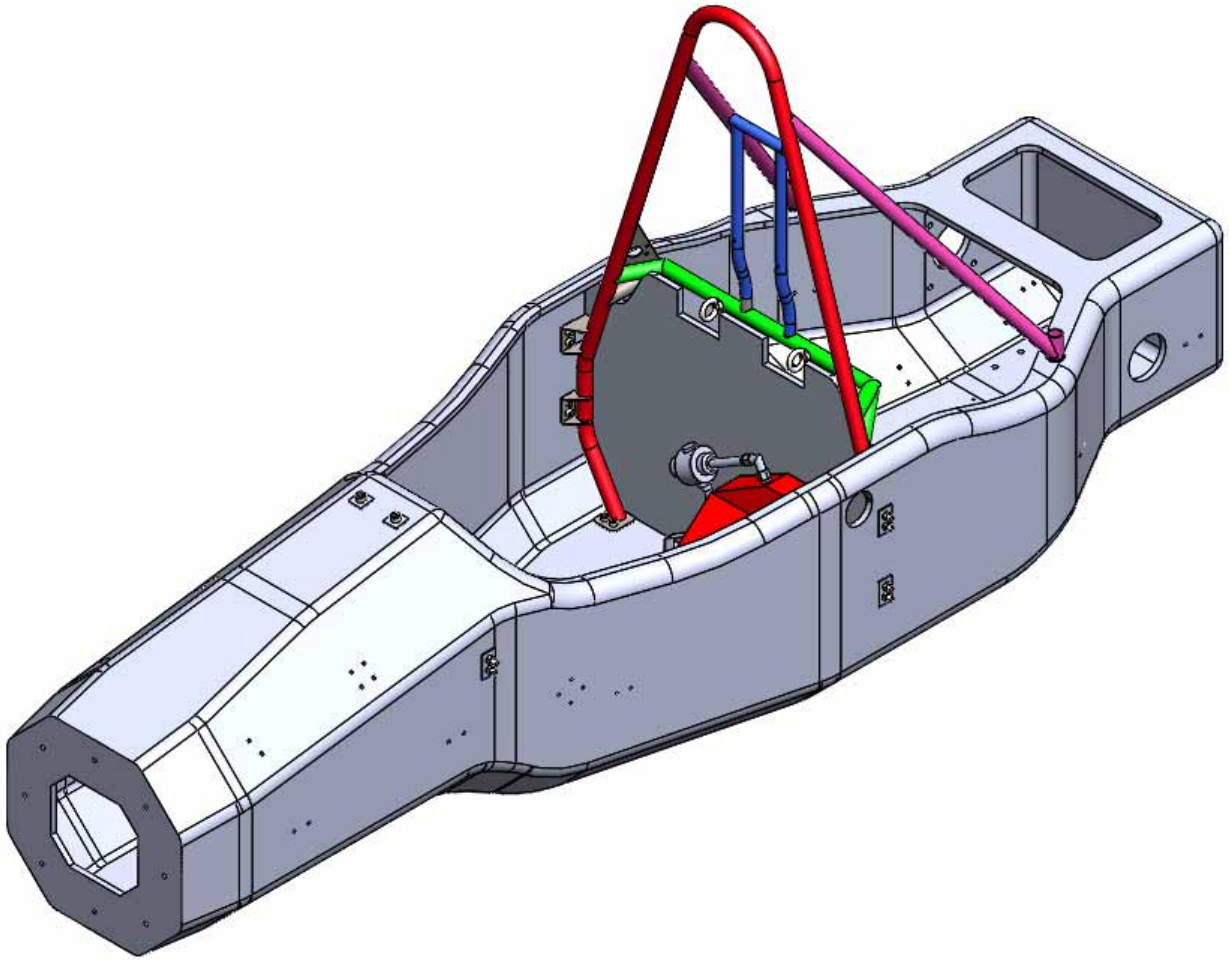
SES Inspection

- Monocoque -



SES = Structural Equivalency Spreadsheet

Contents

1. **Basic Information for SES**
2. **How to report SES**

The bases of the approach of SES are "Steel Tube."

2019-FSAE-Structural-Equivalency-Spreadsheet_V1.8.xls
http://www.fsaeonline.com

1. **Basic Information for SES**
2. **How to report SES**

The bases of the approach of SES are "Steel Tube."

Basic Information for SES

Primary Structure should be properly designed to protect the driver.
SES is the evidence to prove safety of your Primary Structure.

All teams MUST submit either SES or SCRF.
We request additional information or calculations If submitted SES is incomplete.

SES	: Electronic data (Excel/15 MB)
Submission deadline	: 14:00, May 13 (Mon.)
Extended submission deadline	: 14:00, May 18 (Sat.)
Re-submission	: 14:00, Jul. 31 (Wed.)
Submission past deadline	: 10-point penalty for each day past the deadline
Non-submission	: 50-point penalty and may not participate in Technical Inspection

When re-submission or additional data submission is required, a re-submission term is less than one week from a re-submission requirement.

By the defect of IAD, when changes of design, such as Front Bulkhead, are required, extension of a deadline is taken into consideration.

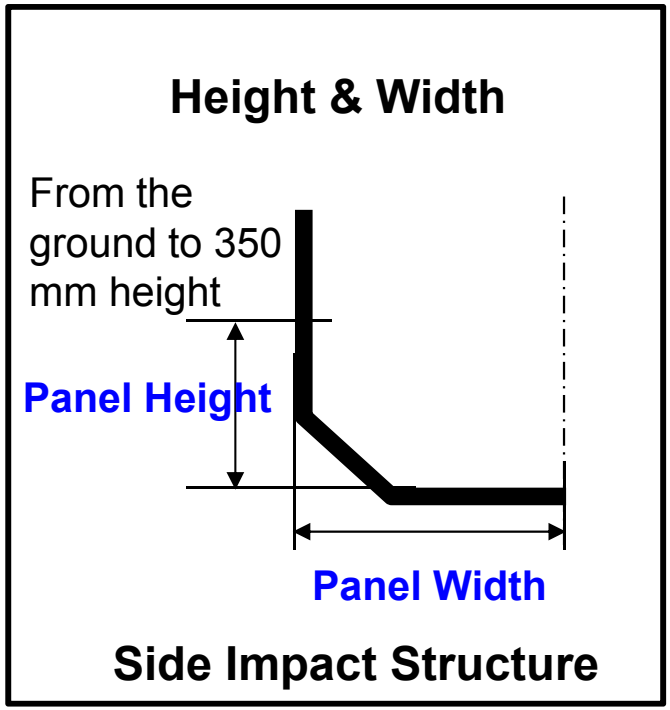
We recommend strongly that SES is recognized at an early stage as much as possible, and makes frame structure decide.

The Bases of SES Calculation

✓ Basic Calculations of Monocoque

Monocoque Guidance Scenario 1 : Equivalent Flat Panel Calculation

At the weakest cross-section of structure, the EI of the monocoque is calculated as the EI of a flat panel with the same composition as the monocoque about the neutral axis of the laminate. The curvature of the panel and geometric cross section of the monocoque must be ignored for these calculations.
It stands for safer calculation.



Note：Calculations of EI that MUST reference rule.

Front Bulkhead Support Structure

Vertical wall must have EI more than ONE Baseline steel tube.

Side Impact Structure

Vertical wall must have EI more than TWO Baseline steel tube

Floor Panel must have EI more than ONE Baseline steel tube

Note：It should be calculated about the weakest cross-section of structure.

The size of the weakest panel
An intersection and a bend are disregarded.

1. Basic Information for SES

2. How to report SES

The bases of the approach to SES are "Steel Tube."

Monocoque Laminate Testing

T.2.31.1 Primary Structure Laminates

Teams must build representative test panels for each ply schedule used in the regulated regions of the monocoque as a flat panel and perform a 3 point bending test on these panels.

a. Test panels must:
    a. Measure 275 mm x 500 mm
    b. Be supported by a span distance of 400 mm
    c. Have equal surface area for the top and bottom skin.
    d. Have bare edges, without skin material.
b. The SES must include:
    a. Data from the 3 point bending tests
    b. Pictures of the test samples
    c. A picture of the test sample and test setup showing a measurement documenting the supported span distance used in the SES.
c. Test panel results must be used to derive stiffness, yield strength, ultimate strength and absorbed energy properties by the SES formula for the purpose of calculating laminate panels equivalency corresponding to Primary Structure regions of the chassis.
d. Test panel results for the Side Impact Laminate must show by calculation, using the embedded SES formula, equivalence to two (2) Side Impact tubes (**T.2.5**) tested per **T.2.31.2 below**, for buckling modulus, ultimate strength and absorbed energy.

T.2.31.2 Comparison Test

a. Teams must make an equivalent test with two Side Impact Baseline Steel tubes (**T.2.5**) such that any compliance in the test rig can be accounted for and to establish an absorbed energy value of the baseline tubes.
b. Baseline tubes must be tested to a minimum displacement of 19.0 mm
c. The calculation of absorbed energy will use the integral of force times displacement from the initiation of load to a displacement of 19.0 mm.

