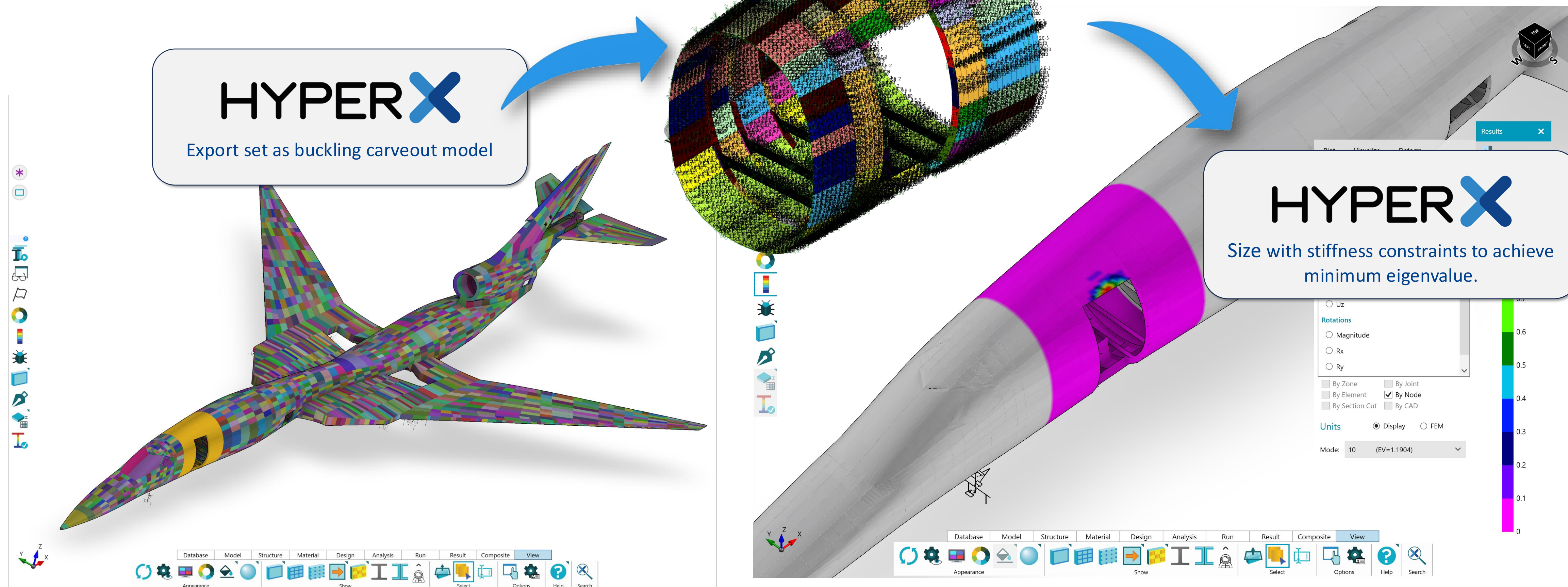
How do we use HyperX?

- Substructure



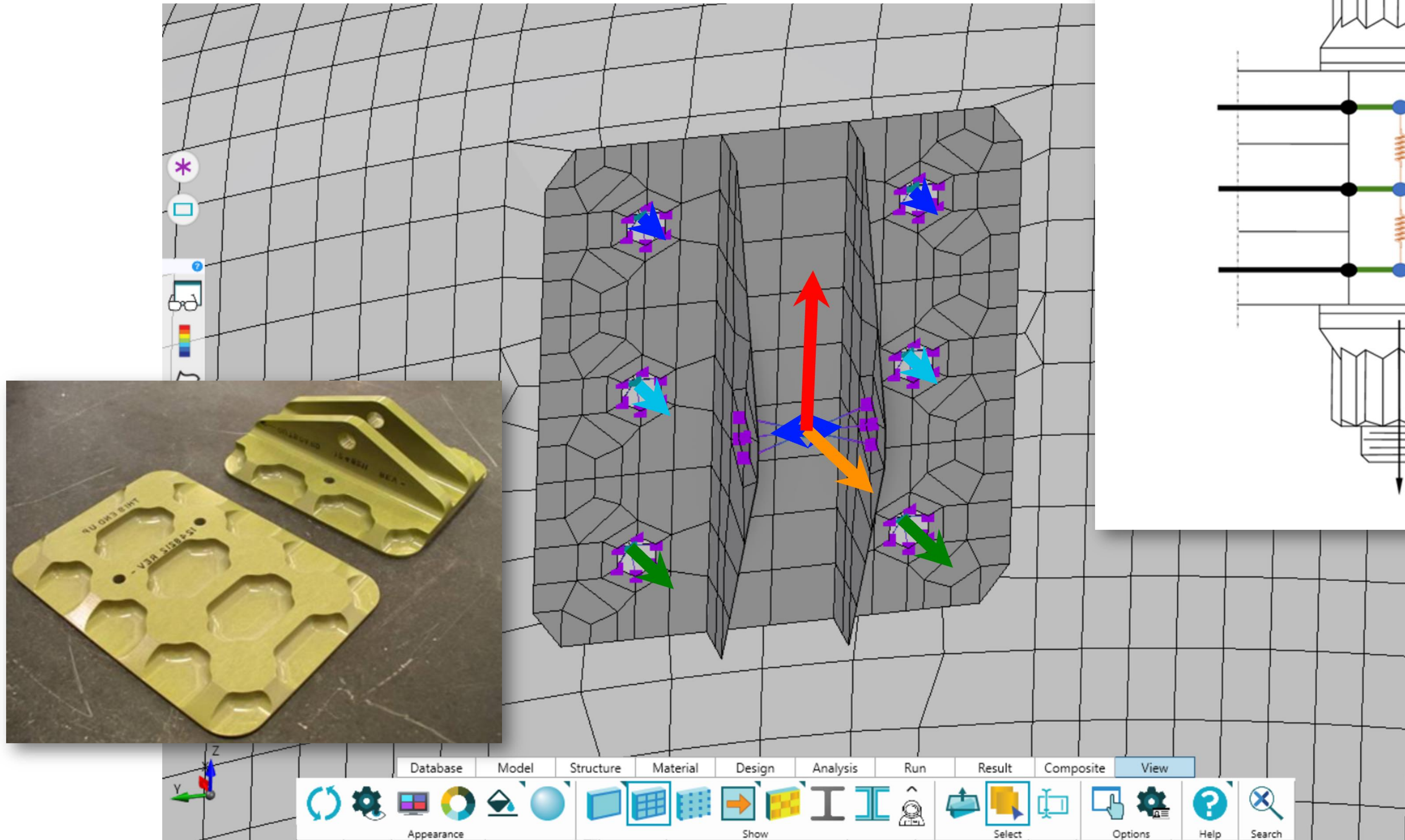
How do we use HyperX?

- Carveout buckling FEMs w/applied GPFO

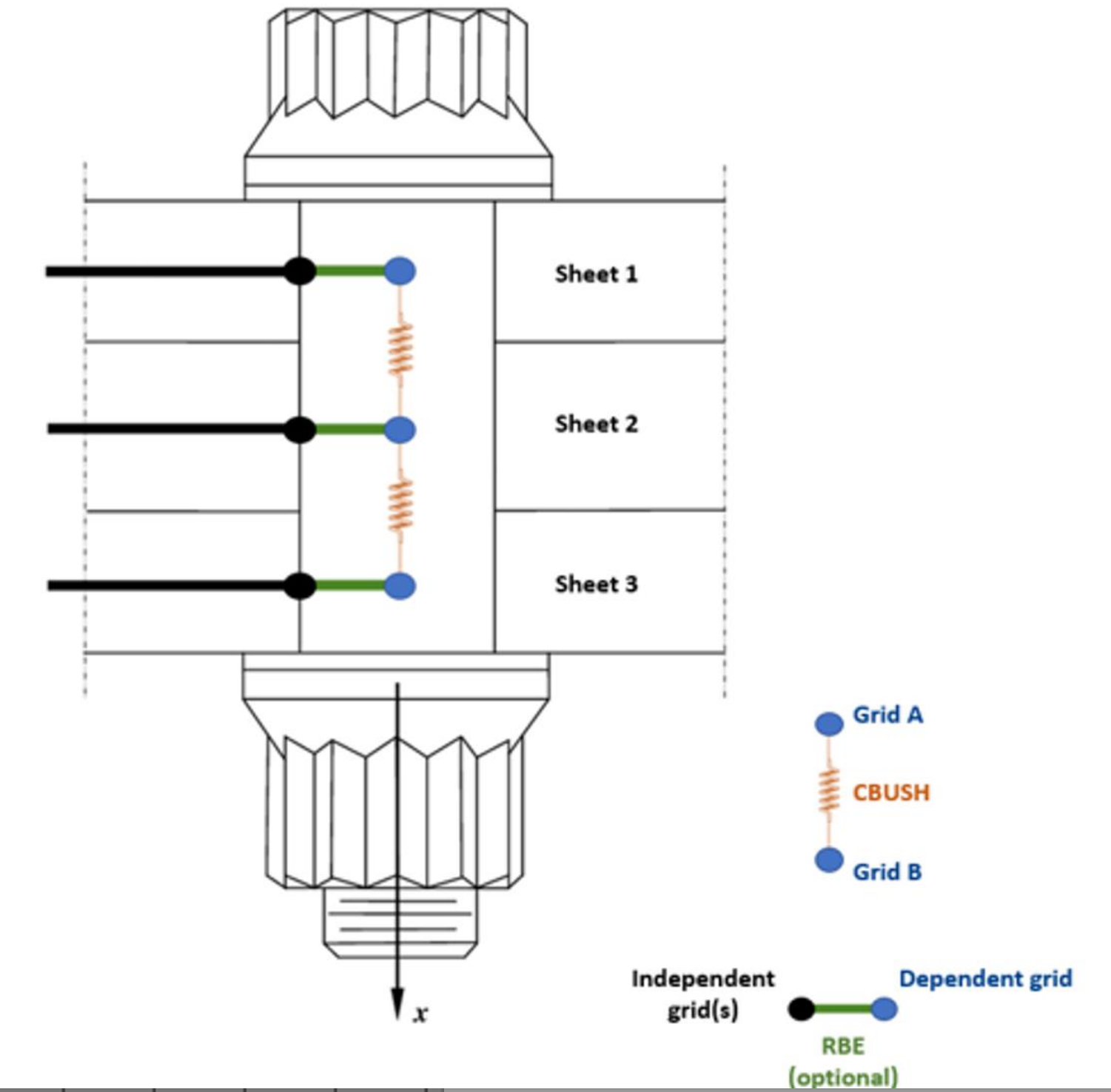


12 | How do we use HyperX?

- Spring models for fastened joints and fittings



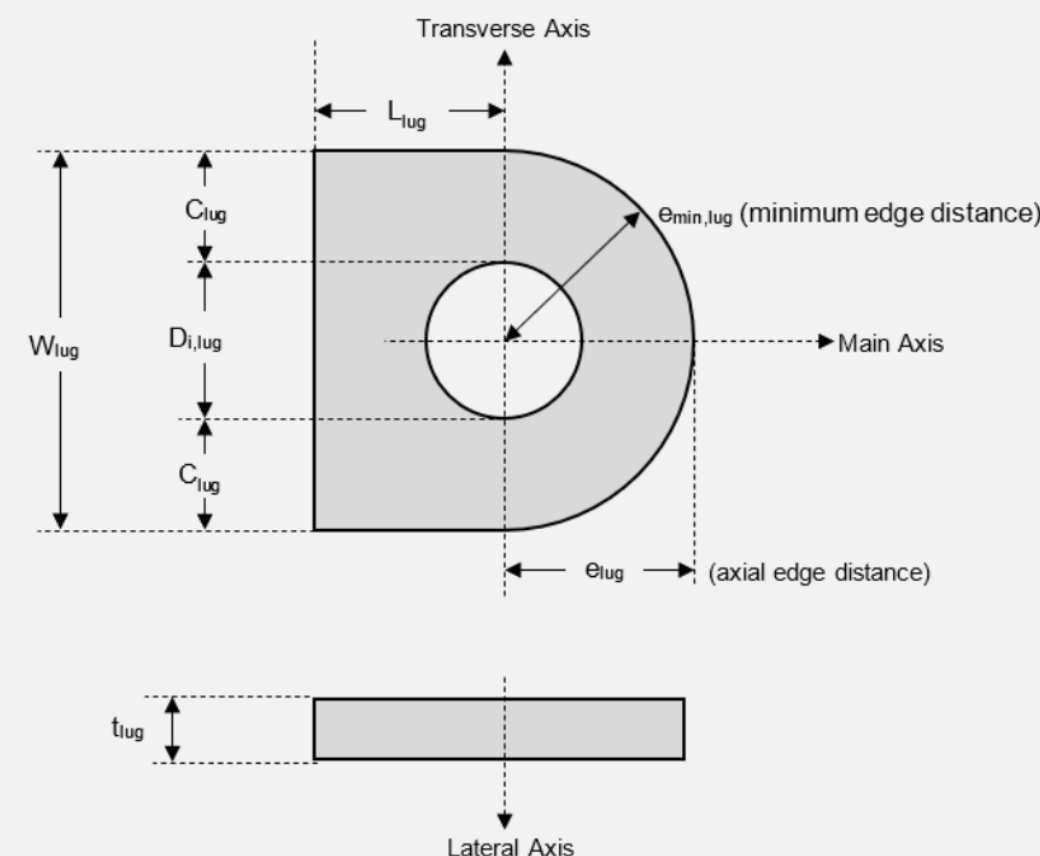
Multi-lap joints (springs in series)



Interfaces

Lug Analysis

Based on Bruhn and Niu. These analyses are performed on HyperX beam zones.



