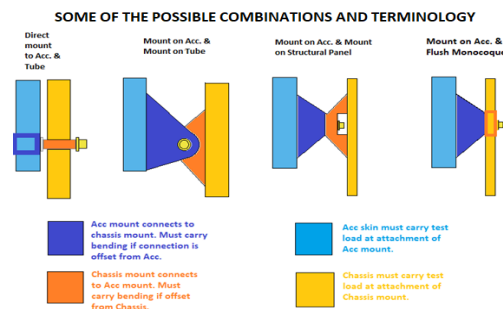


Accumulator Container Attach/Mountの計算 in SES



Rules上の要求

Load Based: いかなる方向へも1か所あたり15kN以上の強度

Corner Mount: 重量の $1/4 \times 40G$ の荷重に対し所定の強度で良いが取り付け箇所の指定あり

SESでは、

①Accumulator ContainerのWall

②Accumulator Mount

③Chassis Mount

④Chassis (Tube or Monocoque Skin)

Acc. Mount 1-5

Chassis Mount 1-5

の4つに分けてそれぞれ計算している

Outboard bending strength is required for the fastener (try to move all pins to ends, gusset thickness parallel to the axis)

F.10.5.6-7	Mounting Method: Mass Based	EQ
	Test Load: 15000 N	EQ
	Accumulator mount symmetry: Left/Right	EQ
	Chassis mount symmetry: Left/Right	EQ

This will change the names of sections.

① Mounting Method

BLANK Accumulator Mount 1		
ACCUMULATOR MOUNT: Where fastener passes through to Chassis Mount		
BLANK		
Intersection of fastener axis and fastener shear plane:		
the front/rear planes of the accumulator segments:	mm	BLANK
the top/bottom planes of the accumulator segments:	mm	BLANK
the left/right planes of the accumulator segments:	mm	BLANK
Total Surface Offset, zero for an internal hardpoint:	0 mm	EQ
Mount material (Accumulator skin if directly mounted):		EQ
Young's Modulus (E):	#N/A Pa	EQ
Ultimate Tensile and Bending Strength (S):	#N/A Pa	EQ
Shear:	#N/A Pa	EQ
F.10.5.8.b	--Pullout--Face thickness, do not include core:	mm
--Tearout--Minimum - Fastener spacing, edge, or corner distance:	mm	BLANK
Number of fasteners used (2x if in double shear):		BLANK
Fastener shear diameter:	mm	BLANK
Threads in shear:		BLANK
Fastener UTS:	Pa	BLANK
--Pullout--Min total perimeter of washers or inserts on one surface:	mm	BLANK
F.10.5.8.a	--Shear-- $0.577 \times \text{fasteners} \times \text{UTS} \times \pi \times r^2 \geq \text{Test Load}$:	0.00E+00
--Pullout--Mount shear*thickness*perimeter $\geq \text{Test Load}$:	#N/A	#N/A
--Tearout--Mount shear*thickness*edge distance $\geq \text{Test Load}$:	#N/A	#N/A
Thread pullout $\min(\text{UTS}) \times \text{face_thickness} \times \pi \times r^2 \geq \text{Test Load}$:	#N/A	#N/A

① ACCUMULATOR MOUNT

MOUNT GEOMETRY - ACCUMULATOR SIDE		
EQ		
Mount cross section on accumulator skin:		N/A
Mount thickness (B):	mm	N/A
Mount length (L):	mm	N/A
Minimum gusset thickness (T):	mm	N/A
Minimum gusset height normal to mount face (H):	mm	N/A
F.3.5	0.0 15000N Bending in shear $M^*y / I < S_u$:	N/A
#N/A	0.0 15000N Bending normal $M^*y / I < S_u$:	N/A
#N/A	Parabolic shear $3 \times \text{Test Load} / 2 \times \text{area} \leq \text{Shear}$:	N/A

② MOUNT GEOMETRY -ACCUMULATOR SIDE

ACCUMULATOR MOUNT :: Accumulator Skin interface		
EQ		
Accumulator skin at accumulator mount:	Exterior Wall	6061-T6 Welded
Young's Modulus (E):	6.90E+10 Pa	N/A
Ultimate Tensile and Bending Strength (S):	1.75E+08 Pa	N/A
Shear:	1.01E+08 Pa	N/A
F.10.5.8.b	3.2 mm	N/A
	Continuous	N/A
	mm	N/A
	mm	N/A
	mm	N/A
	Pa	N/A
	mm	N/A
	0.00E+00	N/A
	0.00E+00	N/A
	0.00E+00	N/A
	54.0 mm	N/A
	3.2 mm	N/A
	1.74E+04 116.3%	N/A
F.10.1.5	1.74E+04 N/mm ²	N/A
F.10.1.5	N/mm ²	N/A
F.5.5.3	mm ²	N/A
	mm	N/A
	mm	N/A

③ ACCUMULATOR MOUNT -Accumulator Skin interface

BLANK Chassis Mount 1		
CHASSIS MOUNT: Where fastener passes through to Accumulator Mount		
BLANK		
Intersection of fastener axis and fastener shear plane:		
Review sections below: mounts per tube, bending if fastener shear is offset:	mm	BLANK
Offset from composite panel or radially from tube surface:		BLANK
Mount material (Composite skin for internal hardpoint):		N/A
Young's Modulus (E):	#N/A Pa	N/A
Ultimate Tensile and Bending Strength (S):	#N/A Pa	N/A
Shear:	#N/A Pa	N/A
F.10.5.8.b	--Pullout--Face thickness, do not include core:	mm
--Tearout--Minimum - Fastener spacing, edge, or corner distance:	mm	N/A
From	Number of fasteners used (2x if in double shear):	0
Accumulator Mount 1	Fastener shear diameter:	0 mm
	Threads in shear:	0
	Fastener UTS:	0.00E+00 Pa
--Pullout--Min total perimeter of washers or inserts on one surface:	mm	N/A
F.10.5.8.a	--Shear-- $0.577 \times \text{fasteners} \times \text{UTS} \times \pi \times r^2 \geq \text{Test Load}$:	0.00E+00
--Pullout--Mount shear*thickness*perimeter $\geq \text{Test Load}$:	#N/A	#N/A
--Tearout--Mount shear*thickness*edge distance $\geq \text{Test Load}$:	#N/A	#N/A
TUBE CHECK: < 95% not a cause for rejection in 2024. See cell AC12.		
BLANK		
Chassis type at mount:		BLANK
F.3.2.1	Square side:	mm
	Chassis tube wall:	mm
F.10.5.2.a	Number of chassis mounts on this tube:	
F.3.4.2	Ultimate Strength (Su):	#N/A Pa
	Acc Mount Tube second moment of inertia (I):	0.00E+00 mm ⁴
	Tube Length (L):	mm
	Chassis mount distance to closest triangulated node (a):	mm
F.10.1.1.a	Tube Max Bending Force (Su*I) / (a*(1-a/L)*OD/2):	
https://engineeringlibrary.org/reference/beam-forces-moments-all-force-stress-manual		
MOUNT GEOMETRY - CHASSIS SIDE		
EQ		
Mount cross section on chassis surface:		N/A
Mount thickness (B):	mm	N/A
Mount length (L):	mm	N/A
Minimum gusset thickness (T):	mm	N/A
Minimum gusset height normal to mount face (H):	mm	N/A
#N/A	0.0 15000N Bending in shear $M^*y / I < S_u$:	N/A
#N/A	0.0 15000N Bending normal $M^*y / I < S_u$:	N/A
#N/A	Parabolic shear $3 \times \text{Test Load} / 2 \times \text{area} \leq \text{Shear}$:	N/A
Chassis Mount to Chassis interface		
EQ		
Chassis wall at chassis mount:		N/A
Young's Modulus (E):	#N/A Pa	N/A
Ultimate Tensile and Bending Strength (S):	#N/A Pa	N/A
Shear:	#N/A Pa	N/A
F.10.5.8.b	mm	N/A
	mm	N/A
	mm	N/A
	mm	N/A
	Pa	N/A
	mm	N/A
	0.00E+00	N/A
	#N/A	#N/A
	#N/A	#N/A
	mm	N/A
	0 mm	N/A
F.10.1.5	N/mm ²	N/A
F.10.1.5	N/mm ²	N/A
F.5.5.3	mm ²	N/A
	mm	N/A
	mm	N/A