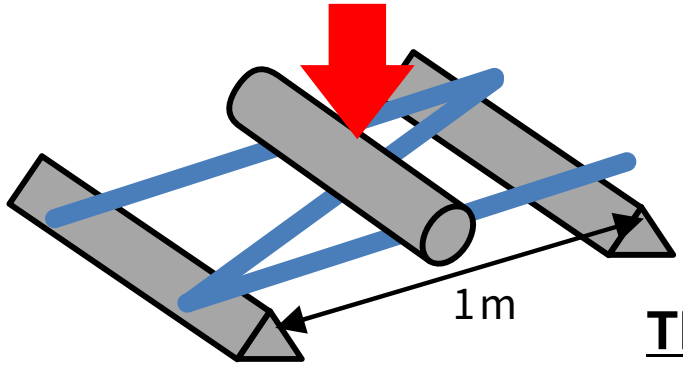
T.2.31.3 Test Conduct

a. The load applicator used to test any panel/tubes as required within this section **T.2.31** must be metallic and have a radius of 50 mm.
b. The load applicator must overhang the test piece to prevent edge loading.
c. Any other material must not be placed between the load applicator and the items on test.

Monocoque Laminated Test

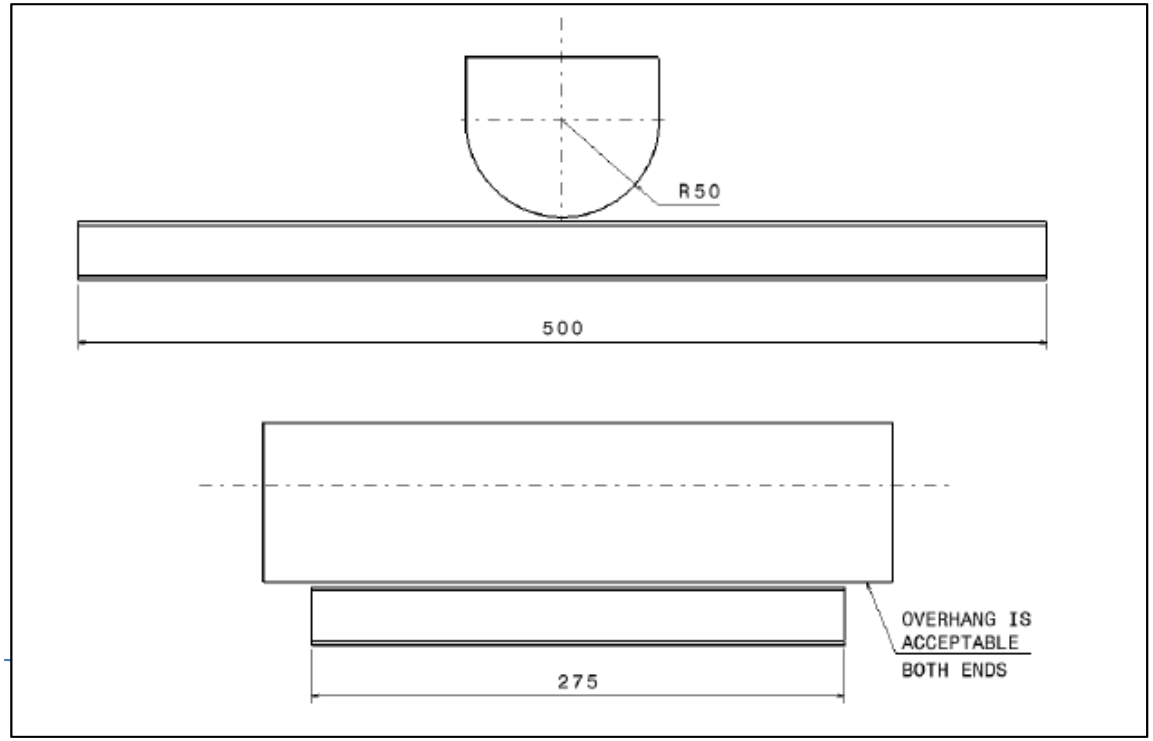
Purpose of SES (Pipe space frame)

Quick evaluation method to check your vehicle structure stiffness and strength compared to the baseline structure.



The number of tubes are considered in span of load transfer area.
The number of tubes are different in this area, please use the number of tubes **in the most weak section.**

The approach to a three-point bending test is the same.



Test Panel is bent by 3 points

A blank is inputted correctly -> A result is judged automatically.

Note: Forces are given in Pa, not Mpa or Gpa.

Material	E (Pa)	S_Ultimate (Pa)	Shear (Pa)	Inner	Outer		
T.2.5.3 Steel	2.00E+11	3.65E+08	2.11E+08	mm	mm	**Scaling Limit**	
T.2.31 Composite						Core Only	N/A
Composite (2)						Core Only	N/A
Composite (3)						Core Only	N/A
Composite (4)						Core Only	N/A
Composite (5)						Core Only	N/A
Composite (6)						Core Only	N/A
Composite (7)						Core Only	N/A
Composite (8)						Core Only	N/A

Summary

EQ

Sections at 95% to 100% EQ will receive extra scrutiny.

mm

T.2.31 SIS Layup has preliminary links to Pa values.

Change these if working in Inch instead of mm. Manually enter inch skin thicknesses above.

Manually match the scaling limit to the result on the T.21 SIS Layup tab.

Copy as many T.2.31 Composite tabs as necessary for unrelated layups.

Give tabs and material list matching names.

Link cells in this table to those results for use in this worksheet.

Skin and core thickness may be scaled based on these values from one T.2.31 3-Point and Shear test.

Core must maintain the same material grade. Honeycombs must also maintain wall thickness and cell size.

Scaled skin must repeat the whole initial layup and remain quasi-isotropic.

No individual layers may be added or subtracted.

An initial layup with two out-of-balance plies may not be scaled.

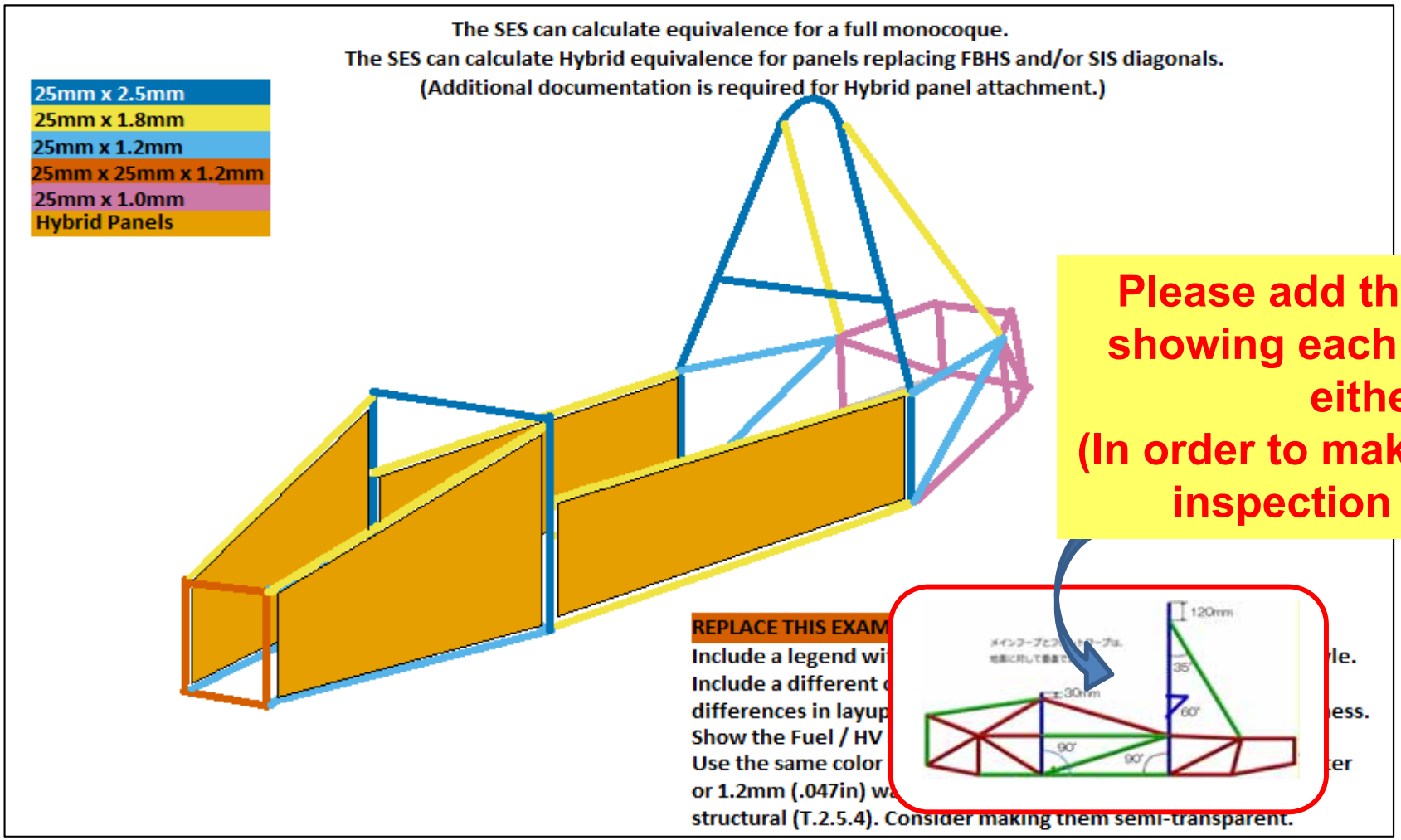
An initial layup with one out-of-balance plies may be doubled only.

An initial layup with no out-of-balance plies may be repeated indefinitely.

Skin and core may not be scaled for a composite Anti-Intrusion plate.