Geometry

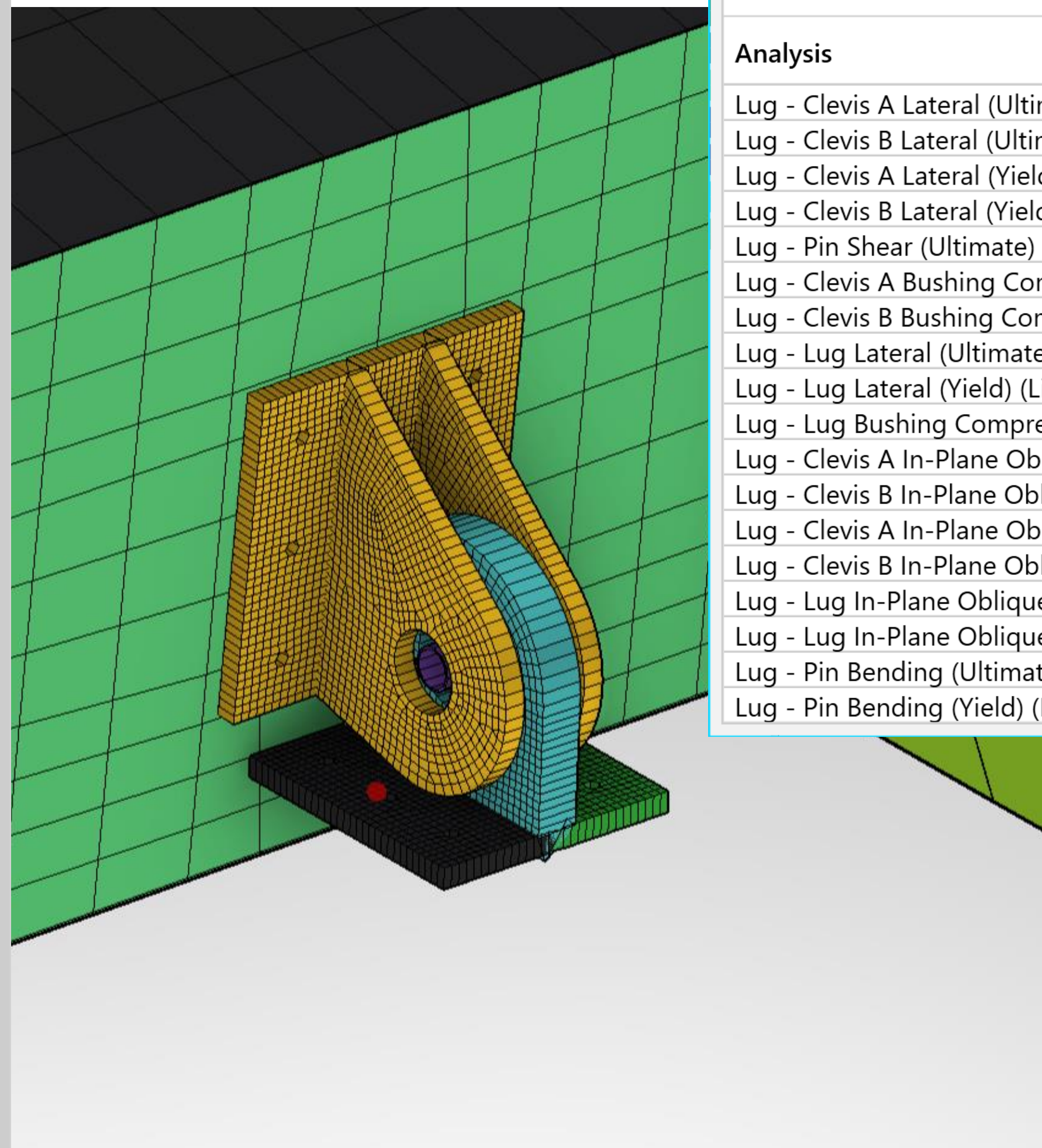
Lug geometry is defined in the analysis settings.

Materials

The lug plugin must be run on designs that use a 5 ply laminate. Each ply must be an isotropic material. The material order is:

1. Lug
2. Clevis
3. Pin
4. Lug Bushing
5. Clevis Bushing

Lug and clevis material family are defined in the analysis settings.



Analysis Watch 1



		Zones
Analysis	Object	313044
Lug - Clevis A Lateral (Ultimate) (Ultimate)	Zone	-0.482
Lug - Clevis B Lateral (Ultimate) (Ultimate)	Zone	-0.482
Lug - Clevis A Lateral (Yield) (Limit)	Zone	-0.367
Lug - Clevis B Lateral (Yield) (Limit)	Zone	-0.367
Lug - Pin Shear (Ultimate) (Ultimate)	Zone	-0.01
Lug - Clevis A Bushing Compressive (Yield) (Limit)	Zone	0.151
Lug - Clevis B Bushing Compressive (Yield) (Limit)	Zone	0.151
Lug - Lug Lateral (Ultimate) (Ultimate)	Zone	0.297
Lug - Lug Lateral (Yield) (Limit)	Zone	0.682
Lug - Lug Bushing Compressive (Yield) (Limit)	Zone	1.75
Lug - Clevis A In-Plane Oblique (Ultimate) (Ultimate)	Zone	2.54
Lug - Clevis B In-Plane Oblique (Ultimate) (Ultimate)	Zone	2.54
Lug - Clevis A In-Plane Oblique (Yield) (Limit)	Zone	2.9
Lug - Clevis B In-Plane Oblique (Yield) (Limit)	Zone	2.9
Lug - Lug In-Plane Oblique (Ultimate) (Ultimate)	Zone	4.74
Lug - Lug In-Plane Oblique (Yield) (Limit)	Zone	6.45
Lug - Pin Bending (Ultimate) (Ultimate)	Zone	66.6
Lug - Pin Bending (Yield) (Limit)	Zone	94.3

How do we use HyperX?

- Fatigue analysis

Fatigue Failure Mode

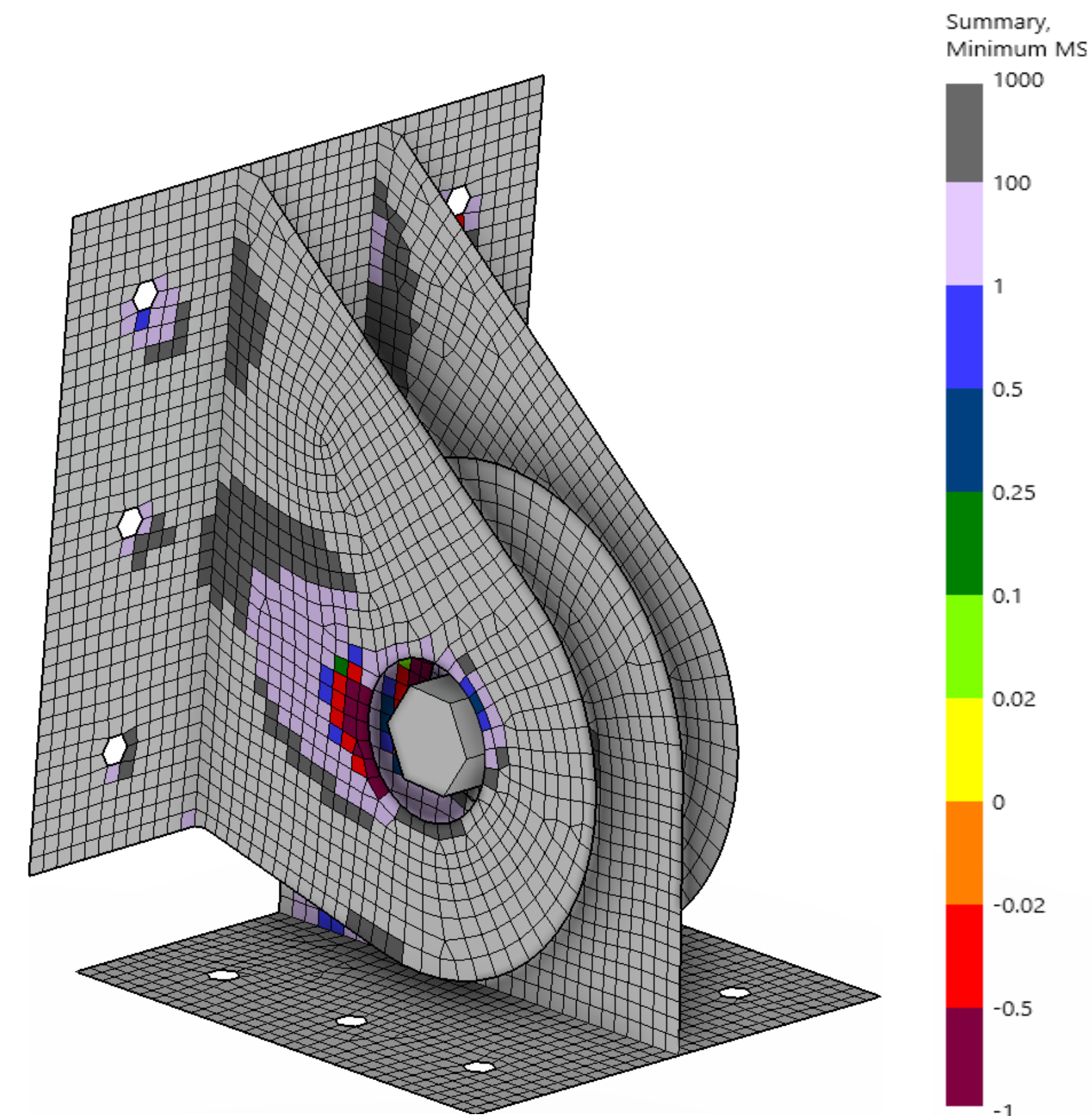
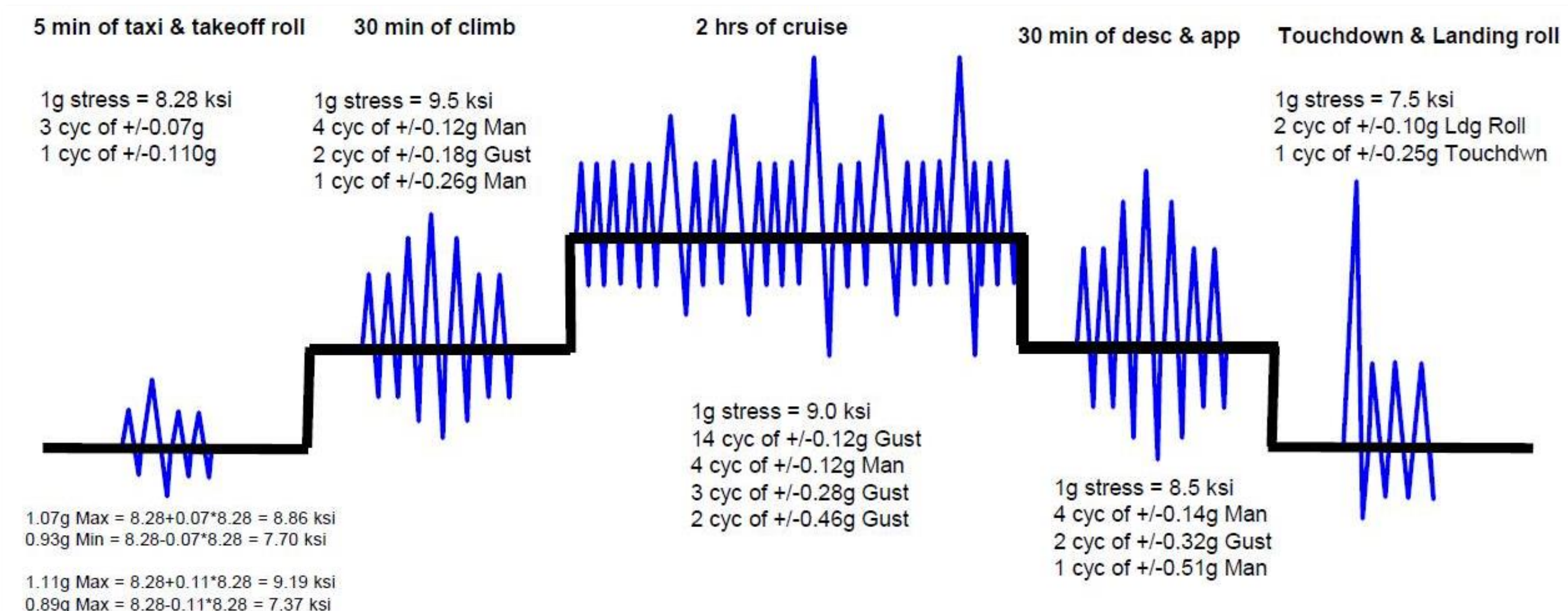
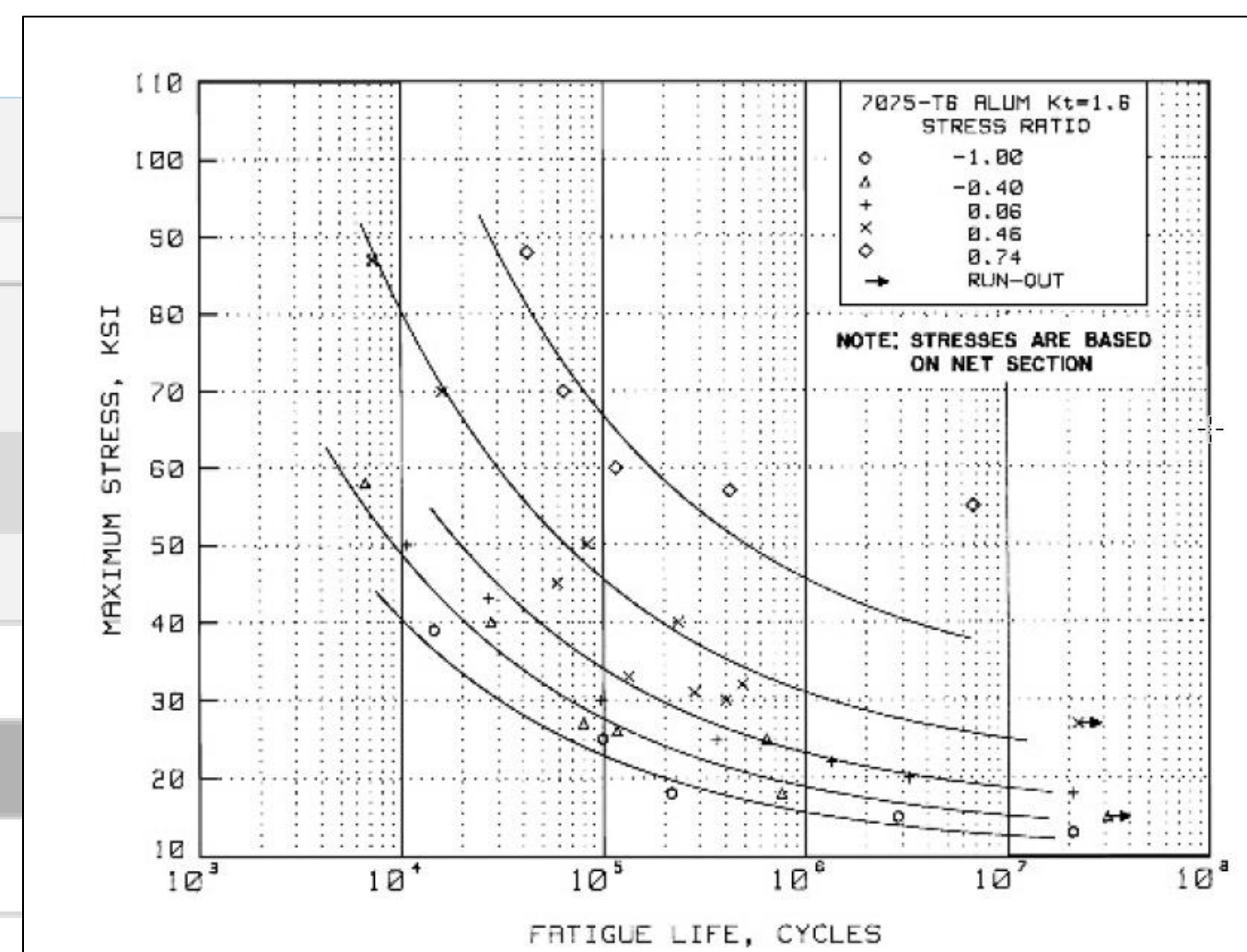
Stress Life Fatigue