④ CHASSIS MOUNT

⑤ TUBE CHECK

⑥ MOUNT GEOMETRY -CHASSIS SIDE

⑦ Chassis Mount to Chassis interface

事前準備としてU22のMounting MethodをRulesを理解したうえで決めておくこと。

Sufficient bending strength is needed for the fastener trying to move ALONG its axis, gusset thickness parallel to the axis:

F.10.5.6-7

Mounting Method: Mass Based

Test Load: 15000 N

EQ

Accumulator mount symmetry: Left/Right

Chassis mount symmetry: Left/Right

This will change the names of sections.

This will change the names of sections.

EQ

EQ

EQ

EQ

Mass Based = Load Based

Corner Attachments

F.10.5.7 Accumulator Attachment – Load Based

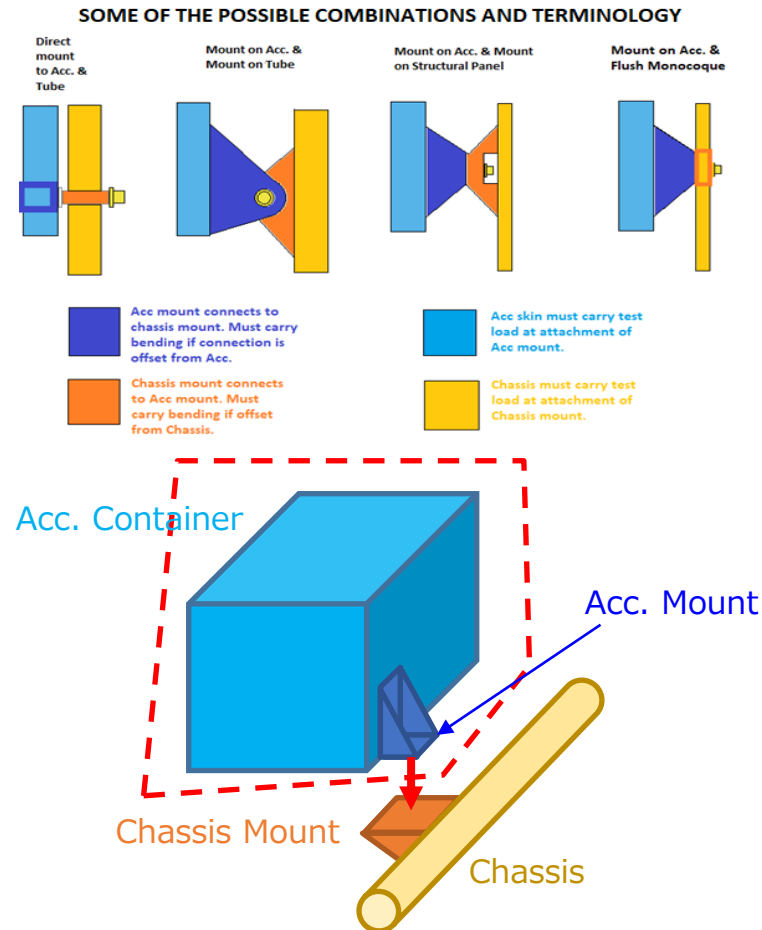
- a. The minimum number of attachment points depends on the total mass of the container:
- | Accumulator Weight | Minimum Attachment Points |
|--------------------|---------------------------|
| < 20 kg | 4 |
| 20 – 30 kg | 6 |
| 30 – 40 kg | 8 |
| > 40 kg | 10 |
- b. Each attachment point, including any brackets, backing plates and inserts, must be able to withstand 15 kN minimum in any direction

F.10.5.6 Accumulator Attachment – Corner Attachments

- a. Eight or more attachments are required for any configuration.
- One attachment for each corner of a rectangular structure of multiple Accumulator Segments
 - More than the minimum number of fasteners may be required for non rectangular arrangements
- Examples: If not filled in with additional structure, an extruded L shape would require attachments at 10 convex corners (the corners at the inside of the L are not convex); an extruded hexagon would require 12 attachments*
- b. The mechanical connections at each corner must be 50 mm or less from the corner of the Segment
- c. Each attachment point must be able to withstand a Test Load equal to 1/4 of total mass of the container accelerating at 40 g