Panel and Tube Clarification/Drawing

An isometric drawing is from the front as follows.



Please add the side view showing each part size to either.
(In order to make a technical inspection smooth)

1. Three views drawing is unnecessary.
2. Illustrate a Fuel Tank in ICV and illustrate Accumulator Container in EV.
3. Please write pipe classification by color like a sample.
4. All pipes smaller than φ25mm or t1.2mm are the same colors.

Insertion Method of Additional Drawing

When an additional drawing is required, insert to the appointed column.

Repeat Rear 3/4 3D CAD with color coded tube sizes / layups.
Use different colors for square and round.
Include a legend that shows each color and size.
Fuel tank or HV systems must be shown in orange.

Additional detail or dimension images.
Multiple or detail images may be used anywhere in the SES.
Additional images may be placed below sections.

Front Bulkhead Support

There should be EI of three or more Baseline pipes only with a perpendicular wall.

(1) It converts by the weakest panel.

=> If a size is inputted into a calculation sheet, comparative evaluation will be carried out to three Baselines. If there is EI of three or more Baseline pipes only with a perpendicular wall.

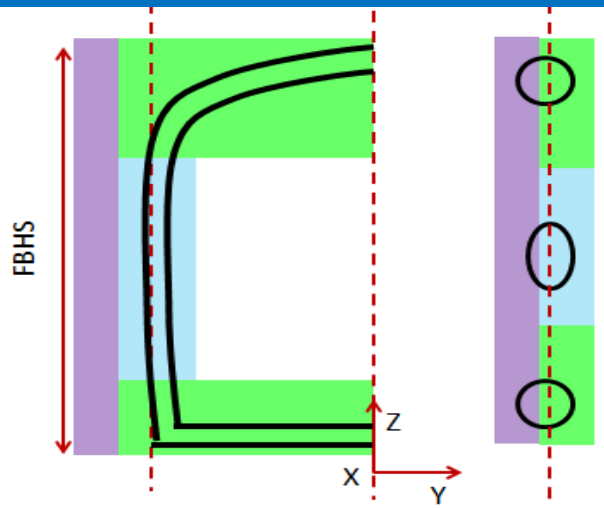
(2) When EI will be less than 100% by (1)

① Calculate the moment of inertia of area Izz of the circumference of a vehicles center vertical axis.

② Calculate moment of inertia of area Iloc+A*d2 of the circumference of a vehicles center vertical axis on the conditions which have three Baseline pipes in the position (distance d) of the width of MHBS one side.

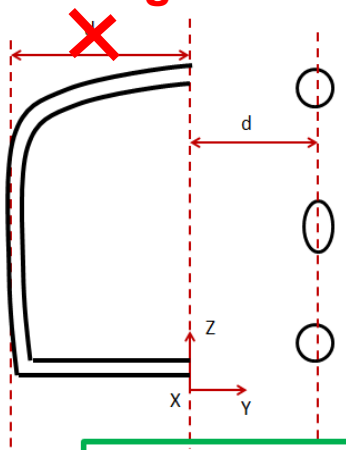
③ $E_{your} * I_{zz} \geqq E_{Baseline} * (I_{loc} + A*d^2)$ A certain thing is proved.

Setting the height of the whole FBHS minimum section to Panel Height in (1) is OKs.
The part must be deducted when there is a space portion.



The calculation method is indicated to guidance.

It is confusing.



Steel tube configuration used for equivalency comparison:

$A = 3 * \frac{\pi}{4} * (d_o^2 - d_i^2)$ $I_{loc} = 3 * \frac{\pi}{64} * (d_o^4 - d_i^4)$

$d = \frac{chassis\_width}{2}$

Composite configuration used for equivalency comparison:

-Use section cut properties calculated by CAD system.

- Izz of half car with the reference coordinate system at the centerline of vehicle.

$I_{zz} \geq I_{loc} + A * d^2$ Passes equivalency test

Compare on this condition.

Front Bulkhead Support

EQ Front Bulkhead Supports (FBHS)

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

EQ

T.2.33	**Front Bulkhead Support Construction:**		**Tube**			EQ
	Baseline Steel Tubes Replaced:		**0**			N/A
	Layup Used:		T.2.31 Composite			N/A
	Composite Panel Height:			mm		N/A
	Composite cross section (d):			mm		N/A
	Composite second moment about car centerline (Izz):			**mm^4**		N/A
	Panel thickness:		0	mm		N/A
	Core thickness:			mm		N/A
	Outer skin thickness:			mm		N/A
	Inner skin thickness:			mm		N/A

Flat Panel Properties			**Flat Panel Properties**			**Flat Panel Properties**		
Outer (b)	0	m	A_1	0.00E+00	m^2	I_1	0.00E+00	m^4
Outer (h)	0	m	A_2	0.00E+00	m^2	I_2	0.00E+00	m^4
Thickness	0	m	y_1	0	m	Ic_1		m^4
Inner (b)	0	m	y_2	0.000	m	Ic_2		m^4
Inner (h)	0	m	Centroid		m	Ic_{12}		%

		0 x Steel Tube	**Composite**		
T.2.5.1	Wall thickness:	0.001194	0	m	N/A
	Outer Diameter / Panel Thickness:	0.0254	0	m	N/A
	Cross sectional area (A):	0.00E+00	0.00E+00	m^2	N/A
	Second moment of inertia (I):	0.00E+00	0.00E+00	m^4	N/A
T.2.5.3a	Young's Modulus (E):	2.00E+11		Pa	N/A
	Ultimate Tensile Strength (S):	3.65E+08		Pa	N/A
	Shear:	2.11E+08		Pa	N/A
Buckling Modulus	E_1*I_1 <= E_2*I_2:	0.00E+00			N/A
T.2.33.2	1 tube <= Vertical EI:	1.33E+03			N/A
UTS	S_1*A_1 <= S_2*A_2:	0.00E+00			N/A
Bending	4*S_1*I_1/r <= 4*S_2*I_2/r:	0.00E+00			N/A
Deflection	Bending_1/(48*EI):	0.00E+00			N/A
Energy	0.5*Bending^2/(48*EI):	0.00E+00			N/A
Offset	Itube + Atube*d^2 <= Izz:	0.00E+00			N/A
T.2.31.4h	Perimeter shear:	4.00E+03			N/A

Front Hoop Brace

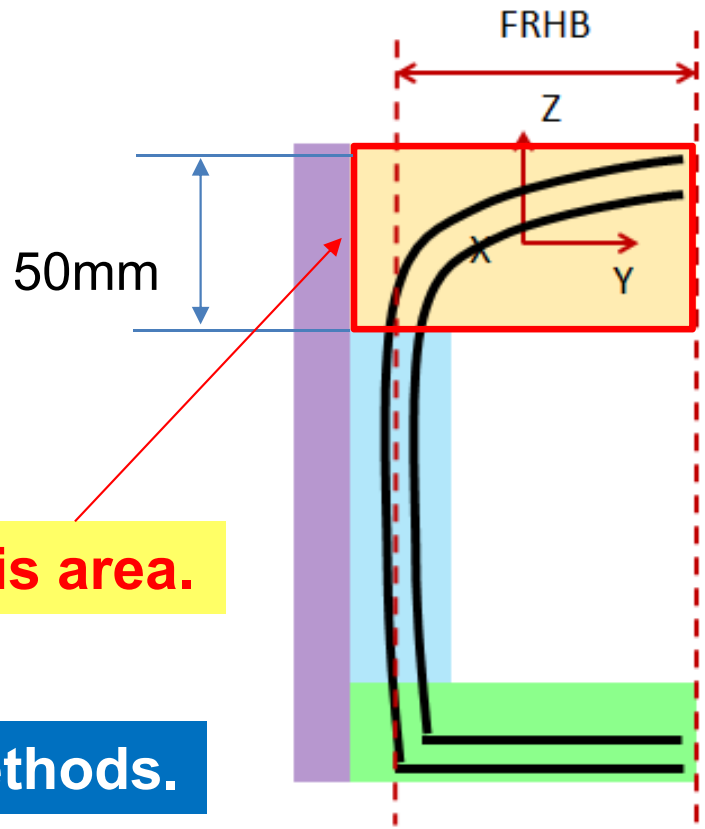
There is EI of one or more F/Hoop Bracing of Baseline only by a top plate.

(1) It converts by the weakest panel.

⇒ If a size is entered in a calculation sheet, it will be evaluated as compared with one Baseline.
It will OK, if there is EI of one or more F/Hoop Bracing of Baseline only by a top plate.
Panel Width is evaluating by the minimum portion from FH before FBH.
When there is an opening, calculate by the minimum width except it.
When the end is R form, only the width of less than 50 mm of lower parts is accepted from a top side.

(2) When EI will be less than 100% by (1)

1. A part within the 50mm under the top board from a vehicle center is regarded as Front Hoop、
2. EI is calculated from the weaker one of the moment of inertia of area of the circumference of a principal axis.
3. It proves that they are one or more FHoop Bracing of Baseline.



Front Hoop Bracing is ONLY this area.

In SES, you have to prove by one of methods.

Front Hoop Brace

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

The height(d) of the moncoque comparison for Forward FHB must not exceed 50mm.