Criteria

Filter... Category Any

☒ Select all

Enabled	Criterion	Required MS	Limit/Ulimate
> ☒	Damage	0	Limit
> ☒	Soderberg	0	Limit
> ☐	R Ratio	0	Limit



- Part-based stress reports and data packets

Create Project Bundle

Archive

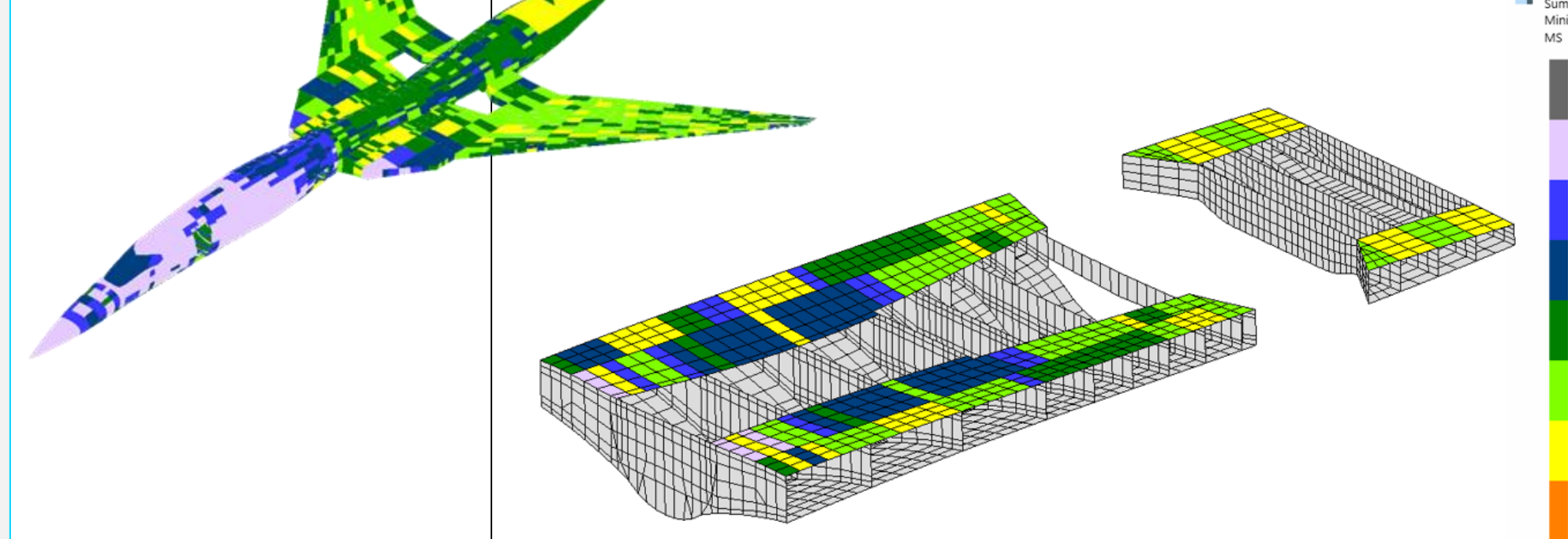
- ☒ Database
- ☒ FEM Input Files
 - ☒ FEM Output Files
- ☒ Working Folder
 - ☒ Include Load Files
- ☒ Include Plugin Packages
- ☒ Include Packages

Options

- ☒ Remove all other projects from database
 - ☐ Delete Unused Properties and Materials
- ☒ Map FEM files to relative paths

Additional Files

Analysis Description



Summary

The critical margin for the upper wing box skins is Crippling, Composite, MIL-HDBK-17. The controlling case at this zone is 110005: C45PTFA_SMP.
The total wing box upper skin weight is 267.5 lbm.

Crippling, Composite, MIL-HDBK-17

Crippling HME

Zone Name	PCOMP 3193040: Component 3193040 (19)
Zone ID	3001312
Object	Bonded_J
Controlling Design Case	110005
Temperature	72.0
Load Property	Peak Load
Material Designation	IM7/TC380 PW
Margin of Safety	0.00046

Detailed inputs

Loads

Cross sectional applied load ($P_{app,sum}$)

Dimensions

	segment# 1	2	3	4
width of individual span segment (b)	4.000	3.000	0.926	N/A
thickness of individual span segment (t)	0.037	0.074	0.037	N/A

$$F_{cu} = (MS_{strength} + 1)\sigma_{x,applied} \quad E_{xc} = \frac{1}{A_{11}^{-1}t} \quad E_{fx} = \frac{12}{D_{11}^{-1}t^3} \quad X_G = \left(\frac{b}{t}\right)\left(\frac{E_{fx}}{E_{xc}}\right)\sqrt{\frac{F_{cu}}{(E_{xc}E_{yc})^{1/2}}}$$

One Free Edge

$$Y_G = 0.5774(X_G^{-0.7908})$$

No Edge Free

$$Y_G = 0.9870(X_G^{-0.8484}) \quad F_{ccn} = Y_G F_{cu} \left(\frac{E_{fx}}{E_{xc}}\right), F_{ccn} \leq F_{cu}$$

Allowables

	segment# 1	2	3	4
Design crushing or crippling stress of individual span segment (F_{ccn})	4401	14014	16847	N/A

$$F_{cc} = \frac{\sum b_n t_n F_{ccn}}{\sum b_n t_n} \quad P_{cc} = F_{cc} A$$

Cross sectional crippling load (P) lb

Margin of Safety

$MS = \frac{P_{cc}}{P} - 1$		0.00046	
Zone ID:	3001312	Load:	Not Found
Material:	IM7/TC380 PW	Temp (F):	Cannot determine
Object:	Bonded_J		

Report Title: Collier Stress Report

Author: Engineer 1

Approver: Approver 1

Database Name: Database.hdb3

Part Number: #100

Revision Date: 6/16/2025

Revision Time: 2:30:00 PM

Page: 49

Report Title: Collier Stress Report

Author: Engineer 1

Approver: Approver 1

Database Name: Database.hdb3

Part Number: #100

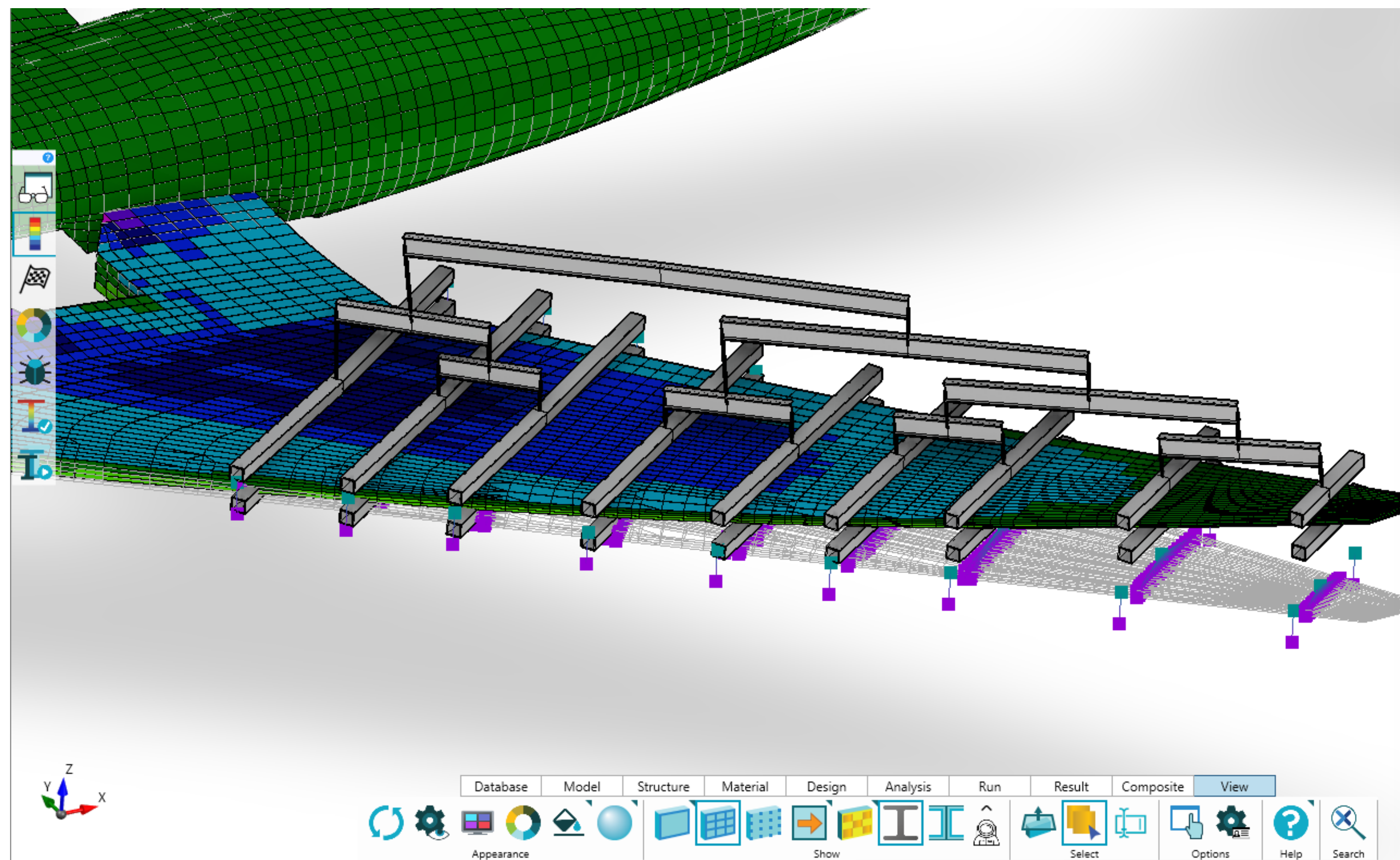
Revision Date: 6/16/2025

Revision Time: 2:30:00 PM

Page: 50

How do we use HyperX?

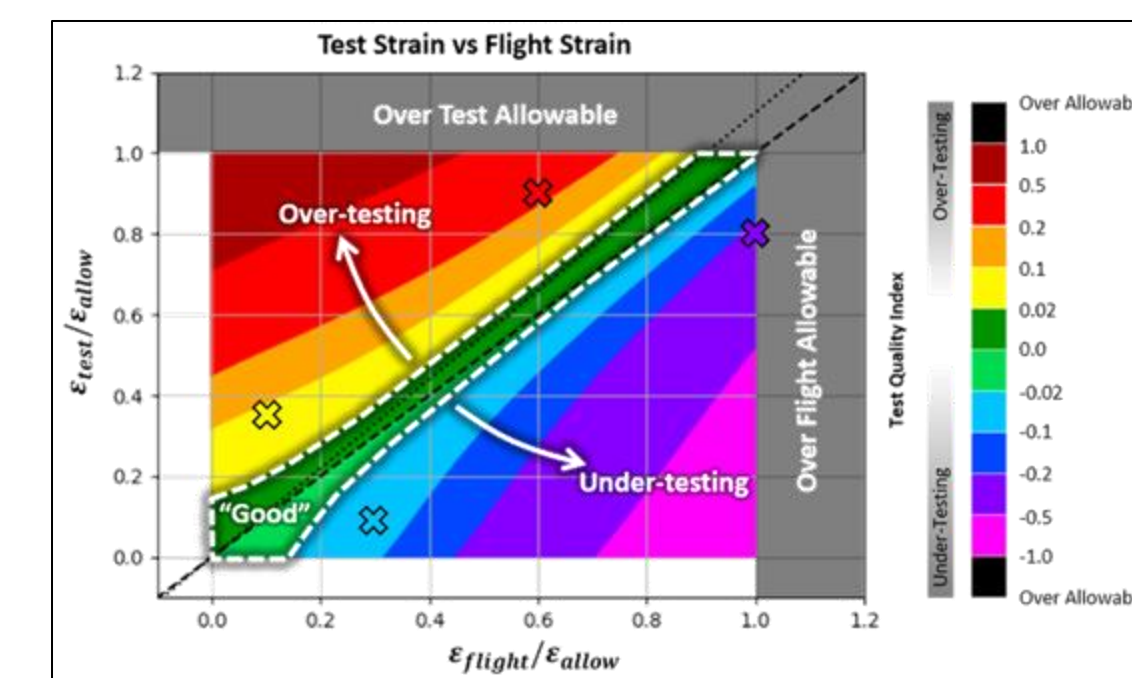
- Structural test planning and support



Collier Aerospace – Testing Assumptions
2024-10-04



TEST PLAN



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How do we use HyperX?