- Mounting Methodによって要件が異なるので注意
- 本資料ではMass Basedで解説するが各Mountごとに記述する内容自体は同じ。

Accumulator Mount 1-5の構成



BLANK		Accumulator Mount 1			
ACCUMULATOR MOUNT: Where fastener passes through to Chassis Mount					
BLANK					
Intersection of fastener axis and fastener shear plane.				EQ	
	the front/rear planes of the accumulator segments:		mm	BLANK	
	the top/bottom planes of the accumulator segments:		mm	BLANK	
	the left/right planes of the accumulator segments:		mm	BLANK	
	Total Surface Offset, zero for an internal hardpoint:	0	mm	EQ	
	Mount material (Accumulator skin if directly mounted):			EQ	
	Young's Modulus (E):	#N/A	Pa	EQ	
	Ultimate Tensile and Bending Strength (S):	#N/A	Pa	EQ	
	Shear:	#N/A	Pa	EQ	
F.10.5.8.b	--Pullout--Face thickness, do not include core:		mm	BLANK	
--Tearout--Minimum - Fastener spacing, edge, or corner distance:			mm	BLANK	
	Number of fasteners used (2x if in double shear):			BLANK	
	Fastener shear diameter:		mm	BLANK	
	Threads in shear:			BLANK	
	Fastener UTS:		Pa	BLANK	
--Pullout--Min total perimeter of washers or inserts on one surface:			mm	BLANK	
F.10.5.8.a	--Shear-- $0.577 * \text{fasteners} * \text{UTS} * \pi * r^2 \geq \text{Test Load}$:	0.00E+00		EQ	
	--Pullout--Mount shear*thickness*perimeter $\geq \text{Test Load}$:	#N/A	#N/A	#N/A	
	--Tearout--Mount shear*thickness*edge distance $\geq \text{Test Load}$:	#N/A	#N/A	#N/A	
	Thread pullout $\min(\text{UTS}) * \text{face_thickness} * \pi * \text{minor}_r^2 \geq \text{Test Load}$:	#N/A	#N/A	#N/A	
MOUNT GEOMETRY - ACCUMULATOR SIDE					
EQ					
	Mount cross section on accumulator skin:			N/A	
	Mount thickness (B):		mm	N/A	
	Mount length (L):		mm	N/A	
	Minimum gusset thickness (T):		mm	N/A	
	Minimum gusset height normal to mount face (H):		mm	N/A	
F.3.5	0.0 15000N Bending in shear $M^*y / I < S_u$:			N/A	
#N/A	0.0 15000N Bending normal $M^*y / I < S_u$:			N/A	
#N/A	Parabolic shear $3 * \text{Test Load} / 2 * \text{area} \leq \text{Shear}$:			N/A	
ACCUMULATOR MOUNT :: Accumulator Skin interface					
EQ					
	Accumulator skin at accumulator mount:	Exterior Wall	6061-T6 Welded	N/A	
	Young's Modulus (E):		6.90E+10 Pa	N/A	
	Ultimate Tensile and Bending Strength (S):		1.75E+08 Pa	N/A	
	Shear:		1.01E+08 Pa	N/A	
F.10.5.8.b		3.2	mm	N/A	
		Continuous		N/A	
			mm	N/A	
			mm	N/A	
			mm	N/A	
			Pa	N/A	
			mm	N/A	
		0.00E+00		N/A	
		0.00E+00		N/A	
		0.00E+00		N/A	
		54.0	mm	N/A	
		3.2	mm	N/A	
		1.74E+04	116.3%	N/A	
F.10.1.5			N/mm^2	N/A	
F.10.1.5			N/mm^2	N/A	
			mm^2	N/A	
F.5.5.3				N/A	
			mm	N/A	
			mm	N/A	

“Acc. Mountの”
Chassis Mountへの取り付け部の強度計算

- BoltのShear
- 最小Perimeterによるせん断 (直に雌ねじを切った場合は引抜強度)
- 再近傍エッジへのティアアウト

※(直に雌ねじを切る場合、ねじインサートの強度がSkinの強度の弱い方)

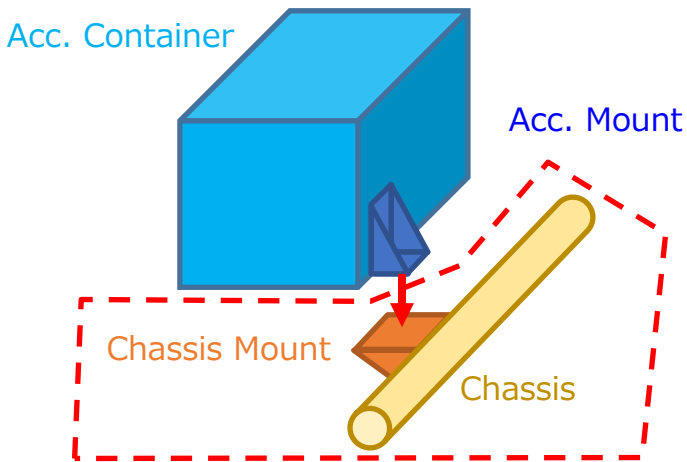
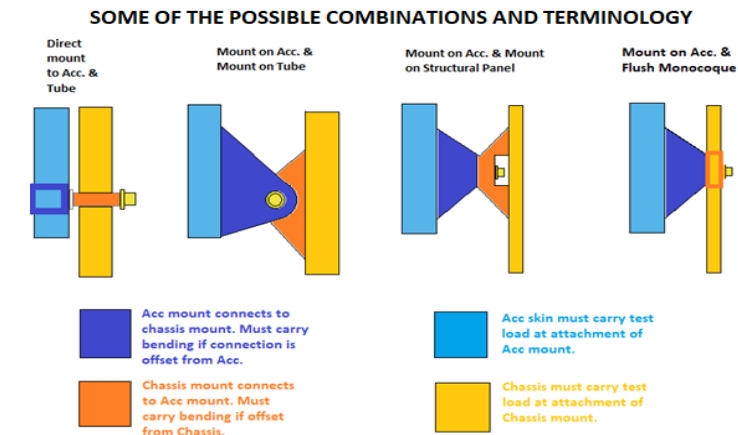
“Acc. Mountそのものの”
形状による強度計算

