NeoCASS Tutorial

How to run a static aeroelastic analysis "three maneuver sizing"

Version 2.2(.790)

August 2017

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Do not forget to run the script *set_neocass_path* in the installation directory. That allows to include the NeoCASS routines into the current path. Then change directory that you will use for your analysis and start *NeoCASS*, typing it in the command window.





Maneuvers Set Definition



Guess/SMARTCAD trir	n interface		Solution Met	hod	Joined wing	
 ✓ Pullup ✓ Ailerons ✓ Engine Out Cruise attitude (HCI Min cruise mach nu Max ceiling attitude Clean max lift coef All flaps down max All flaps down max Clean lift curve slop Reference surface Flap deflection for Sink speed at landi Shock absorber st Landing gear effici Maneuvers set defining Number of flight coef 	 Horizontal tail/canard Static Gust High Lift RU) [m]: umber (MCRU) []: (HMAX) [m]: ficient (CLMAX) []: (CL at Take Off (CLMAXTO) []: (CL at Landing (CLMAXLAND) [] pe (CLALPHAD) []: (USERSREF) [m^2]: TO (FLAPTO) [deg]: Landing (FLAPLAND) [deg]: ing (VSINK) [m/s]: roke at landing (STROKE) [m]: intion anditions: 	Vertical tail Taildown Landing	Elastic Ir 'A To Ic 'S	ircraft Solution Me Rigid Aircraft' o impose thre bad condition SELECT Values	ethod select ethod select ee user-defined s click on: s'	

Maneuvers Set Definition: man. ID 1



Maneuver Definition	Mach: 0.5	Altitude [m]:	X	For example, define three
Symmetric Maneuvers Cruise/Climb (AoA, pitch control surfaces)	~	Anti-Symmetric Maneuvers Sideslip levelled flight	~	symmetric and one anty-
Parameters				symmetric.
Angle of attack (ANGLEA) [deg]:		Sideslip angle (SIDES) [deg]:	0	
Roll rate (ROLL) [1/s]:	0	p rate (URDD4) [1/s^2]:	0	Pull Up maneuver:
Pitch rate (PITCH) [1/s]:	0	q rate (URDD5) [1/s^2]:	0	Z acceleration =
Yaw rate (YAW) [1/s]:	0	r rate (URDD6) [1/s^2]:	0	3,5*g.
Elevator rotation (elev1r) [deg]:		X acc (URDD1) [m/s^2]:		
Canard rotation (elevC1r) [deg]:		Y acc (URDD2) [m/s^2]:	0	Clicking 'Save' the
Aileron rotation (aileronr) [deg]:	0	Z acc (URDD3) [m/s^2]:	34.3	next maneuver's
Rudder rotation (rudder1) [deg]:	0	Vertical speed (VGUST) [EAS m/s]:	0	setting window
1st Flap rotation (flap1r) [deg]:	0	Strut efficiency (LNDGEFF) []:	0	
2nd Flap rotation (flap2r) [deg]:	0	Sink speed (VSINK) [m/s]:	0	will appear.
Symmetric maneuver		Shock absorber stroke (STROKE) [m]:	0	T
User defined maneuver	Save	Discard		

Maneuvers Set Definition: man. ID 2



Maneuver Definition			– 🗆 X]
2	Mach: 0.5	Altitude [m]:	5000	
Symmetric Maneuvers		Anti-Symmetric Maneuvers		
Cruise/Climb (AoA, pitch control surfaces)	~	Sideslip levelled flight	~	
Parameters				
Angle of attack (ANGLEA) [deg]:		Sideslip angle (SIDES) [deg]:	0	
Roll rate (ROLL) [1/s]:	0	p rate (URDD4) [1/s^2]:	0	Negative g
Pitch rate (PITCH) [1/s]:	0	q rate (URDD5) [1/s^2]:	0	maneuver:
Yaw rate (YAW) [1/s]:	0	r rate (URDD6) [1/s^2]:	0	Z acceleration =
Elevator rotation (elev1r) [deg]:		X acc (URDD1) [m/s^2]:		-1,5*g.
Canard rotation (elevC1r) [deg]:		Y acc (URDD2) [m/s^2]:	0	
Aileron rotation (aileronr) [deg]:	0	Z acc (URDD3) [m/s^2]:	-14.7	
Rudder rotation (rudder1) [deg]:	0	Vertical speed (VGUST) [EAS m/s]:	0	
1st Flap rotation (flap1r) [deg]:	0	Strut efficiency (LNDGEFF) []:	0	
2nd Flap rotation (flap2r) [deg]:	0	Sink speed (VSINK) [m/s]:	0	
Symmetric maneuver		Shock absorber stroke (STROKE) [m]:	0	-
User defined maneuver	Save	Discard	_	