					EQ
T.2.14	**Front Hoop Brace Construction:**		**Tube**		EQ
	Baseline Steel Tubes Replaced:		**0**		N/A
	Layup Used:		T.2.31 Composite		N/A
	Composite Panel Width:			mm	N/A
	Composite cross section height (d):			mm	N/A
	Composite second moment about car centerline (Izz):			**mm^4**	N/A
	Panel thickness:		0	mm	N/A
	Core thickness:			mm	N/A
	Outer skin thickness:			mm	N/A
	Inner skin thickness:			mm	N/A

Flat Panel Properties			**Flat Panel Properties**			**Flat Panel Properties**		
Outer (b)	0	m	A_1	0.00E+00	m^2	I_1	0.00E+00	m^4
Outer (h)	0	m	A_2	0.00E+00	m^2	I_2	0.00E+00	m^4
Thickness	0	m	y_1	0	m	Ic_1		m^4
Inner (b)	0	m	y_2	0.000	m	Ic_2		m^4
Inner (h)	0	m	Centroid		m	Ic_{12}		%

		0 x Steel Tube	**Composite**		
	Wall thickness:	0.0016	0	m	N/A
	Outer Diameter / Panel Thickness:	0.0254	0	m	N/A
	Cross sectional area (A):	0.00E+00	0.00E+00	m^2	N/A
	Second moment of inertia (I):	0.00E+00	0.00E+00	m^4	N/A
T.2.5.3a	Young's Modulus (E):	2.00E+11		Pa	N/A
	Ultimate Tensile Strength (S):	3.65E+08		Pa	N/A
	Shear:	2.11E+08		Pa	N/A
Buckling Modulus	E_1*I_1 <= E_2*I_2:	0.00E+00			N/A
UTS	S_1*A_1 <= S_2*A_2:	0.00E+00			N/A
Bending	4*S_1*I_1/r <= 4*S_2*I_2/r:	0.00E+00			N/A
Deflection	Bending_1/(48*EI):	0.00E+00			N/A
Energy	0.5*Bending^2/(48*EI):	0.00E+00			N/A
Offset	Itube + Atube*d^2 <= Izz:	0.00E+00			N/A
	Perimeter shear:			N	

The case which needs Rear FHB

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

A rearward FHB is calculated as a flat panel between the FH and MH, above the SIS.

		EQ			
T.2.20.2b	**Rear Front Bulkhead Support:**	**N/A**			N/A
	Baseline Steel Tubes Replaced:	**0**			N/A
	Layup Used:	T.2.31 SIS Layup			N/A
	Composite Panel Height:		mm		N/A
	Panel thickness:	0	mm		N/A
	Core thickness:		mm		N/A
	Outer skin thickness:		mm		N/A
	Inner skin thickness:		mm		N/A

Flat Panel Properties			**Flat Panel Properties**			**Flat Panel Properties**		
Outer (b)	0	m	A_1	0.00E+00	m^2	I_1	0.00E+00	m^4
Outer (h)	0	m	A_2	0.00E+00	m^2	I_2	0.00E+00	m^4
Thickness	0	m	y_1	0	m	Ic_1		m^4
Inner (b)	0	m	y_2	0.000	m	Ic_2		m^4
Inner (h)	0	m	Centroid		m	Ic_{12}		m^4

			0 x Steel Tube	**Composite**		
T.2.5.1	Wall thickness:		0.0012	0	m	N/A
	Outer Diameter / Panel Thickness:		0.0254	0	m	N/A
	Cross sectional area (A):		0.00E+00	0.00E+00	m^2	N/A
	Second moment of inertia (I):		0.00E+00		m^4	N/A
T.2.5.3a	Young's Modulus (E):		2.00E+11	#N/A	Pa	N/A
	Ultimate Tensile Strength (S):		3.65E+08	#N/A	Pa	N/A
	Shear:		2.11E+08	#N/A	Pa	N/A
Buckling Modulus	E_1*I_1 <= E_2*I_2:		0.00E+00	#N/A	#N/A	N/A
UTS	S_1*A_1 <= S_2*A_2:		0.00E+00	#N/A	#N/A	N/A
Bending	4*S_1*I_1/r <= 4*S_2*I_2/r:		0.00E+00	#N/A	#N/A	N/A
Deflection	Bending_1/(48*EI):		0.00E+00	#N/A	#N/A	N/A
Energy	0.5*Bending^2/(48*EI):		0.00E+00	#N/A	#N/A	N/A
	Perimeter shear:			#N/A	N	

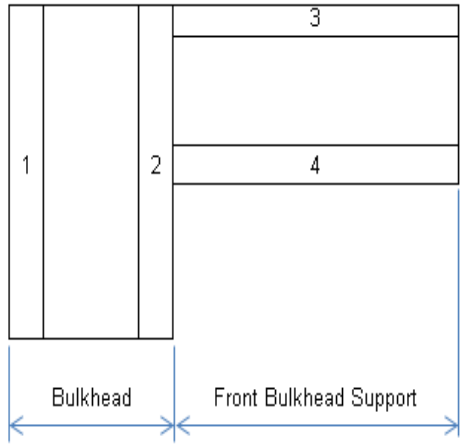
Front Bulkhead

EI of the weakest panel proves that they are two or more Baseline pipes.

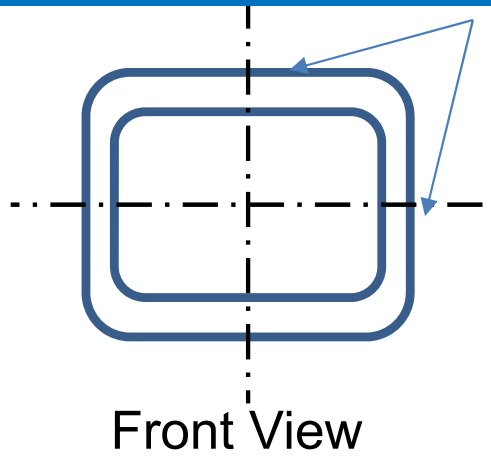
(1) Equivalent Flat Panel Calculation
Chassis where, when calculated as a flat panel, Front Bulkhead & structure between from rear face of FBH to 25.4mm show >=100% equivalency to 2 FBH tube.

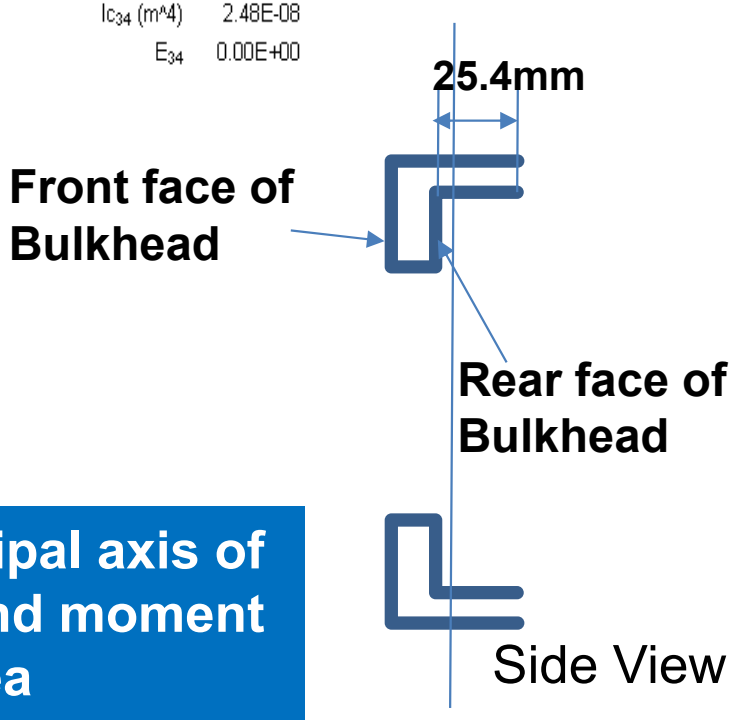
(2) Chassis where the flat panel calculation shows <100% equivalence to 2 FBH tube. In this case additional proof of equivalence is required, by showing the actual chassis.

	BH	FBHS	
b (m)	0.03	0.003	b_3 (m)
h_1 (m)	0.002	0.003	b_4 (m)
h_2 (m)	0.002	0.0254	h (m)
A_1 (m^2)	6.00E-05	I_1 (m^4)	2.00E-11
A_2 (m^2)	6.00E-05	I_2 (m^4)	2.00E-11
A_3 (m^2)	7.62E-05	I_3 (m^4)	4.10E-09
A_4 (m^2)	7.62E-05	I_4 (m^4)	4.10E-09
x_1 (m)	0.001	Ic_1 (m^4)	3.25E-08
x_2 (m)	0.021	Ic_2 (m^4)	6.57E-10
x_3 (m)	0.0347	Ic_3 (m^4)	1.24E-08
x_4 (m)	0.0347	Ic_4 (m^4)	1.24E-08
Centroid (m)	0.0243		
		Ic_{12} (m^4)	3.31E-08
		Ic_{34} (m^4)	2.48E-08
		E_{34}	0.00E+00



Calculate about Weaker cross-section





Principal axis of second moment of area

Front Bulkhead

EQ

Front Bulkhead

EQ

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

T.2.19	**Front Bulkhead Construction:**	**Tube**				N/A
	Baseline Steel Tubes Replaced:	**0**				N/A
	Layup Used:	T.2.31 Composite				N/A
	Front Bulkhead Height:		mm			N/A
	Front Bulkhead Width:		mm			N/A
	Cutout Height		mm			N/A
	Cutout Width		mm			N/A
	Composite Panel Height:	0	mm			N/A
	Thickness of panel:	0	mm			N/A
	Core thickness:	0	mm			N/A
	Outer skin thickness:	0	mm			N/A
	Inner skin thickness:	0	mm			N/A