- せん断曲げ
- 通常曲げ
- Parabolic Shear

“Acc. ContainerのWall部の”
強度計算

- マウント方法ごとに計算

Chassis Mount 1-5の構成



BLANK Chassis Mount 1			
CHASSIS MOUNT: Where fastener passes through to Accumulator Mount			
BLANK			
Intersection of fastener axis and fastener shear plane:			
Review sections below: mounts per tube, bending if fastener shear is offset.		EQ	BLANK
Offset from composite panel or radially from tube surface:		mm	BLANK
Mount material (Composite skin for internal hardpoint):			N/A
Young's Modulus (E):		#N/A Pa	N/A
Ultimate Tensile and Bending Strength (S):		#N/A Pa	N/A
Shear:		#N/A Pa	N/A
F.10.5.8.b --Pullout--Face thickness, do not include core:		mm	N/A
--Tearout--Minimum - Fastener spacing, edge, or corner distance:		mm	N/A
From Number of fasteners used (2x if in double shear):		1	N/A
Accumulator Mount 1 Fastener shear diameter:		8 mm	N/A
Threads in shear:		Yes	N/A
Fastener UTS: 8.00E+08 Pa			N/A
Pullout--Min total perimeter of washers or inserts on one surface:		43 mm	N/A
F.10.5.8.a--Shear--0.577*fasteners*UTS*pi*r^2 >= Test Load: 2.32E+04 154.7%			N/A
--Pullout--Mount shear*thickness*perimeter >= Test Load:		#N/A #N/A	N/A
--Tearout--Mount shear*thickness*edge distance >= Test Load:		#N/A #N/A	N/A
TUBE CHECK: < 95% not a cause for rejection in 2024. See cell AC12.			
BLANK			
Chassis type at mount:			BLANK
F.3.2.1 Square side:		mm	BLANK
F.10.5.2.a Number of chassis mounts on this tube:			BLANK
F.3.4.2 Ultimate Strength (Su):		#N/A Pa	EQ
Acc Mount Tube second moment of inertia (I): 0.00E+00 mm^4			BLANK
Tube Length (L):		mm	BLANK
Chassis mount distance to closest triangulated node (a):		mm	BLANK
F.10.1.1.a Tube Max Bending Force (Su*I)/(a*(1-a/L)*OD/2):			BLANK
https://engineeringlibrary.org/reference/beam-forces-moments-air-force-stress-manual			
MOUNT GEOMETRY - CHASSIS SIDE			
EQ			
Mount cross section on chassis surface:			N/A
Mount thickness (B):		mm	N/A
Mount length (L):		mm	N/A
Minimum gusset thickness (T):		mm	N/A
Minimum gusset height normal to mount face (H):		mm	N/A
#N/A 0.0 15000N Bending in shear M*y / I < Su:			N/A
#N/A 0.0 15000N Bending normal M*y / I < Su:			N/A
#N/A Parabolic shear 3*Test Load/2*area <= Shear:			N/A
Chassis Mount to Chassis interface			
EQ			
Chassis wall at chassis mount:			N/A
Young's Modulus (E):		#N/A Pa	N/A
Ultimate Tensile and Bending Strength (S):		#N/A Pa	N/A
Shear:		#N/A Pa	N/A
F.10.5.8.b		mm	N/A
		mm	N/A
		mm	N/A
		mm	N/A
		mm	N/A
		mm	N/A
		mm	N/A
		0.00E+00	N/A
		#N/A #N/A	N/A
		#N/A #N/A	N/A
		mm	N/A
		0 mm	N/A
F.10.1.5		N/mm^2	N/A
F.10.1.5		N/mm^2	N/A
		mm^2	N/A
F.5.5.3			N/A
		mm	N/A
		mm	N/A
		mm	N/A
		mm	N/A

“Chassis Mountの”
Acc. Mountへの取り付け部の強度計算

- BoltのShear (Accで計算済み)
- 最小Perimeterによるせん断 (直に雌ねじを切った場合は引抜強度)
- 再近傍エッジへのティアアウト

“Tubeの強度” (Tube Only)
両端固定梁の1点(or 2点)荷重に対する強度を見ている

“Chassis Mountそのものの”
形状による強度計算

- せん断曲げ
- 通常曲げ
- Parabolic Shear

“Chassis側の接合強度”

①ACCUMULATOR MOUNT 入力ガイダンス

ACCUMULATOR MOUNT: Where fastener passes through to Chassis Mount

CHECK				
Intersection of fastener axis and fastener shear plane				
Between	the front/rear planes of the accumulator segments:	0	mm	EQ
Between	the top/bottom planes of the accumulator segments:	0	mm	EQ
Outside	the left/right planes of the accumulator segments:	13.32	mm	EQ
Total Surface Offset, zero for an internal hardpoint:		13.32	mm	EQ
Mount material (Accumulator skin if directly mounted):		core		EQ
Young's Modulus (E):		4.62E+10	Pa	EQ
Ultimate Tensile and Bending Strength (S):		3.89E+08	Pa	EQ
Shear:		1.08E+08	Pa	EQ
F.10.5.7.b	Mounting face thickness (Do not include core.):	8.8	mm	EQ
Minimum - Fastener spacing, edge, or corner distance:		8.7	mm	EQ
Number of fasteners used (2x if in double shear):		1		EQ
Fastener diameter:		6	mm	EQ
Threads in shear:		Yes		CHECK
Fastener UTS:		1.40E+09	Pa	CHECK
Min total perimeter of all washers, inserts, brackets on one surface:		20.7345	mm	EQ
F.10.5.7.c --Shear-- $0.577 * \text{fasteners} * \text{UTS} * \pi * r^2 \geq \text{Test Load}$:		2.28E+04	15.2%	EQ
--Pullout-- $\text{Mount shear} * \text{thickness} * \text{perimeter} \geq \text{Test Load}$:		1.97E+04	131.5%	EQ
--Tearout-- $\text{Mount shear} * \text{thickness} * \text{edge distance} \geq \text{Test Load}$:		1.65E+04	110.3%	EQ

「コンテナ内のSegment端」と「Acc. MountのChassis Mountとの締結点」との位置関係

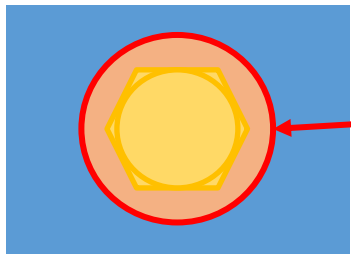
ボルト穴から最寄りのエッジまでの距離

せん断で受ける場合はボルトの谷底径 (F.10.5.8a)

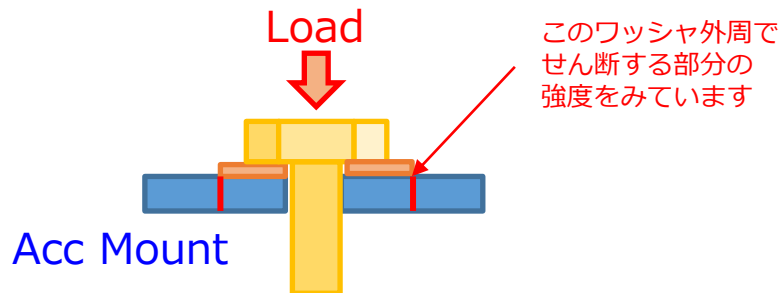
車両前後方向への荷重に対しせん断ならばYes (F.10.1.1a)

ボルトの強度

Chassis Mount との締結でAcc. Mountをせん断しうる物体(ボルトヘッド・ワッシャ・カラー)の最小の周長



※通常の場合にMin total Perimeterに入力する寸法



Acc. Mount <-> Chassis Mount間に径の小さいカラーを挟む場合はそのカラーの外周がMin Perimeterになる場合があるので注意

ブラケットに直接雌ねじを切った場合は、ボルト径の周長を入力し、Thicknessにはねじ部深さを入力する(一般的な雌ねじ引抜強度の計算になる)

