



FLAM-AIR

NOSOTROS

Origen universitario

Emprendimiento

Compromiso social

I+D

ORGANIGRAMA





Servicio personalizado

Garantía de calidad

Organización

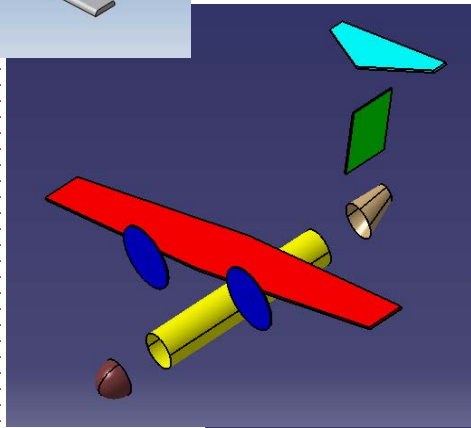
Facilidad de gestión



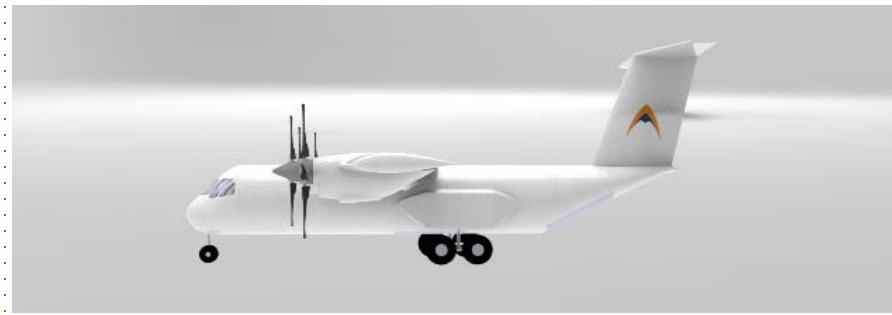
FLAM-AIR

DISEÑO

EVOLUCIÓN DEL DISEÑO DEL FL-18

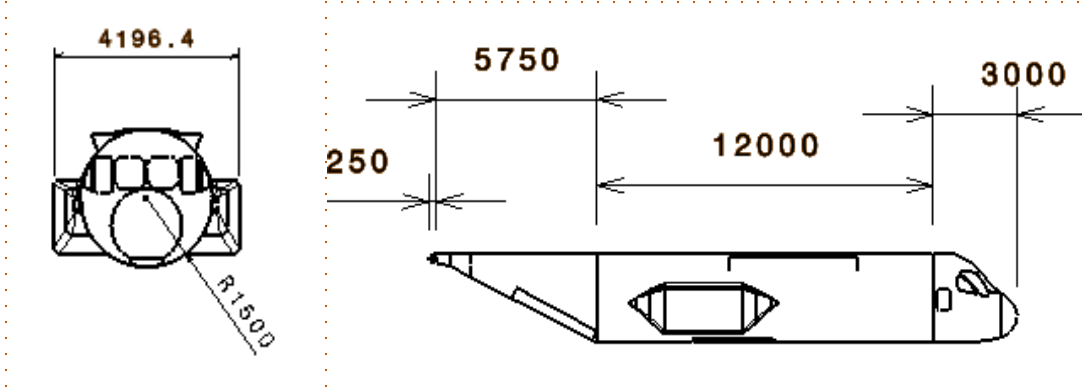


DESCRIPCIÓN GEOMÉTRICA GENERAL

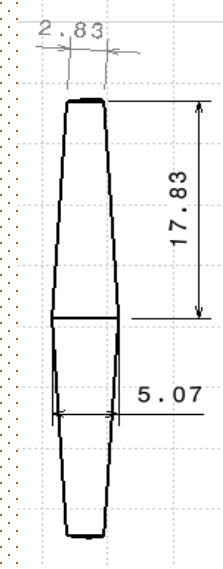


Las cotas para cada una de las 3 vistas vienen indicadas en el informe

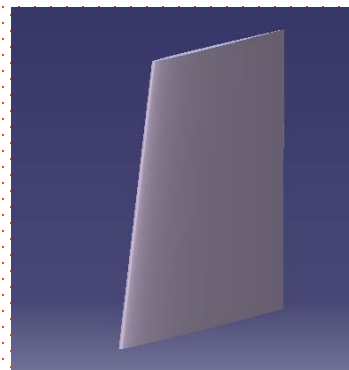
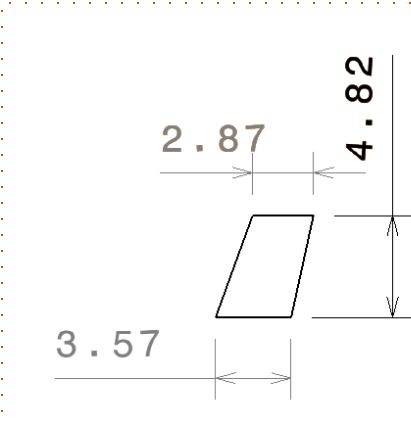
DESCRIPCIÓN GEOMÉTRICA DETALLADA



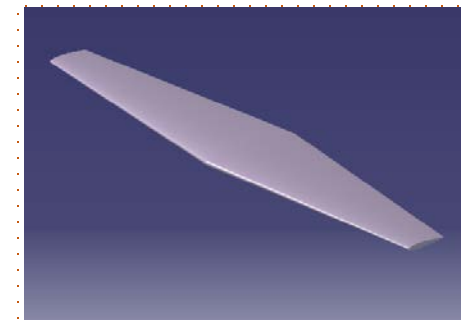
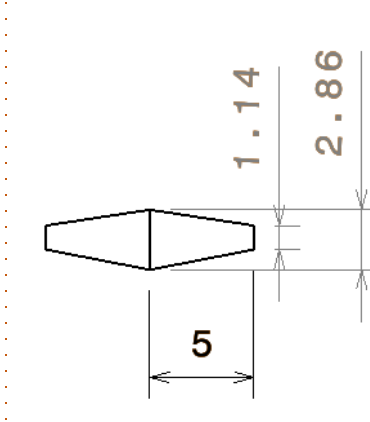
Fuselaje



Alas



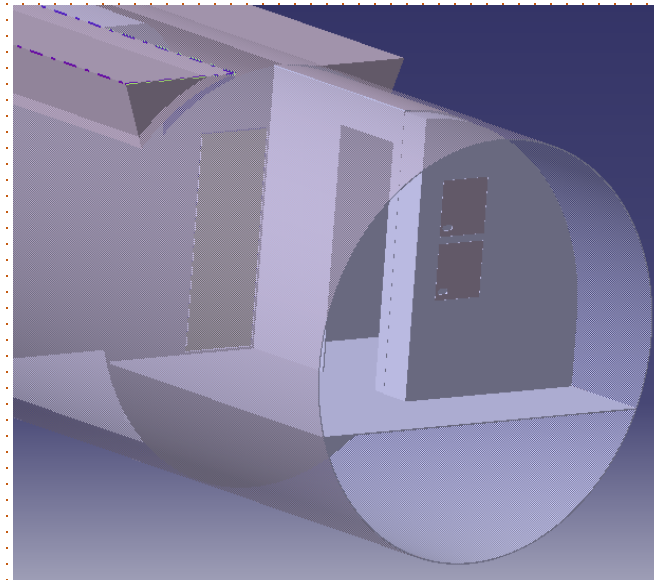
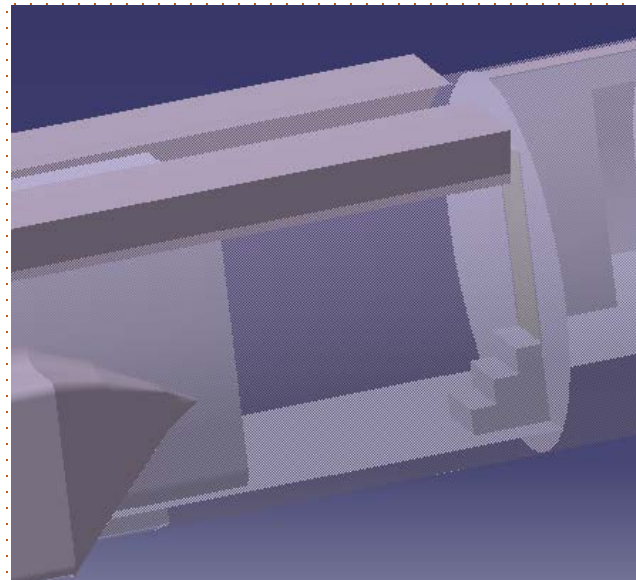
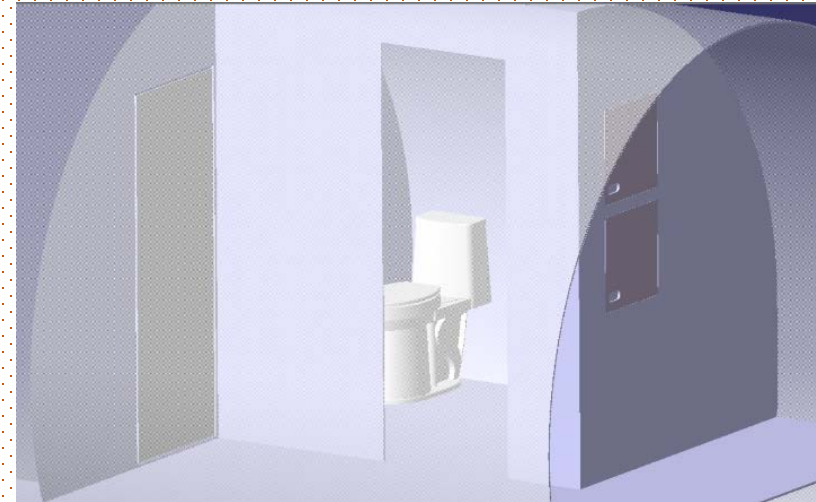
VTP



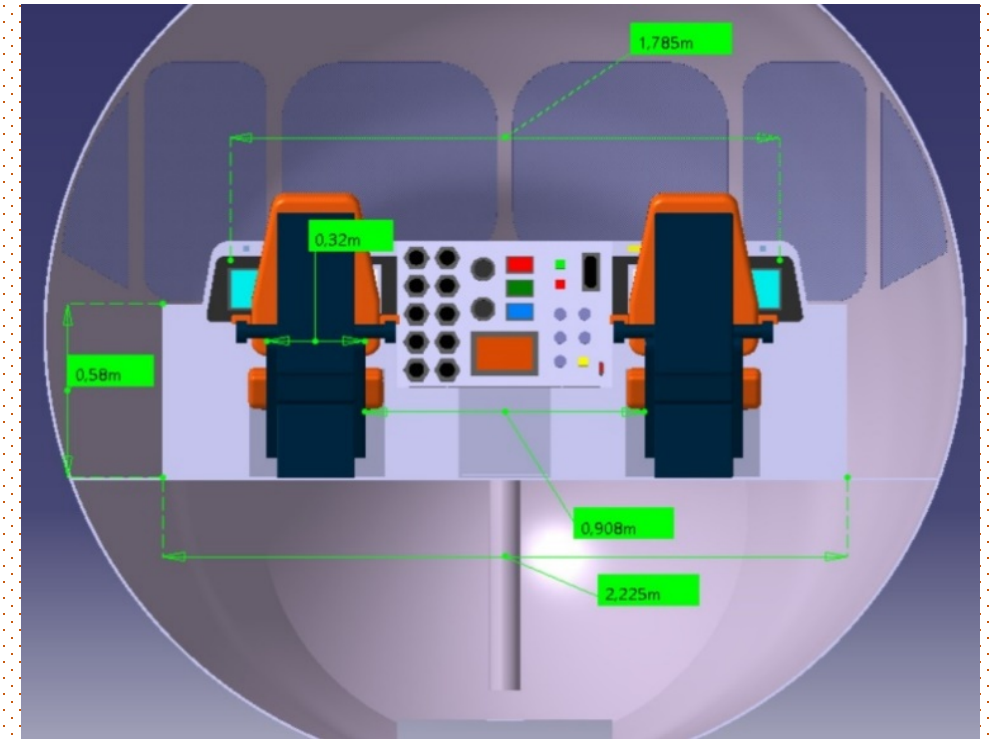
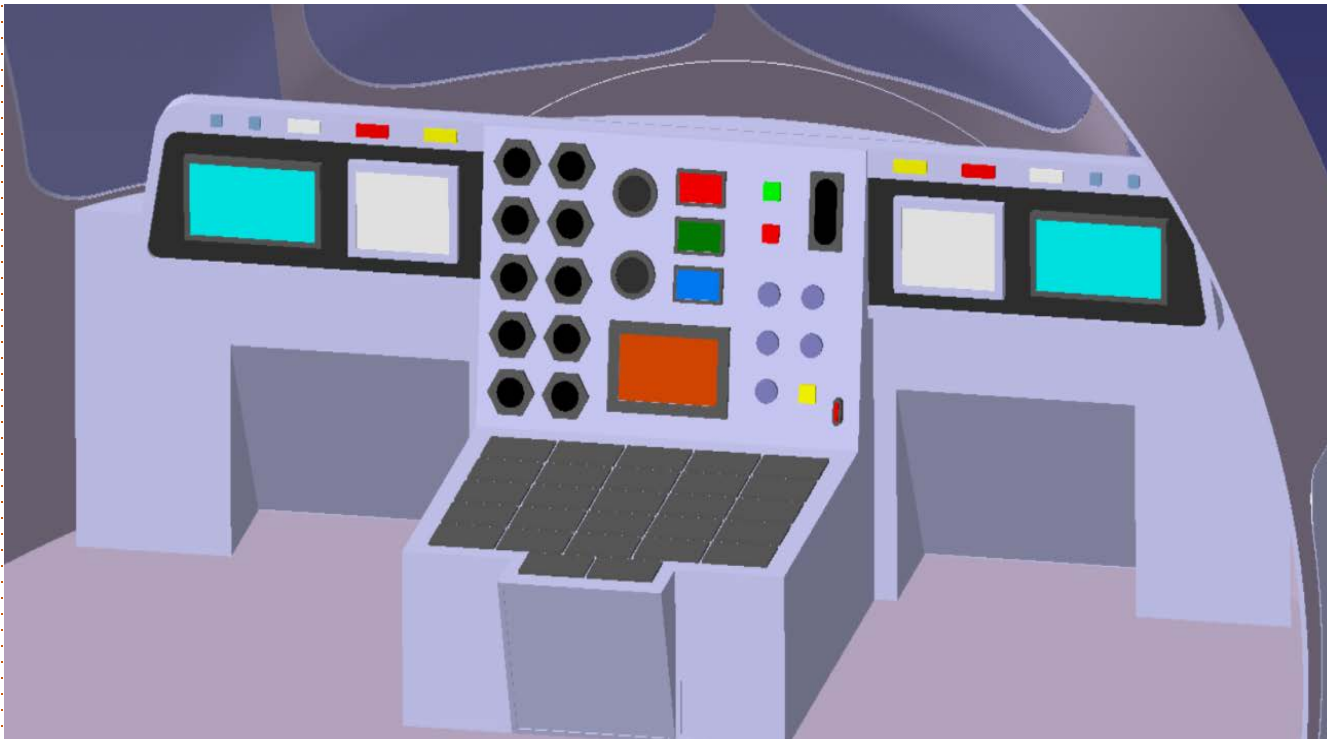
HTP

DESCRIPCIÓN GEOMÉTRICA **DETALLADA**

Interior del fuselaje

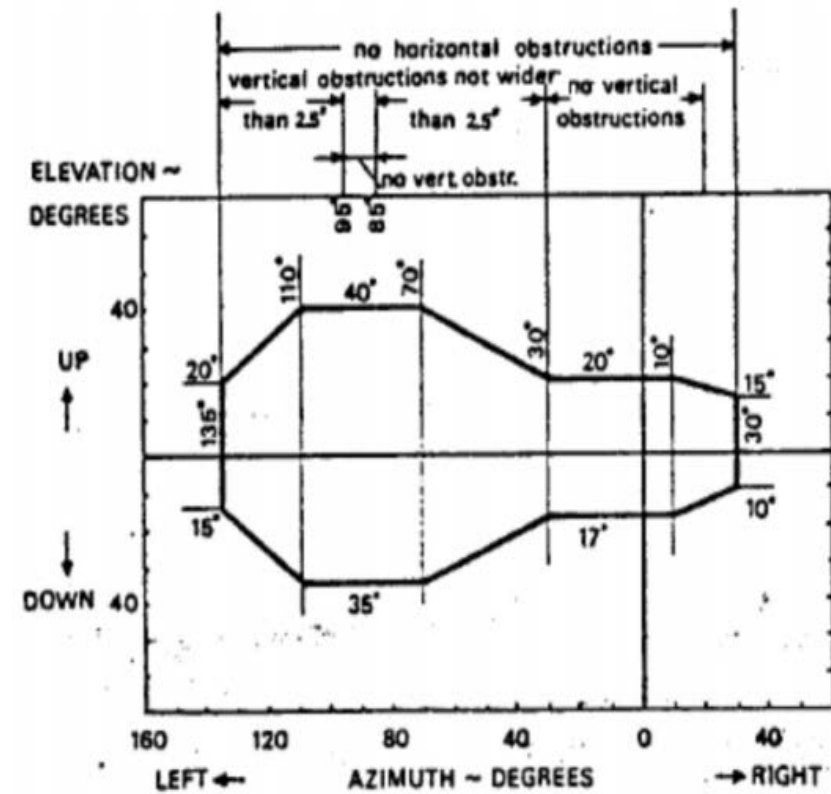
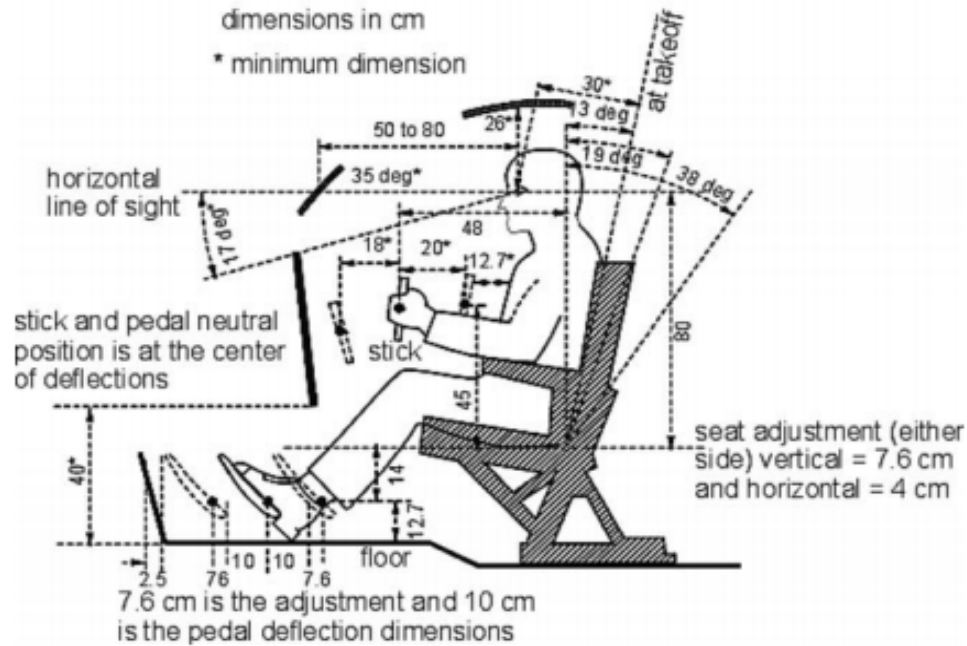