- Loads Processing, Enveloping, & Visualization

Node ID: 42564, Subcase
117, Mode #562, EV: 4.074

Node ID: 3106, Subcase
117, Mode #649, EV: 4.686

Node ID: 420, Subcase
117, Mode #613, EV: 4.443

Node ID: 5848, Subcase
117, Mode #171, EV: 1.549

Node ID: 10002, Subcase
117, Mode #20, EV: 4.025

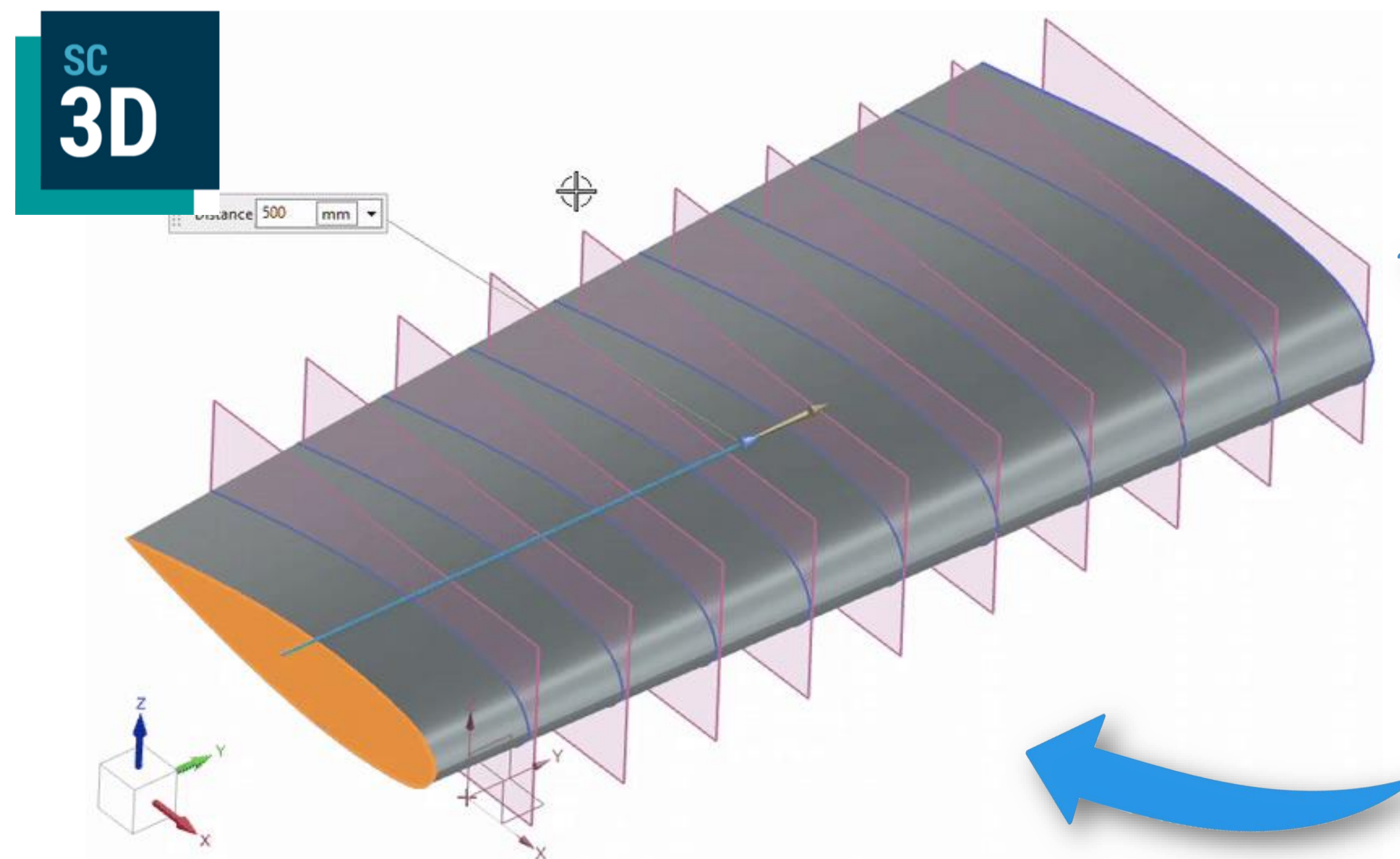
Node ID: 2594, Subcase
117, Mode #248, EV: 2.052

Node ID: 42360, Subcase
117, Mode #7, EV: 2.156

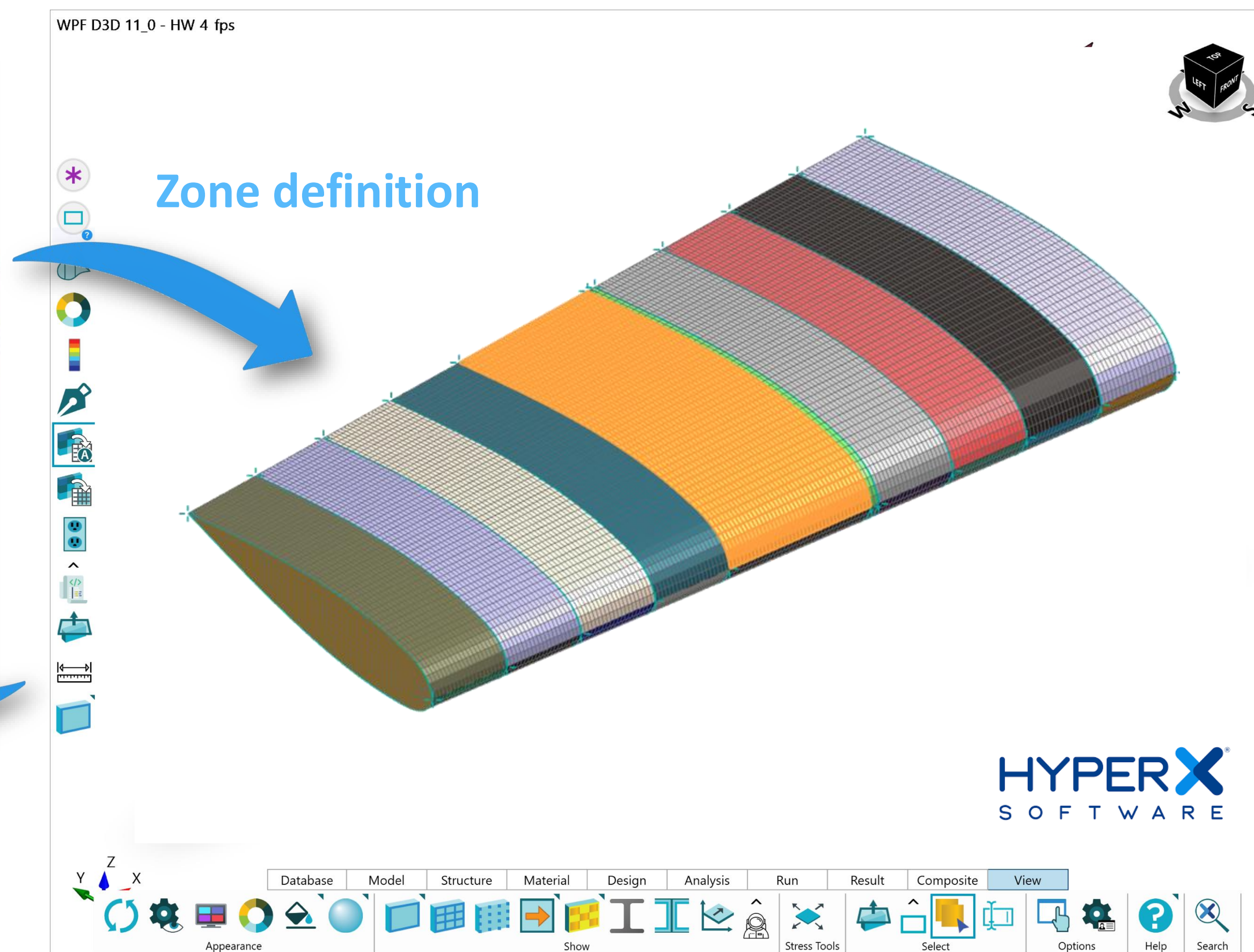
Node ID: 5488, Subcase
117, Mode #102, EV: 1.040

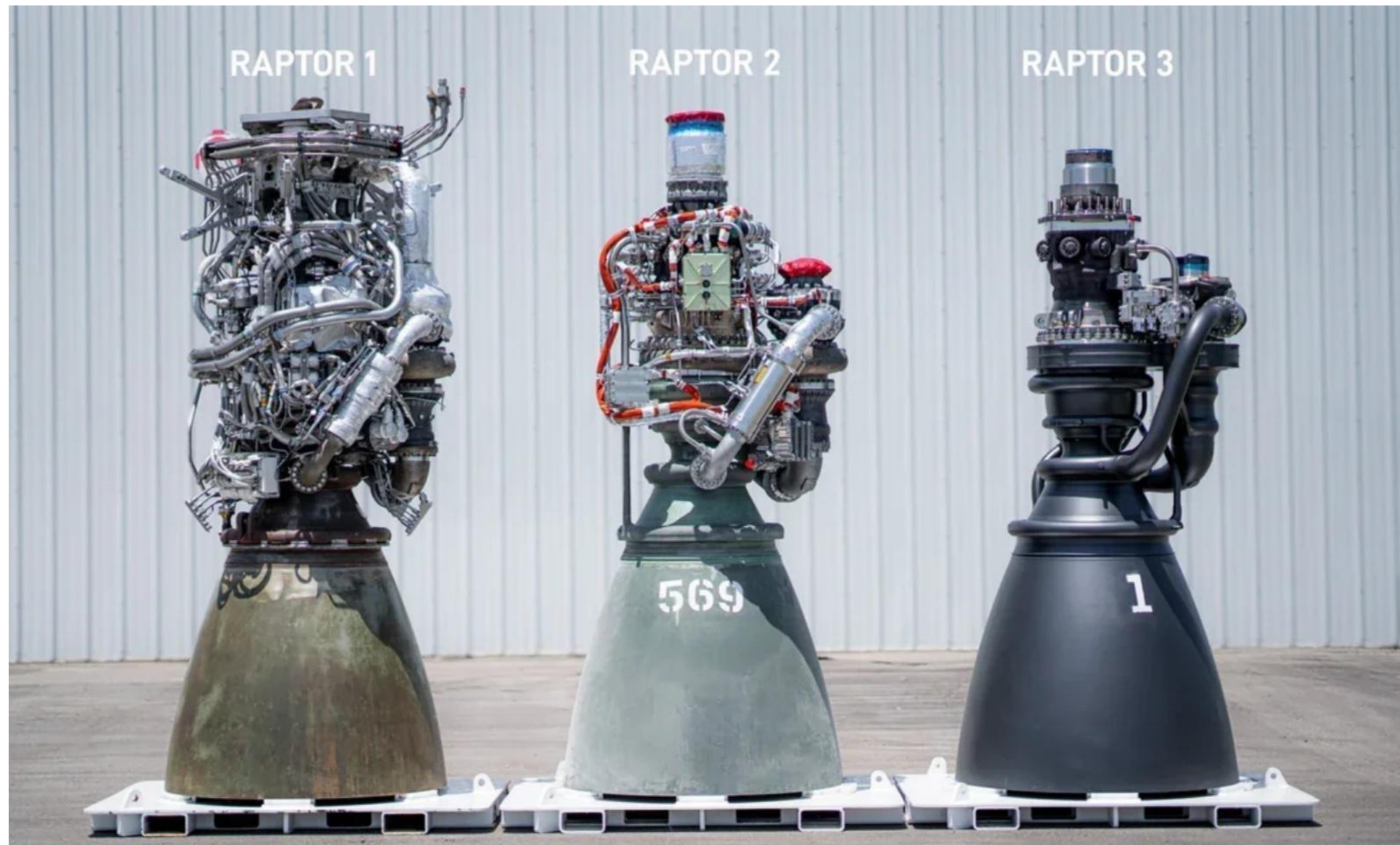
How do we use HyperX?

- Automate customer-specific workflows using software APIs



Sizing updates,
linked to CAD entities





Engineer (prototype)
Just get me the answer!

Methods and automations
Plugin + automation tool

Software dev.
robust software feature

Collaboration with our Software & Support Teams



Customer

"I'd like some help..."

- Setting up studies
- Running these trades
- Detailed sizing & stress analysis
- Generating stress notes
- Etc."