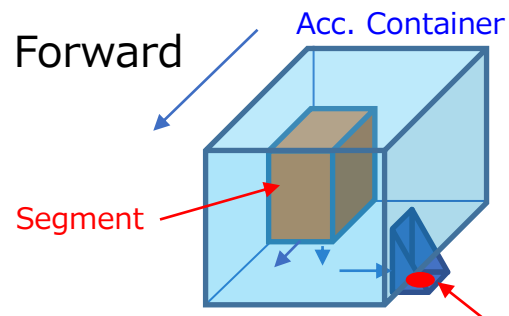
①ACCUMULATOR MOUNT 入力ガイダンス

ACCUMULATOR MOUNT: Where fastener passes through to Chassis Mount			
CHECK			
Intersection of fastener axis and fastener shear plane			
Between	the front/rear planes of the accumulator segments:	0 mm	EQ
Between	the top/bottom planes of the accumulator segments:	0 mm	EQ
Outside	the left/right planes of the accumulator segments:	13.32 mm	EQ
Total Surface Offset, zero for an internal hardpoint:		13.32 mm	EQ
Mount material (Accumulator skin if directly mounted):		core	EQ
Young's Modulus (E):		4.62E+10 Pa	EO

入力の間違いが多い

距離は最寄りのSegment↔締結点間の距離を入力のこと
(全部Betweenになる事はほぼあり得ない)

例 : Outside, Between の選び方 (Acc. ContainerとChassis Mountとのボルト締結点との位置関係)



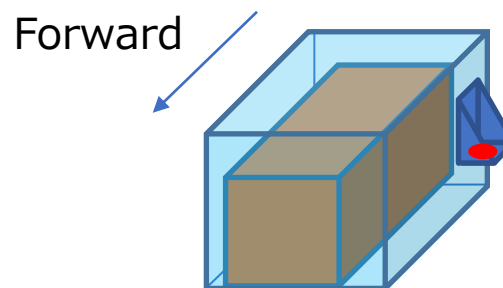
締結点とSegmentの位置関係

"Outside" the front/rear
"Outside" the top/bottom
"Outside" the left/right

前後 : 締結点はsegmentよりも前なので
Front/RearはOutside

上下 : 締結点は床板分だけSegment
よりも下なので
Top/BottomはOutside

左右 : 締結点はsegmentよりも左なので
Left/RightはOutside

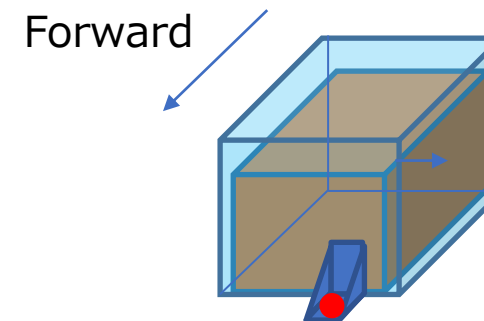


"Between" the front/rear
"Between" the top/bottom
"Outside" the left/right

前後 : 締結点はSegmentの間
Front/RearはBetween

上下 : 締結点はSegmentの間
Top/BottomはBetween

左右 : 締結点はSegmentよりも左なので
Left/RightはOutside



"Outside" the front/rear
"Outside" the top/bottom
"Between" the left/right

前後 : 締結点はsegmentよりも前なので
Front/RearはOutside

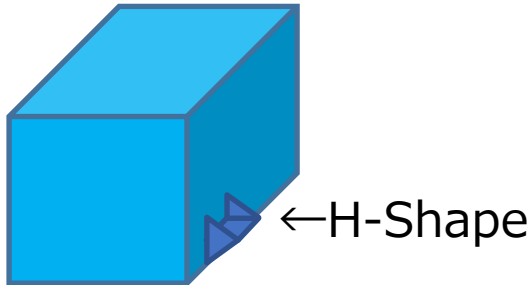
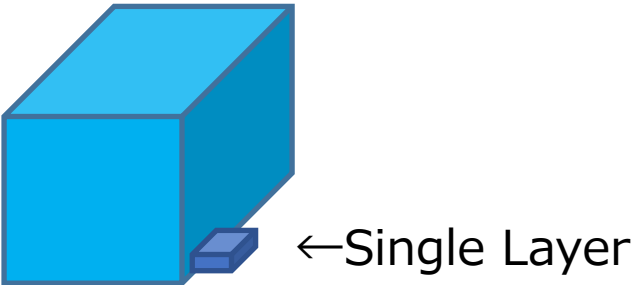
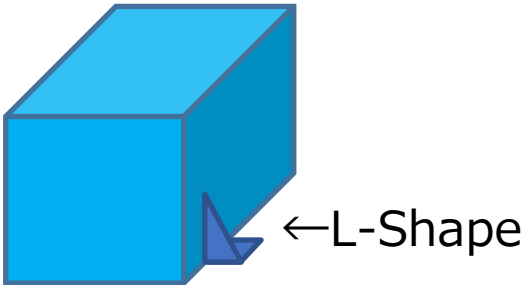
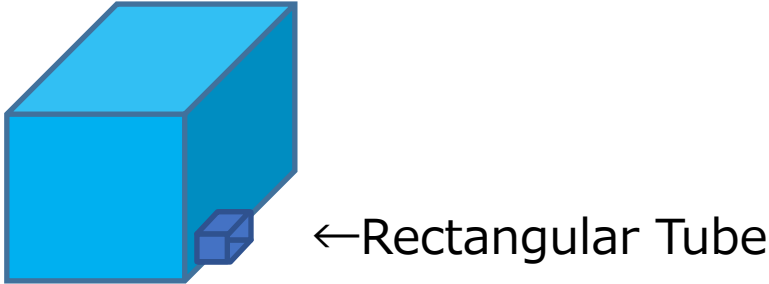
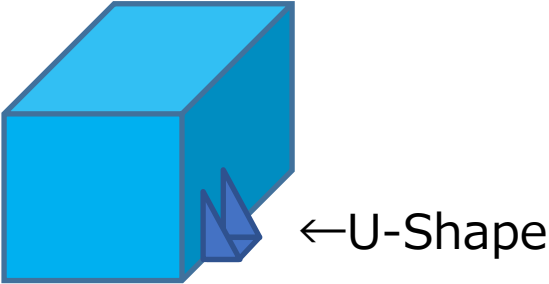
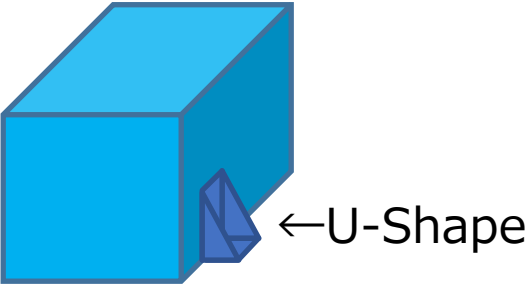
上下 : 締結点は床板分だけSegment
よりも下なので
Top/BottomはOutside