DESCRIPCIÓN GEOMÉTRICA DETALLADA



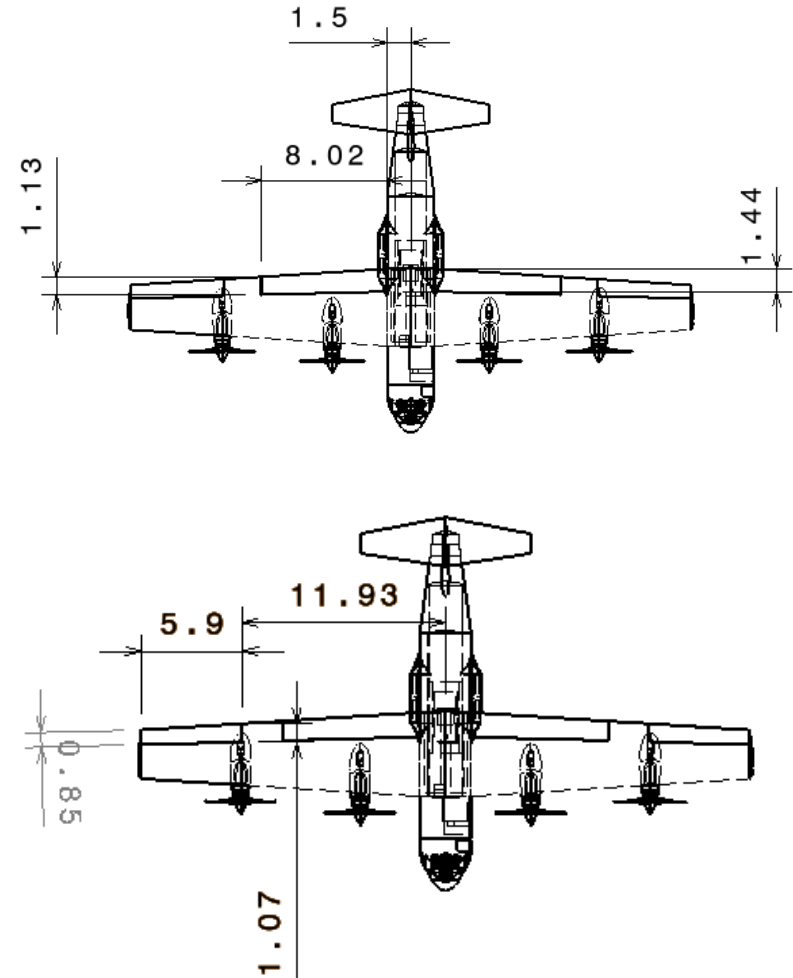
DESCRIPCIÓN GEOMÉTRICA DETALLADA

Interior de la cabina

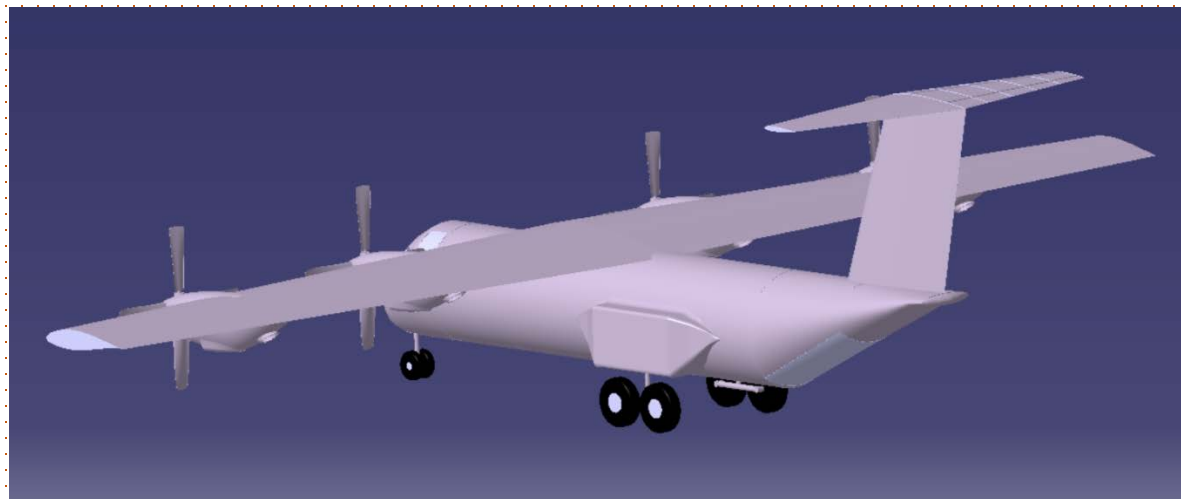
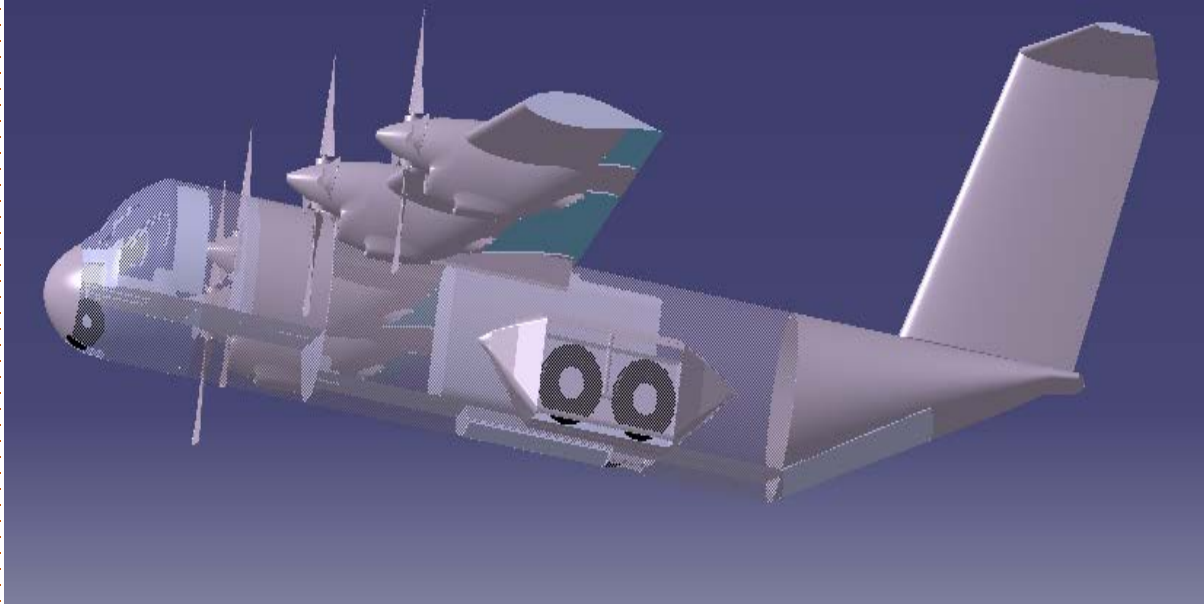


DESCRIPCIÓN GEOMÉTRICA DETALLADA

Superficies hipersustentadoras



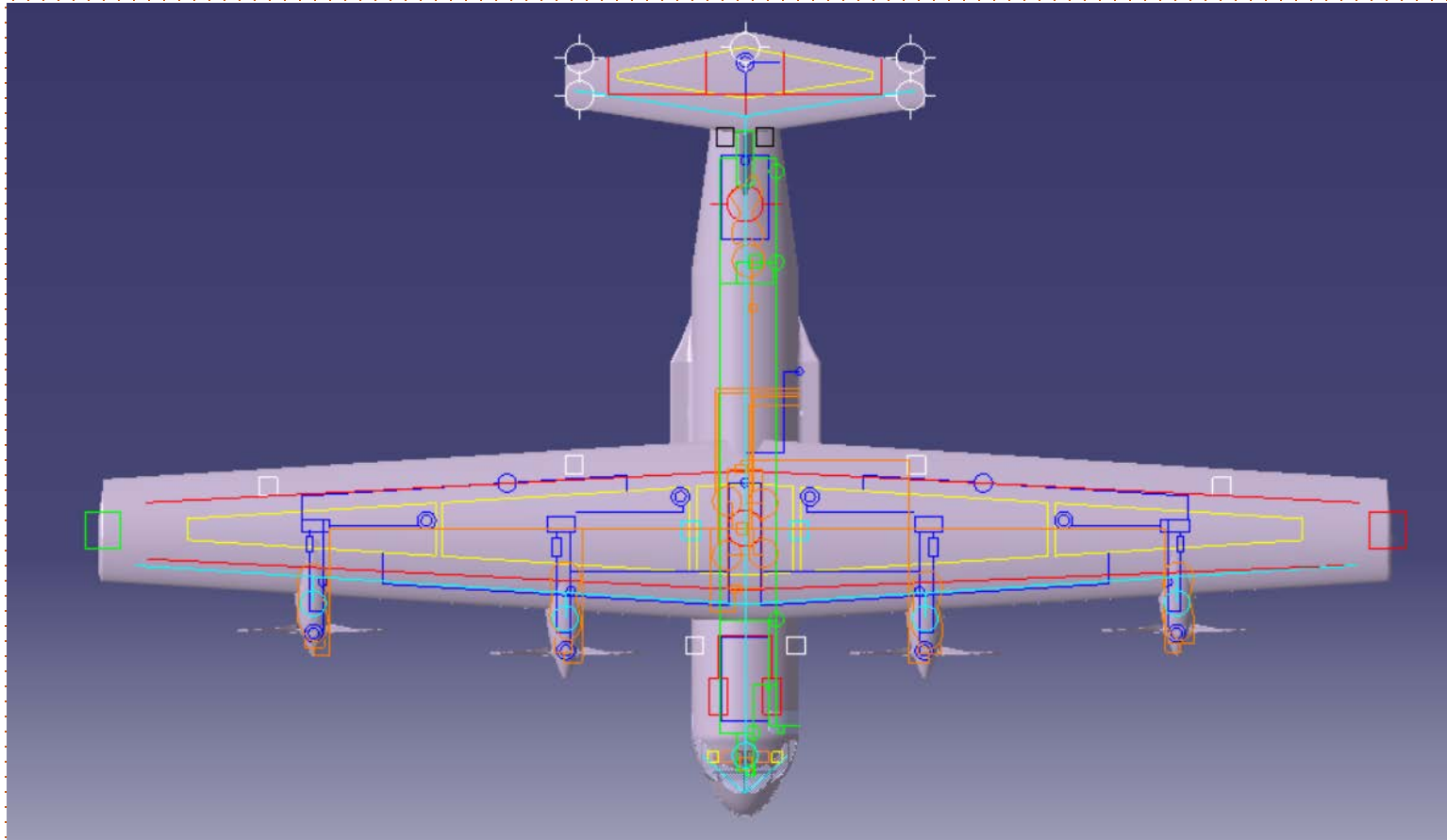
DESCRIPCIÓN GEOMÉTRICA **DETALLADA**



Tren de aterrizaje

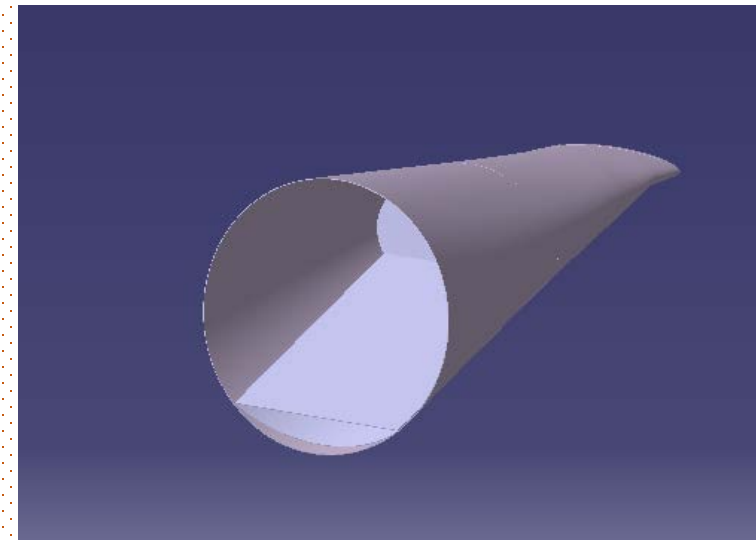
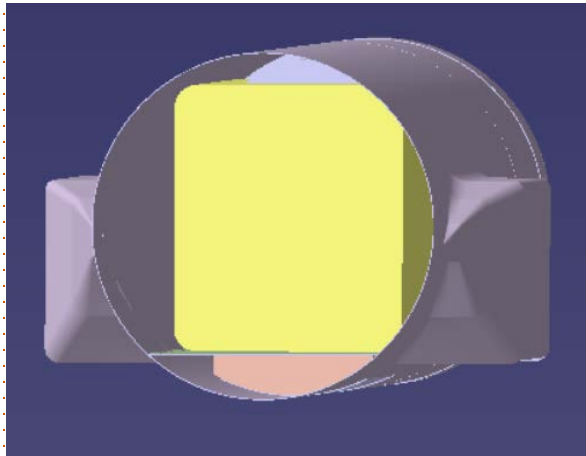
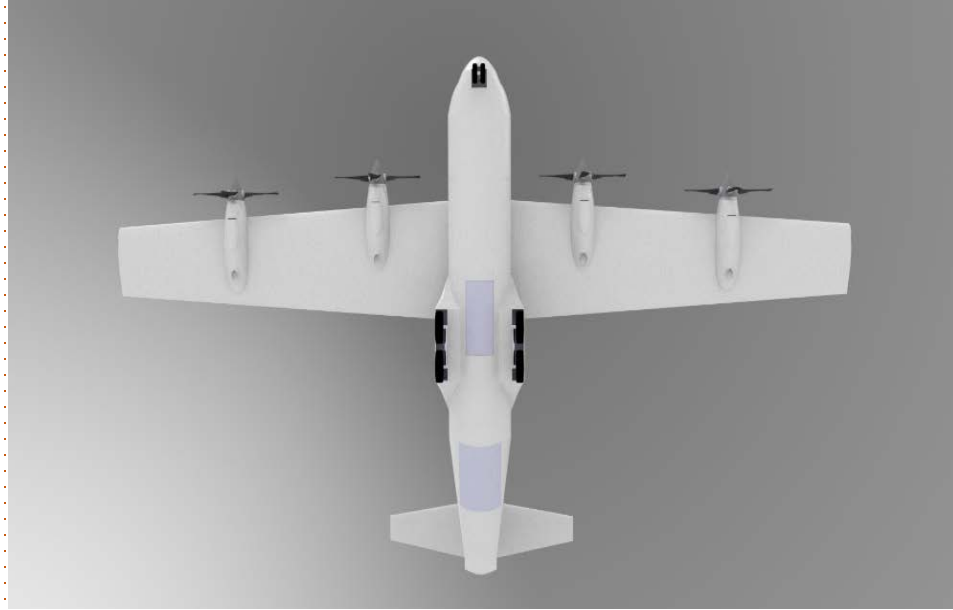
Dimensiones	
Altura fuselaje (H_f)	1,19m
X_n	0,88 m
X_m	11,2 m
Wheel Base/Batalla (B)	10,31 m
Ángulo overturn	29,5°
Ángulo clearance	17,39°
Wheel Track	3,69 m

DESCRIPCIÓN DE LOS SISTEMAS

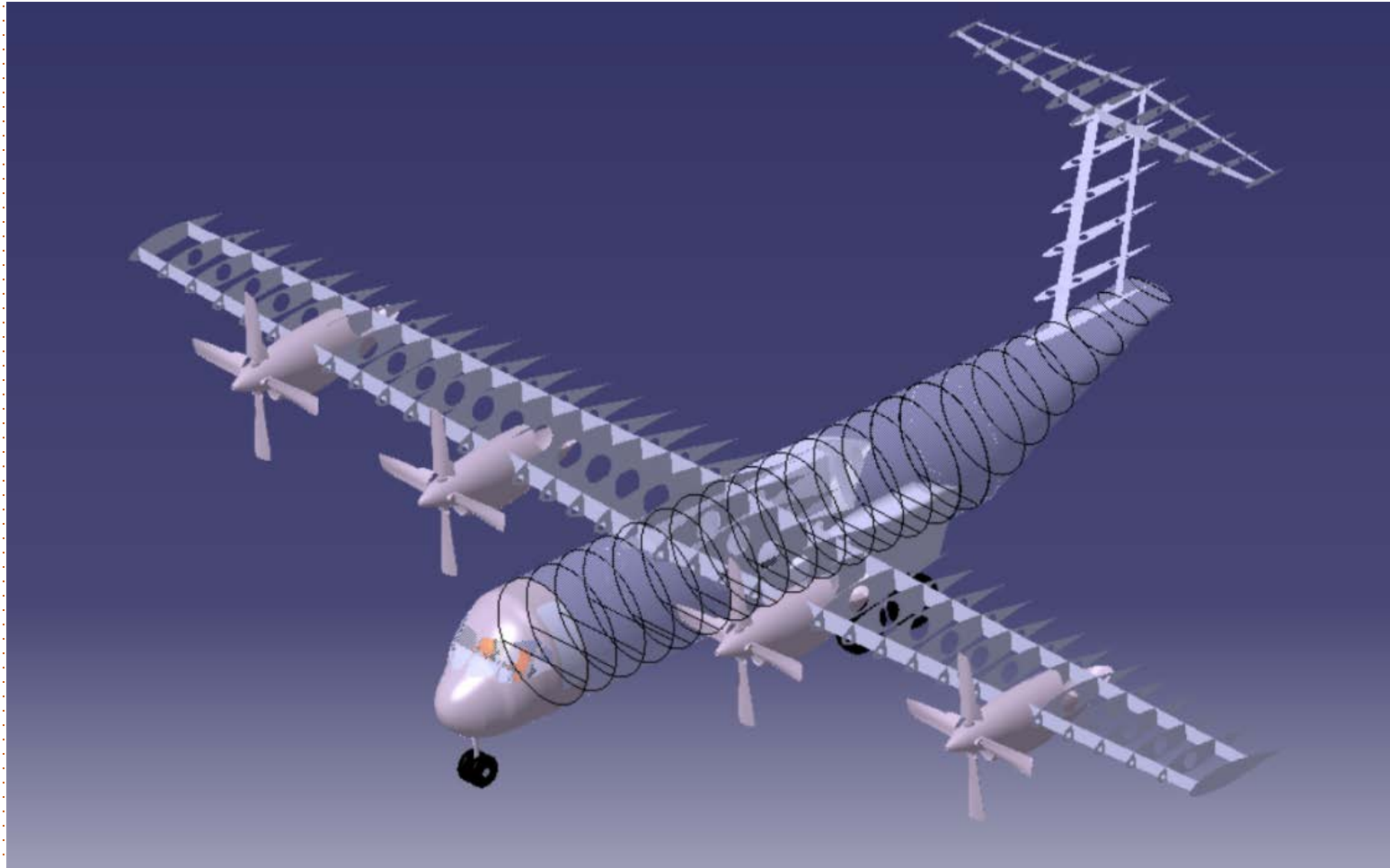


- Sistema de combustible
- Depósitos de combustible
- Sistema de control de vuelo
- Sistema hidráulico
- Sistema antiincendios
- Sistema antihielo
- Sistema eléctrico

ADECUACIÓN A LA CARGA DE PAGO



ARQUITECTURA INTERNA



AVANCES TECNOLÓGICOS Y POSIBLES MEJORAS

Avances

tecnológicos

- **More Electric Aircraft**
- **Fly by Wire**
- **FADEC**
- **CPIOMs y AFDX**
- **Materiales compuestos**

Posibles mejoras

- **Superficie alar**
- **Tren de aterrizaje**
- **Almacenamiento retardante**
- **Suelta retardante**





FLAM-AIR

ESTRUCTURAS

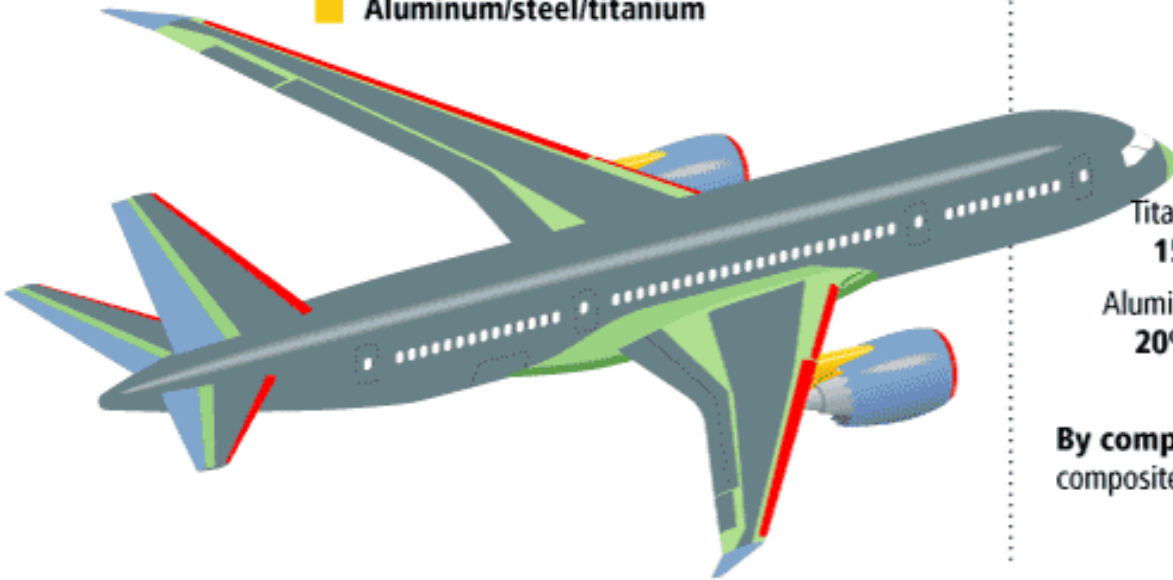
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Diseño y Sistemas

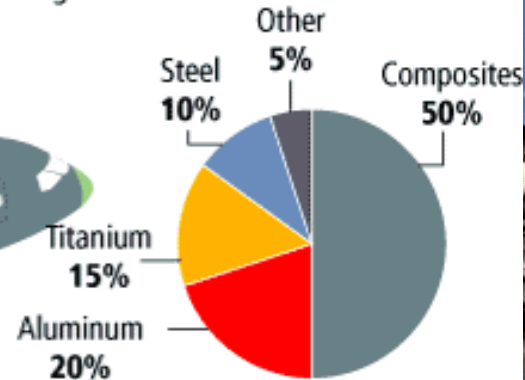


Materials used in 787 body

- Fiberglass
- Aluminum
- Carbon laminate composite
- Carbon sandwich composite
- Aluminum/steel/titanium



Total materials used
By weight



By comparison, the 777 uses 12 percent composites and 50 percent aluminum.