Bulkhead Panel Properties		
Outer (b)	0	m
Outer (h)	0	m
Thickness	0	m
Inner (b)	0	m
Inner (h)	0	m

FBHS 25mm Properties		
Outer (b)	0	m
Outer (h)	0.0254	m
Thickness	0	m
Inner (b)	0	m
Inner (h)	0.0254	m

Bulkhead Panel Properties		
A_1	0.00E+00	m^2
A_2	0.00E+00	m^2
y_1	0	m
y_2	0.000	m

FBHS 25mm Properties		
A_1	0.00E+00	m^2
A_2	0.00E+00	m^2
y_1	0.0127	m
y_2	0.013	m
Centroid		m

Bulkhead Panel Properties		
I_1	0.00E+00	m^4
I_2	0.00E+00	m^4
Ic_1		m^4
Ic_2		m^4
Ic_{12}		m^4

FBHS 25mm Properties		
I_1	0.00E+00	m^4
I_2	0.00E+00	m^4
Ic_1		m^4
Ic_2		m^4
Ic_{12}		m^4

	0 x Steel Tube	**Composite**		
Wall thickness:	0.0016	0	m	N/A
Outer Diameter / Panel Thickness:	0.0254	0	m	N/A
Cross sectional area (A):	0.00E+00	0.00E+00	m^2	N/A
Second moment of inertia I:	0.00E+00		m^4	N/A
Young's Modulus (E):	2.00E+11		Pa	N/A
Ultimate Tensile Strength (S):	3.65E+08		Pa	N/A
Shear:	2.11E+08		Pa	N/A

T.2.5.3a			
Buckling Modulus	E_1*I_1 <= E_2*I_2:	0.00E+00	N/A
UTS	S_1*A_1 <= S_2*A_2:	0.00E+00	N/A
Bending	4*S_1*I_1/r <= 4*S_2*I_2/r:	0.00E+00	N/A
Deflection	Bending_1/(48*EI):	0.00E+00	N/A
Energy	0.5*Bending^2/(48*EI):	0.00E+00	N/A
T.2.31.4h	Perimeter shear:	0.00E+00	N/A

AI Attachment

EQ

AI Attachment

EQ				
T.2.22.2	**AI Attachment:**	**Welded**		N/A
	AI plate must at least reach the centerline of Front Bulkhead tubes.			N/A
	Fastener diameter:		mm	N/A
	No. of fasteners (8 x 8mm):			N/A
	Min Distance between bolt centers >=50mm (2in):		mm	N/A
	Washer/bolt perimeter:		mm	N/A
	Panel thickness:	0	mm	N/A
	Core thickness:	0	mm	N/A
	Outer skin thickness:	0	mm	N/A
	Inner skin thickness:	0	mm	N/A
	Insert Perimeter on bulkhead:		mm	N/A
	Backing plate thickness:		mm	N/A
	Backing plate perimeter on bulkhead:		mm	N/A
	Distance to nearest edge:		mm	N/A
	Skin shear strength:		Pa	N/A
	Perimeter shear strength >20000N:	#VALUE!	N	N/A
	Tearout strength >20000N:	#VALUE!	N	N/A

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

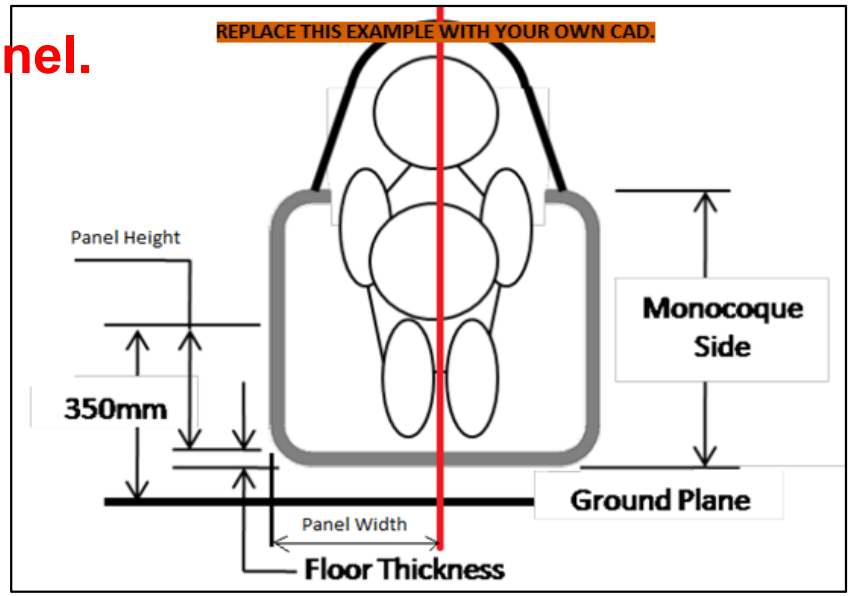
Side Impact Structure

EI of the weakest panel proves that they are two or more Baseline pipes.

(1) It converts by the weakest panel.

A choice only has converting by the weakest panel.

The minimum EI of a perpendicular wall
≧EI applicable to two Baseline pipes
The minimum EI (floor boards)
≧ EI applicable to one Baseline pipes



FSAE™ MONOCOQUE SIDE IMPACT STRUCTURE GUIDANCE NOTES

There is only one scenario for monocoque side-impact structure equivalency.

Unlike other areas of the monocoque, no allowance for geometric form is allowed.

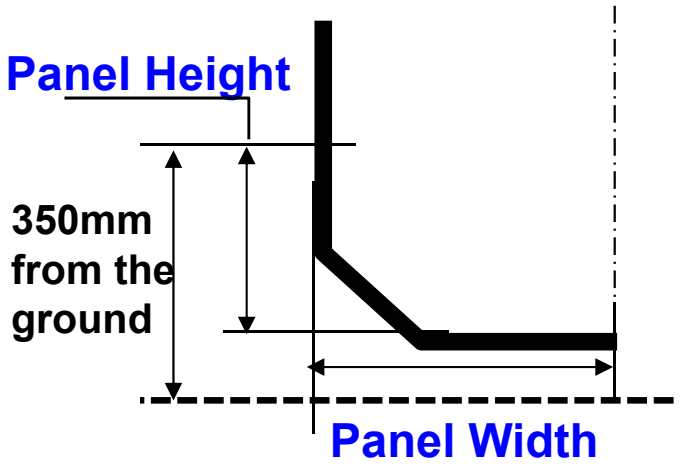
Proof by the technique of anything but this (structure correction) isn't admitted.

The height of Side Impact Structure in monocoque **structure must not include above 350mm from the ground.**

SES cannot be calculated by more than **Panel Height 325mm in consideration of 25mm operation of a suspension**.

A rules-compliant car cannot have a vertical panel more than 325mm at ride height.

The size of a calculation panel
An intersection and a bend are disregarded.



Side Impact Vertical

EQ

Side Impact Structure (SIS)

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

EQ							
T.2.34	**Side Impact Vertical Construction:**		**Tube**				EQ
	Baseline Steel Tubes Replaced:		**0**				N/A
	Layup Used:		T.2.31 Composite				N/A
	Composite Panel Height:				mm		N/A
	Panel thickness:		0		mm		N/A
	Core thickness:				mm		N/A
	Outer skin thickness:				mm		N/A
	Inner skin thickness:				mm		N/A
	Flat Panel Properties						
	Outer (b)	0	m				
	Outer (h)	0	m				
	Thickness	0	m				
	Inner (b)	0	m				
	Inner (h)	0	m				
	Flat Panel Properties						
	A_1	0.00E+00	m^2				
	A_2	0.00E+00	m^2				
	y_1	0	m				
	y_2	0.000	m				
	Centroid		m				
	Flat Panel Properties						
	I_1	0.00E+00	m^4				
	I_2	0.00E+00	m^4				
	Ic_1		m^4				
	Ic_2		m^4				
	Ic_{12}		m^4				
			0 x Steel Tube		**Composite**		
	Wall thickness:		0.0016		0	m	N/A
	Outer Diameter / Panel Thickness:		0.0254		0	m	N/A
	Cross sectional area (A):		0.00E+00		0.00E+00	m^2	N/A
	Second moment of inertia (I):		0.00E+00			m^4	N/A
T.2.5.3a	Young's Modulus (E):		2.00E+11			Pa	N/A
	Ultimate Tensile Strength (S):		3.65E+08			Pa	N/A
	Shear:		2.11E+08			Pa	N/A
Buckling Modulus	E_1*I_1 <= E_2*I_2:		0.00E+00				N/A
UTS	S_1*A_1 <= S_2*A_2:		0.00E+00				N/A
T.2.34.5	Perimeter shear 7500N (1685lbs):		7.50E+03				N/A

Side Impact Floor

EQ

Side Impact Structure (SIS)

EQ

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

T.2.34	**Side Impact Floor Construction:**	**Tube**			EQ
	Baseline Steel Tubes Replaced:	**0**			N/A
	Layup Used:	T.2.31 Composite			N/A
	Composite Panel Height:		mm		N/A
	Panel thickness:	0	mm		N/A
	Core thickness:		mm		N/A
	Outer skin thickness:		mm		N/A
	Inner skin thickness:		mm		N/A

Flat Panel Properties			**Flat Panel Properties**			**Flat Panel Properties**		
Outer (b)	0	m	A_1	0.00E+00	m^2	I_1	0.00E+00	m^4
Outer (h)	0	m	A_2	0.00E+00	m^2	I_2	0.00E+00	m^4
Thickness	0	m	y_1	0	m	Ic_1		m^4
Inner (b)	0	m	y_2	0.000	m	Ic_2		m^4
Inner (h)	0	m	Centroid		m	Ic_{12}		%

		0 x Steel Tube	**Composite**		
	Wall thickness:	0.0016	0	m	N/A
	Outer Diameter / Panel Thickness:	0.0254	0	m	N/A
	Cross sectional area (A):	0.00E+00	0.00E+00	m^2	N/A
	Second moment of inertia (I):	0.00E+00		m^4	N/A
T.2.5.3a	Young's Modulus (E):	2.00E+11		Pa	N/A
	Ultimate Tensile Strength (S):	3.65E+08		Pa	N/A
	Shear:	2.11E+08		Pa	N/A
Buckling Modulus	E_1*I_1 <= E_2*I_2:	0.00E+00			N/A
UTS	S_1*A_1 <= S_2*A_2:	0.00E+00			N/A
T.2.34.5	Perimeter shear 7500N (1685lbs):	7.50E+03			N/A

Main Hoop Brace Support

EI of the weakest panel proves that they are two or more Baseline pipes.