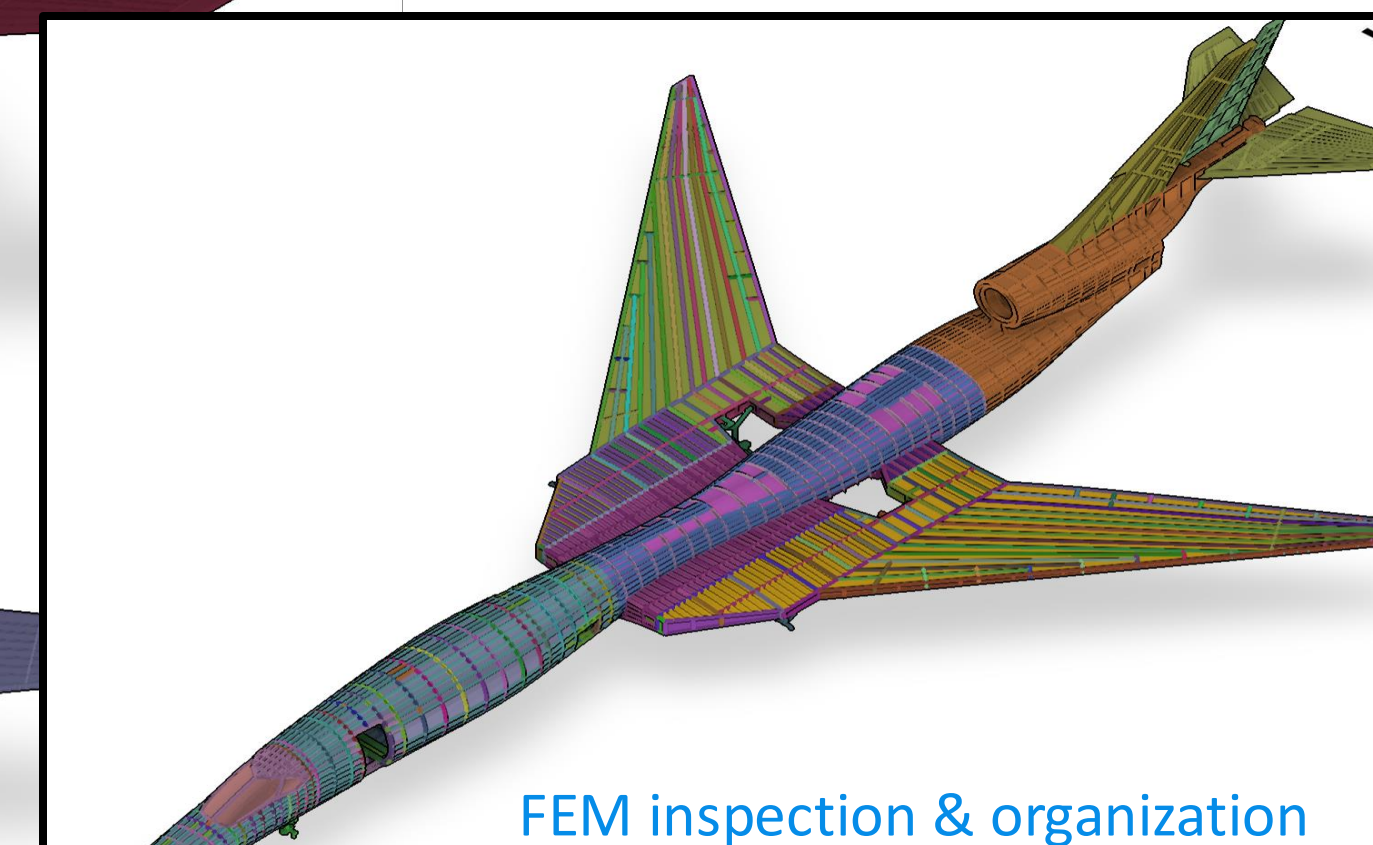
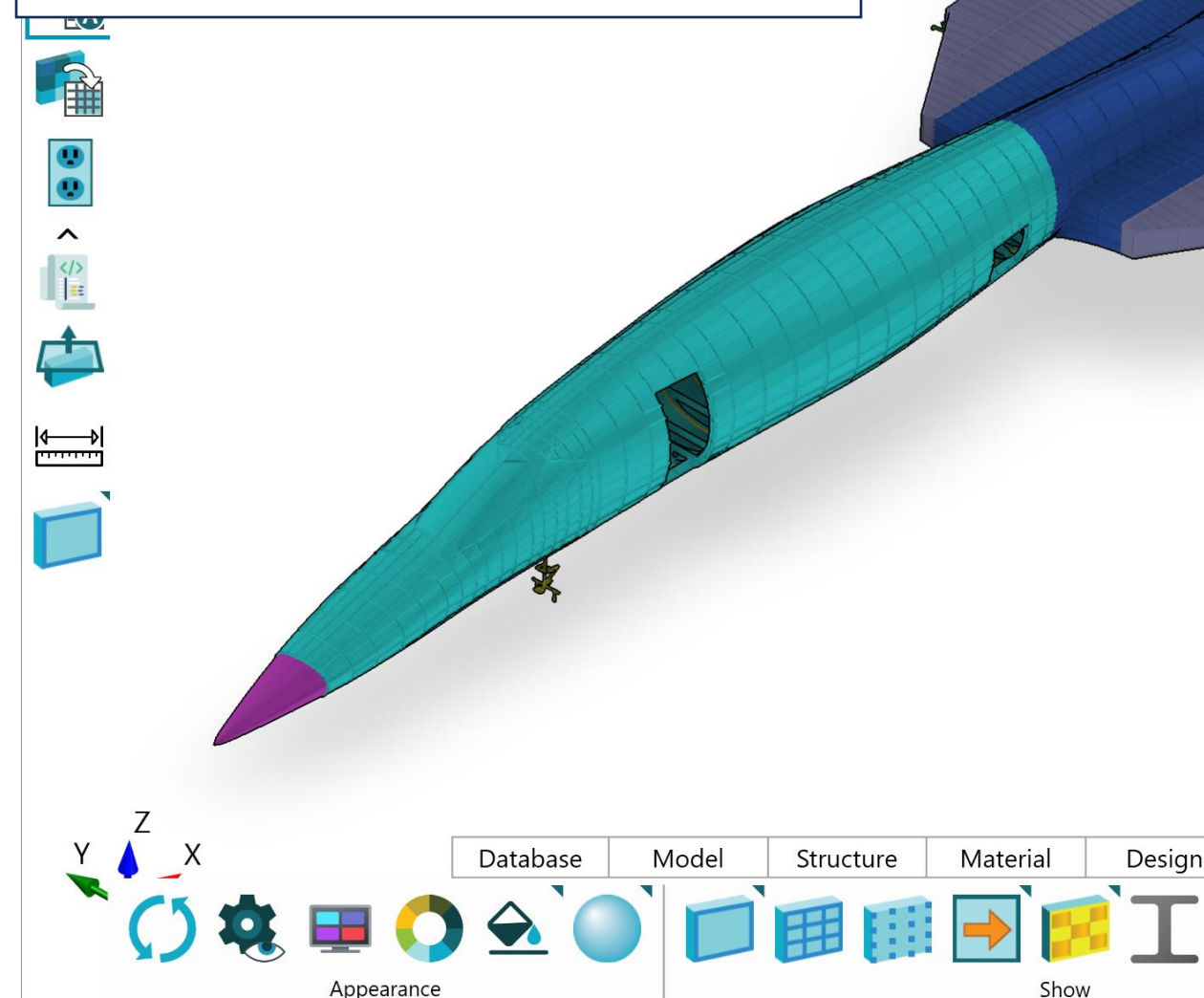
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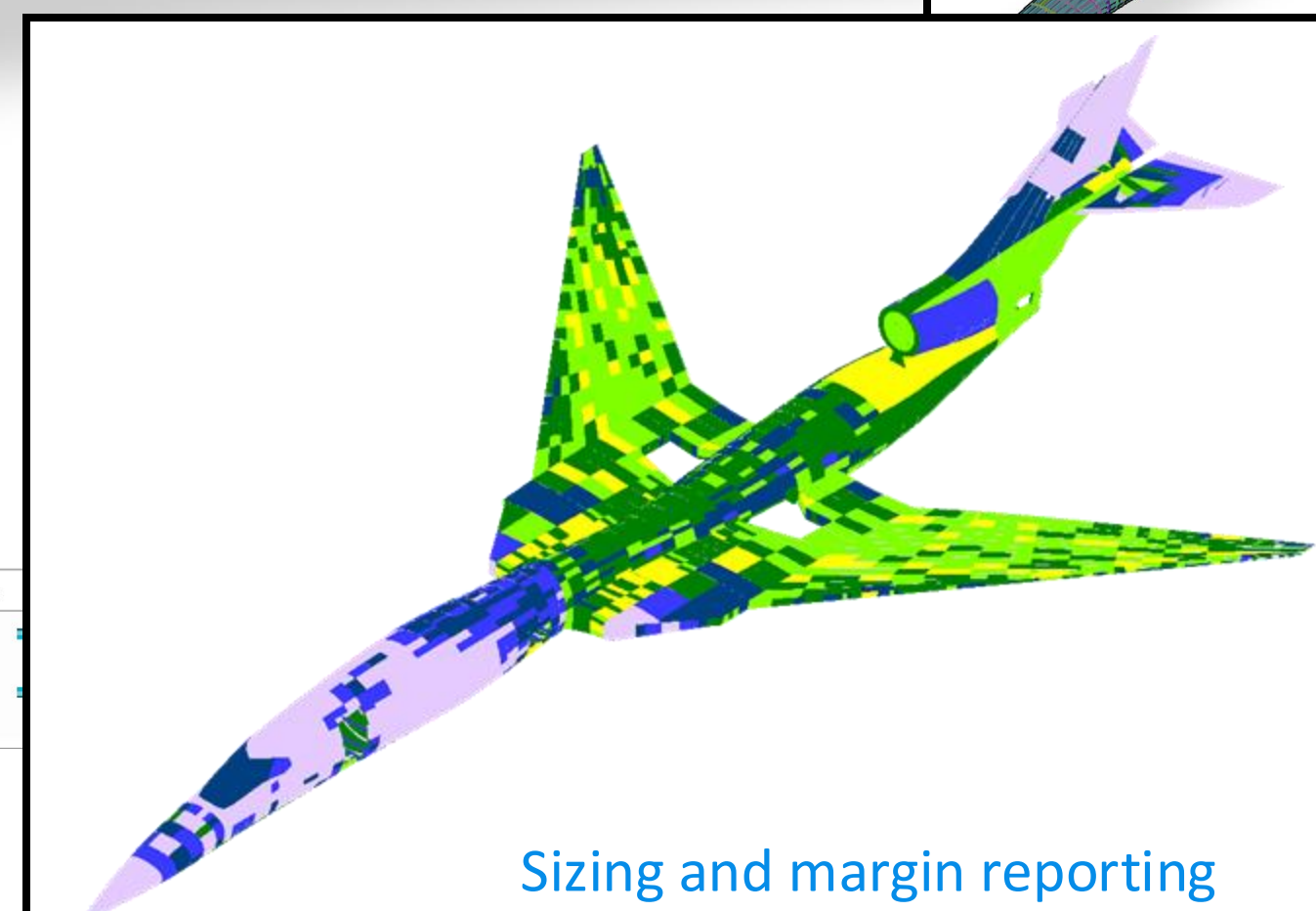
Customer engineers



Collier engineers



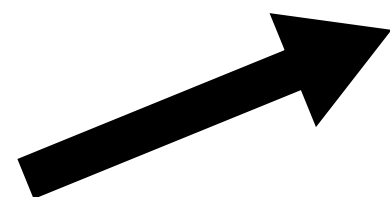
FEM inspection & organization



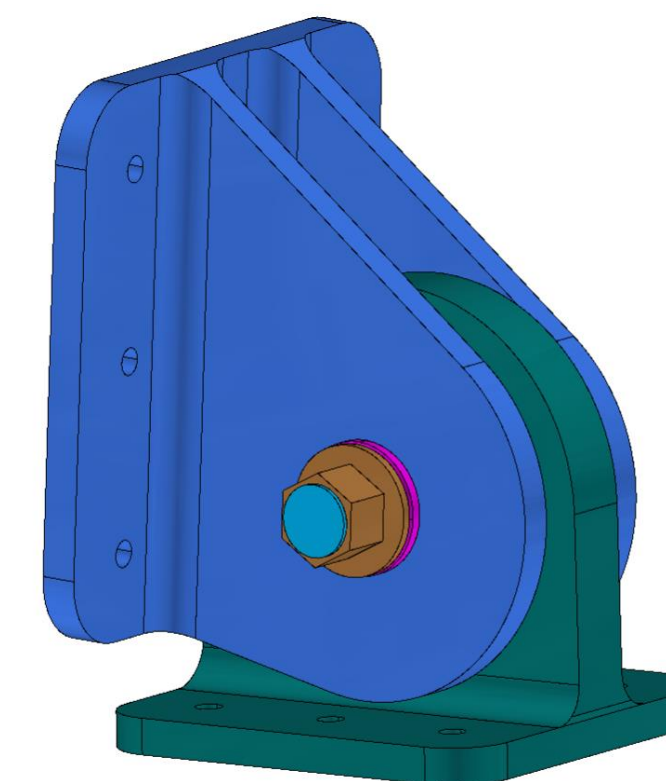
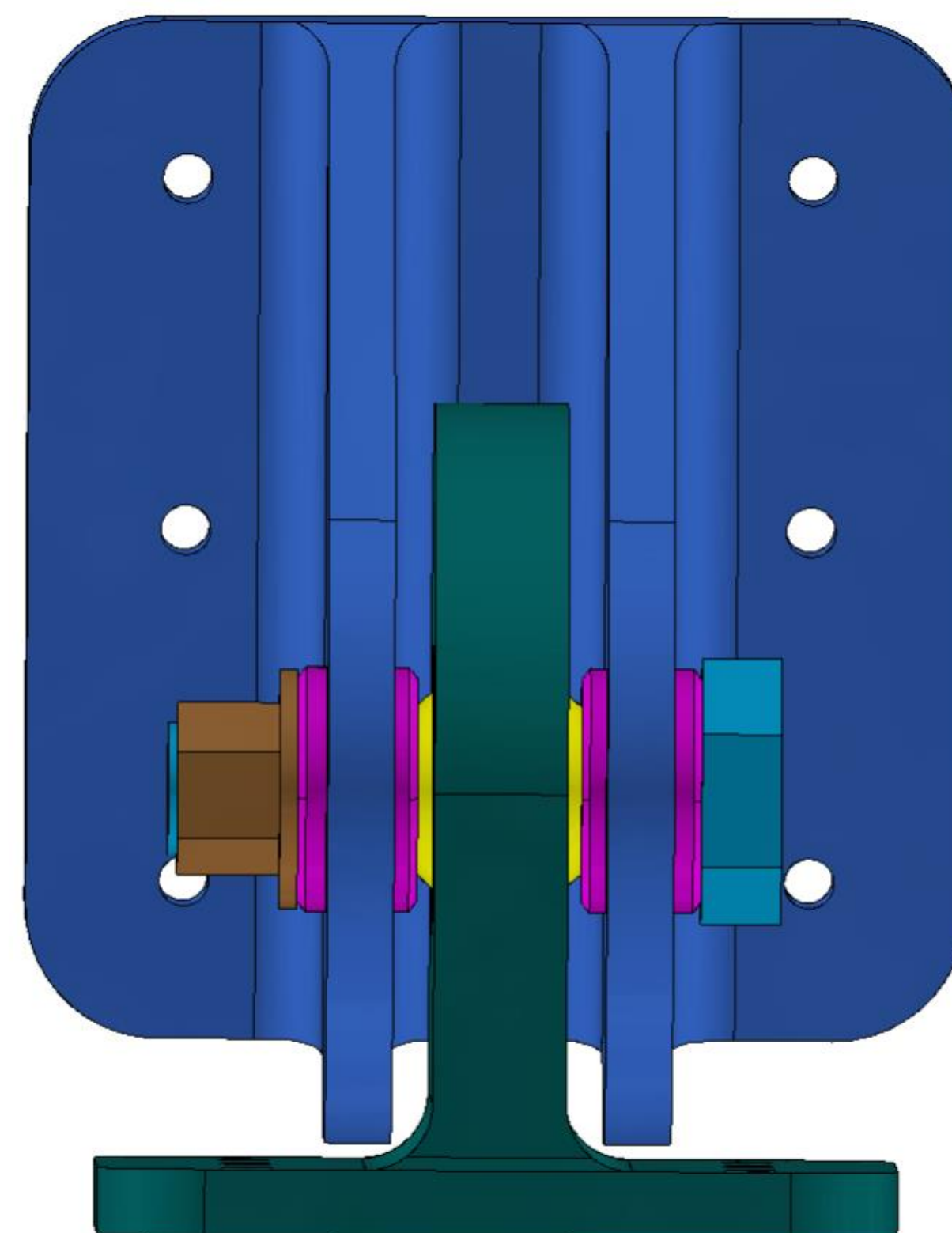
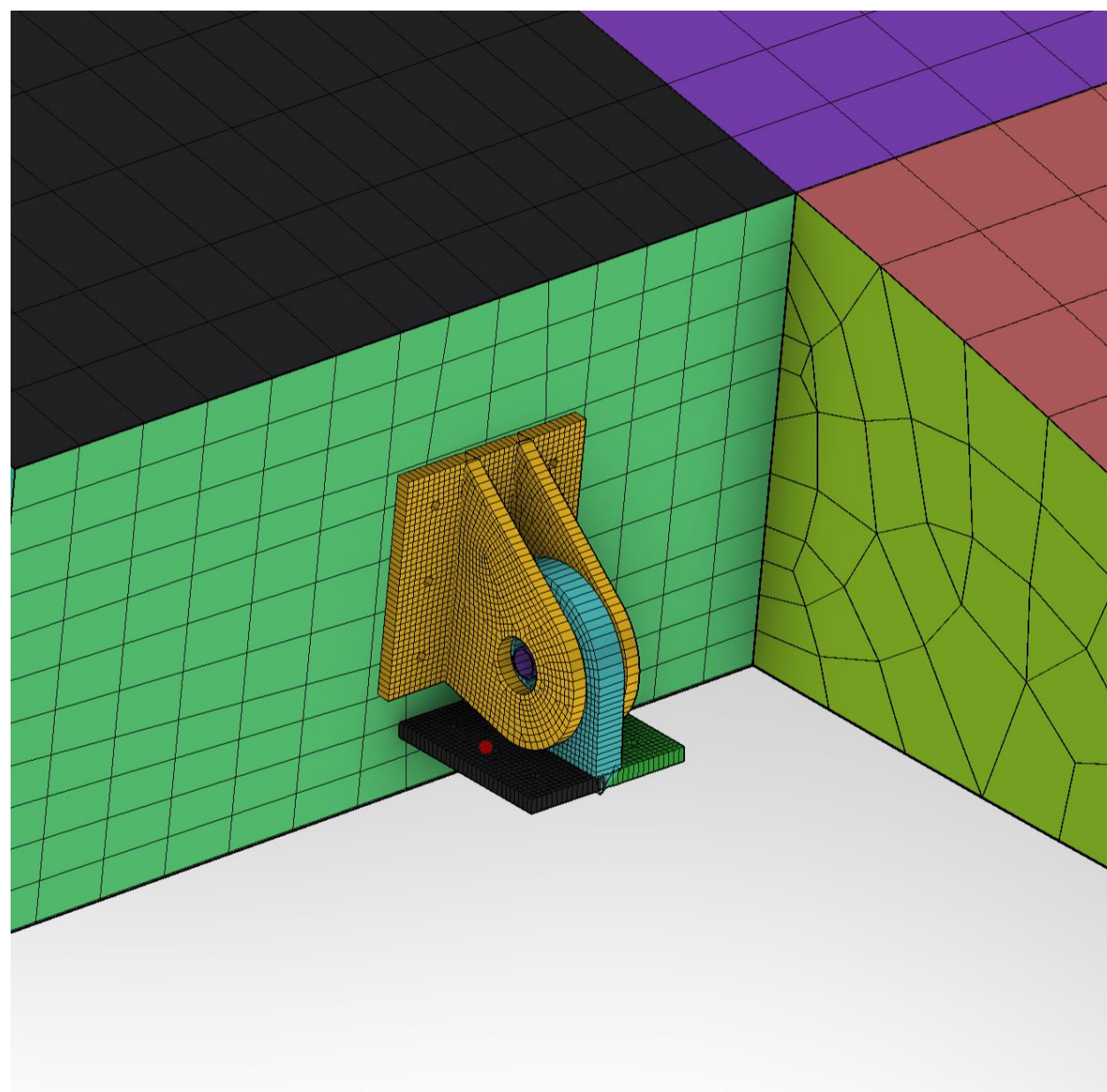
Sizing and margin reporting