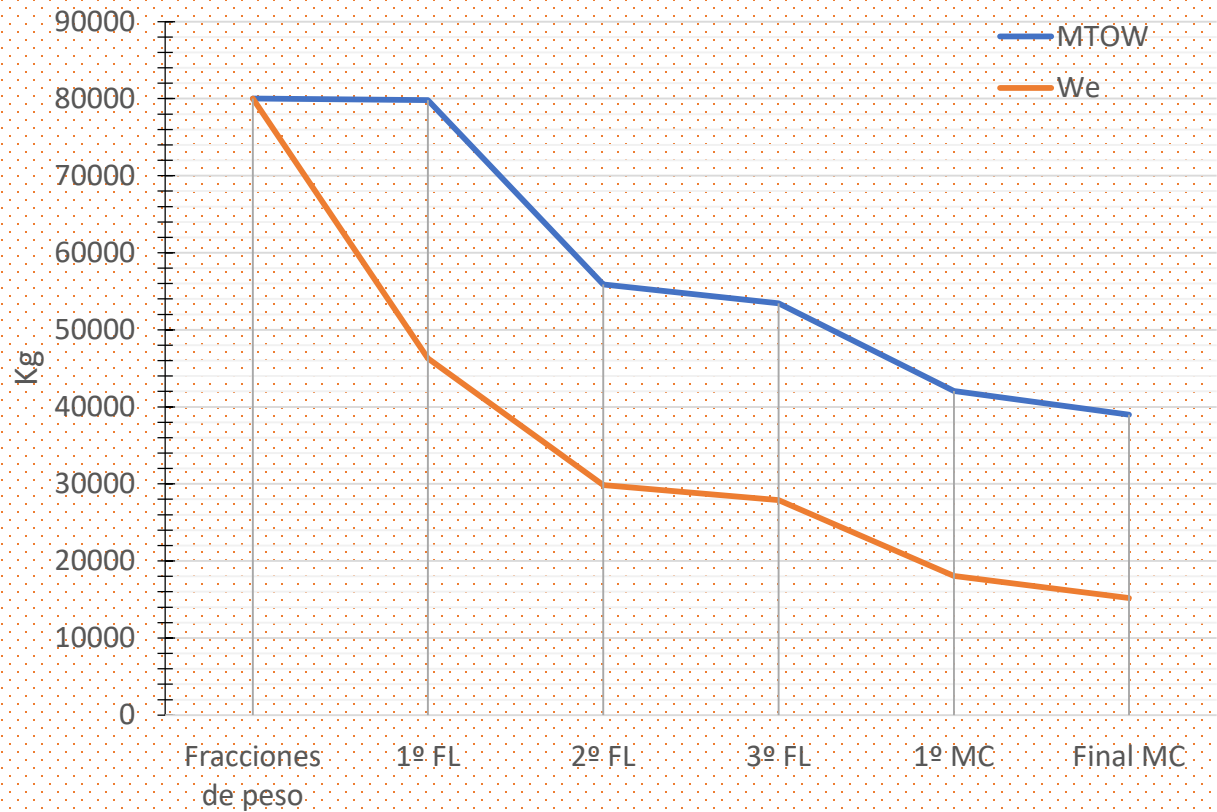


ESTRUCTURAS – Evolución pesos

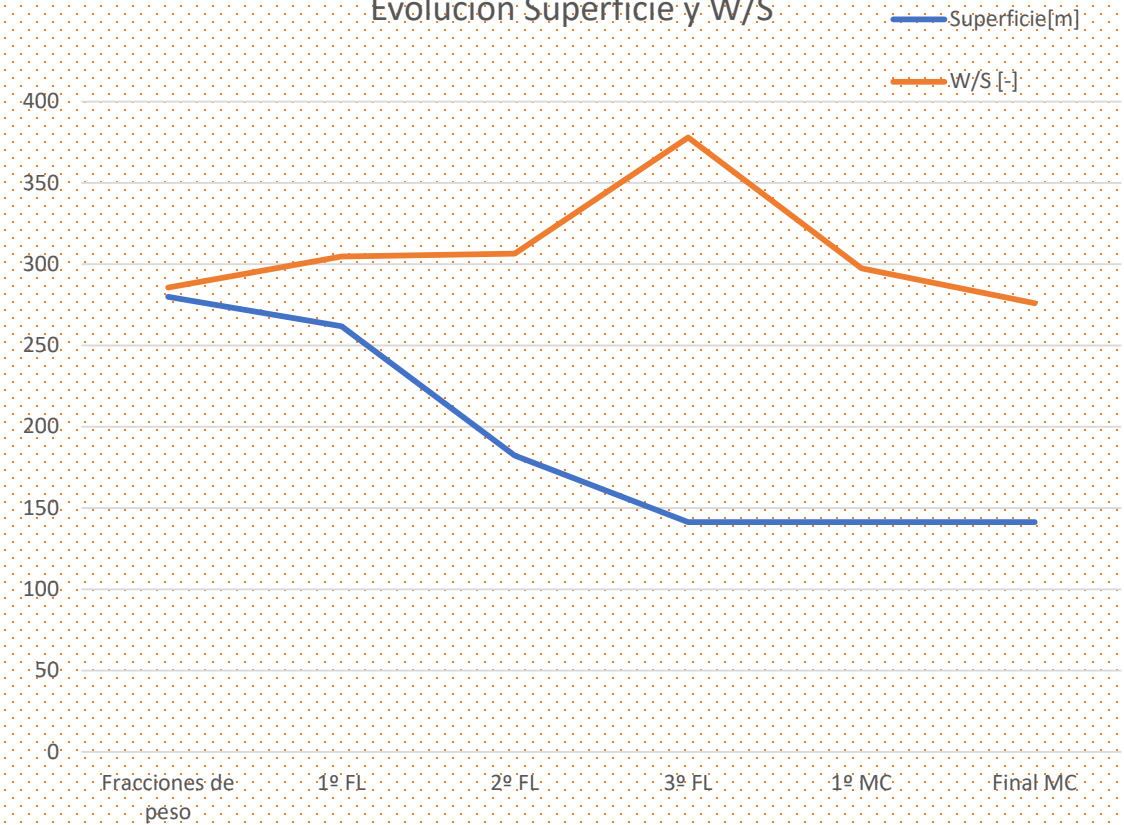
Evolución:	MTOW [kg]	W _{vacío} [KG]	Superficie [m ²]	W/S
Fracciones de peso	80000	80000	280	285.71
1º FL	79830,8	46301.86	261,9	304.81
2º FL	55894,5	29861.8	182,35	306.523
3º FL	53418,8	27887.3	141,306	378.01
1º MC	42041.7	18038.1	141,306	297.517
Final MC	38996.5	15194	141.306	275.978
	51.25%		49.53%	

ESTRUCTURAS – Evolución de pesos

Evolución Pesos



Evolución Superficie y W/S



ESTRUCTURAS – Comparativa con otros aviones

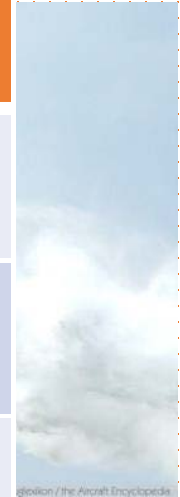
Grumman S-2T Turbine Tracker.



CASA C-295 W

Bombardier CL-415

	Wempty [Kg]	MTOW [Kg]	S [m ²]
Grumman S-2T	8310	11860	45,6
CASA C-295W	11450	23200	59
Bombardier CL-415	12882	21318	100
Lockheed P-2V	15819	29076	92,2
Flam-Air FL-18	15194	38996.5	141.3
Lockheed C-130H	34.400	70300	162.1



Lockheed C-130

ESTRUCTURAS – Factores lineales

ELEMENTO	Datos Característico	Factor para cazas	Factor para transporte y bombarderos	Factor para aviación general
Ala	S alar expuesta	44	49	12
Estabilizador Horizontal	S HTP	20	27	10
Estabilizador Vertical	S VTP	26	27	10
Cola en V	S Cola V	26	27	10
Canard	S Canard	20	27	10
Fuselaje	S Mojada fus	23	24	7
Tren de Aterrizaje	MTOW	0.033 Navy:0.045	0.43	0.057
Motores	Peso del motor	1.3	1.3	1.4
Sistemas	MTOW	0.17	0.17	0.10

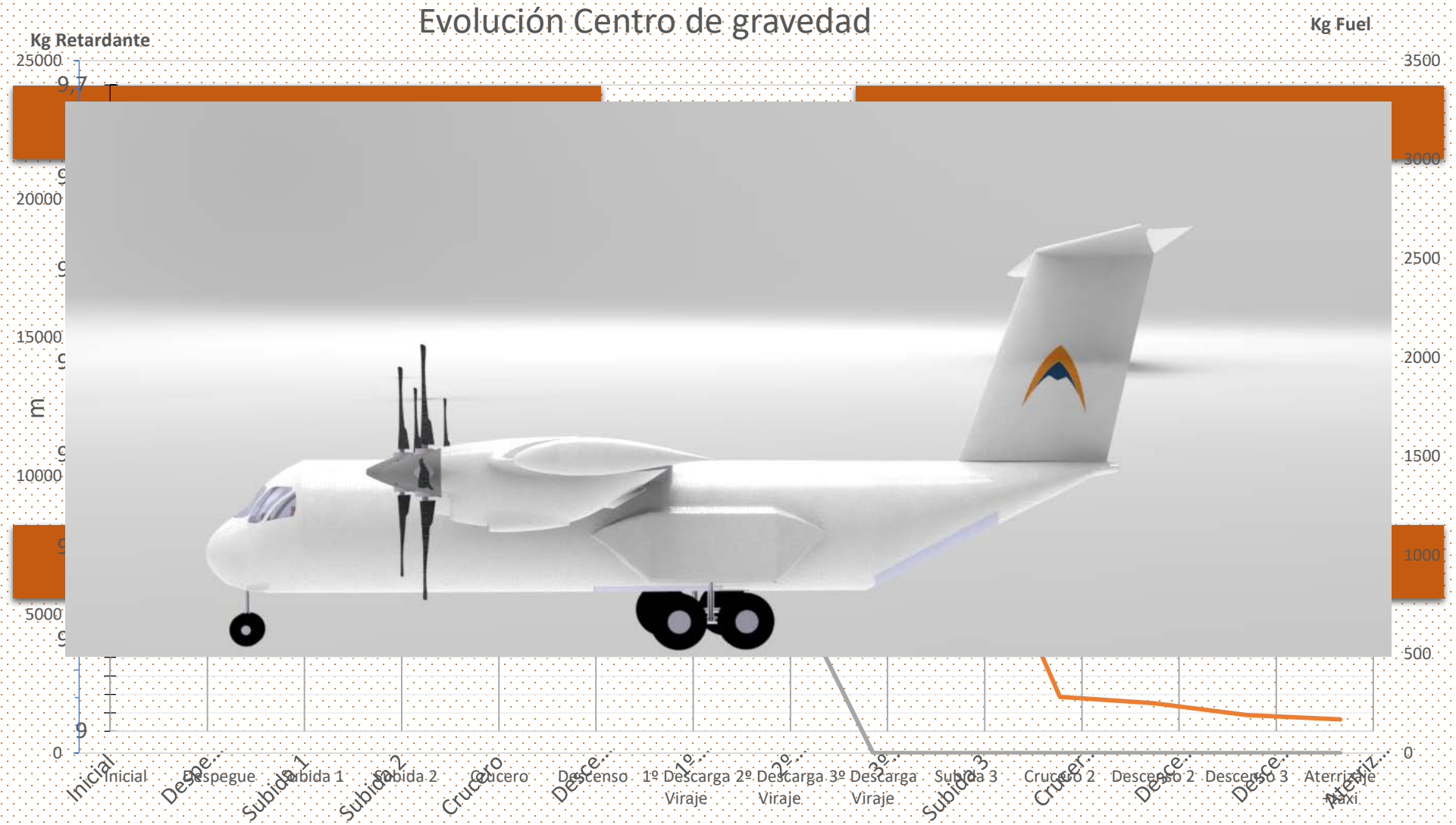
ESTRUCTURAS – Método Completo

Pesos globales	Kg	% Peso total			Elementos estructurales	Peso [kg]	% Peso Estructural
Estructura	10749.4	27.57			Ala	3734.63	33.54
Refuerzos	384.466	0.98		Empl	HTP	350.196	3.14
Sistemas	4060.07	10.41			VTP	280.602	2.52
Crew	200	0.51			Fuselaje	1907.05	17.12
Payload	20411.6	52.34			Tren	1072.64	9.63
Fuel	3190.93	8.18			Motores	3788.79	34.02

Estima pesos de los Equipos formados basados en:

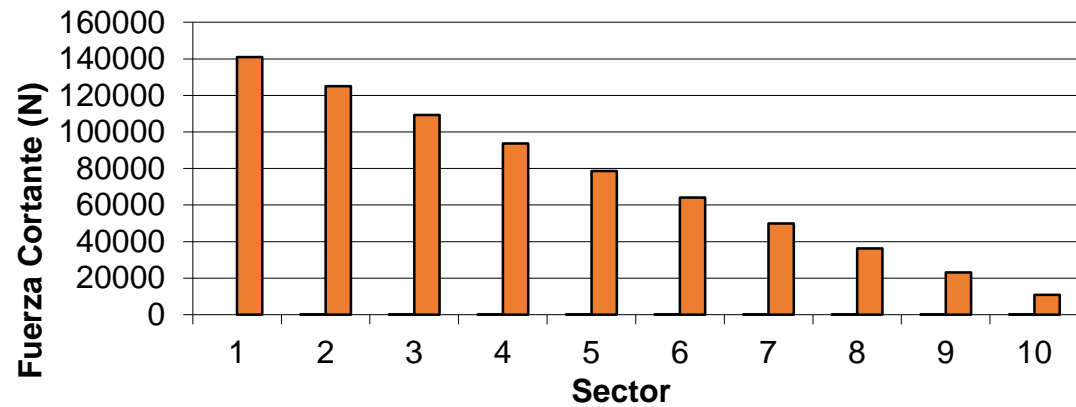
	Sistemas	Peso [kg]	% Peso Sistemas	
	Control de vuelo	509.43	12.54	cas de
	Hidráulico	272.982	6.72	ntaje sob
	Instrumentación	498.639	12.28	stema
	Electricidad	672.618	16.56	
	API + Oxígeno	769.7727	18.95	
Torer	APU	194.987	4.80	
	Mobiliario	902.749	22.23	
	Equipaje	238.866	5.88	

ESTRUCTURAS – Centros de gravedad

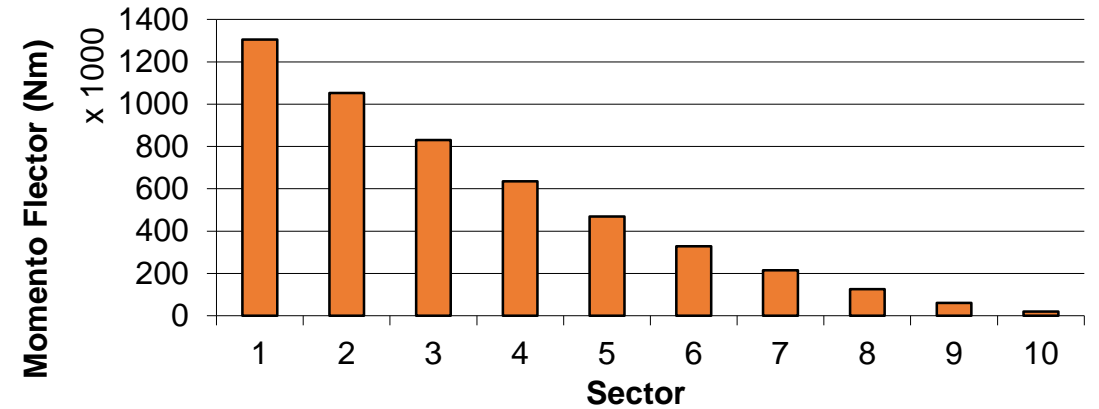


ESTRUCTURAS – Cargas aerodinámicas

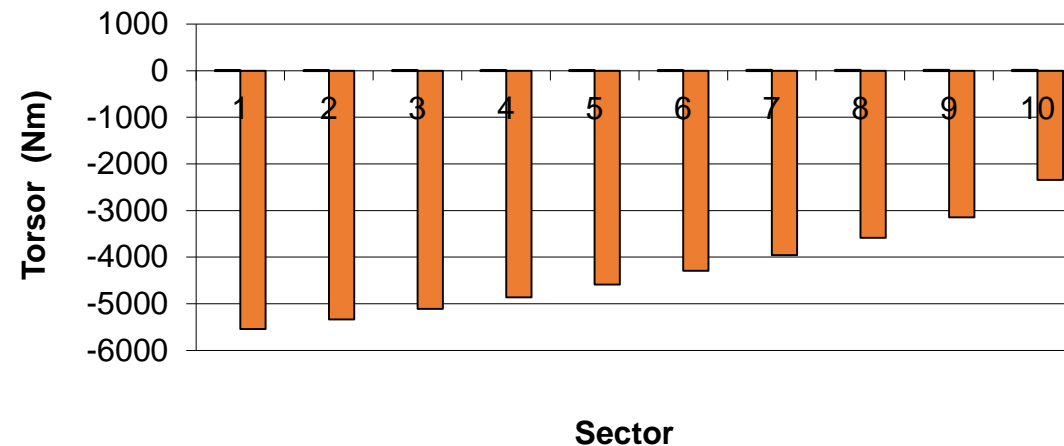
Distribución de cortantes



Distribución de momento flector



Distribución de Torsores



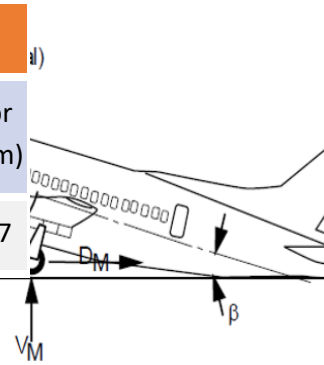
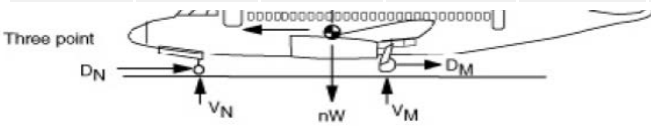
ESTRUCTURAS – Cargas estructurales

Two and Three points

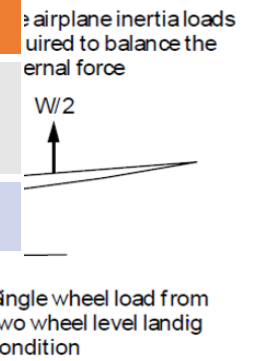
Tail down landing

One Wheel landing

Aterrizaje – 2 puntos			Aterrizaje - 3 puntos			Aterrizaje - 3 puntos		
Axial MG(N)	Cortante MG (N)	Flector MG (Nm)	Axial MG (N)	Cortante MG (N)	Flector MG (Nm)	Axial NG (N)	Cortante NG(N)	Flector NG (Nm)
447111.9	3246.3	3863.1	369440.2	2822.86	3359.21	155343.4	846.86	1007.7