(1) It converts by the weakest panel.

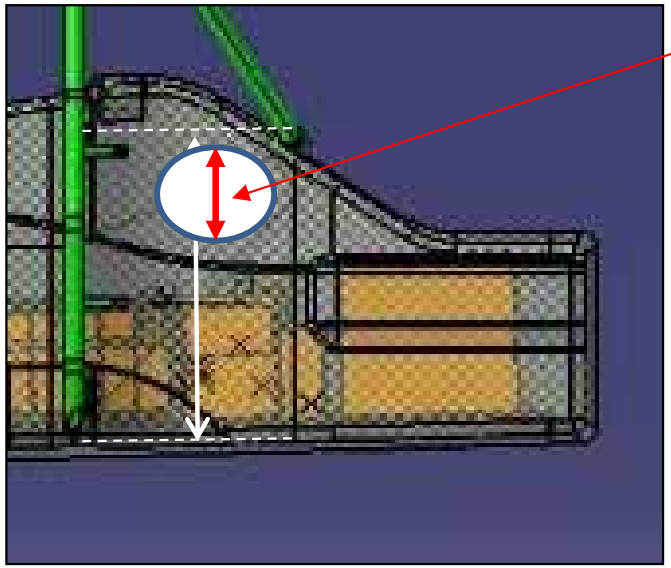
=> If a size is inputted into a calculation sheet, comparative evaluation will be carried out to two Baselines. Panel Height is as the under figure.
When there is a space portion, it calculates in the minimum height except the height.

(2) When EI will be less than 100% by (1)

① Calculate the moment of inertia of area Izz of the circumference of a vehicles center vertical axis.

② Calculate moment of inertia of area Iloc+A*d2 of the circumference of a vehicles center vertical axis on the conditions which have three Baseline pipes in the position (distance d) of the width of MHBS one side.

③ $E_{your} * I_{zz} \geqq E_{Baseline} * (I_{loc} + A*d^2)$ A certain thing is proved



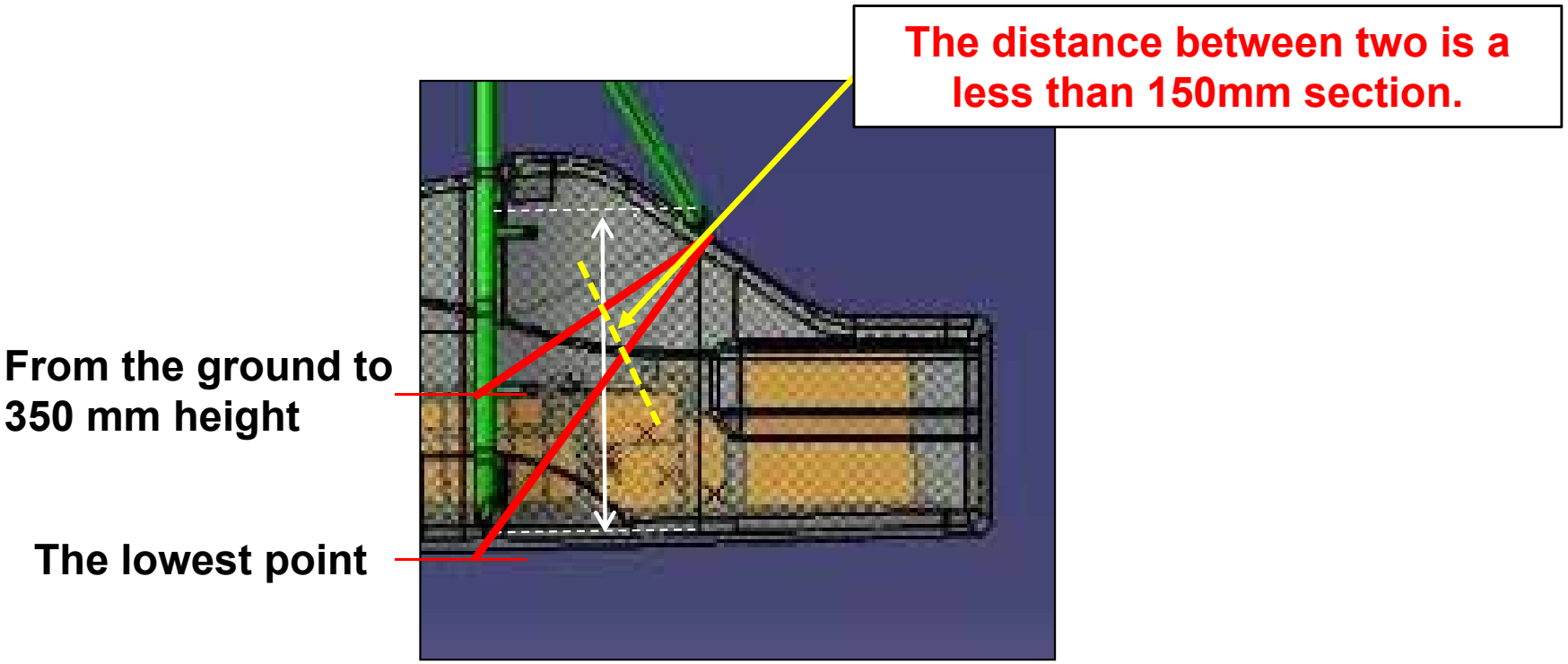
The part is deducted when there is a space portion.

Main Hoop Brace Support

EI of the weakest panel proves that they are two or more Baseline pipes.

(3) When panel conversion cannot be performed

The same calculation as (2) is done.
When MHBS in tube frame structure is assumed, the width of two pipes calculates the section used for calculation in the section used as less than 150mm.



In SES, you have to prove by one of methods.

Main Hoop Brace Support

EQ Main Hoop Brace Supports (MHBS)

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

EQ						
T.2.13	**Main Hoop Brace Support Construction:**		**Tube**			EQ
	Baseline Steel Tubes Replaced:		**0**			N/A
	Layup Used:		T.2.31 Composite			N/A
	Composite Panel Height:			mm		N/A
	Composite cross section depth (d):			mm		N/A
	Composite second moment about car centerline (Izz):			**mm^4**		N/A
	Panel thickness:		0	mm		N/A
	Core thickness:			mm		N/A
	Outer skin thickness:			mm		N/A
	Inner skin thickness:			mm		N/A

Flat Panel Properties		
Outer (b)	0	m
Outer (h)	0	m
Thickness	0	m
Inner (b)	0	m
Inner (h)	0	m

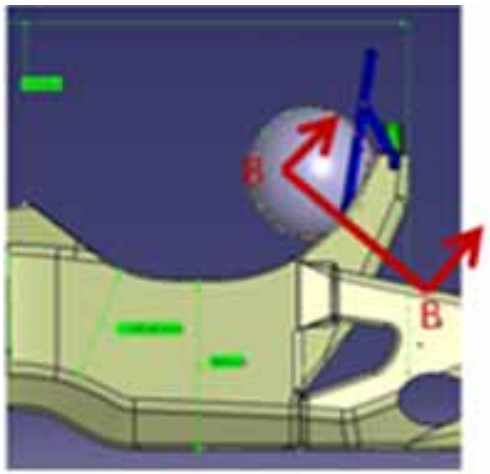
Flat Panel Properties		
A_1	0.00E+00	m^2
A_2	0.00E+00	m^2
y_1	0	m
y_2	0.000	m
Centroid		m

Flat Panel Properties		
I_1	0.00E+00	m^4
I_2	0.00E+00	m^4
Ic_1		m^4
Ic_2		m^4
Ic_{12}		%

		0 x Steel Tube	**Composite**		
T.2.5.1	Wall thickness:	0.001194	0	m	N/A
	Outer Diameter / Panel Thickness:	0.0254	0	m	N/A
	Cross sectional area (A):	0.00E+00	0.00E+00	m^2	N/A
	Second moment of inertia (I):	0.00E+00	0.00E+00	m^4	N/A
	Young's Modulus (E):	2.00E+11		Pa	N/A
	Ultimate Tensile Strength (S):	3.65E+08		Pa	N/A
	Shear:	2.11E+08		Pa	N/A
Buckling Modulus	E_1*I_1 <= E_2*I_2:	0.00E+00			N/A
UTS	S_1*A_1 <= S_2*A_2:	0.00E+00			N/A
Bending	4*S_1*I_1/r <= 4*S_2*I_2/r:	0.00E+00			N/A
Deflection	Bending_1/(48*EI):	0.00E+00			N/A
Energy	0.5*Bending^2/(48*EI):	0.00E+00			N/A
Offset	Itube + Atube*d^2 <= Izz:	0.00E+00			N/A
	Perimeter shear:			N	

Shoulder Harness Attachment

A blank is inputted correctly –> A result is judged automatically.