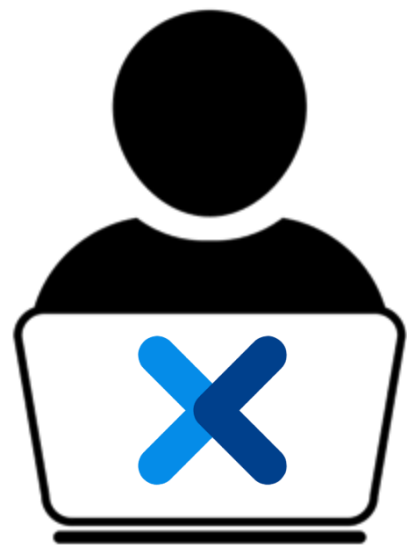


Can we analyze this feature with HyperX ?

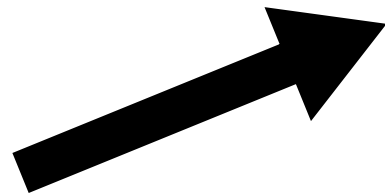


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Can we analyze this feature with HyperX ?



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Methods research and prototyping analysis criteria and process.

Lug Net Tension Efficiency Factor 'K_t' lookup curve:

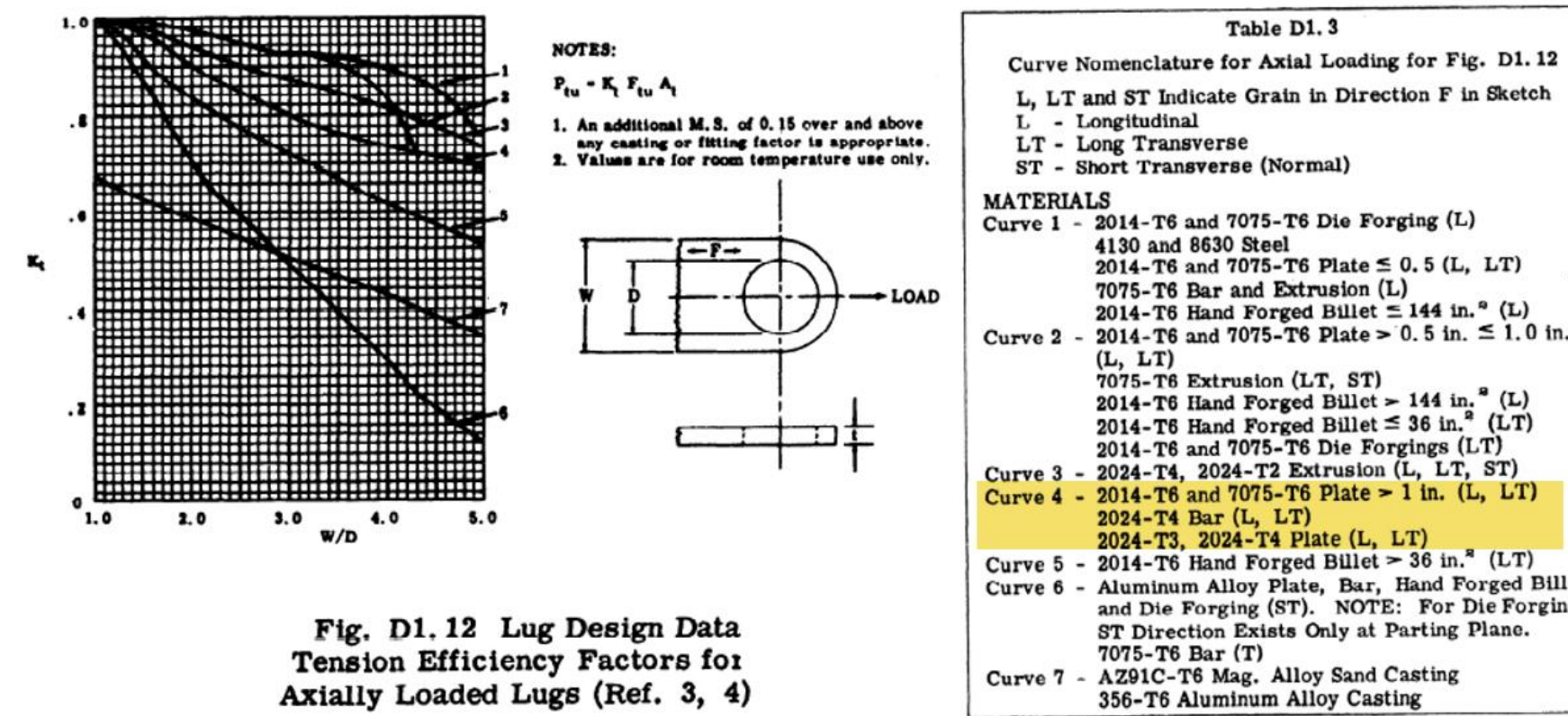


Fig. D1.12 Lug Design Data
Tension Efficiency Factors for
Axially Loaded Lugs (Ref. 3, 4)

Figure 7-3 – Lug Net Tension Efficiency factor [Bruhn]

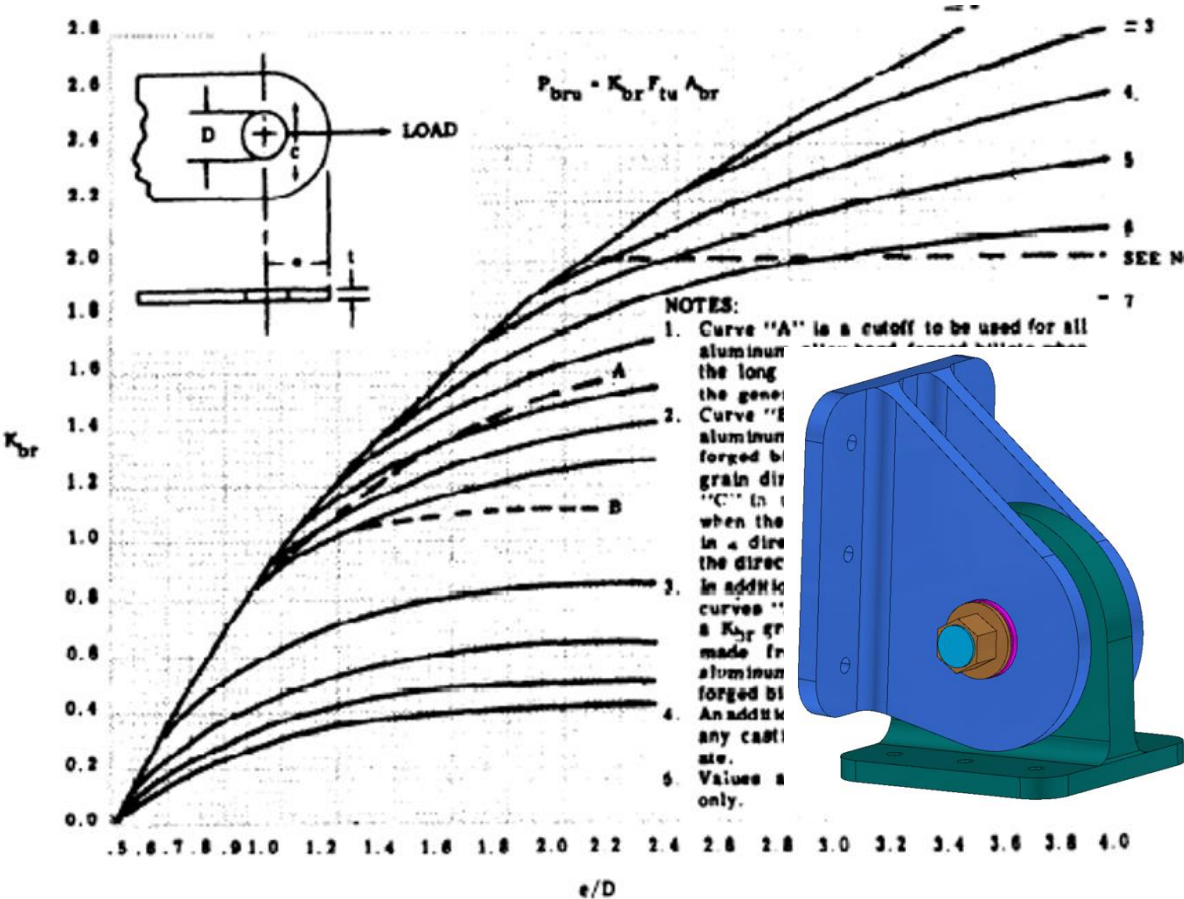
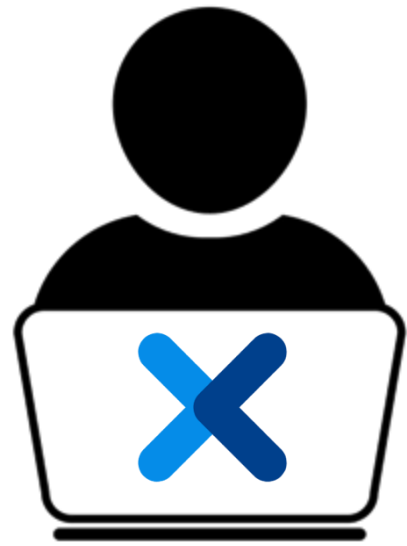


Fig. D1.13 Lug Design Data
Shear-Bearing Efficiency Factors for
Axially Loaded Lugs (Ref. 3, 4)

A	B	C	D	E	F	G
1	Lug and Clevis Plug In					
2	Lug Oblique Stre					
3						
4						
5	Methodology				Lug In-Plane C	
6	Associated HME				HyperX_HME	
7						
8	Zone Name				LH Lug Fitting	
9	Zone ID				7	
10	Controlling Design Case				User Load (S)	
11	Temperature				86 deg F	
12	Material Designation				7050, T7451, P	
13	Margin of Safety				2.	
14						
15	Detailed inputs					
16	Loads					
17	Axial Load (P_{axial})				1377.	
18	Transverse Load ($P_{transverse}$)				8627.	
19						
20	Axial Load (P_a)				40299.	
21	Transverse Load (P_t)				33033.	
22						
23	Variables					
24	Yield Factor (C)				1.1.	
25	Joint Fitting Factor (JF)				1.1.	
26	Net Tension Efficiency Factor (K_t)				0.87963	
27	Shear-Bearing Efficiency Factor (K_{br})				0.86607	
28	Transverse Efficiency Factor (K_{tr})				0.78.	
29						
30	Dimensions					
31	A_t				0.77.	
32	A_{br}				0.65.	
33	Oblique Angle (θ)					
34						
35	Allowables					
36	Tensile Strength (F_{ty})				64631.	
37						
38	Margin of Safety					
39	Yield				2.73913908	
40						

Temperature		100 deg F	
Material Designation		7050, T7451, Plate, Thickness: 3.001	
Margin of Safety		1.257007003	
Detailed inputs			
Loads			
Axial Load (P _{axial})	1377.6 lb/in		
Transverse Load (P _{transverse})	8627.5 lb/in		
Axial Load (P _a)	41394.3 lb/in		
Transverse Load (P _t)	29777.6 lb/in		
Variables			
Yield Factor (C)	1.1		
Joint Fitting Factor (JF)	1.15		
Net Tension Efficiency Factor (K _t)	0.87963		
Shear-Bearing Efficiency Factor (K _{br})	0.86607		
Transverse Efficiency Factor (K _{tr})	0.62302		
Dimensions			
A _t	0.7755 in^2		
A _{br}	0.6545 in^2		
Oblique Angle (θ)	deg		
Allowables			
Tensile Strength (F _{tu})	73025.7 lb/in		
Margin of Safety			
Ultimate	1.257007003		