左右 : 締結点はSegmentの間
Left/RightはBetween

②MOUNT GEOMETRY –ACCUMULATOR SIDE 入力ガイダンス

SESに添付されたガイダンスをよく見て入力のこと

MOUNT GEOMETRY - ACCUMULATOR SIDE									
EQ									
Mount cross section on accumulator skin:				U-Shape		EQ			
Mount thickness (B):				8.8	mm	EQ			
Mount length (L):				24	mm	EQ			
Minimum gusset thickness (T):				2.7	mm	EQ			
Minimum gusset height normal to mount face (H):				63.8	mm	EQ			
F.3.5	12.0	15000N Bending in shear $M^*y / I < Su$:		4.00E+07	10.3%	EQ			
3.89E+08	26.8	15000N Bending normal $M^*y / I < Su$:		1.92E+07	4.9%	EQ			
1.08E+08	Parabolic shear $3*Test\ Load/2*area \leq Shear$:		4.05E+07		37.5%	EQ			



③ACCUMULATOR MOUNT::Accumulator Skin Interface 入力ガイダンス

ACCUMULATOR MOUNT :: Accumulator Skin interface			
BLANK			
Accumulator skin at accumulator mount:	Exterior Wall	MHBS F.4.3	EQ
	Young's Modulus (E):	4.96E+10 Pa	EQ
	Ultimate Tensile and Bending Strength (S):	1.78E+08 Pa	EQ
	Shear:	5.01E+07 Pa	EQ
	Accumulator total skin/wall thickness:	0 mm	BLANK
F.10.5.7.c	Mount interface with accumulator:	Bolted	EQ
Minimum - Fastener spacing, accumulator edge, or corner distance:		mm	BLANK
	Number of fasteners used:		BLANK
	Fastener diameter:	mm	BLANK
	Threads in shear:		EQ
	Fastener UTS:	Pa	BLANK
Min total perimeter of all washers, inserts, brackets on one surface:		mm	BLANK
	Fastener shear >= Test Load:	0.00E+00	EQ
	Accumulator Pullout >= Test Load:	0.00E+00	EQ
	Accumulator Tearout >= Test Load:	0.00E+00 0.0%	EQ
		mm	N/A
		0 mm	N/A
			N/A
		N/mm^2	N/A
		N/mm^2	N/A
		mm^2	N/A
F.5.5.3			N/A
		mm	N/A
		mm	N/A
			N/A

Mount(ブラケット)とAcc.の取り付け部との関係
Continuousは一体成型(Monocoque)や削り出し

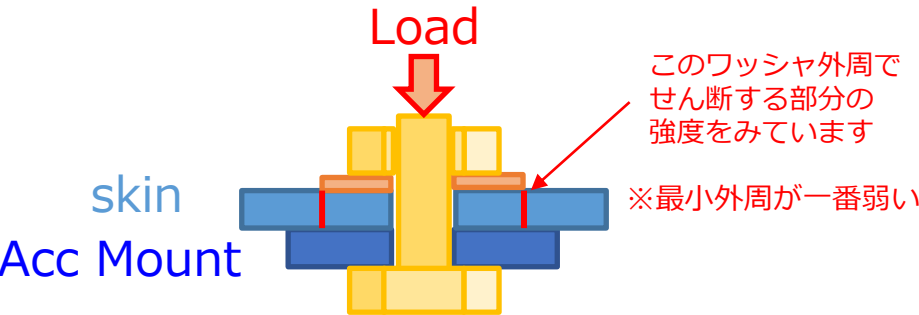
選んでBlankを埋めていくだけ

Acc.にAcc.Mountをボルト締結した場合(Bolted)
Perimeter of ~はSkin(wall)をせん断しうる最小周長

Monocoque時 インサートの外周
Acc.MountのSkinとの接触部外周長
BackingPlateの外周長
の最小値

Tubeの場合 ワッシャ外周長(BackingPlateの場合も)
BoltHead / Nut座面の外周長
Acc.MountのSkinとの接触部外周長
の最小値

Acc.のWallにAcc. Mountをボルト・ナットで締結する場合



③ACCUMULATOR MOUNT::Accumulator Skin Interface 入力ガイダンス

ACCUMULATOR MOUNT :: Accumulator Skin interface

BLANK		
Accumulator skin at accumulator mount:	Exterior Wall	MHBS F.4.3
Young's Modulus (E):	4.96E+10 Pa	EQ
Ultimate Tensile and Bending Strength (S):	1.78E+08 Pa	EQ
Shear:	5.01E+07 Pa	EQ
Accumulator total skin/wall thickness:	0 mm	BLANK
F.10.5.7.c Mount interface with accumulator:	Bolted	EQ
Minimum - Fastener spacing, accumulator edge, or corner distance:	mm	BLANK
Number of fasteners used:		BLANK
Fastener diameter:	mm	BLANK
Threads in shear:		EQ
Fastener UTS:	Pa	BLANK
Min total perimeter of all washers, inserts, brackets on one surface:	mm	BLANK
Fastener shear >= Test Load:	0.00E+00	EQ
Accumulator Pullout >= Test Load:	0.00E+00	EQ
Accumulator Tearout >= Test Load:	0.00E+00	EQ
	0.00E+00 0.0%	N/A
	mm	N/A
	0 mm	N/A
		N/A
	N/mm^2	N/A
	N/mm^2	N/A
	mm^2	N/A
		N/A
	mm	N/A
	mm	N/A
		N/A

F.5.5.3

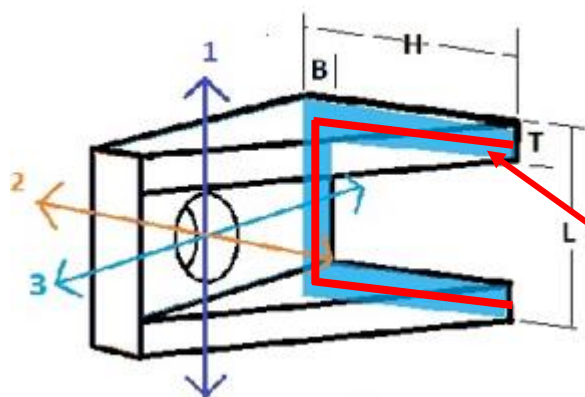
Mount(ブラケット)とAcc.の取り付け部との関係
Continuousは一体成型(Monocoque)や削り出し

選んでBlankを埋めていくだけ

Acc. ContainerにAcc.Mountを溶接の場合(Welded)
溶接長を入力

Acc. ContainerにAcc.Mountを接着の場合(Bonded)
接着剤の強度(せん断 & T-Peel強度)、接着面積
接着部の外周長、接着したContainer外壁/床の厚さ
を入力

一体成型の場合(Continuous)
Mount部形状のCenterline長を入力(左図参照)