Tail Down landing			One – Wheel Landing	
Axial MG(N)	Cortante MG (N)	Flector MG (Nm)	Axial MG (N)	
444228.56	50695.79	60327.99	447111.93	

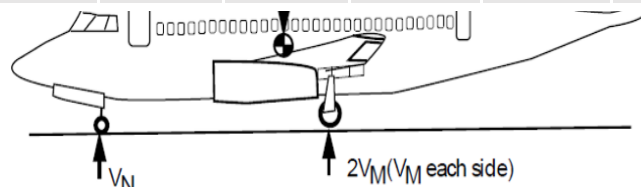


Aterrizaje – 2 puntos			Aterrizaje - 3 puntos			Aterrizaje – 3 puntos		
Axial MG(N)	Cortante MG (N)	Flector MG (Nm)	Axial MG (N)	Cortante MG (N)	Flector MG (Nm)	Axial NG (N)	Cortante NG (N)	Flector NG (Nm)
447111.9	10696.65	12729	369036.1	9301.4	11068.7	156151.6	2790.4	3320.6

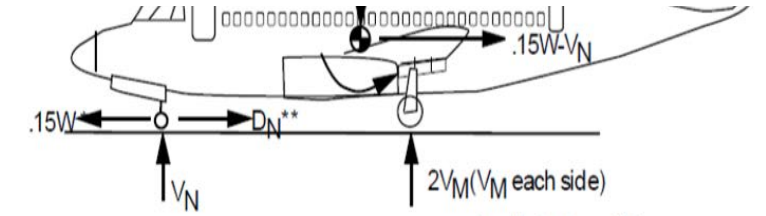
al frenar



Solo tren principal			Tren de morro (NG)			Tren principal(MG)		
Axial MG(N)	Cortante MG (N)	Flector MG (Nm)	Axial MG (N)	Cortante MG (N)	Flector MG (Nm)	Axial NG (N)	Cortante NG(N)	Flector NG (Nm)
195103.4	156082.7	185738.4	161287.1	129029.7	153545.3	67632.6	54106.1	64386.2

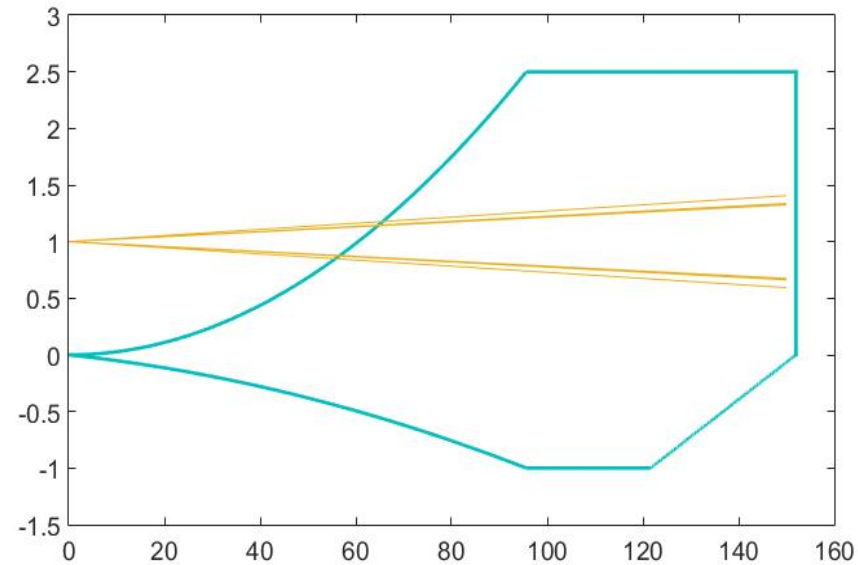


Tren de morro (NG)			Tren principal(MG)		
Axial MG (N)	Cortante MG (N)	Flector MG (Nm)	Axial NG (N)	Cortante NG(N)	Flector NG (Nm)
157868.8	5992.67	26944.8	66818.15	9434.8	11227.41

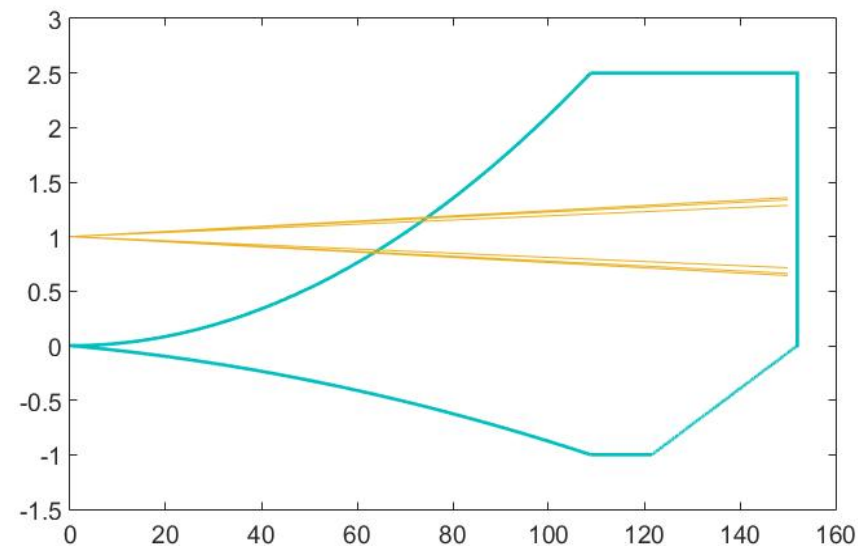


ESTRUCTURAS – Diagrama V_n

Misión Primera Línea



Misión Ferry

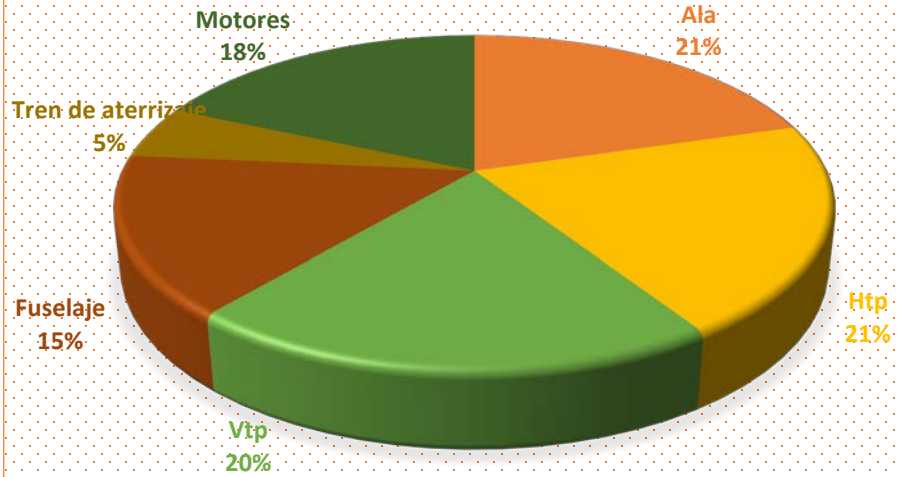


Factores de Carga

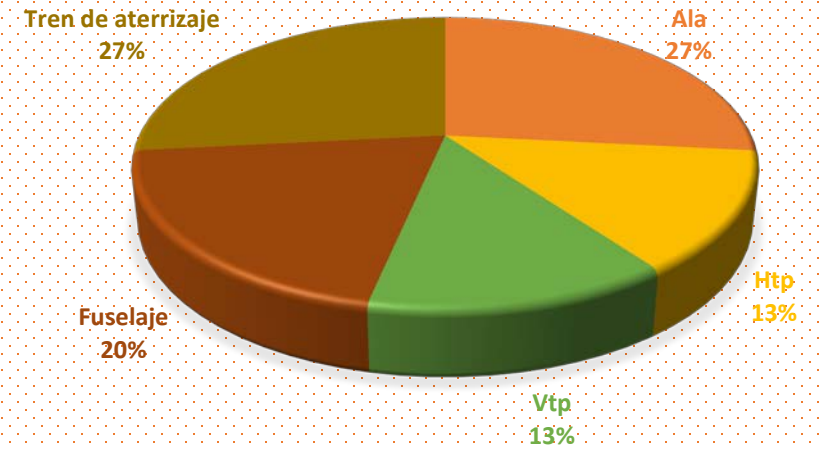
N max	2.5
N min	-1
N lim	3.75
Ráfaga no restrictiva	
Se cumple con RFP del cliente	

ESTRUCTURAS – Material y Refuerzos

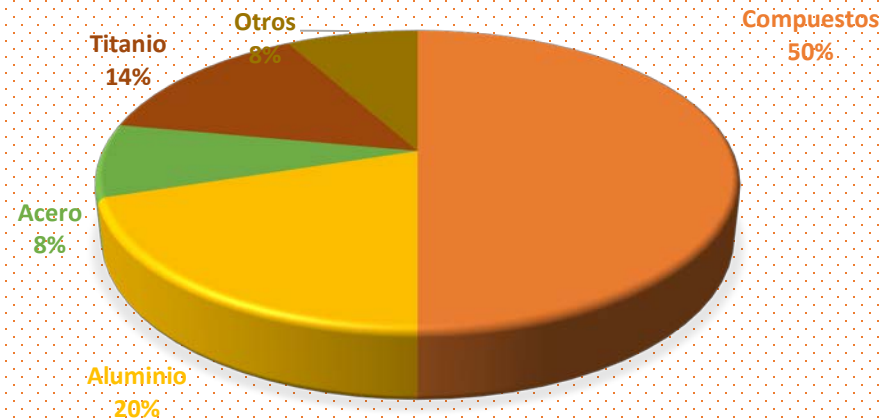
REDUCCIÓN DE MATERIAL



REFUERZOS



COMPOSICIÓN





PROPULSIÓN Y ACTUACIONES

PROPULSIÓN Y ACTUACIONES

PROPULSIÓN

ESTIMACIONES PRELIMINARES:

MODELO DE REFERENCIA:
C-130H Hercules

Superficie alar

$$\frac{S_{wet}}{S_{ref}} = 4.82$$

SELECCIÓN DE CARGA ALAR:

CARGA ALAR

$$\frac{W}{S} = 275.978 \left[\frac{kg}{m^2} \right]$$

	Configuración sucia	Configuración media	Configuración limpia
CD_o	0.021	0.018	0.014

PROPULSIÓN Y ACTUACIONES

ESTUDIO PRELIMINAR POTENCIA PESO:

Potencia disponible [kW]	Potencia disponible [shp]	MTOW [kg]	P_{SL}/W_{To} [W/N]
9133.764	12248.561	38996.6	23.961

SELECCIÓN PLANTA DE POTENCIA:

Búsqueda de motores:

planta motora tipo turbohélice

Tipo de motor	Potencia [shp]	Consumo [lb/(hr·shp)]	Peso [lb]
Napier, Eland NEI.6 Mk.504A	3500	~	1820
General Electric, T64-GE-P4D-1	3400	0.48	1188
Europrop TP400- D6 (A400M)	11000	0.39	4035
Rolls-Royce, Tyne RTy.12 Mk.101	5460	0.45	2219
Rolls-Royce, Tyne RTY.20 MK 21	6100	0.45	2203

PROPULSIÓN Y ACTUACIONES

Datos básicos de la planta propulsora:

- Potencia total al nivel del mar por motor: 5 460 shp
- Número de motores: 4
- Consumo a nivel del mar: $0.45 \frac{lb}{hr*hp}$
- Peso por motor: 1006.5 kg [total: 4026.1 kg]
- Diámetro de las hélices: 4.27 metros [dimensionadas del Fokker F-27]

Datos adicionales de la hélice:

- Número de palas por hélice: 4
- Torsión de la pala en el 75% de la cuerda: 15°
- Tipo de hélice: hélice de paso fijo
- Rendimiento moto-propulsivo: 0.82

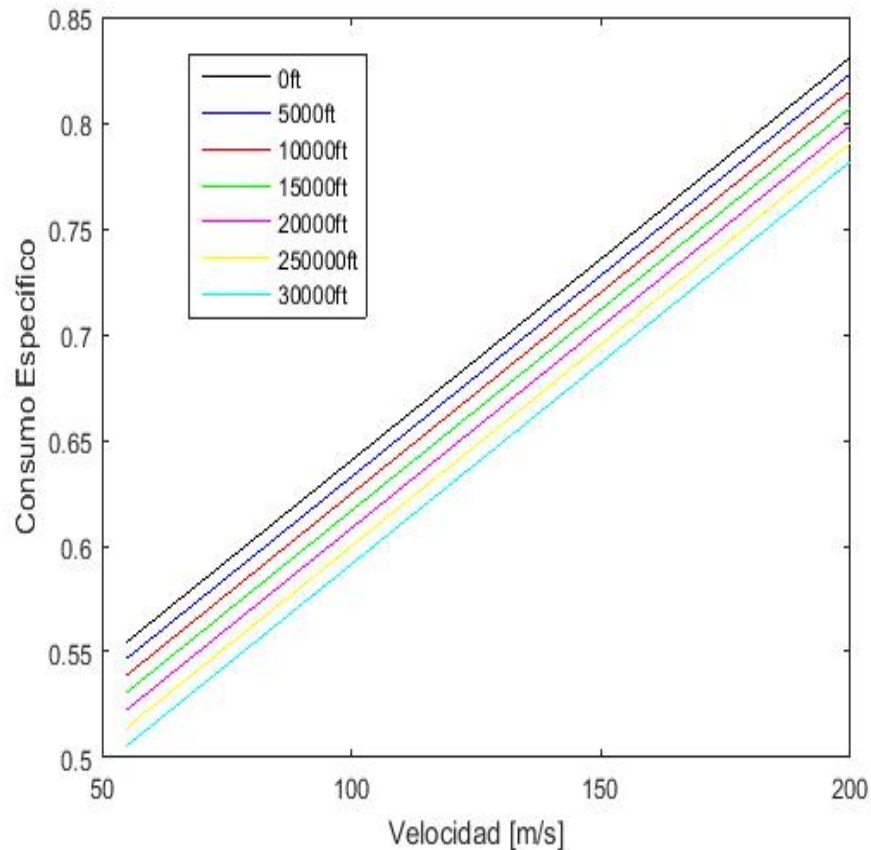
PROPULSIÓN Y ACTUACIONES

Dimensionado:

	Escalado 75%	Escalado 60% [definitivo]
Potencia por motor	4095 [shp]	3276 [shp]
Potencia total (4 motores)	16380 [shp]	13104 [shp]
Peso por motor	754.875 [kg]	603.9 [kg]
Peso total (4 motores)	3019.50 [kg]	2415.6 [kg]
Longitud del motor	2.5154 [m]	2.33508 [m]
Diámetro del motor	0.99698 [m]	0.92551 [m]
Diámetro palas de la hélice	4.03125 [m]	3.8553 [m]

PROPULSIÓN Y ACTUACIONES

CONSUMO ESPECÍFICO:



Misión primera línea:

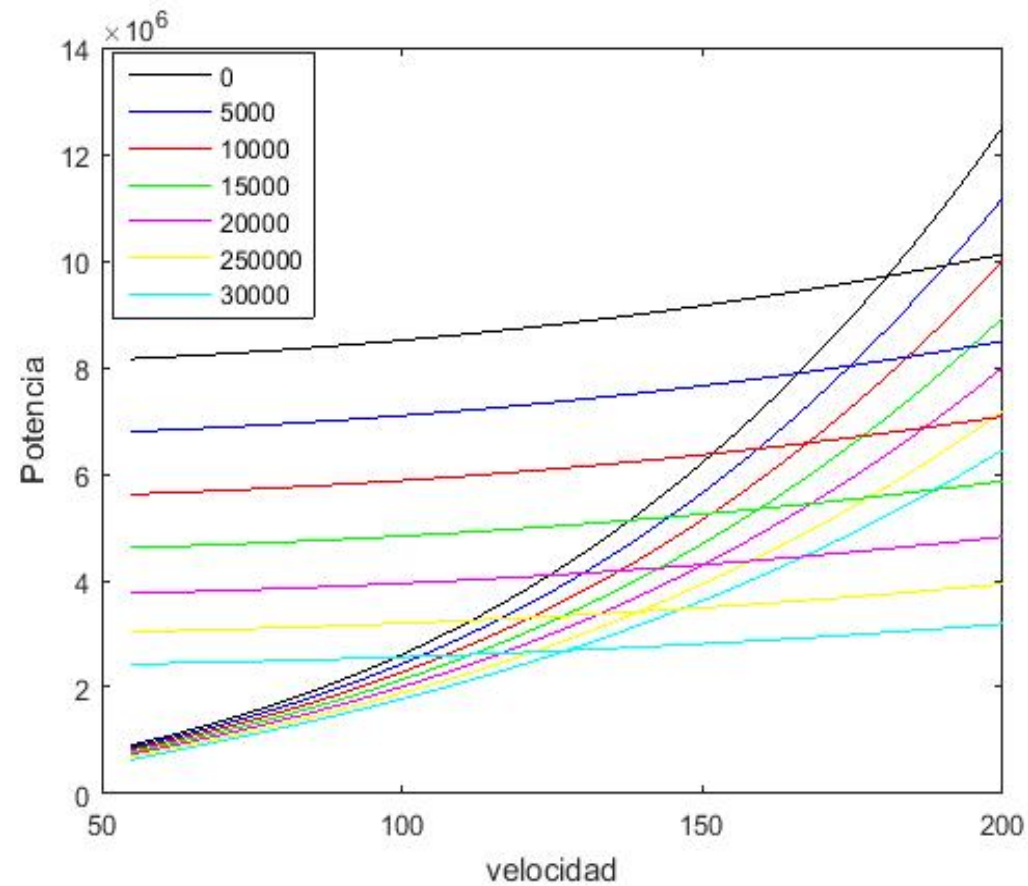
Despegue	Subida	Crucero-ida	Crucero-vuelta	Descenso
0.5552355	0.6088772	0.7057481	0.7064883	1.0975105

Misión ferry:

Despegue	Subida	Crucero (max. Alcance)	Crucero (max. Autonomía)	Descenso
0.5046	0.5351	0.5455	0.5474	0.949

PROPULSIÓN Y ACTUACIONES

POTENCIA REQUERIDA FRENTE A POTENCIA DISPONIBLE:



PROPULSIÓN Y ACTUACIONES

ACTUACIONES

MISIÓN DE PRIMERA LÍNEA:

FUEL TOTAL:

$$W_f = 2397.848 \text{ kg}$$

Velocidad minimiza CASM:

$$V_{opt} = 148.5522 \text{ m/s}$$

Tramo de vuelo	Consumo de combustible [kg]	Tiempo de vuelo [s]
<i>Taxi [5000ft]</i>	30.4166	540
<i>Despegue [5000ft]</i>	10.2158	14.5112
<i>Subida 1 [5000ft-6500ft]</i>	28.9978	40.4287
<i>Subida 2 [6500ft-15000ft]</i>	223.955	322.1448
<i>Crucero 1 [15000ft]</i>	935.0784	1778.1852
<i>Descenso 1 [15000ft-300ft]</i>	77.8151	1016.382
<i>Virajes [300ft]</i>	31.6698	116.4681
<i>Subida 3 [300ft-15000ft]</i>	140.1829	212.5668
<i>Crucero 2 [15000ft]</i>	828.6857	1951.9787
<i>Descenso 2 [15000ft-6500ft]</i>	30.3497	455.3539
<i>Descenso 3 [6500ft-5000ft]</i>	42.0671	636.1806
<i>Aterrizaje [5000ft]</i>	1.5155	25.0178
<i>Taxi [5000ft]</i>	16.8981	300

PROPULSIÓN Y ACTUACIONES

MISIÓN DE FERRY:

FUEL TOTAL:

$$W_f = 7860.9125 \text{ kg}$$

Velocidad minimiza
combustible:

$$V_{opt} = 85.2648 \text{ m/s}$$

Tramo de vuelo	Consumo de combustible [kg]	Tiempo de vuelo [s]
<i>Taxi y despegue [5000ft]</i>	32.7644	3.4973
<i>Subida 1[5000ft-6500ft]</i>	8.376	12.5635
<i>Subida 2 [6500ft-15000ft]</i>	98.6291	170.9673
<i>Crucero [20000ft]</i>	7596.697	43318.422
<i>Descenso 1 [20000ft-6500ft]</i>	71.1237	1265.8515
<i>Descenso 2 [6500ft-5000ft]</i>	33.903	555.7826
<i>Aterrizaje y taxi [5000ft]</i>	18.4193	28.6516