Material Margin	
Margin	
Detailed Derive	
Axial Load (P_{axial})	1377.6 lb/in
Transverse Load ($P_{transverse}$)	8627.5 lb/in
Moment (M)	1450.31 lb/in - in
σ_a	963.354 psi
σ_b	11064 psi
σ_{tr}	23111.9 psi
Variables	
Joint Fitting Factor (JF)	1.15
Equations	
$M = P_{lat} L$	
$\sigma_b = \frac{6M}{W t^2}$	
$\sigma_a = \frac{P_a}{W t}$	
$\sigma_{tr} = \frac{6P_{tr} L}{t W^2}$	
$\sigma_t = \sigma_a + \sigma_b + \sigma_{tr}$	
$MS_{yield} = \frac{F_{ty}}{\sigma_t JF}$	
Dimensions	
Lug Length (L)	1.66 in
Lug Width (W)	2.6 in
Lug Thickness (t)	0.55 in
Oblique Angle (θ)	deg
Allowables	
Yield Tensile Strength (F_y)	64631.1 lb/in
Margin of Safety	
Yield	0.839284778



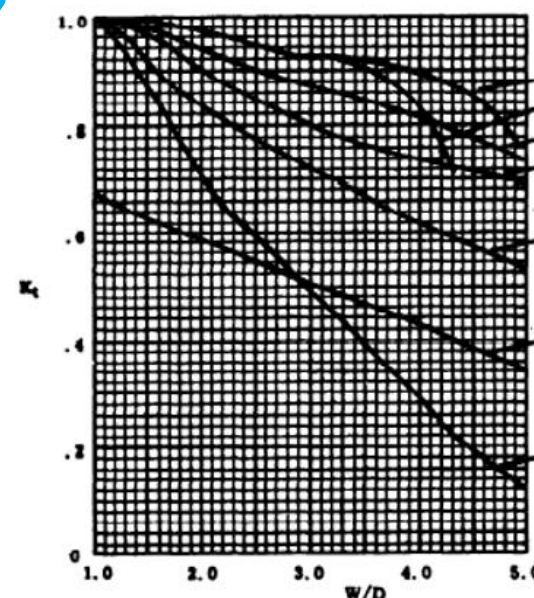
That's perfect!
No changes required.
You nailed it on the first try!

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Here's method/process
and some prelim results,
do you agree with this
analysis approach ?

Methods research and prototyping analysis criteria and process.

Lug Net Tension Efficiency Factor ' K_t ' lookup curve:



NOTES:

1. An additional M.S. of 0.15 over and above any casting or fitting factor is appropriate.
2. Values are for room temperature use only.

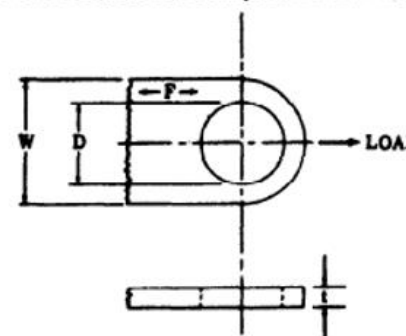
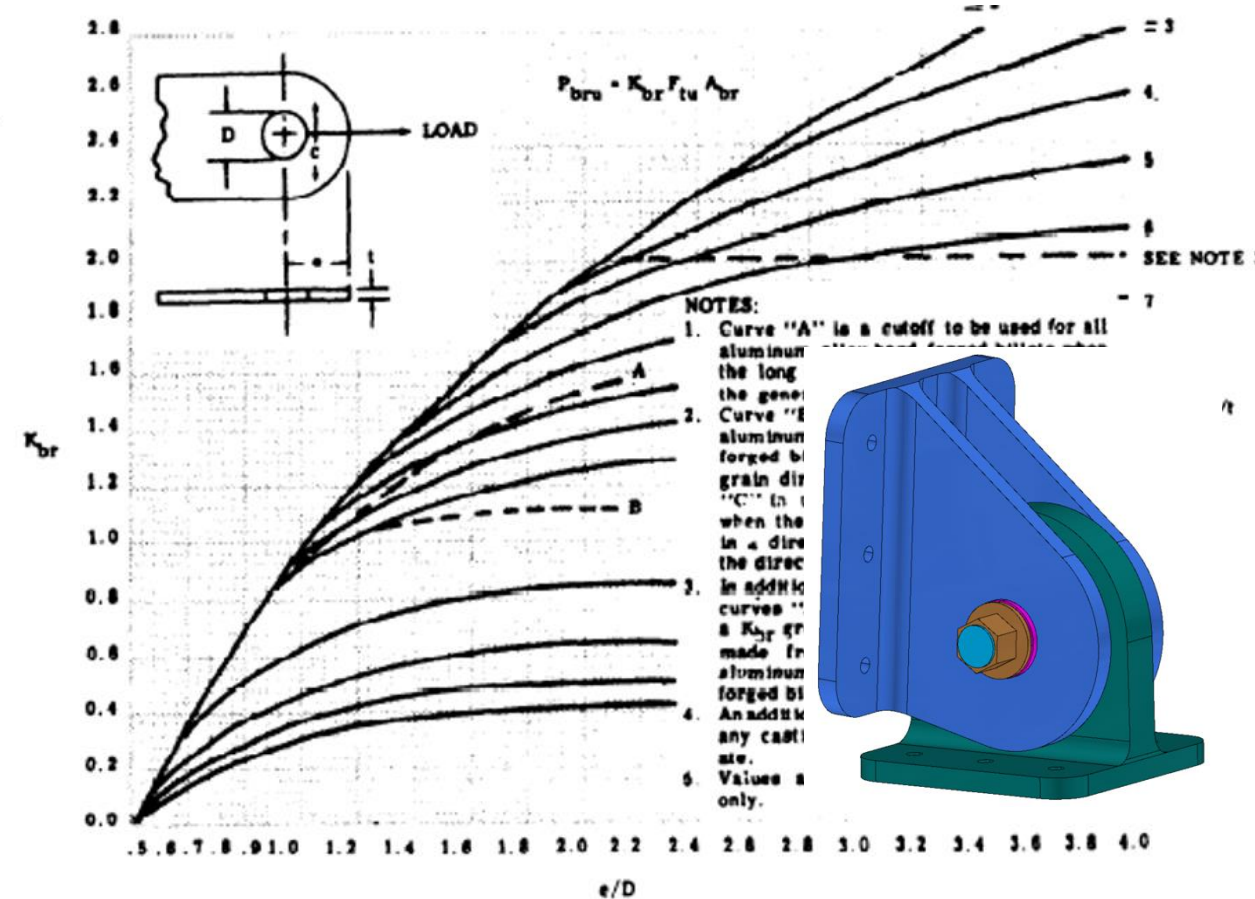


Fig. D1.12 Lug Design Data
Tension Efficiency Factors for
Axially Loaded Lugs (Ref. 3, 4)

Table D1.3	
Curve Nomenclature for Axial Loading for Fig. D1.12	
L, LT and ST Indicate Grain in Direction F in Sketch	
L - Longitudinal	
LT - Long Transverse	
ST - Short Transverse (Normal)	
MATERIALS	
Curve 1 - 2014-T6 and 7075-T6 Die Forging (L)	
4130 and 8630 Steel	
2014-T6 and 7075-T6 Plate ≤ 0.5 (L, LT)	
7075-T6 Bar and Extrusion (L)	
2014-T6 Hand Forged Billet ≤ 144 in. ³ (L)	
Curve 2 - 2014-T6 and 7075-T6 Plate > 0.5 in. ≤ 1.0 in. (L, LT)	
7075-T6 Extrusion (LT, ST)	
2014-T6 Hand Forged Billet > 144 in. ³ (L)	
2014-T6 Hand Forged Billet ≤ 36 in. ³ (LT)	
2014-T6 and 7075-T6 Die Forgings (LT)	
Curve 3 - 2024-T4, 2024-T2 Extrusion (L, LT, ST)	
Curve 4 - 2014-T6 and 7075-T6 Plate > 1 in. (L, LT)	
2024-T4 Bar (L, LT)	
2024-T3, 2024-T4 Plate (L, LT)	
Curve 5 - 2014-T6 Hand Forged Billet > 36 in. ³ (LT)	
Curve 6 - Aluminum Alloy Plate, Bar, Hand Forged Billet and Die Forging (ST). NOTE: For Die Forging, ST Direction Exists Only at Parting Plane.	
7075-T6 Bar (T)	
Curve 7 - AZ91C-T6 Mag. Alloy Sand Casting	
356-T6 Aluminum Alloy Casting	



NOTES:

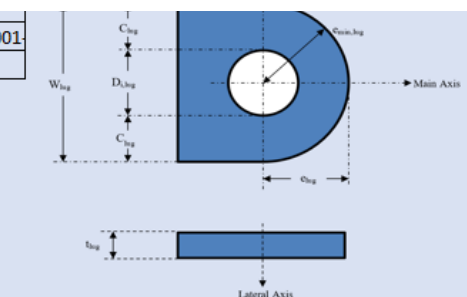
1. Curve "A" is a cutoff to be used for all aluminum the long the grain.
2. Curve "B" is aluminum forged bi grain dis "C" in 1 when the in a dire the direc in addit curves "A" & "B" if made in aluminum forged bi An addit any casti are.
3. Values are only.

Industry SME



"ehh, good enough"

Lug and Clevis Plug in	
Lug Oblique Stre	
Methodology	Lug In-Plane C
Associated HME	HyperX_HME
Zone Name	LH Lug Fitting
Zone ID	7
Controlling Design Case	User Load (S)
Temperature	86 deg F
Material Designation	7050, T7451, Plate, Thickness: 3.001
Margin of Safety	2.73913908
Detailed inputs	
Loads	
Axial Load (P_{axial})	1377.6 lb/in
Transverse Load ($P_{transverse}$)	8627.5 lb/in
Axial Load (P_a)	40299.4 lb/in
Transverse Load (P_t)	33032.9 lb/in
Variables	
Yield Factor (C)	1.1
Joint Fitting Factor (JF)	1.15
Net Tension Efficiency Factor (K_t)	0.87963
Shear-Bearing Efficiency Factor (K_{br})	0.86607
Transverse Efficiency Factor (K_{tr})	0.7809
Dimensions	
A_t	0.7755 in ²
A_{tr}	0.6545 in ²
Oblique Angle (θ)	deg
Allowables	
Tensile Strength (F_u)	64631.1 lb/in
Margin of Safety	
Yield	2.73913908



Equations

$$P_{ay} = C \frac{F_{ty}}{F_{tu}} P_{au}$$

$$P_{try} = K_{try} F_{ty} A_{br}$$

$$R_{ay} = \frac{P_{axial}}{P_{ay}}$$

$$R_{try} = \frac{P_{transverse}}{P_{try}}$$

$$MS_{yield} = \frac{1}{R_{ay}^{1.6} + R_{try}^{1.6}} - 1$$

Material Designation	7050, T7451, Plate, Thickness: 3.001
Margin of Safety	1.257007003
Detailed inputs	
Loads	
Axial Load (P_{axial})	1377.6 lb/in
Transverse Load ($P_{transverse}$)	8627.5 lb/in
Axial Load (P_a)	41394.3 lb/in
Transverse Load (P_t)	29777.6 lb/in
Variables	
Yield Factor (C)	1.1
Joint Fitting Factor (JF)	1.15
Net Tension Efficiency Factor (K_t)	0.87963
Shear-Bearing Efficiency Factor (K_{br})	0.86607
Transverse Efficiency Factor (K_{tr})	0.62302
Dimensions	
A_t	0.7755 in ²
A_{tr}	0.6545 in ²
Oblique Angle (θ)	deg
Allowables	
Tensile Strength (F_u)	73025.7 lb/in
Margin of Safety	
Ultimate	1.257007003

Equations

$$P_{au} = \min(K_t F_{tu} A_t, K_{br} F_{tu} A_{br})$$

$$P_{tru} = K_{tru} F_{tu} A_{br}$$

$$R_{au} = \frac{P_{axial}}{P_{au}}$$

$$R_{tru} = \frac{P_{transverse}}{P_{tru}}$$

$$MS_{ult} = \frac{1}{R_{au}^{1.6} + R_{tru}^{1.6}} - 1$$

Fig. D1.13 Lug Design Data
Shear-Bearing Efficiency Factors for
Axially Loaded Lugs (Ref. 3, 4)

Axial Load (P_{axial})	1377.6 lb/in
Transverse Load ($P_{transverse}$)	8627.5 lb/in
Moment (M)	1450.31 lb/in - in
σ_a	963.354 psi
σ_b	11064 psi
σ_{tr}	23111.9 psi

Variables

$$Joint Fitting Factor (JF) = 1.15$$

Dimensions

Lug Length (L)	1.66 in
Lug Width (W)	2.6 in
Lug Thickness (t)	0.55 in
Oblique Angle (θ)	deg

Allowables

Yield Tensile Strength (F_y)	64631.1 lb/in
----------------------------------	---------------