Continuousで入力する
Centerline長

④CHASSIS MOUNT (Acc. Mount接合点)入力ガイダンス

CHASSIS MOUNT: Where fastener passes through to Accumulator Mount		
CHECK		
Intersection of fastener axis and fastener shear plane:	Offset Mounts	EQ
Review sections below: mounts per tube, bending if fastener shear is offset.		EQ
Offset from composite panel or radially from tube surface:	20 mm	EQ
Mount material (Composite skin for internal hardpoint):	Steel Welded	EQ
Young's Modulus (E):	2.00E+11 Pa	EQ
Ultimate Tensile and Bending Strength (S):	3.00E+08 Pa	EQ
Shear:	1.73E+08 Pa	EQ
F.10.5.8.b --Pullout--Face thickness, do not include core:	3.2 mm	EQ
--Tearout--Minimum - Fastener spacing, edge, or corner distance:	20 mm	EQ
From Number of fasteners used (2x if in double shear):	1	EQ
Accumulator Mount 1 Fastener shear diameter:	8 mm	CHECK
Threads in shear:	Yes	CHECK
Fastener UTS:	8.00E+08 Pa	EQ
--Pullout--Min total perimeter of washers or inserts on one surface:	45 mm	EQ
F.10.5.8.a --Shear-- $0.577 \times \text{fasteners} \times \text{UTS} \times \pi \times r^2 \geq \text{Test Load}$:	2.32E+04 154.7%	EQ
--Pullout--Mount shear*thickness*perimeter $\geq \text{Test Load}$:	2.49E+04 166.2%	EQ
--Tearout--Mount shear*thickness*edge distance $\geq \text{Test Load}$:	2.22E+04 147.7%	EQ

取り付け構造(図①)

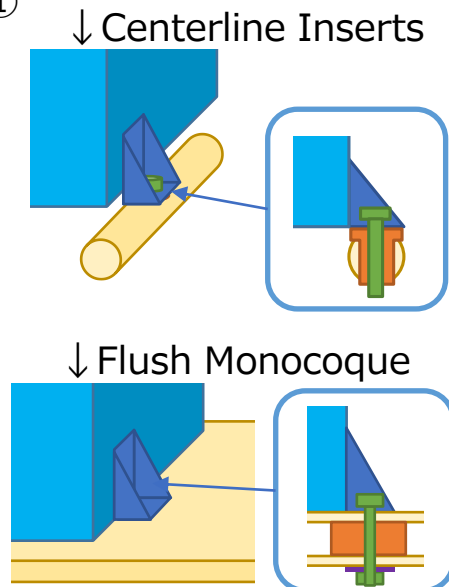
ChassisからAcc.Mountとの接合点までの距離(図②)

Mount(ブラケット)の材質

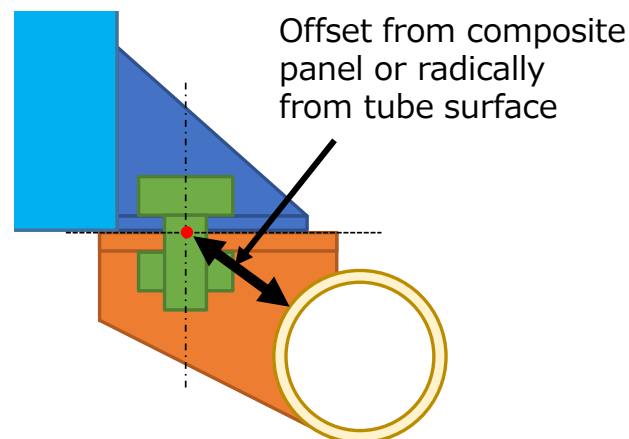
Mount(ブラケット)の厚さと
取付穴からエッジまでの距離

ワッシャ、Acc. Mountのせん断長、ナット外周長の最小値(図③)

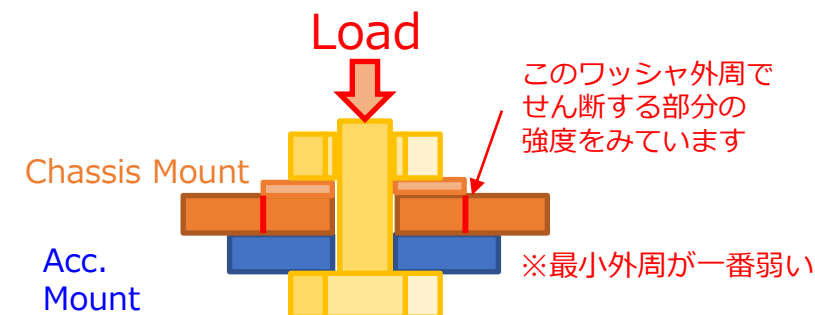
図①



図②



図③ ChassisMountの Min-Perimeter



上記以外は全てOffset Mounts

⑤TUBE CHECK入力ガイダンス

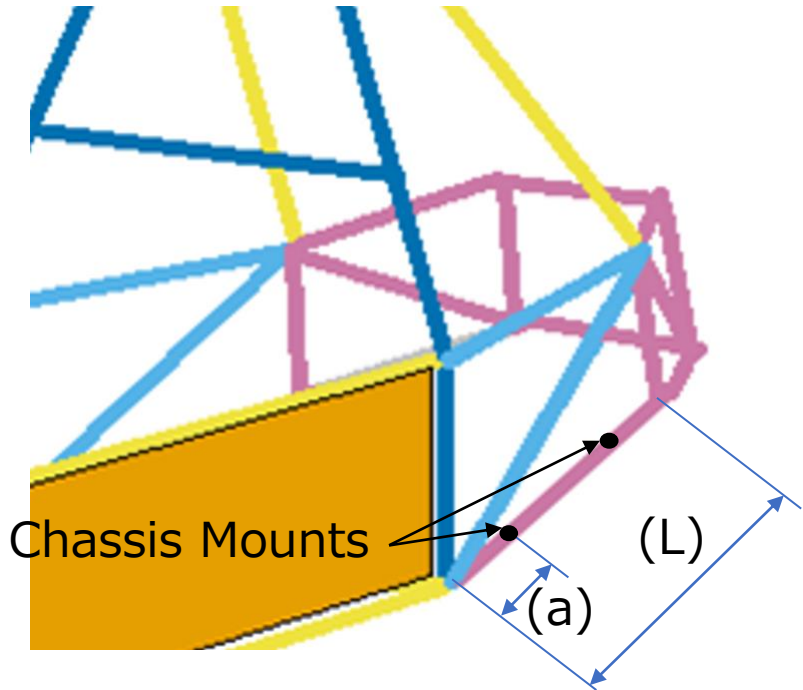
TUBE CHECK: < 95% not a cause for rejection in 2024. See cell AC12.