PROPULSIÓN Y ACTUACIONES

MISIÓN DE RESERVA:



FUEL TOTAL:

$$W_f = 478.7924 \text{ kg}$$

RESERVA DE COMBUSTIBLE:

$$W_f = 6.0908\%$$

PROPULSIÓN Y ACTUACIONES

COMPARACIÓN MISIONES:

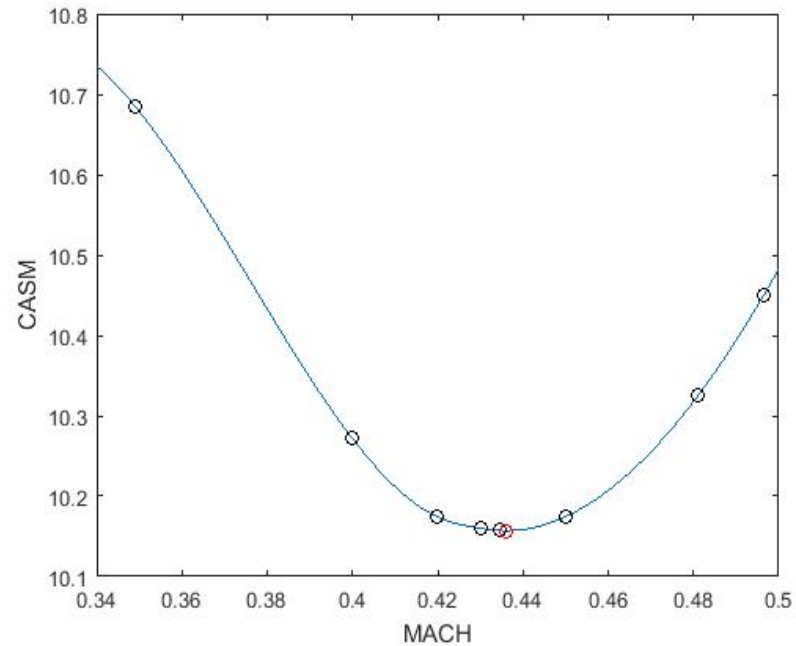
Misión primera línea	DESPEGUE	ATERRIZAJE
Distancia 15°C	445.1247 [m]	641.2728 [m]
Distancia 35°C	458.9844 [m]	640.3518 [m]
Fuel 15°C	10.2158 [kg]	1.5155 [kg]
Fuel 35°C	10.8713 [kg]	1.5794 [kg]

Misión ferry	DESPEGUE	ATERRIZAJE
Distancia 15°C	172.5239 [m]	832.5956 [m]
Distancia 35°C	173.3785 [m]	832.7369 [m]
Fuel 15°C	2.3478 [kg]	1.5212 [kg]
Fuel 35°C	3.0401 [kg]	1.899 [kg]

PROPULSIÓN Y ACTUACIONES

OPTIMIZACIÓN DE OPERACIONES:

Optimización CASM:

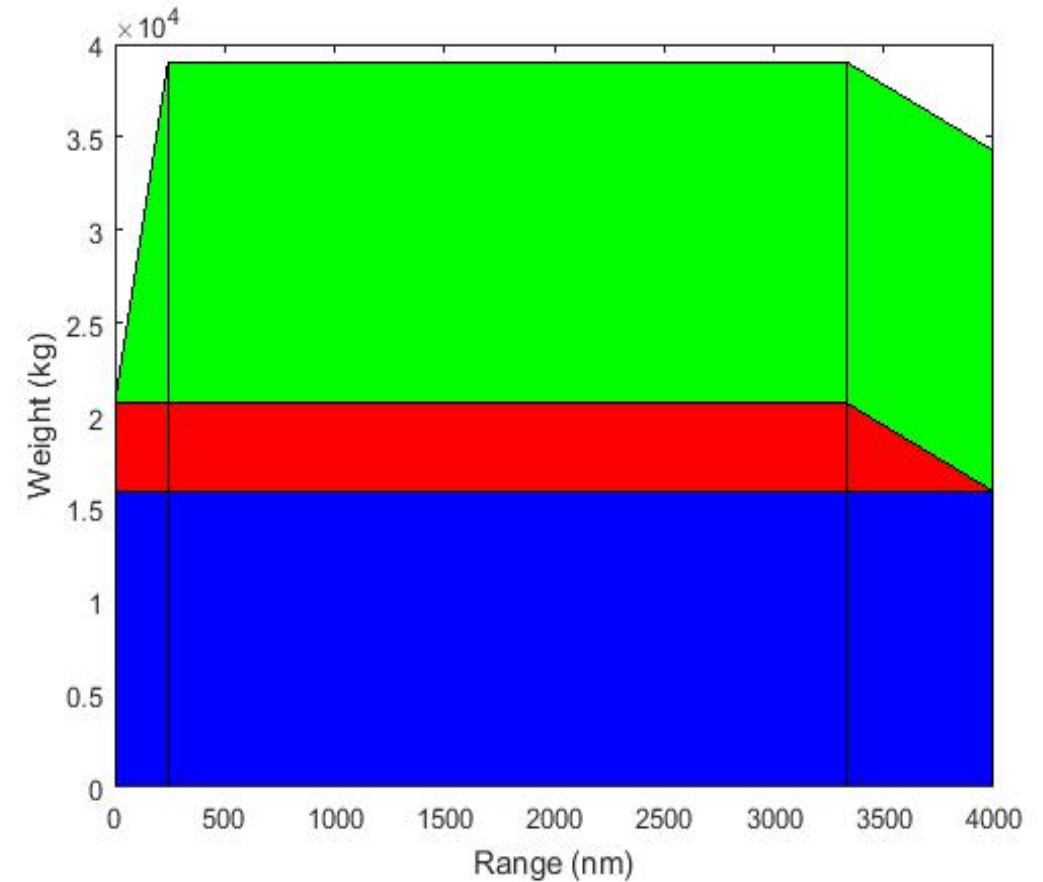


MACH	CASM
0.415	9.9971
0.4345	9.8851
0.45	9.843
0.46	9.8344
0.481	9.8647
0.4965	9.9266

PROPULSIÓN Y ACTUACIONES

CARGA DE PAGO- ALCANCE:

Ra	Rb	Rc
241.248 [nm]	3334.811 [nm]	4000.127 [nm]
446.791 [km]	6176.070 [km]	7408.235 [km]



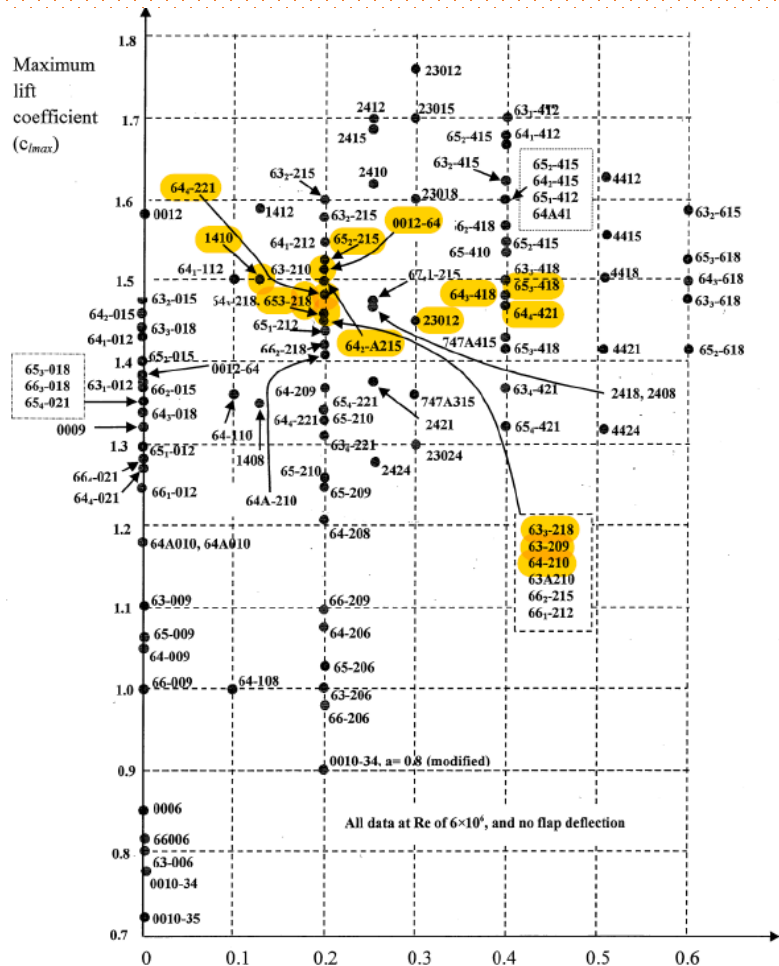


FLAM-AIR

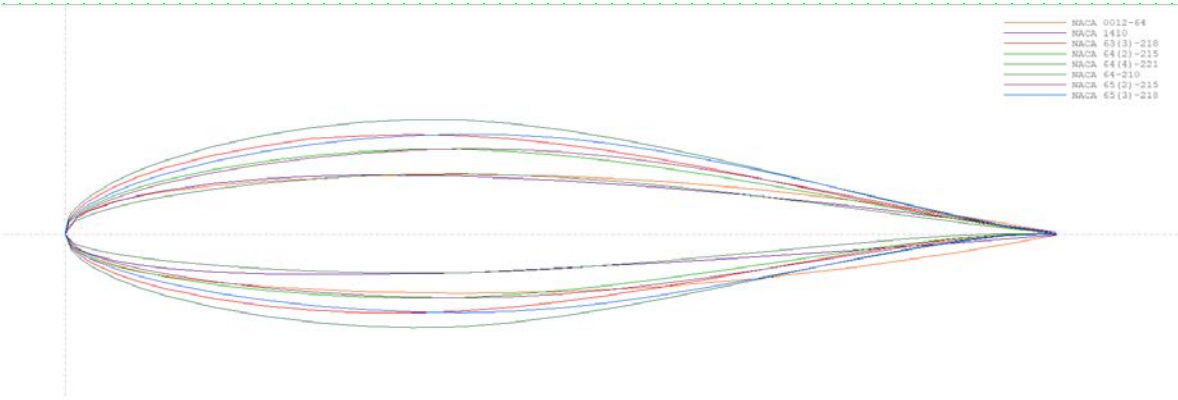
AERODINÁMICA

AERODINÁMICA

Problema 2D: Elección de perfiles



Iteración 1



642-215

63-209

653-218

64-210

644-221

0009

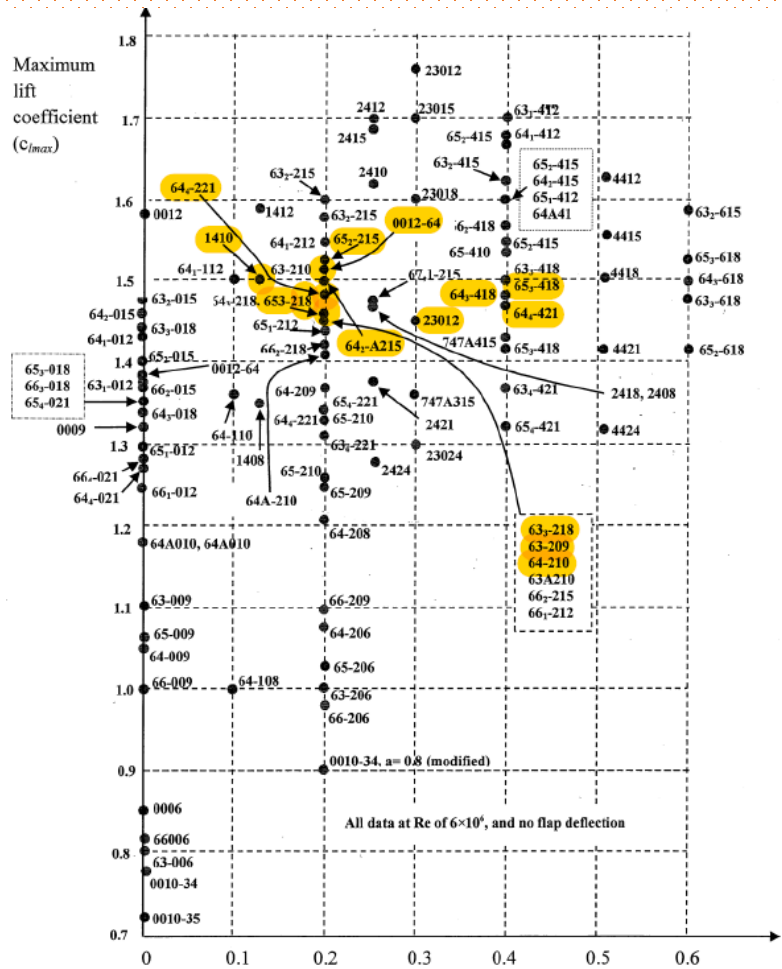
652-215

0012

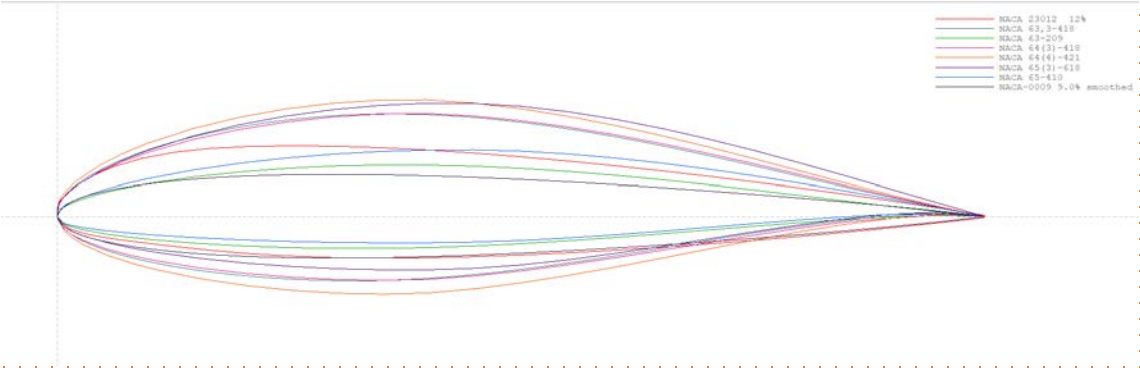
1410

AERODINÁMICA

Problema 2D: Elección de perfiles



Iteración 2



643-418

644-421

653-618

633-418

23012

65-410

AERODINÁMICA

Perfil	$C_{d_{min}}$	C_{m_0}	α_{stall} (°)	α_0 [°]	$(C_l / C_d)_{max}$	$C_{l_{max}}$	C_{l_0}	C_{l_a}	$(C_l^{3/2} / C_d)_{max}$	Stall Quality
65 ₃ -618	0.00458	0.31425	26	-4.556	131.531	1.717	0.506	6.4683	136.861	sharp
23012	0.00530	0.51050	21	-1.199	164.907	2.082	0.139	6.1977	206.882	mod
64 ₄ -421	0.00469	0.32750	27	-3.016	127.193	1.622	0.358	6.6031	133.344	sharp
63 ₃ -418	0.00425	0.42075	21	-3.066	150.997	2.007	0.366	6.4687	177.369	mod-
65-410	0.00573	0.37200	19.5	-3.011	157.158	1.812	0.342	6.1068	183.422	mod--

Mejor resultado (criterio)	Valor mínimo	Valor mínimo (abs)	Valor máximo	Valor mínimo	Valor máximo	Valor máximo	Valor máximo	Valor máximo	Valor máximo	Valor máximo
	0.00425	0.31425	27	-4.556	164.907	2.082	0.506	6.6031	206.882	Moderate

Perfil	$C_{d_{min}}$	C_{m_0}	α_{stall} (°)	α_0 [°]	$(C_l / C_d)_{max}$	$C_{l_{max}}$	C_{l_0}	C_{l_a}	$(C_l^{3/2} / C_d)_{max}$	Stall Quality	NOTA
65 ₃ -618	9.28	10	9.63	10	7.98	8.25	10	9.80	6.62	5	8.50
23012	8.02	6.16	7.78	2.63	10	10	2.75	9.39	10	10	8.30
64 ₄ -421	9.06	9.60	10	6.62	7.71	7.79	7.08	10	6.45	5	8.12
63 ₃ -418	10	7.47	7.78	6.73	9.16	9.64	7.23	9.80	8.57	8.75	8.76
65-410	7.42	8.45	7.22	6.61	9.53	8.70	6.76	9.25	8.87	7.5	8.09

AERODINÁMICA

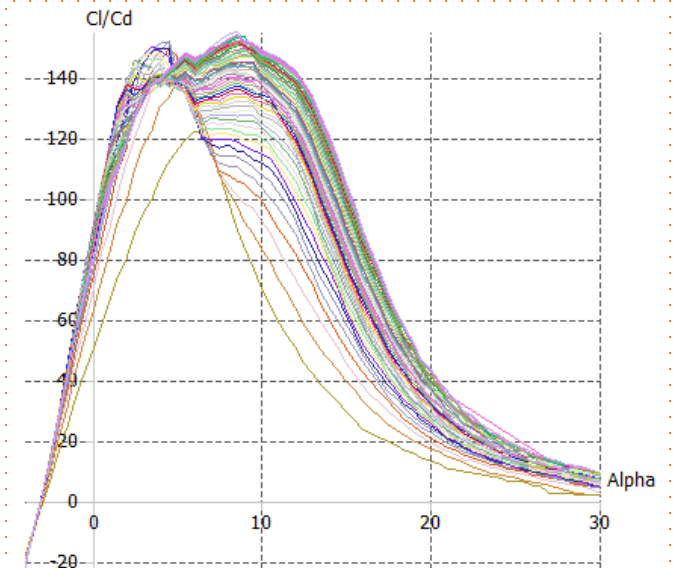
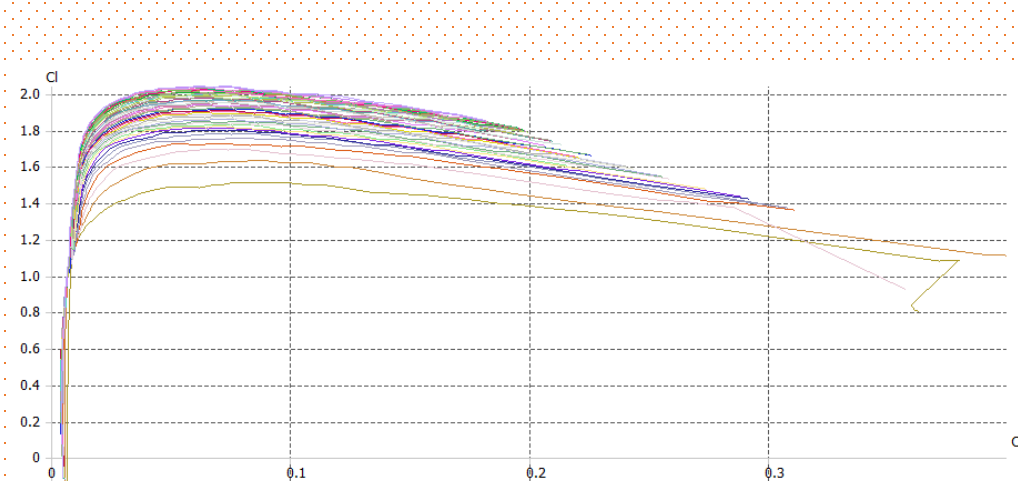
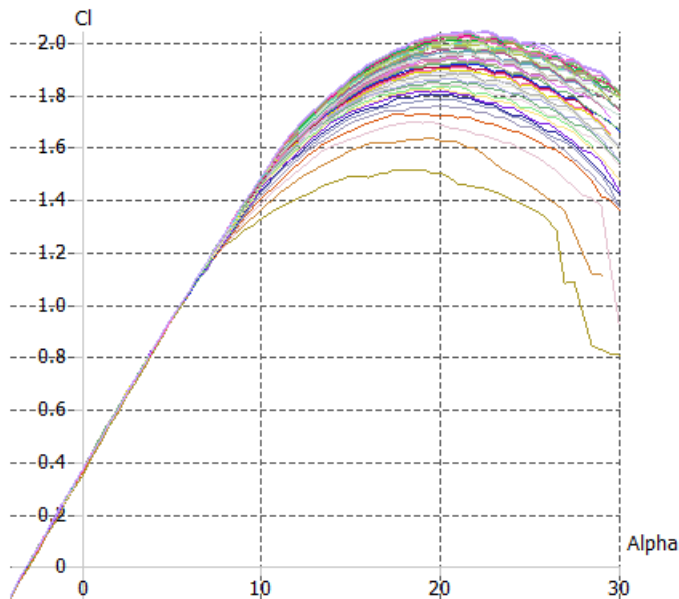
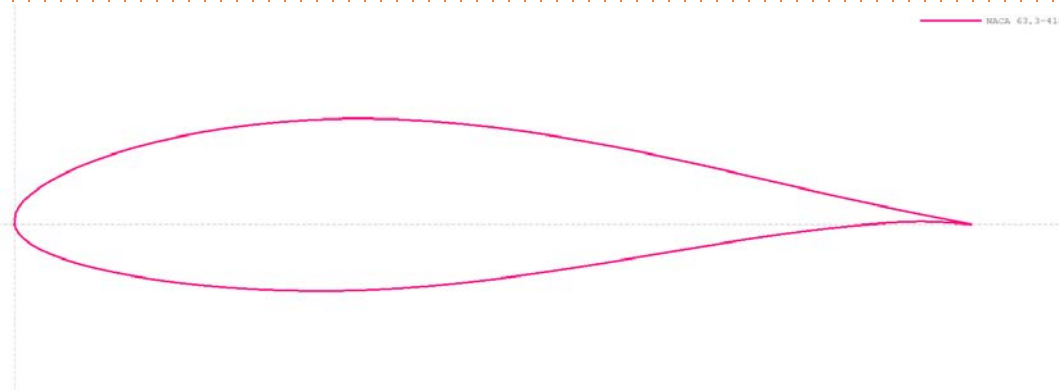
633-418