Margin of Safety

Yield	0.839284778
-------	-------------

Equations

$$M = P_{lat} L$$

$$\sigma_b = \frac{6M}{W t^2}$$

$$\sigma_a = \frac{P_a}{W t}$$

$$\sigma_{tr} = \frac{6 P_{tr} L}{t W^2}$$

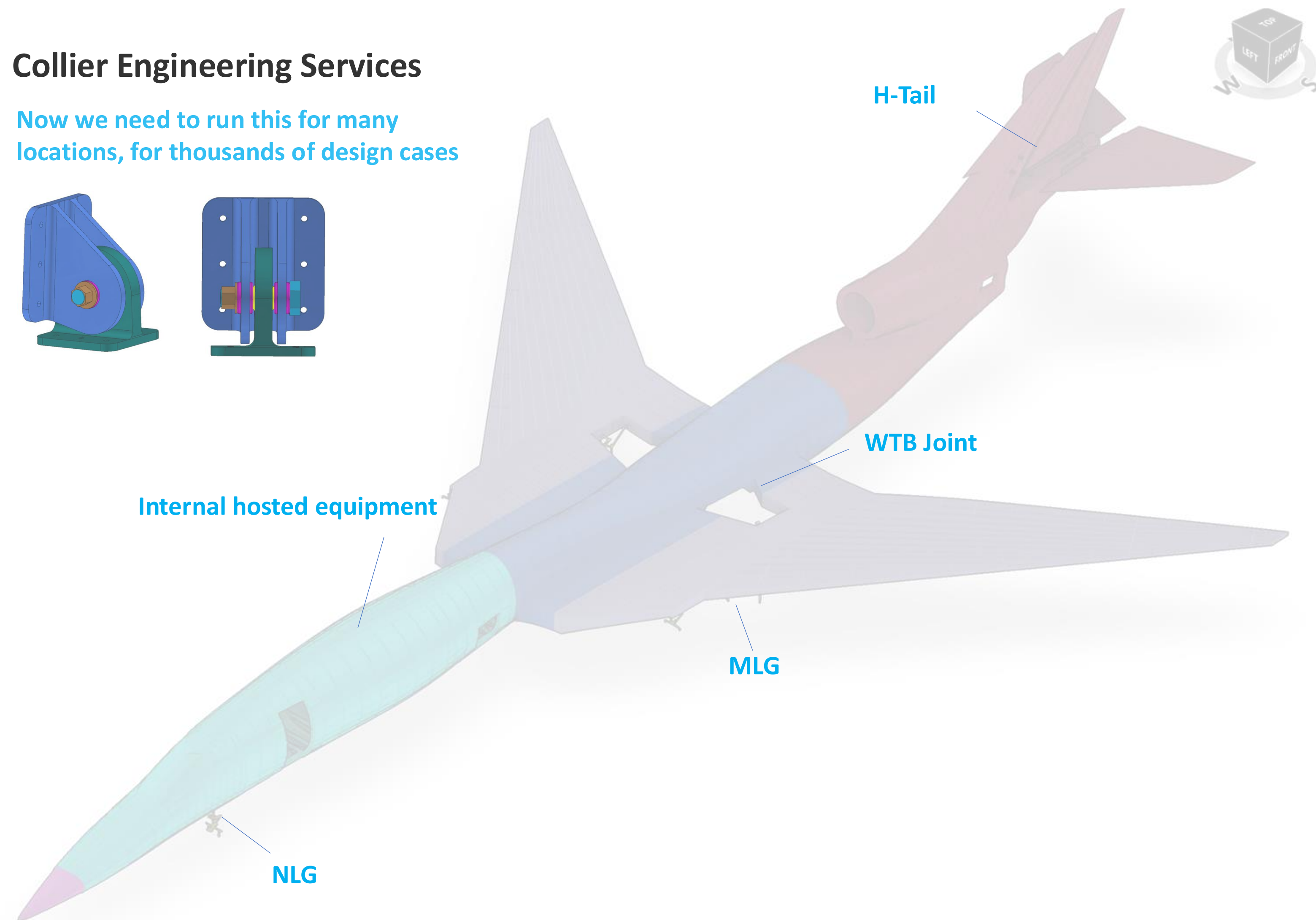
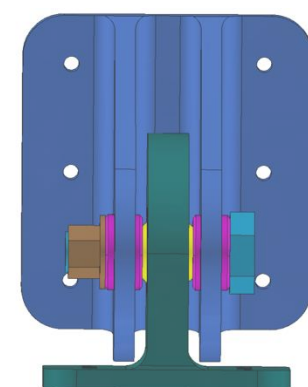
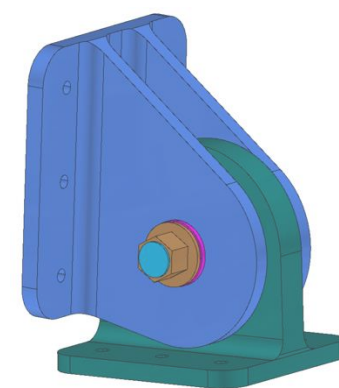
$$\sigma_t = \sigma_a + \sigma_b + \sigma_{tr}$$

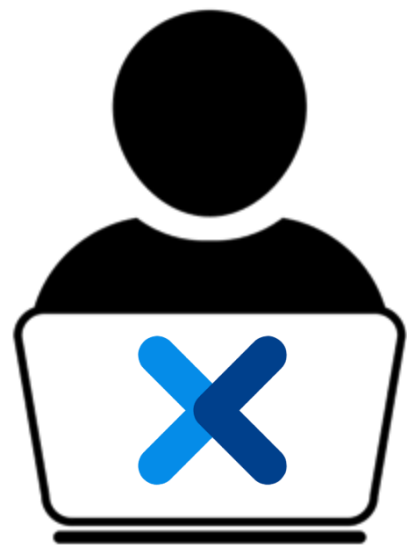
$$MS_{yield} = \frac{F_{ty}}{\sigma_t JF}$$



Collier Engineering Services

Now we need to run this for many locations, for thousands of design cases





Collier Engineering Services

We need a new plugin package and/or automation tools

Methods & Automation Services

We need GUI and API updates to support this request

HyperX Software Dev.

We need testing of the software updates

Software Testing

We need user documentation to explain how to use the new features.

Customer Support and Documentation

6. Failure Criteria

6.1. Lug Strength

The following section outlines the strength calculations used to write margins of safety for the following analysis methods.

Lug Analysis

Based on Bruhn and Niu. These analyses are performed on HyperX beam zones.

Figure 4-1, Lug Geometry

Geometry

Lug geometry is defined in the analysis settings.

Materials

The lug plugin must be run on designs that use a 5 ply laminate. Each ply must be an isotropic material. The material order is:

1. Lug
2. Clevis
3. Pin
4. Lug Bushing
5. Clevis Bushing

Lug and clevis material family are defined in the analysis settings.

Category	Required MS	Limit/Ultimate
id)	0	Limit
matel)	0	Ultimate
	0	Limit
	0	Ultimate
(Yield)	0	Limit
(Ultim)	0	Limit
	0	Ultimate
	0	Ultimate

LUG ANALYSIS

METHODS DOCUMENTATION

4. Geometry Definition

This section outlines the basic geometry of the lug, clevis, pin, and bushing.

4.1. Lug Geometry

Figure 4-1 below shows the lug dimensions and labels as defined in the plugin.

Figure 4-1, Lug Geometry

6. Failure Criteria

6.1. Lug Strength

The following section outlines the strength calculations used to write margins of safety for the following analysis methods.

- Lug In-Plane Oblique Axial (yield and ultimate)
- Lug In-Plane Oblique Transverse (yield and ultimate)
- Lug Lateral (yield and ultimate)

6.1.1. Single Shear

6.1.1.1. Lug In-Plane Oblique Axial, Transverse, and Interaction

Tension Across the Net Section Strength

Figure 6-1 Net Section Failure (Bruhn)

$$\sigma_{t,max,lug} = \frac{P}{(W_{lug} - D_b) t_{lug} + \frac{6 M_{lug}}{k_b (W_{lug} - D_b) t_{lug}^2}}$$

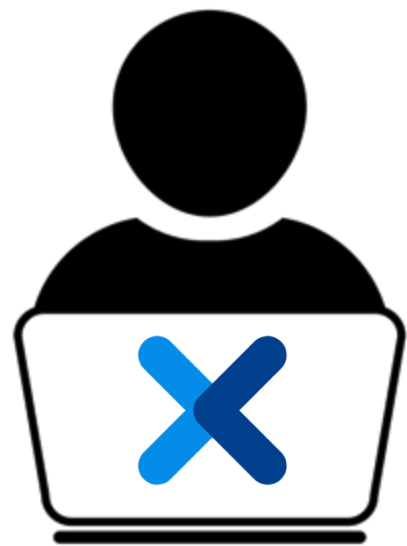
Where the plastic bending coefficient (k_b) for the lug is assumed to be perfectly elastic (1.0) to be conservative.

$$P_{t,max,lug} = K_b \sigma_{t,max,lug} A_{t,lug}$$

Where K_b is the net-tension stress coefficient obtained lookup curves located in the appendix. Note: To determine K_b , the materials ultimate strain must be known and is specified as a user input in the plugin.

$$F_{t,lug} = K_b F_{tu}$$
$$F_{t,lug,min} = \min(F_{t,lug}, 1.304 F_{t,lug})$$
$$P_{t,lug} = F_{t,lug,min} (W - D) t_{lug}$$





Collier Engineering Services

Methods & Automation Services

HyperX Software Dev.

Software Testing

Customer Support and Documentation

Lug Failure Mode

Lug_Clevis_pin_analysis

Criteria

Filter...

Category Any

☒ Select all

Enabled	Criterion	Required MS	Limit/Ulimate
☒	Lug - Lug In-Plane Oblique (Yield)	0	Limit
☒	Lug - Lug In-Plane Oblique (Ultimate)	0	Ultimate
☒	Lug - Lug Lateral (Yield)	0	Limit
☒	Lug - Lug Lateral (Ultimate)	0	Ultimate
☒	Lug - Clevis A In-Plane Oblique (Yield)	0	Limit
☒	Lug - Clevis A In-Plane Oblique (Ultimate)	0	Ultimate
☒	Lug - Clevis A Lateral (Yield)	0	Limit
☒	Lug - Clevis A Lateral (Ultimate)	0	Ultimate

Settings

Filter...

Setup

Loading

Use transformed component loads ☒

Oblique Load Angle (deg) 30

Clevis Load Distribution (%) 0.6

Axial Load Percentage 10

Use Maximum Lateral Load? ☒

Clamp Up Load 100

Apply

Close

Lug Analysis

Based on Bruhn and Niu. These analyses are performed on HyperX beam zones.

Geometry

Lug geometry is defined in the analysis settings.

Materials

The lug plugin must be run on designs that use a 5 ply laminate. Each ply must be an isotropic material. The material order is:

1. Lug

2. Clevis

3. Pin

4. Lug Bushing

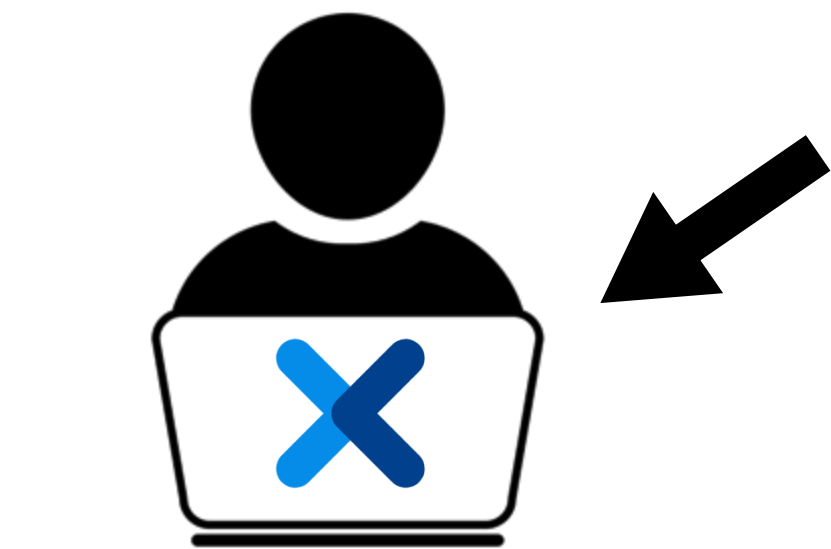
5. Clevis Bushing

Lug and clevis material family are defined in the analysis settings.

Here's the software + plugin that does what you need. Verify the analysis results !
Go impress the customer !

28

(Customer Perspective) Engage with the Collier ES team



Collier Engineering Services

Here's a HyperX DB, with results for all interfaces & Part-by-part stress reports



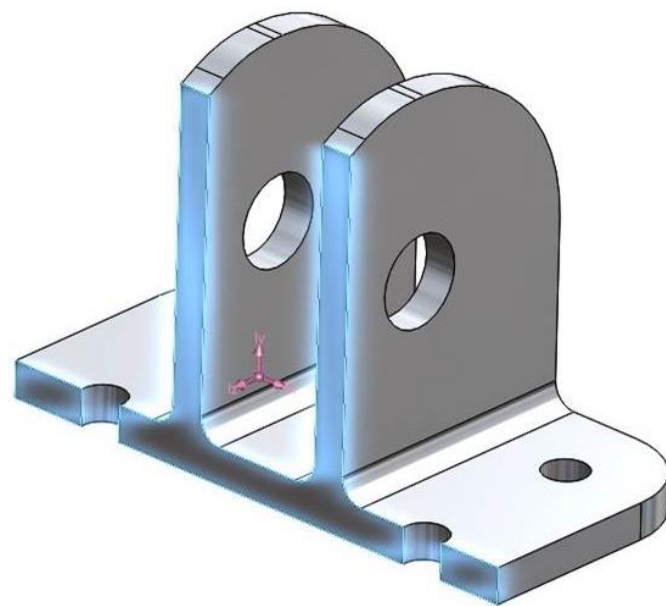
Sweet, now I can update CAD and release parts

Methods & Automation Services

HyperX Software Dev.

Software Testing

Customer Support and Documentation



Analysis Watch 1

Analysis	Object	Zones
Lug - Clevis A Lateral (Ultimate) (Ultimate)	Zone	-0.482
Lug - Clevis B Lateral (Ultimate) (Ultimate)	Zone	-0.482
Lug - Clevis A Lateral (Yield) (Limit)	Zone	-0.367
Lug - Clevis B Lateral (Yield) (Limit)	Zone	-0.367
Lug - Pin Shear (Ultimate) (Ultimate)	Zone	-0.01
Lug - Clevis A Bushing Compressive (Yield) (Limit)	Zone	0.151
Lug - Clevis B Bushing Compressive (Yield) (Limit)	Zone	0.151
Lug - Lug Lateral (Ultimate) (Ultimate)	Zone	0.297
Lug - Lug Lateral (Yield) (Limit)	Zone	0.682
Lug - Lug Bushing Compressive (Yield) (Limit)	Zone	1.75
Lug - Clevis A In-Plane Oblique (Ultimate) (Ultimate)	Zone	2.54
Lug - Clevis B In-Plane Oblique (Ultimate) (Ultimate)	Zone	2.54
Lug - Clevis A In-Plane Oblique (Yield) (Limit)	Zone	2.9
Lug - Clevis B In-Plane Oblique (Yield) (Limit)	Zone	2.9
Lug - Lug In-Plane Oblique (Ultimate) (Ultimate)	Zone	4.74
Lug - Lug In-Plane Oblique (Yield) (Limit)	Zone	6.45
Lug - Pin Bending (Ultimate) (Ultimate)	Zone	66.6
Lug - Pin Bending (Yield) (Limit)	Zone	94.3