EQ	
Chassis type at mount:	Tube
	Round
F.3.2.1 Chassis tube diameter:	25.4 mm
Chassis tube wall:	1.6 mm
F.10.5.2.a Number of chassis mounts on this tube:	2
F.3.4.2 Ultimate Strength (Su):	3.00E+08 Pa
Acc Mount Tube second moment of inertia (I):	8.51E+03 mm^4
Tube Length (L):	250 mm
Chassis mount distance to closest triangulated node (a):	15 mm
F.10.1.1.a Tube Max Bending Force (Su*I)/(a*(1-a/L)*OD/2):	1.43E+04 95.03%
https://engineeringlibrary.org/reference/beam-forces-moments-air-force-stress-manual	

Tube Frameのみ

1本のTubeに取り付け可能なChassis Mountsは2 個まで
F.10.5.2a

Tubeの長さ(L)と、ノードからの近傍距離(a) 下図参照



Tubeの曲げ強度の計算
2024SESでは95%未満でもRejectにはならない
両端固定梁への1点集中荷重or2点荷重で計算される
Chassis Mountsが1Tubeに2か所あるとノードでのモーメント
がかなり大きくなるので少なくとも1か所はノードに設けるこ
とが望ましい
一方をノードに設けた場合はTubeには1点だけとなるので個数
を1にしてもう片方のChassis Mountについて記述すること

⑥MOUNT GEOMETRY –CHASSIS SIDE 入力ガイダンス



MOUNT GEOMETRY - CHASSIS SIDE									
EQ									
Mount cross section on chassis surface:				U-Shape		EQ			
Mount thickness (B):				3.2	mm	EQ			
Mount length (L):				25	mm	EQ			
Minimum gusset thickness (T):				2	mm	EQ			
Minimum gusset height normal to mount face (H):				25	mm	EQ			
F.3.5	12.5	15000N	Bending in shear $M*y / I < Su$:	2.84E+08	94.6%	EQ			
3.00E+08	8.3	15000N	Bending normal $M*y / I < Su$:	2.98E+08	99.5%	EQ			
1.73E+08		Parabolic shear $3*Test\ Load/2*area \leq Shear$:	1.25E+08	72.2%		EQ			

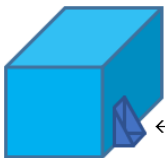
-ACCUMULATOR SIDEと同じ
ガイダンスをよく見て入力のこと

②MOUNT GEOMETRY –ACCUMULATOR SIDE 入力ガイダンス



MOUNT GEOMETRY - ACCUMULATOR SIDE									
EQ									
Mount cross section on accumulator skin:				U-Shape		EQ			
Mount thickness (B):				8.8	mm	EQ			
Mount length (L):				24	mm	EQ			
Minimum gusset thickness (T):				2.7	mm	EQ			
Minimum gusset height normal to mount face (H):				63.8	mm	EQ			
F.3.5	12.0	15000N	Bending in shear $M*y / I < Su$:	4.00E+07	10.3%	EQ			
3.89E+08	26.8	15000N	Bending normal $M*y / I < Su$:	1.92E+07	4.9%	EQ			
1.08E+08		Parabolic shear $3*Test\ Load/2*area \leq Shear$:	4.05E+07	37.5%		EQ			

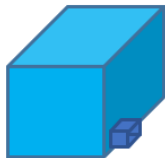
SESに添付されたガイダンスをよく見て入力のこと



←U-Shape



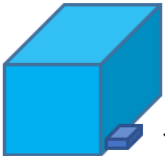
←U-Shape



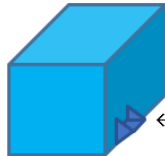
←Rectangular Tube



←L-Shape



←Single Layer



←H-Shape

⑦Chassis Mount to Chassis Interface 入力ガイダンス

Chassis Mount to Chassis interface

EQ

Chassis wall at chassis mount: Steel Welded EQ

Young's Modulus (E): 2.00E+11 Pa EQ

Ultimate Tensile and Bending Strength (S): 3.00E+08 Pa EQ

Shear: 1.73E+08 Pa EQ

Chassis total skin/wall thickness: 1.6 mm EQ

Mount interface with chassis: Welded EQ

F.10.5.8.b

mm N/A

mm N/A

mm N/A

Pa N/A

mm N/A

0.00E+00 N/A

0.00E+00 N/A

0.00E+00 N/A

Total weld perimeter: 60.0 mm EQ

Thickness is assumed = skin thickness: 1.6 mm EQ

Shear strength >= Test Load: 1.66E+04 110.8% EQ

F.10.1.5

N/mm^2 N/A

F.10.1.5

N/mm^2 N/A

F.5.5.3

mm N/A

mm N/A

mm N/A

mm N/A

Offset Mounts または
Centerline InsertsかFlush MonocoqueでOffset≠0の場合は
Chassis-Chassis Mount間の強度を計算する
記入方法はACCUMULATOR MOUNT::Accumulator Skin Interfaceと同じ。

ただし、Centerline InsertsでOffset=0の場合は
F.3.4.3 Welded Insertsシートの[Welded Tube Insert]
で強度を示す。
Flush MonocoqueでOffset=0の場合は
F.7.8-9 Attachmentsシートの[Accumulator To Mono, Hybrid Panels]
で強度を示す

BLANK

ASSEMBLED

TUBE + HOLE

FULL CROSS-SECTION

INSERT

BLANK

mm

Welded Tube Insert

Welded Tube Insert

Welded Tube Insert

Minimum Tube With Hole

Material

Original tube

Weld thickness

Insert

Tube cross section area (A₂)

Tube second moment of inertia (I₂)

Tube with hole cross section area (A₂)

Tube with hole second moment of inertia (I₂)

Insert collar cross section area (A₂)

Insert collar second moment of inertia (I₂)

Young's Modulus (E)

Unstressed Yield Strength (S_y)

Unstressed Ultimate Strength (S_u)

Welded Yield Strength (S_y)

Welded Ultimate Strength (S_u)

Backing Modulus

Yield

Ultimate

Bending

Deflection

Energy

BLANK Accumulator To Mono, Hybrid Panels

F.7.9.6 The tube centerline should intersect the bolt centerline between the skins.

Brackets without gussets are unacceptable.

BLANK

F.7.8 EV Accumulator Mounts, Flush to Monocoque: Bolted EQ

Type SES Tab Name, EV Accumulator Attachment Layout: BLANK

F.7.8.8 EV Accumulator Attachment: Skin-Insert-Skin EQ

Fastener diameter: mm BLANK

No. of fasteners per mount: BLANK

is and other cores are not insert material. Panel thickness: 0 mm EQ

Insert material: mm BLANK

Scaling option, layout repeats: Outer skin thickness: Layup mm EQ

Scaling option, layout repeats: Inner skin thickness: Typo mm EQ

For multiple mounts of the same design, enter each worst case value.

For multiple mounts on different layouts, screenshot this section or copy this tab.

Backing perimeter on monocoque skin: mm BLANK

F.7.8.6 Backing: 0.00E+00 0.00E+00 mm: 0.00% BLANK

Accumulator Mount Perimeter on monocoque skin: mm BLANK

Min - Fastener spacing, edge, weaker layup, or corner distance: mm BLANK

F.7.9.1 Skin shear strength: Typo Pa EQ

Perimeter shear strength >15000N: 0.00% EQ

Perimeter shear strength >15000N: 0.00% EQ

Tearout shear strength >15000N: 0.00% EQ