$$C_{l_{m\acute{a}x}} = 2,007$$

$$C_{d_{m\acute{i}n}} = 0,00425$$

$$E_{m\acute{a}x} = 150,997$$

$$\alpha_{STALL} = 21$$



AERODINÁMICA

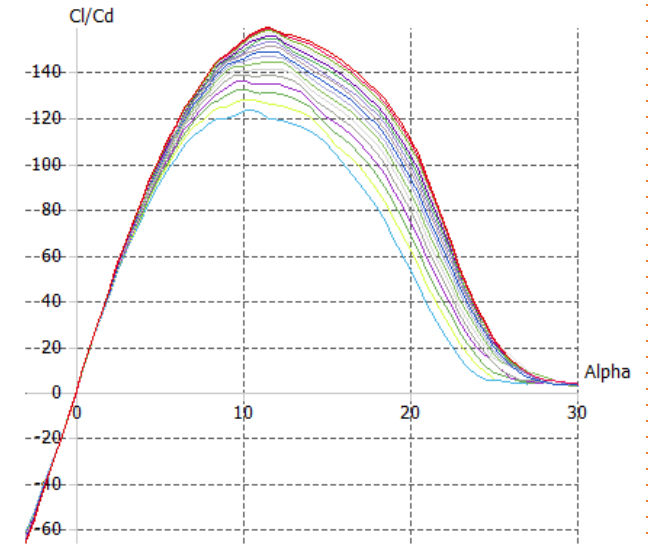
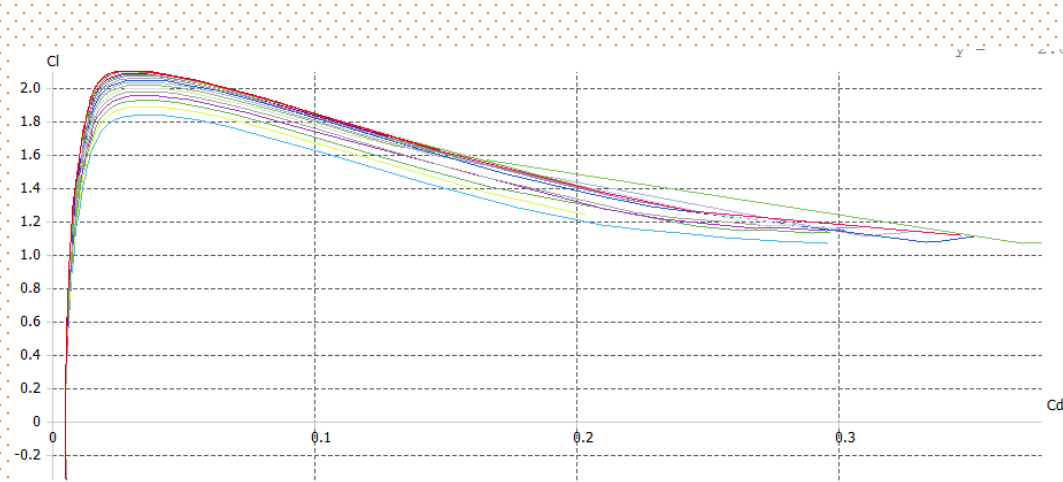
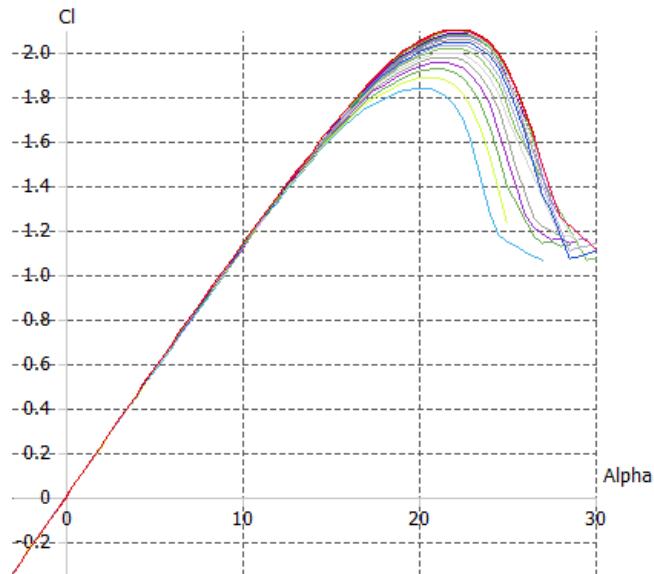
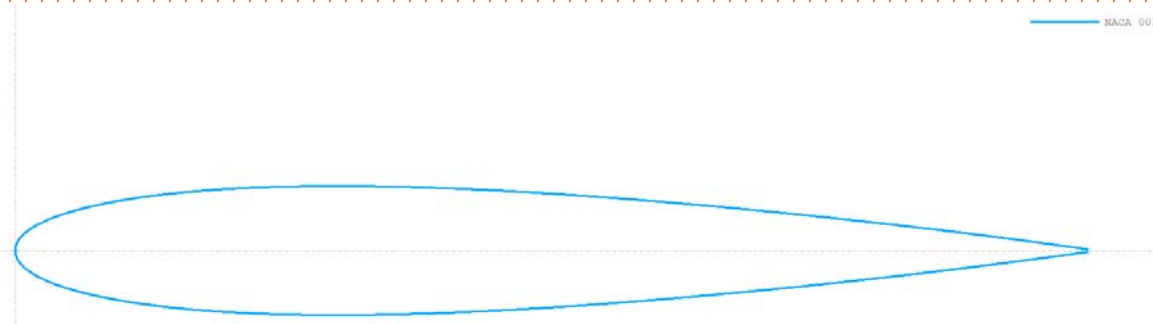
0012

$$C_{l_{m\acute{a}x}} = 2,096$$

$$C_{d_{m\acute{i}n}} = 0,0048178$$

$$E_{m\acute{a}x} = 160,258$$

$$\alpha_{STALL} = 22,839$$



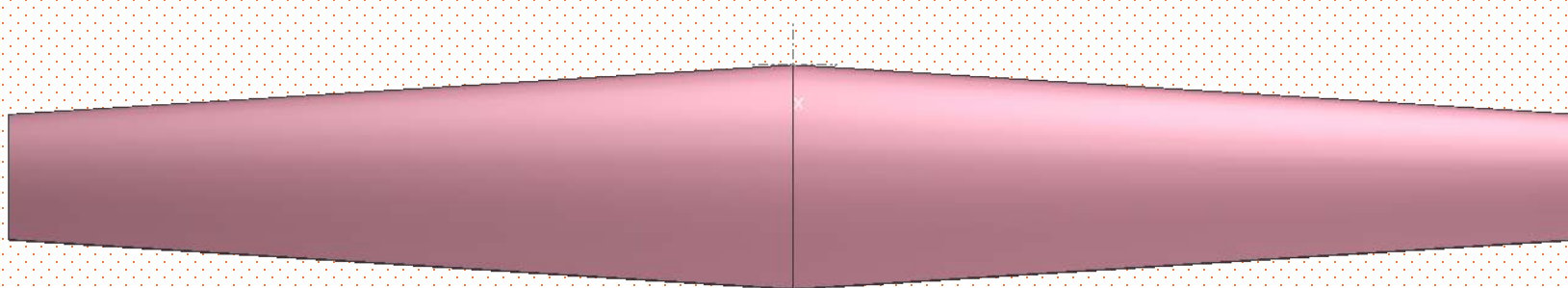
AERODINÁMICA

Problema 3D

Ala

Iteración	S_{ref}	AR	b	C_{D0}	α_{STALL}	$(C_L/C_D)_{m\acute{a}x}$	$C_{Lm\acute{a}x}$	C_{L0}	$C_{L\alpha}$
1	182.426	10.59	43.95	0.005747030	19.5	36.6129	1.691182	0.1410579	5.6638
2 (C.P.)	182.426	10.59	43.95	0.004982486	23.5	44.1055	1.942788	0.2995903	5.972
3	141.306	9	35.66	0.006659609	25	40.967376	1.937877	0.291737	5.4599
final	141.306	9	35.66	0.004744923	25	40.686795	1.9506650	0.291715	5.5098

$e = 0.958605541$



¿Winglets?



NO

AERODINÁMICA

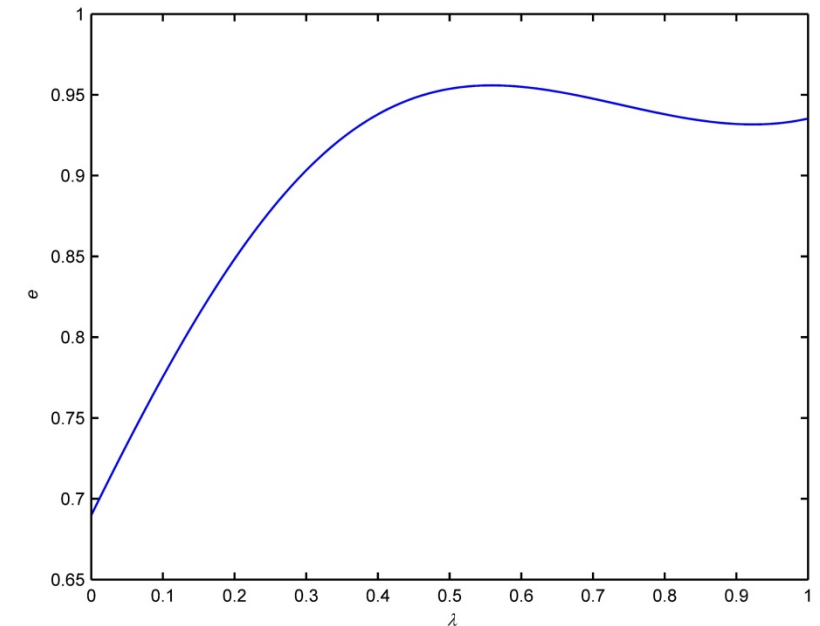
$$e = \frac{1.1C_{L\alpha}}{R \cdot C_{L\alpha} + (1-R)\pi AR}$$

$$R = a_1\lambda_1^3 + a_2\lambda_1^2 + a_3\lambda_1 + a_4$$

$$a_1 = 0.0004 \quad a_2 = -0.0080 \quad a_3 = 0.0501 \quad a_4 = 0.8642$$

$$\lambda_1 = \frac{AR \cdot \lambda}{\cos(A)}$$

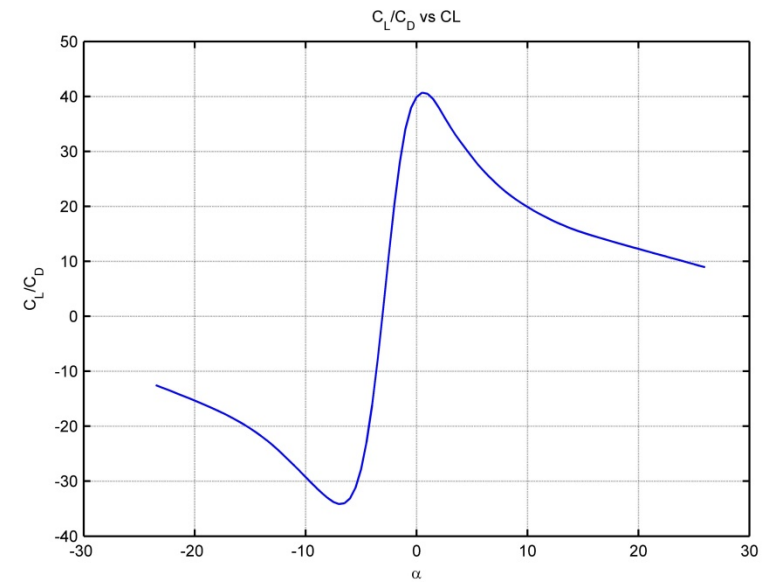
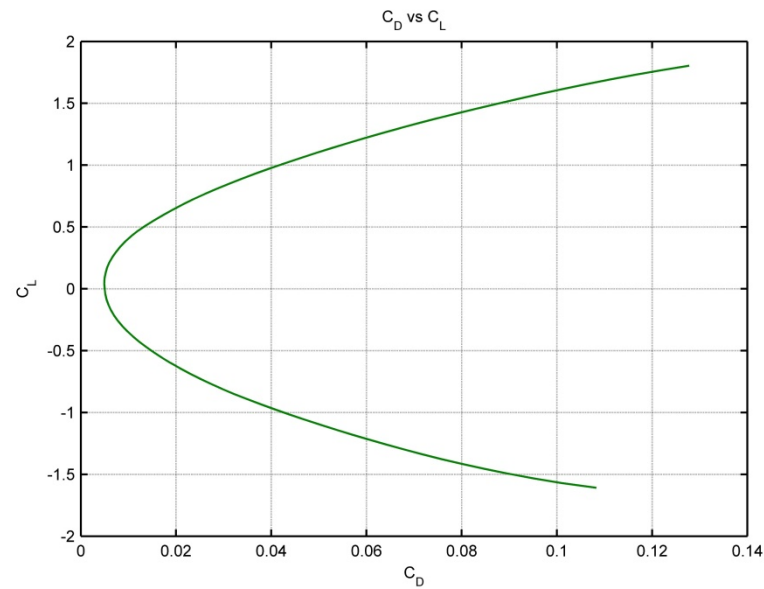
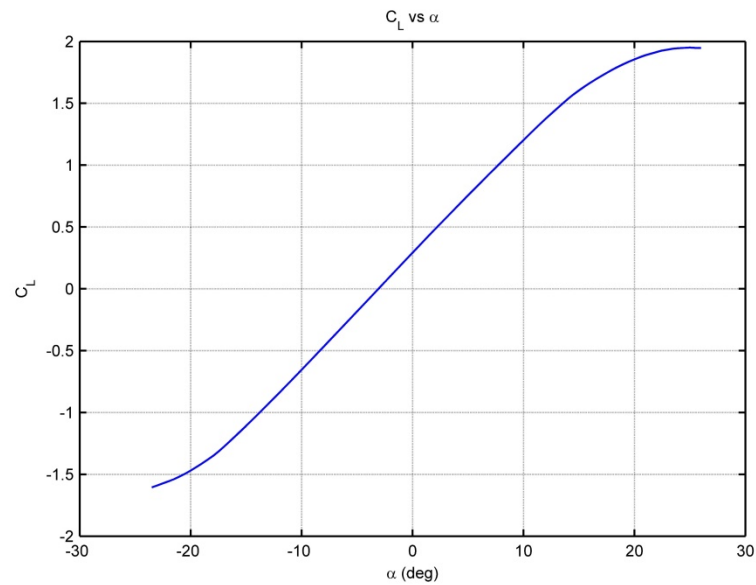
$$C_{L\alpha} = \frac{2\pi AR}{2 + \sqrt{AR^2(1 + \tan^2(A)) - M^2} + 4}$$



AERODINÁMICA

Problema 3D

Ala

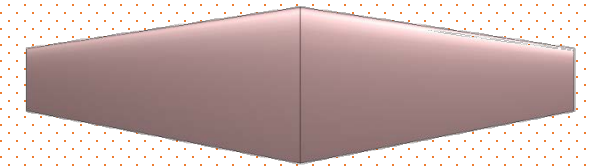


AERODINÁMICA

Estabilizadores

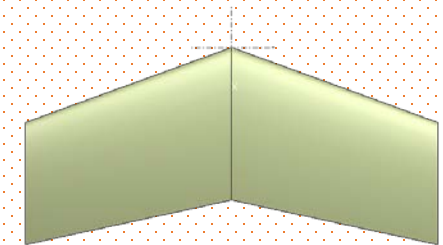
HTP

Iteración	S_{ref}	AR	b	C_{D_0}	C_{M_0}	C_{L_0}	C_{L_α}
F.O.S.	35.378	5.54	14	0.005045093	0	0	4.8248
3	20	5	10	0.005045093	0	0	4.8248
Final ($\downarrow P$)	20	5	10	0.005019599	0	0	4.6442



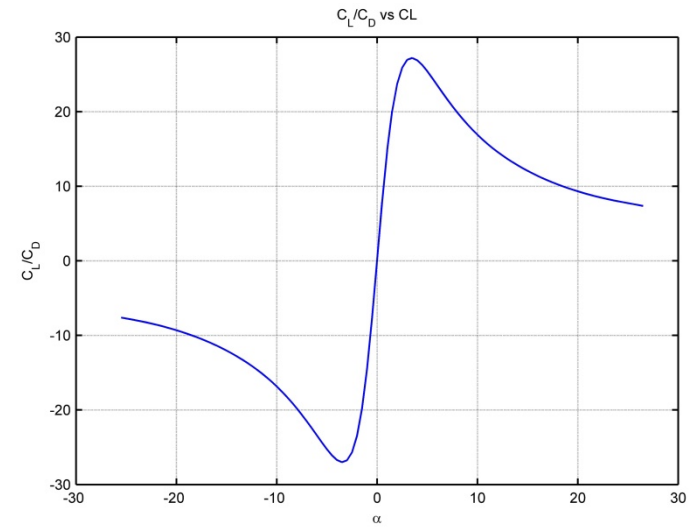
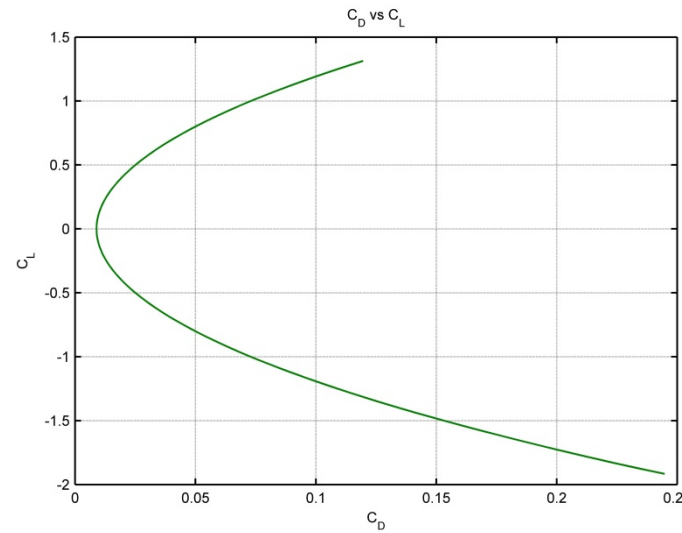
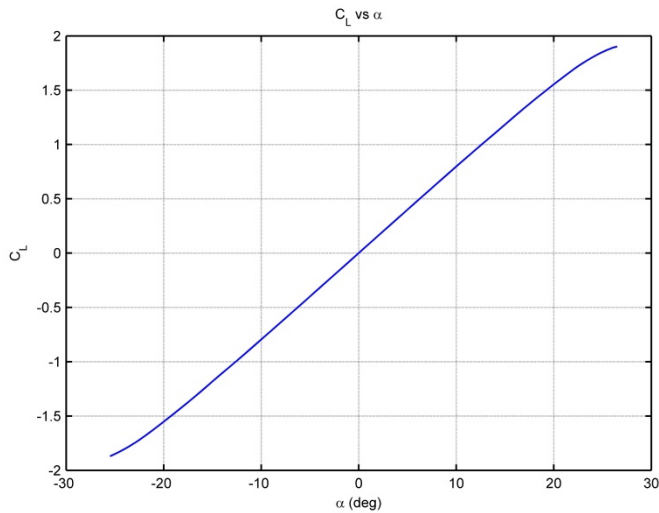
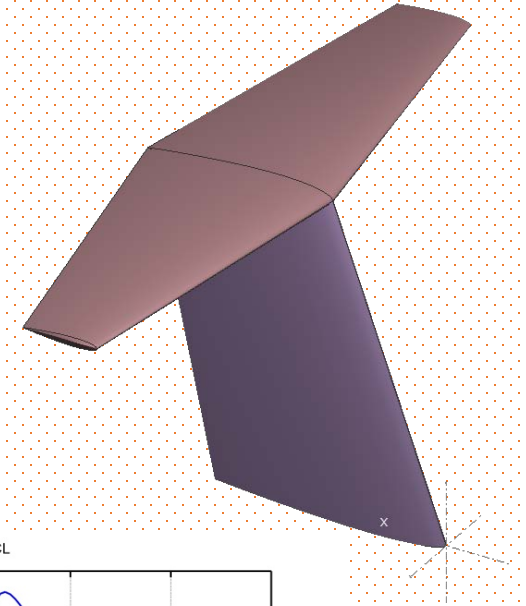
VTP