You should write a size to a drawing correctly.

EQ Shoulder Harness Attachment

EQ

T.4.5	**Shoulder Harness Attachment:**	**Straight Tube**				EQ
	Baseline Steel Tubes Replaced:	**0**				N/A
	Layup Used:	T.2.31 Composite				N/A
	Composite Panel Dimension (Intersecting Car Centerline):			mm		N/A
	Composite cross section depth (d):			mm		N/A
	Composite second moment about car centerline (Izz):			**mm^4**		N/A
	Panel thickness:	0		mm		N/A
	Core thickness:			mm		N/A
	Outer skin thickness:			mm		N/A
	Inner skin thickness:			mm		N/A

Flat Panel Properties			**Flat Panel Properties**			**Flat Panel Properties**		
Outer (b)	0	m	A_1	0.00E+00	m^2	I_1	0.00E+00	m^4
Outer (h)	0	m	A_2	0.00E+00	m^2	I_2	0.00E+00	m^4
Thickness	0	m	y_1	0	m	Ic_1		m^4
Inner (b)	0	m	y_2	0.000	m	Ic_2		m^4
Inner (h)	0	m	Centroid		m	Ic_{12}		%

		0 x Steel Tube	**Composite**		
T.2.5.1	Wall thickness:	0.0024	0	m	N/A
	Outer Diameter / Panel Thickness:	0.0254	0	m	N/A
	Cross sectional area (A):	0.00E+00	0.00E+00	m^2	N/A
	Second moment of inertia (I):	0.00E+00	0.00E+00	m^4	N/A
T.2.5.3a	Young's Modulus (E):	2.00E+11		Pa	N/A
	Ultimate Tensile Strength (S):	3.65E+08		Pa	N/A
	Shear:	2.11E+08		Pa	N/A
Buckling Modulus	E_1*I_1 <= E_2*I_2:	0.00E+00			N/A
UTS	S_1*A_1 <= S_2*A_2:	0.00E+00			N/A
Bending	4*S_1*I_1/r <= 4*S_2*I_2/r:	0.00E+00			N/A
Deflection	Bending_1/(48*EI):	0.00E+00			N/A
Energy	0.5*Bending^2/(48*EI):	0.00E+00			N/A
Offset	Itube + Atube*d^2 <= Izz:	0.00E+00			N/A
	Perimeter shear:			N	

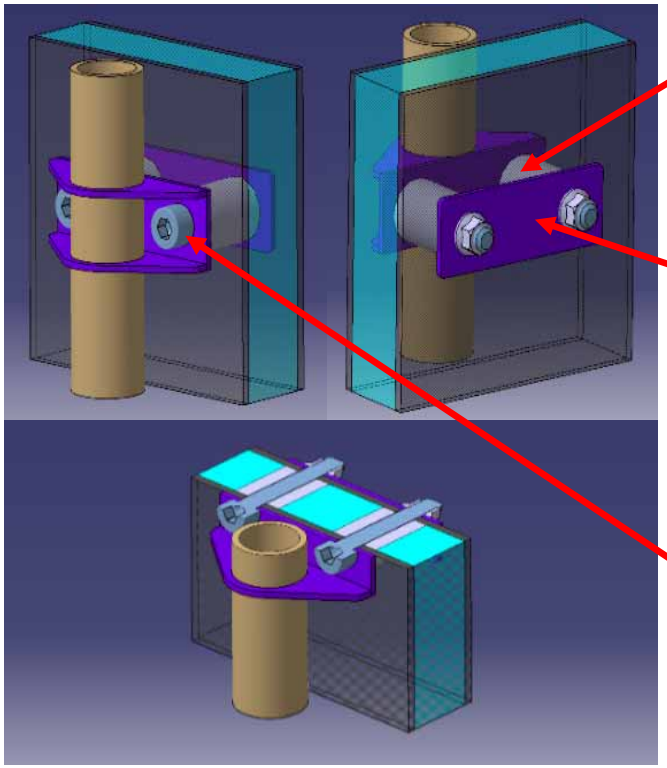
Monocoque Attachments

Graphical Evidence for Bracket / Insert / Backing Plate / Edge Distance are required

More than 2 attachments in each side are required each attachment must have Min. TWO M8 bolts. Front Hoop can be laminated

(Expose a part so that inspector can inspection the pipe thickness)

That it the bracket itself bends or breaks in 30kN or less is not accepted.



Insert

No crushing of the core is permitted

Backing Plate

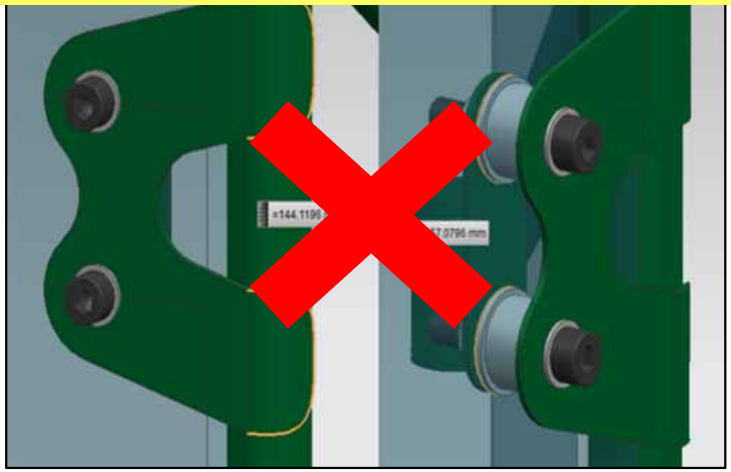
It's necessary the back plate made from steel beyond t2 is indispensable. Input outside perimeter length correctly.

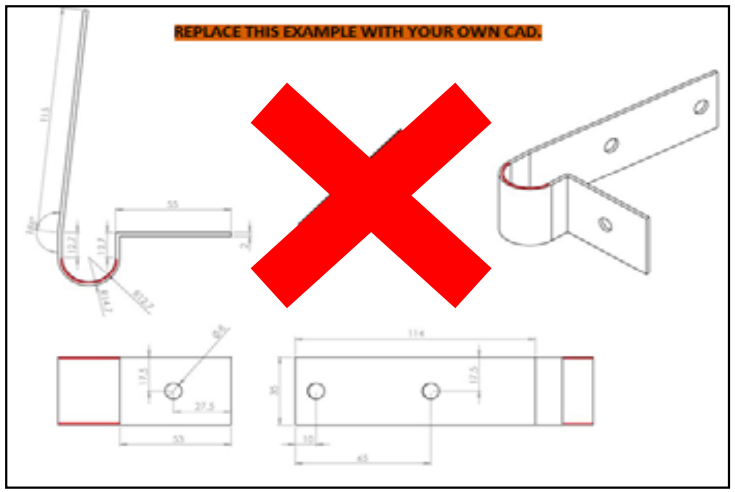
Bracket

Input outside perimeter length & weld length correctly

Edge Distance

Distance from bolt centerline to nearest "free edge"





Front Hoop Mounts

Attachments evaluation in case of Front Hoop is a lamination.

EQ Front Hoop Mounts

EQ				
T.2.36.4	**Front Hoop Mounts:**	Welded		N/A
	Front Hoop Mounts:	Bolted		N/A
	Front Hoop Lamination:	T.2.31 Composite		N/A
	Front Hoop centerline length:		mm	N/A
	Laminate thickness:		mm	N/A
	Skin shear area - centerline x 1 thickness:		m^2	N/A
	Skin shear strength:		Pa	N/A
T.2.36.4b	Single tearout path >=180000N:		N	N/A
	Front Hoop Lamination:	Pre-Cure		N/A
	Lap joint strength:		Pa	N/A
	Total bond width including both sides of the Front Hoop:		mm	N/A
	Bond shear area:	0	m^2	N/A
T.2.36.4b	Bond failure >=180000N:	0	N	N/A

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

Front Hoop Mounts

Attachments evaluation in case of Front Hoop is bolted.