Iteración	S_{ref}	AR	b	C_{D_0}	C_{M_0}	C_{L_0}	C_{L_α}
F.O.S.	15.2	1.05	4	0	0	0	4.8248
3	15.4974	1.5	4.8214	0.002134323	0	0	5.0681
Final ($\downarrow P$)	15.4974	1.5	4.8214	0.003893203	0	0	1.9078



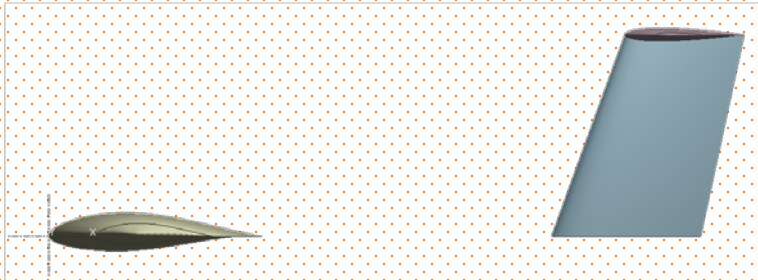
AERODINÁMICA

Estabilizadores



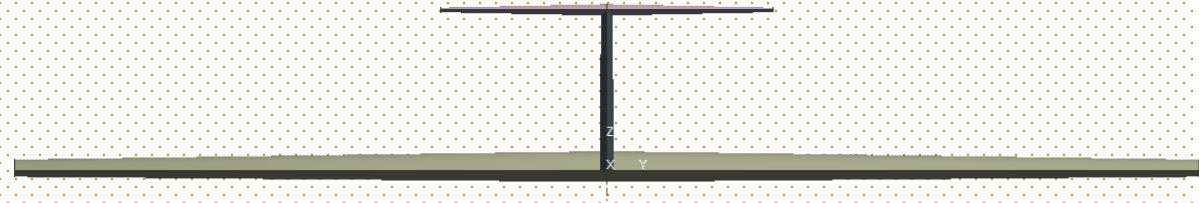
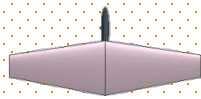
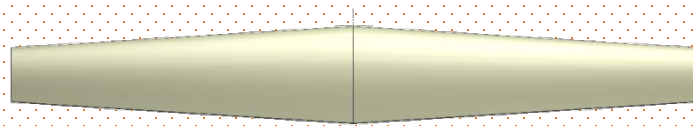
AERODINÁMICA

Avión completo



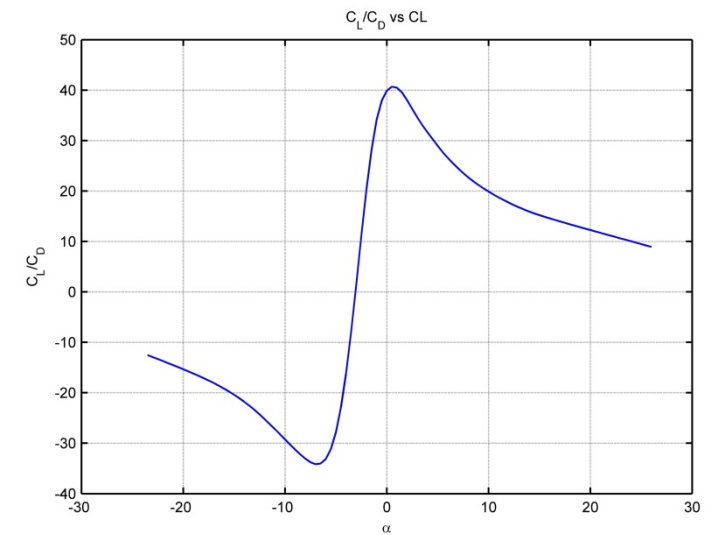
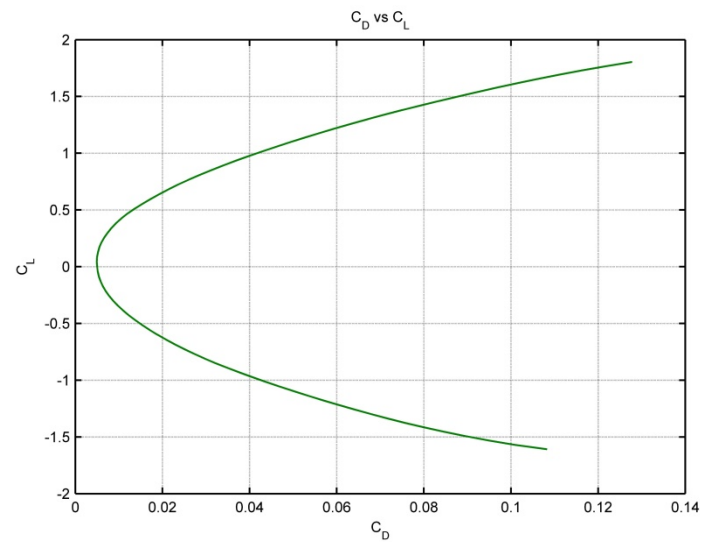
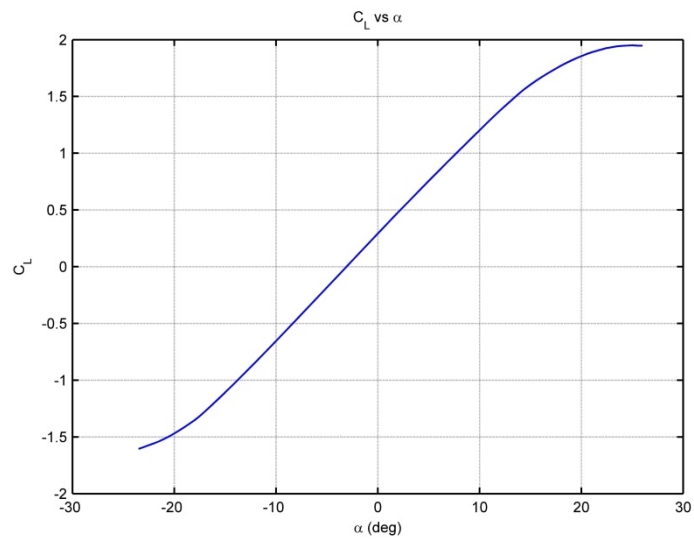
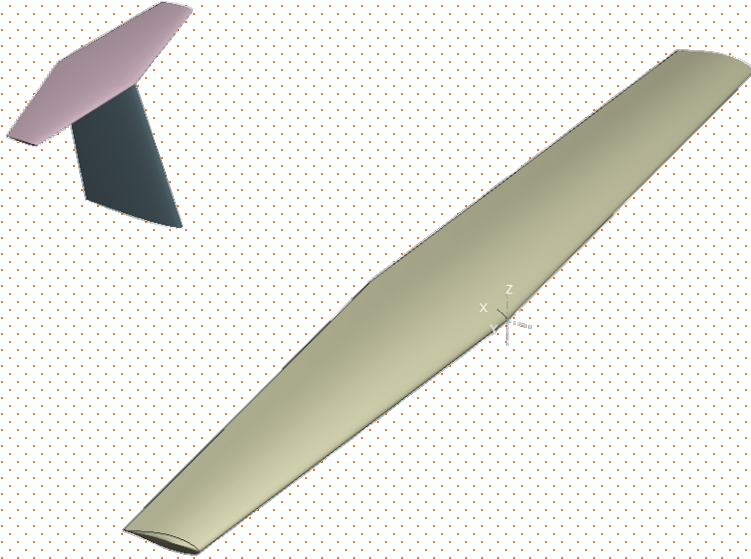
C_{L_0}	C_{L_α}	C_{M_0}	C_{M_α}
0.291715000	5.2130	0.096198	-0.373

e	E_{T0}	E_C	E_{CR1}	E_{CR2}	E_D	E_{LNDG}
0.958605541	39.27	39.19	38.75	20.07	19.89	19.89



AERODINÁMICA

Avión completo



AERODINÁMICA

Dispositivos hipersustentadores

3 iteraciones



Final

	$C_{L_{max}}$	$\alpha_{stall} [^\circ]$	$C_{L_{max}} (3D)$	$\alpha_{stall} [^\circ](3D)$
Basic aerofoil Clark Y	1.29	15	1.6912	19.5000
.30c Plain flap deflected 45°	1.95	12	2.0805	17.7450
.30c Slotted flap deflected 45°	1.98	12	2.0982	17.7450
.30c Split flap deflected 45°	2.16	14	2.2044	18.9150
.30c hinged at .80c Split flap (Zap) deflected 45°	2.26	13	2.2634	18.3300
.30c hinged at .90c Split flap (Zap) deflected 45°	2.32	12.5	2.2988	18.0375
.30c Fowler flap deflected 40°	2.82	13	2.5938	18.3300
.40c Fowler flap deflected 40°	3.09	14	2.7531	18.9150
Fixed slot	1.77	24	1.9744	24.7650
Handley Page automatic slot	1.84	28	2.0157	27.1050
Fixed slot and .30c plain flap deflected 45°	2.18	19	2.2162	21.8400
Fixed slot and .30c slotted flap deflected 45°	2.26	18	2.2634	21.2550
Handley Page slot and .40c Fowler flap deflected 40°	3.36	16	2.9124	20.0850

			$[^\circ]$	$[^\circ]$	$[^\circ]$
Despegue	2.5	0.65	6	-0.3	23.7
Aterrizaje	3.125	1.28	15	-0.7	23.3

AERODINÁMICA

Polar

CBM

Coficiente	Valor	Valor relativo
$C_{D_{ala}}$	0.005984259	38.01%
$C_{D_{fuselaje}}$	0.002692869	17.10%
$C_{D_{motores}}$	0.000393355	2.50%
$C_{D_{HTP}}$	0.001859624	11.81%
$C_{D_{VTP}}$	0.000610531	3.88%
$C_{D_{upsweep}}$	0.004202081	26.70%
$C_{D_{gear}}$	0	0%
$C_{D_{flaps}}$	0	0%
C_{D_0} (sin L&P)	0.015742718	100%
$\Delta C_{D_{L\&P}}$	0.000472282	+3%
C_{D_0}	0.016215000	-

$$C_{D_0} = 0.0211588057$$

Método numérico

	C_{D_0}	$k1$	$k2$
Configuración limpia	0.006260059101	0.0393679548	-0.003051976
Configuración sucia (TO)	0.006333352725	0.0410901792	-0.004588059
Configuración sucia (LNDG)	0.00634145802	0.0411697768	-0.004659914

Método mixto

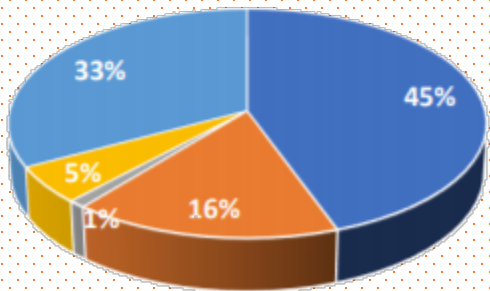
	C_{D_0}	$k1$	$k2$
Crucero 15000 ft	0.01385281869	0.0393679548	-0.003051976
Crucero 20000 ft	0.01398001276	0.0393679548	-0.003051976
Despegue	0,0272578340	0.0410901792	-0.004588059
Aterrizaje	0.03728592650	0.0411697768	-0.004659914

AERODINÁMICA

Polar

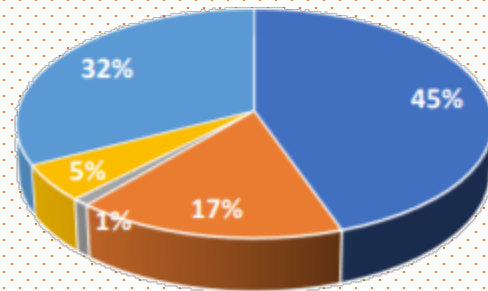
CRUCERO 15000 FT

- Superficies sustentadoras
- Fuselaje
- Motores
- Carenas LG
- Upsweep



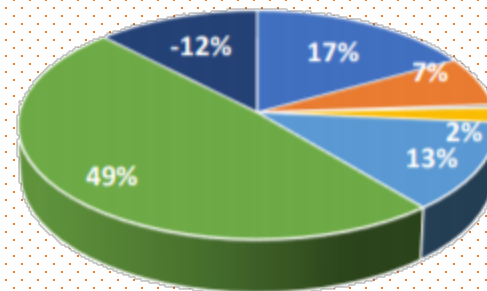
CRUCERO 20000 FT

- Superficies sustentadoras
- Fuselaje
- Motores
- Carenas LG
- Upsweep



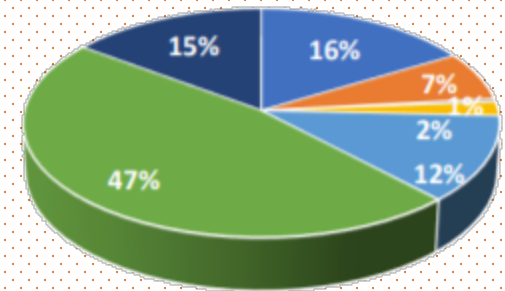
DESPEGUE

- Superficies sustentadoras
- Fuselaje
- Motores
- Carenas LG
- Upsweep
- Tren de aterrizaje
- Flaps



ATERRIZAJE

- Superficies sustentadoras
- Fuselaje
- Motores
- Carenas LG
- Upsweep
- Tren de aterrizaje
- Flaps





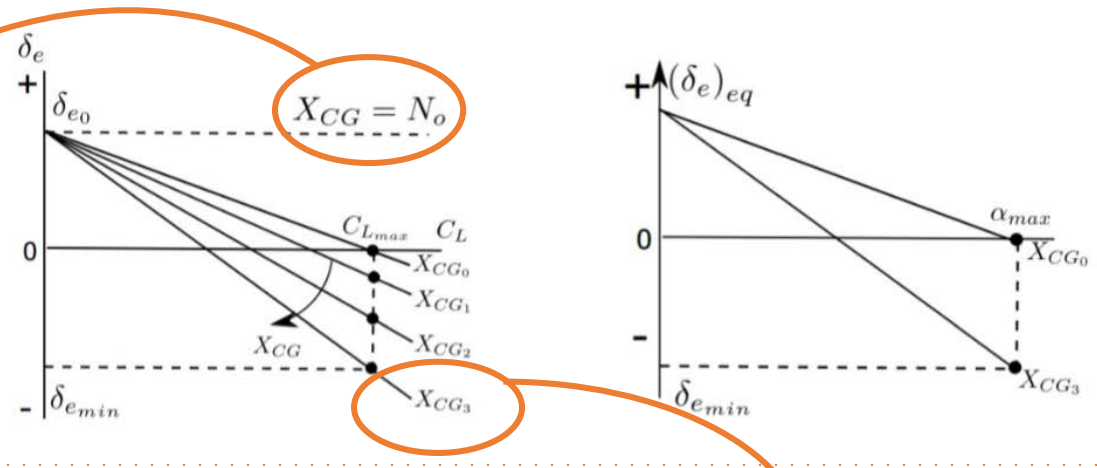
FLAM-AIR

ESTABILIDAD

ESTABILIDAD

CENTROS DE GRAVEDAD

CG más atrasado



CG más adelantado

ME > 0 → CG = 10.144m

$$\bar{x}_{cg} = N_0 - \frac{C_{M0} + C_{M\delta_e} \delta_{e,min}}{C_{l\alpha} \alpha_{w,max}} = 2.188 \rightarrow \text{CG} = 8.903\text{m} \rightarrow \text{ME} = 31.4\%$$

ESTABILIDAD

ESTABILIDAD ESTÁTICA TRIMADO LONGITUDINAL

1º ITERACIÓN

Misión de Primera Línea

2º ITERACIÓN

Nf 8,947

NPL_Nf

ESTABILIDAD

ESTABILIDAD ESTÁTICA TRIMADO LONGITUDINAL

Evolución

3º ITERACIÓN

9,467

18,5

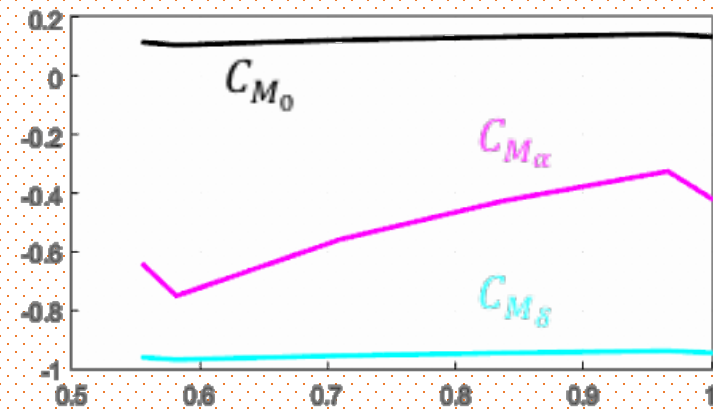
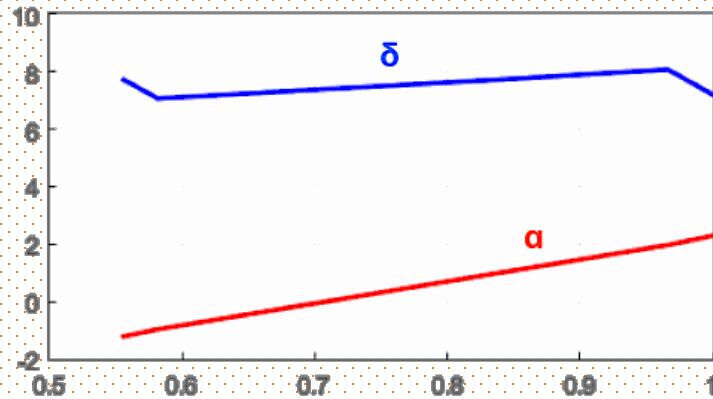
Aterrizaje + taxi

ESTABILIDAD

ESTABILIDAD ESTÁTICA TRIMADO LONGITUDINAL

3º ITERACIÓN

α [°]