EQ Front Hoop Mounts

EQ				
T.2.40	**Front Hoop Mounts:**	Welded		N/A
T.2.35.3	Number of Main Hoop Mounts on each side:	3		N/A
	Top Front Hoop mount layup used:	T.2.31 Composite		N/A
	Fastener diameter:		mm	N/A
T.2.40.6	No. of fasteners (2 x 8mm):			N/A
	Panel thickness:	0	mm	N/A
	Core thickness:		mm	N/A
	Outer skin thickness:		mm	N/A
	Inner skin thickness:		mm	N/A
	Bracket to brace weld length:		mm	N/A
	Bracket thickness:		mm	N/A
	Bracket perimeter on monocoque:		mm	N/A
	Insert Perimeter on monocoque:		mm	N/A
	Backing plate thickness:		mm	N/A
	Backing plate perimeter on monocoque:		mm	N/A
	Distance to nearest edge:		mm	N/A
	Skin shear strength:		Pa	N/A
T.2.40.1	Perimeter shear strength >30000N:		N	N/A
	Perimeter shear strength >30000N:		N	N/A
	Tearout strength >30000N:		N	N/A

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

Front Hoop Mounts

Attachments evaluation of Upper SIS Mount

EQ Front Hoop Mounts

EQ				
T.2.40	Upper SIS mount layup used:	T.2.31 Composite		N/A
	Fastener diameter:		mm	N/A
T.2.40.6	No. of fasteners (2 x 8mm):			N/A
	Panel thickness:	0	mm	N/A
	Core thickness:		mm	N/A
	Outer skin thickness:		mm	N/A
	Inner skin thickness:		mm	N/A
	Bracket to brace weld length:		mm	N/A
	Bracket thickness:		mm	N/A
	Bracket perimeter on monocoque:		mm	N/A
	Insert Perimeter on monocoque:		mm	N/A
	Backing plate thickness:		mm	N/A
	Backing plate perimeter on monocoque:		mm	N/A
	Distance to nearest edge:		mm	N/A
	Skin shear strength:		Pa	N/A
T.2.40.1	Perimeter shear strength >30000N:		N	N/A
	Perimeter shear strength >30000N:		N	N/A
	Tearout strength >30000N:		N	N/A

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

Front Hoop Mounts

Attachments evaluation of Bottom SIS Mount

EQ Front Hoop Mounts

EQ				
T.2.40	Bottom mount layup used:	T.2.31 Composite		N/A
	Fastener diameter:		mm	N/A
T.2.40.6	No. of fasteners (2 x 8mm):			N/A
	Panel thickness:	0	mm	N/A
	Core thickness:		mm	N/A
	Outer skin thickness:		mm	N/A
	Inner skin thickness:		mm	N/A
	Bracket to brace weld length:		mm	N/A
	Bracket thickness:		mm	N/A
	Bracket perimeter on monocoque:		mm	N/A
	Insert Perimeter on monocoque:		mm	N/A
	Backing plate thickness:		mm	N/A
	Backing plate perimeter on monocoque:		mm	N/A
	Distance to nearest edge:		mm	N/A
	Skin shear strength:		Pa	N/A
T.2.40.1	Perimeter shear strength >30000N:		N	N/A
	Perimeter shear strength >30000N:		N	N/A
	Tearout strength >30000N:		N	N/A

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

Main Hoop Mounts

Main Hoop Attachments is only bolted.

EQ Main Hoop Mounts

EQ				
T.2.40	**Main Hoop Mounts:**	Welded		N/A
T.2.35.3	Number of Main Hoop Mounts on each side:	3		N/A
	Top mount layup used:	T.2.31 Composite		N/A
	Fastener diameter:		mm	N/A
T.2.40.6	No. of fasteners (2 x 8mm):			N/A
	Panel thickness:	0	mm	N/A
	Core thickness:		mm	N/A
	Outer skin thickness:		mm	N/A
	Inner skin thickness:		mm	N/A
	Bracket to brace weld length:		mm	N/A
	Bracket thickness:		mm	N/A
	Bracket perimeter on monocoque:		mm	N/A
	Insert Perimeter on monocoque:		mm	N/A
	Backing plate thickness:		mm	N/A
	Backing plate perimeter on monocoque:		mm	N/A
	Distance to nearest edge:		mm	N/A
	Skin shear strength:		Pa	N/A
T.2.40.1	Perimeter shear strength >30000N:		N	N/A
	Perimeter shear strength >30000N:		N	N/A
	Tearout strength >30000N:		N	N/A

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

Main Hoop Mounts

Attachments evaluation of Upper SIS Mount.

EQ

Main Hoop Mounts

	EQ			
T.2.40	Upper SIS mount layup used:	T.2.31 Composite		N/A
	Fastener diameter:		mm	N/A
T.2.40.6	No. of fasteners (2 x 8mm):			N/A
	Panel thickness:	0	mm	N/A
	Core thickness:		mm	N/A
	Outer skin thickness:		mm	N/A
	Inner skin thickness:		mm	N/A
	Bracket to brace weld length:		mm	N/A
	Bracket thickness:		mm	N/A
	Bracket perimeter on monocoque:		mm	N/A
	Insert Perimeter on monocoque:		mm	N/A
	Backing plate thickness:		mm	N/A
	Backing plate perimeter on monocoque:		mm	N/A
	Distance to nearest edge:		mm	N/A
	Skin shear strength:		Pa	N/A
T.2.40.1	Perimeter shear strength >30000N:		N	N/A
	Perimeter shear strength >30000N:		N	N/A
	Tearout strength >30000N:		N	N/A

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

Main Hoop Mounts

Attachments evaluation of Bottom SIS Mount.

EQ Main Hoop Mounts

	EQ			
T.2.40	Bottom mount layup used:	T.2.31 Composite		N/A
	Fastener diameter:		mm	N/A
T.2.40.6	No. of fasteners (2 x 8mm):			N/A
	Panel thickness:	0	mm	N/A
	Core thickness:		mm	N/A
	Outer skin thickness:		mm	N/A
	Inner skin thickness:		mm	N/A
	Bracket to brace weld length:		mm	N/A
	Bracket thickness:		mm	N/A
	Bracket perimeter on monocoque:		mm	N/A
	Insert Perimeter on monocoque:		mm	N/A
	Backing plate thickness:		mm	N/A
	Backing plate perimeter on monocoque:		mm	N/A
	Distance to nearest edge:		mm	N/A
	Skin shear strength:		Pa	N/A
T.2.40.1	Perimeter shear strength >30000N:		N	N/A
	Perimeter shear strength >30000N:		N	N/A
	Tearout strength >30000N:		N	N/A

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

Hoop Brace Mounts

Attachments evaluation of Main Hoop Brace Mount.

EQ Hoop Brace Mounts

EQ				
T.2.40	**Main Hoop Brace Mounts:**	Welded		N/A
	Layup used:	T.2.31 Composite		N/A
	Fastener diameter:		mm	N/A
T.2.40.6	No. of fasteners (2 x 8mm or 1 x 10mm):			N/A
	Panel thickness:	0	mm	N/A
	Core thickness:		mm	N/A
	Outer skin thickness:		mm	N/A
	Inner skin thickness:		mm	N/A
	Bracket to brace weld length:		mm	N/A
	Bracket thickness:		mm	N/A
	Bracket perimeter on monocoque:		mm	N/A
	Insert Perimeter on monocoque:		mm	N/A
	Backing plate thickness:		mm	N/A
	Backing plate perimeter on monocoque:		mm	N/A
	Distance to nearest edge:		mm	N/A
	Skin shear strength:		Pa	N/A
T.2.40.1	Perimeter shear strength >30000N:		N	N/A
	Perimeter shear strength >30000N:		N	N/A
	Tearout strength >30000N:		N	N/A

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

Hoop Brace Mounts

Attachments evaluation of Forward Front Hoop Brace Mount.

EQ Hoop Brace Mounts

EQ				
T.2.40	**Forward Front Hoop Brace Mounts:**	Welded		N/A
	Layup used:	T.2.31 Composite		N/A
	Fastener diameter:		mm	N/A
T.2.40.6	No. of fasteners (2 x 8mm or 1 x 10mm):			N/A
	Panel thickness:	0	mm	N/A
	Core thickness:		mm	N/A
	Outer skin thickness:		mm	N/A
	Inner skin thickness:		mm	N/A
	Bracket to brace weld length:		mm	N/A
	Bracket thickness:		mm	N/A
	Bracket perimeter on monocoque:		mm	N/A
	Insert Perimeter on monocoque:		mm	N/A
	Backing plate thickness:		mm	N/A
	Backing plate perimeter on monocoque:		mm	N/A
	Distance to nearest edge:		mm	N/A
	Skin shear strength:		Pa	N/A
T.2.40.1	Perimeter shear strength >30000N:		N	N/A
	Perimeter shear strength >30000N:		N	N/A
	Tearout strength >30000N:		N	N/A

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.

Hoop Brace Mounts

Attachments evaluation of Reward Front Hoop Brace Mount.

EQ Hoop Brace Mounts

EQ				
T.2.40	**Rearward Front Hoop Brace Mounts:**	N/A		N/A
	Layup used:	T.2.31 Composite		N/A
	Fastener diameter:		mm	N/A
T.2.40.6	No. of fasteners (2 x 8mm or 1 x 10mm):			N/A
	Panel thickness:	0	mm	N/A
	Core thickness:		mm	N/A
	Outer skin thickness:		mm	N/A
	Inner skin thickness:		mm	N/A
	Bracket to brace weld length:		mm	N/A
	Bracket thickness:		mm	N/A
	Bracket perimeter on monocoque:		mm	N/A
	Insert Perimeter on monocoque:		mm	N/A
	Backing plate thickness:		mm	N/A
	Backing plate perimeter on monocoque:		mm	N/A
	Distance to nearest edge:		mm	N/A
	Skin shear strength:		Pa	N/A
T.2.40.1	Perimeter shear strength >30000N:		N	N/A
	Perimeter shear strength >30000N:		N	N/A
	Tearout strength >30000N:		N	N/A

A blank is inputted correctly –> A result is judged automatically.

You should write a size to a drawing correctly.