ESTABILIDAD

ESTABILIDAD ESTÁTICA TRIMADO LONGITUDINAL

Evolución

4º ITERACIÓN

434

17,4

Descenso 3

ESTABILIDAD

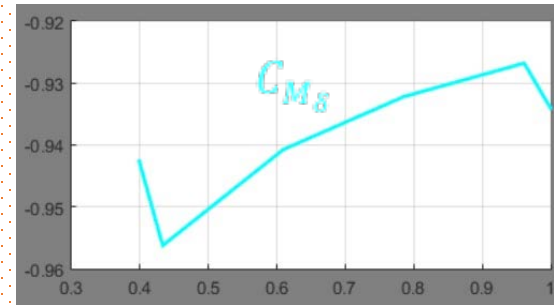
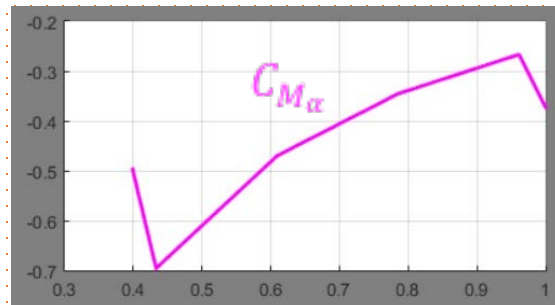
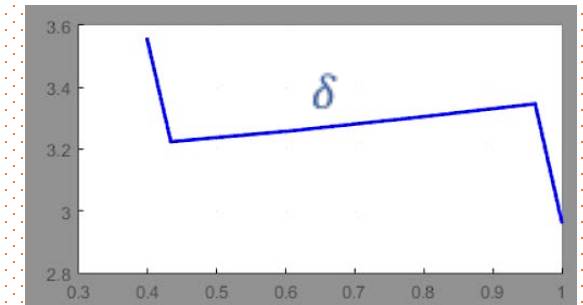
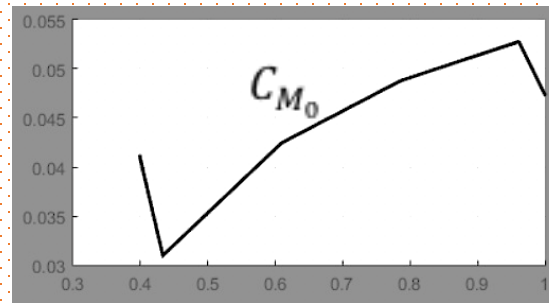
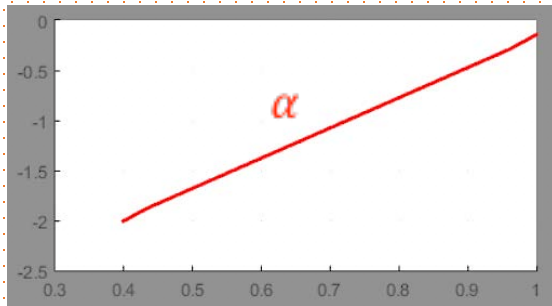
4º ITERACIÓN

ESTABILIDAD ESTÁTICA TRIMADO LONGITUDINAL

$\alpha[^\circ]$

69

-0,943



ESTABILIDAD

ESTABILIDAD ESTÁTICA TRIMADO LONGITUDINAL

Misión de Ferry



$$V_w = 79.1 \%$$
$$V_{HTP} = 20.9 \%$$

ESTABILIDAD

ESTABILIDAD ESTÁTICA TRIMADO LONGITUDINAL

Misión de Ferry

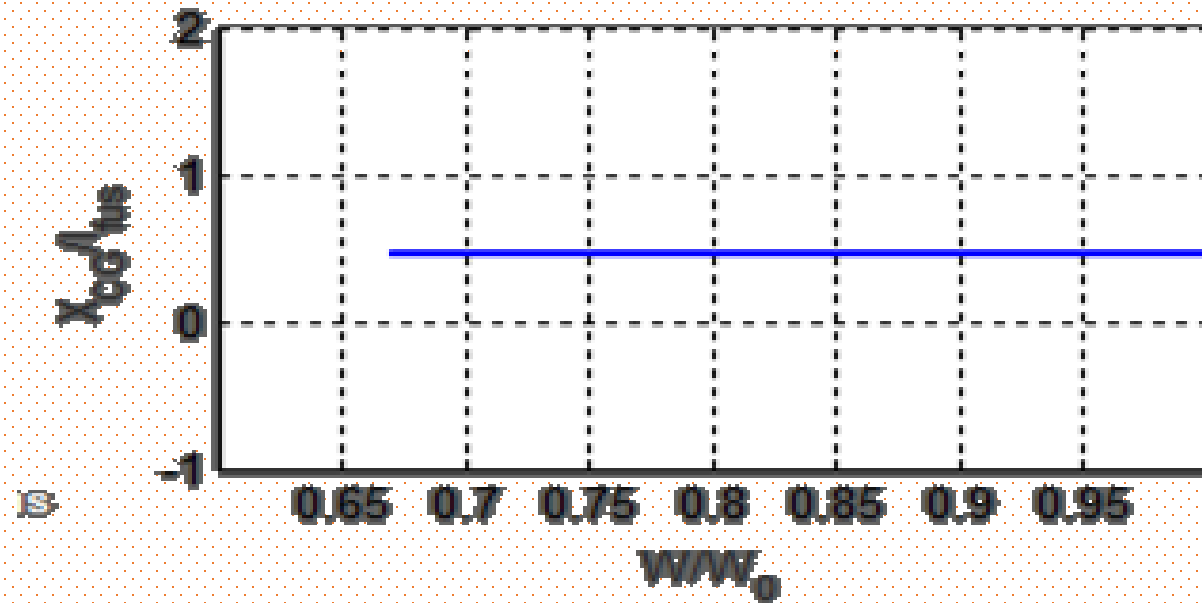
Evolución

Aterrizaje + taxi

ESTABILIDAD

ESTABILIDAD ESTÁTICA TRIMADO LONGITUDINAL

Misión de Ferry



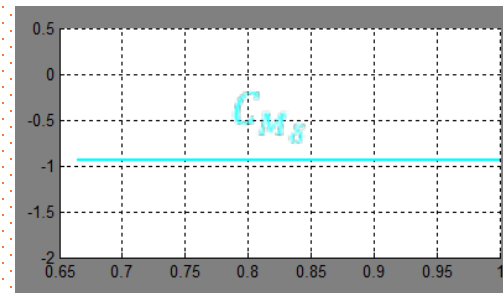
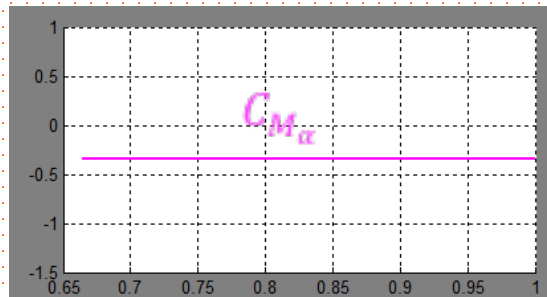
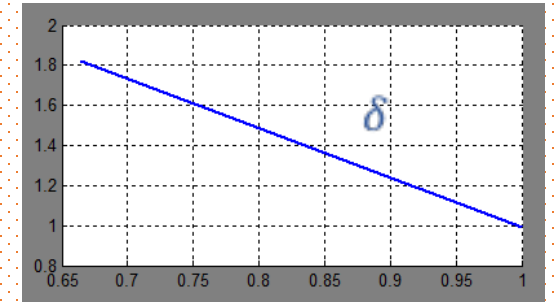
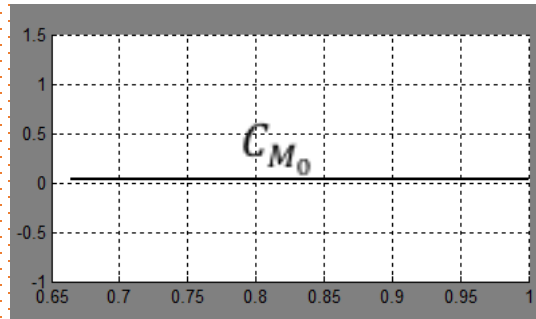
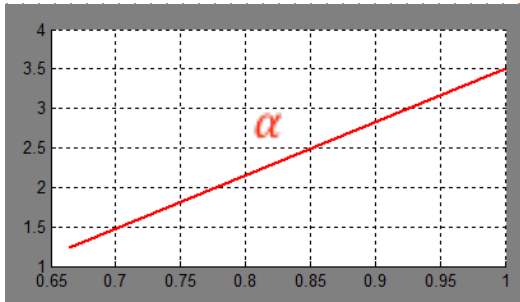
ESTABILIDAD

ESTABILIDAD ESTÁTICA TRIMADO LONGITUDINAL

α [°]

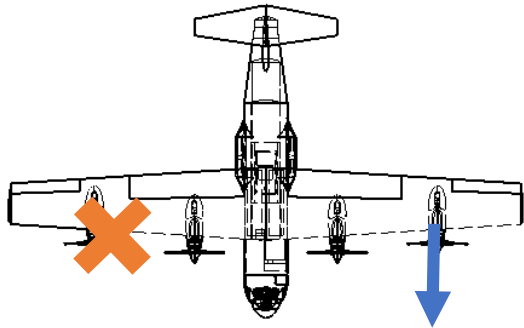
342

-0,941



ESTABILIDAD

ITERACIÓN 3



**TRIMAD
DIRECC**

VERTICAL STABILIZER DESIGN

S_ref (m2)	141.306	b_w (m)	35.7	V_s (m/s)	53.75	h (ft)	15000
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Available Cn_dr Estimation

S_v (m2)	15.2	S_rud/S_v	0.35
l_v (m)	11.03	eta_v	0.95

Lift Slope Estimation

b_v (m)		Cl _a (1/rad)	
cr_v (m)			
TR_v			
LAM_v(°)			
S_hor (m2)			
z_hor (m)			
Dfus_v (m)		Cl _{a_v} (1/rad)	4.64

Vertical Conf.

Convencional
 Twin-vertical

Estimate Cl_{a_v}

OEI Required Cn_dr

P_inop_eng (kW)	3053.64	d_inop_eng (m)	10
dr_max (°)	20	eta_prop	0.82

Propeller Type

Fixed-Pitch
 Variable-Pitch

Calcular
(Cn_dr)_OEI -0.075623

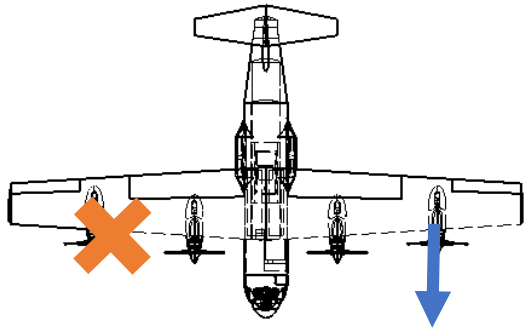
LOAD MODEL

CLOSE

Calculate Cn_dr (1/rad) -0.083348

ESTABILIDAD

MOTOR SIN RESBALAMIENTO



**FALLO
RESBAL**

ONE ENGINE INOPERATIVE AND SIDESLIP ANGLE ANALYSIS

$$\begin{bmatrix} C_{Y\beta} & C_{Y\delta_a} & C_{Y\delta_r} \\ C_{l\beta} & C_{l\delta_a} & C_{l\delta_r} \\ C_{n\beta} & C_{n\delta_a} & C_{n\delta_r} \end{bmatrix} \begin{bmatrix} \beta \\ \delta_a \\ \delta_r \end{bmatrix} = \begin{bmatrix} \frac{-(mg\sin(\phi)\cos(\gamma) + F_{Y_{T_1}})}{qS_{ref}} \\ \frac{-L_{T_1}}{qS_{ref}b} \\ \frac{-(N_{T_1} + \Delta N_{D_1})}{qS_{ref}b} \end{bmatrix}$$

MATRIX

-0.31409	0	0.3864
-0.046793	0.25992	0.02515
0.076187	-0.01544E	-0.11247

RESTORE INITIAL VALUES

ONE ENGINE INOPERATIVE

h (ft) Estudio de condiciones

beta (°)

V/Vstall

P/Pmax

SOLVE

phi da dr

SIDESLIP ANGLE

h (ft) Estudio de condiciones

beta (°)

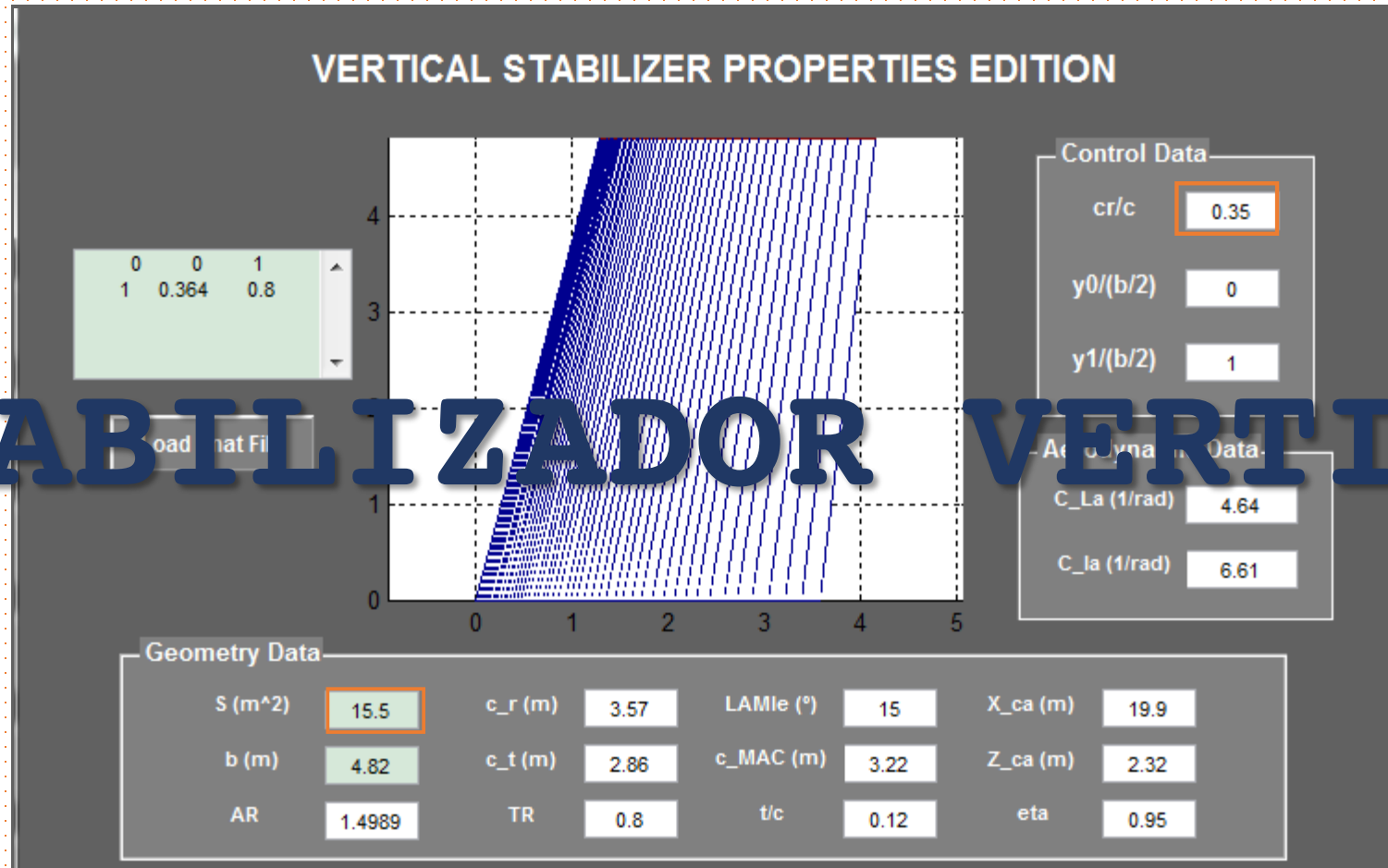
V/Vstall

SOLVE

phi da dr

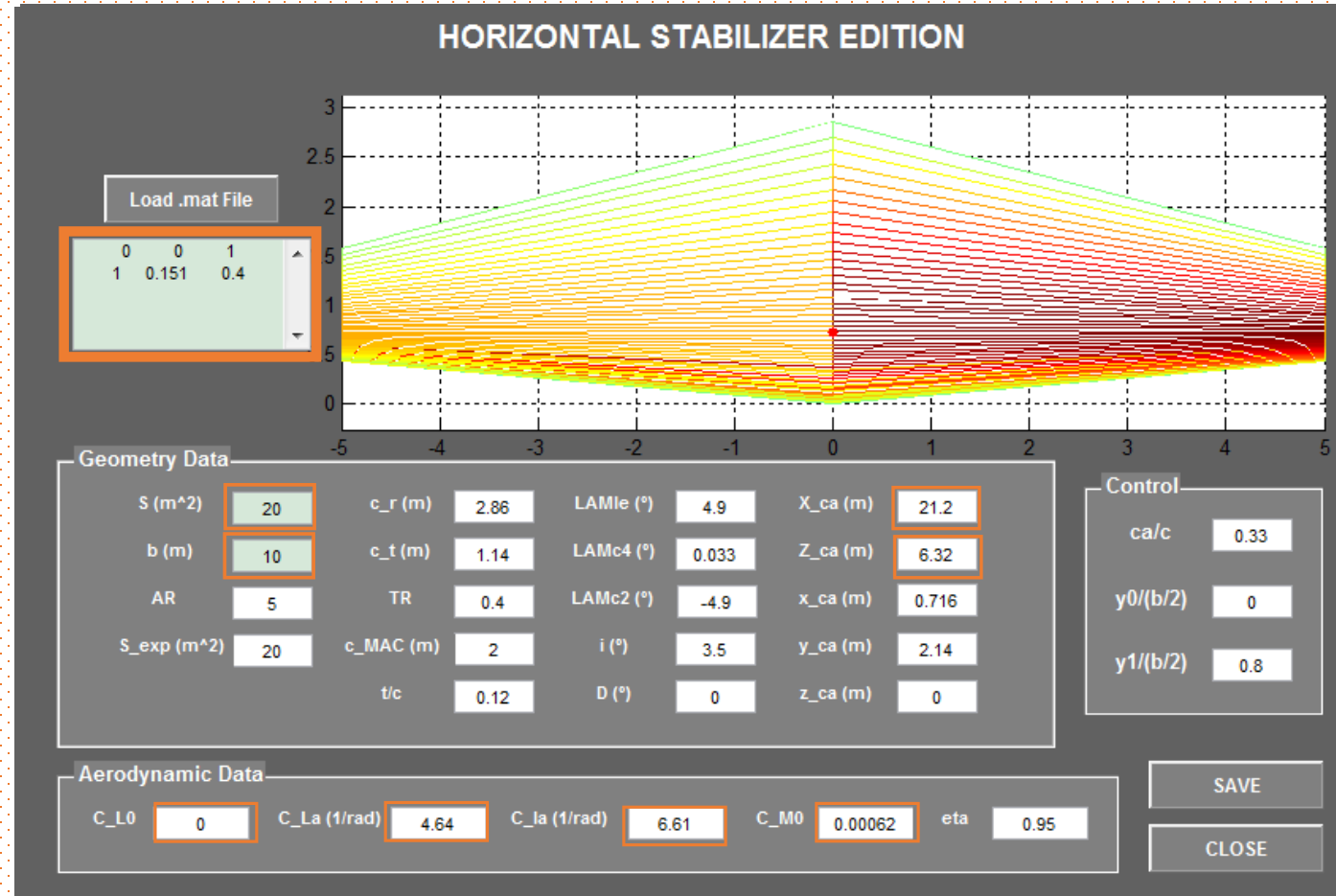
ESTABILIDAD

ITERACIÓN 2



ESTABILIDAD

ITERACIÓN 21



ESTABILIDAD

ALERONES AMISÓN PRIMERA LÍNEA

AILERONS DESIGN

b (m) S (m²) LAM (°) V_cor (m/s)

h (m) c_r (m) c_t (m)

Available CI_da Estimation

ca/c Cla

t/c

y_0 (m) y_1 (m)

CI_da

Required CI_da Calculation

P (rad/s) da_max (°)

(CI_da)_req

ESTABILIDAD

COMPORTAMIENTO DINÁMICO LONGITUDINAL

Modo	K_1	K_2	K_3	K_4
	-11.1775	6.2764	-0.04569+0.093316i	-0.04569-0.093316i

Modo	w [rad/s]	τ [s]	T [s]	ξ
Corto periodo	11.1775	0.062	Inf	1
Fugoide	0.10388	15.181	67.3323	0.43943

ESTABILIDAD

COMPORTAMIENTO DINÁMICO LATERAL-DIRECCIONAL

Modo	K_1	K_2	K_3	K_4	K_5
	0	-4.7314	-0.00084887	-0.17343+1.6984i	-0.17343+1.6984i

Modo	w [rad/s]	[s]	T [s]	ξ	[s]
Balanceo holandés	1.7072	3.9959	3.6996	0.10159	
Espiral					816.3824
Convergencia en balance		0.14647			

Gracias por pensar en





 **FLAM-AIR**