Maneuvers Set Definition: man. ID 3



Maneuver Definition			-	×	
3	Mach: 0.5	Altitude [m]: 50	100		
Symmetric Maneuvers		Anti-Symmetric Maneuvers			
Cruise/Climb (AoA, pitch control surfaces)	~	Sideslip levelled flight	~		
Parameters					
Angle of attack (ANGLEA) [deg]:		Sideslip angle (SIDES) [deg]:	20		
Roll rate (ROLL) [1/s]:	0	p rate (URDD4) [1/s^2]:	0		
Pitch rate (PITCH) [1/s]:	0	q rate (URDD5) [1/s^2]:	0		Sideslip maneuver:
Yaw rate (YAW) [1/s]:	0	r rate (URDD6) [1/s^2]:	0		sideslip angle = 20°
Elevator rotation (elev1r) [deg]:		X acc (URDD1) [m/s^2]:			
Canard rotation (elevC1r) [deg]:		Y acc (URDD2) [m/s^2]:			
Aileron rotation (aileronr) [deg]:		Z acc (URDD3) [m/s^2]:	9.81		
Rudder rotation (rudder1) [deg]:		Vertical speed (VGUST) [EAS m/s]:	0	1	
1st Flap rotation (flap1r) [deg]:	0	Strut efficiency (LNDGEFF) []:	0		
2nd Flap rotation (flap2r) [deg]:	0	Sink speed (VSINK) [m/s]:	0		
Symmetric maneuver		Shock absorber stroke (STROKE) [m]:	0		×
User defined maneuver	Save	Discard			



Save the trim condition in a .inc file (*3trimcond.inc*) and run guess creating *geo3trim.inc*





The *ChEcK window* comes up in order to check the way your aircraft is modeled. In the three slide below there is an output example of *Aerodynamic, Structural and Aeroelastic Models* of *B747-400*.

承 ChEcK	_		×		
Aerodynamic Model Structural Model	Aero	elastic N	lodel		
Horizontal tail all movable Canard	i all mo	ovable			
Mass Configuration					
Max number of iterations3Tolerance for convergence check (EPS):1.0e-3					
Run Exit	t]			



ChEcK phase





ChEcK phase





ChEcK phase





Dimensioning Maneuvers



If everything goes well, the output will be similar to this one:

In order to view which maneuver was the most accountable for each <u>a/c part</u> (in terms of bending, shear and torque), one have to load the guess result and process these data through the 'plot_sizing_man' function.



Dimensioning Maneuvers



For instance, the sizing maneuver of the fuselage in bending loading is predictably the pull-up m. (ID 1)





The same will be for bend, torque and shear of wings.





The negative g maneuver (ID 2) is the dimensioning one for horizontal tail as far as the torque loading is considered.





Finally, the side slip m. (ID 3) is the most significant for the vertical tail sizing.





Set *Reference Values* and then press *Settings* for assigning loading details for further analysis.

承 NeoCASS				- 0	×				
File	Se	ettings	Run	Results					
LOAD NeoCASS	project	Solver Input Data Ref. Values	Settings	Enabled Solvers					
Open aircraft Sizing mode	EDIT	AS	REFERENCE_Se	ttings		_		×	
Open techno RUN GUES	S EDIT	Read Analysis In Open SMAF	Reference values Ref.	7 Ref. Span	34	Ref. Surfa	ace 145		
			0 Full model	Ok	vry Heigh	t 2 (Cancel			Te
	St	tatic aeroela	stic analysis	s – V2.2.790 -	Rel.1 Aug	just 20'	17 - pag	. 18	



Trim conditions Static Aeroelastic Ana	Set Control Surf		Select	'Static Aeroelast	ic Analysis' and
Number of flight	1 SELECT Value	*S	flight of	condition analyze	ne out the three d before during
O Modal Analysis			GUESS	module, for instan	ce 'pull-up'.
Normalizati 1 MA	SS V ID ID DO	0 1 ~			
Number of Mode	DES From 0 To	999999	Then (GENERATE the si	tatic inc file that
Flutter Analysis			contain	s these informatic	
Number of reduced frequence	Dies N.Freq INSER	T Values	contain	is these informatic)n.
Modal Base [Qhh] MSELE	СТ				
Mode FMODE	S				
OV-g plot	O Flutter Enve	NeoCASS			- U X
Max speed 340.3	N.Mach	File	S	ettings Run	Results
Max V step 50	INSERT	LOAD NeoC/	ASS project	Solver Input Data	Enabled Solvers
Density 1.225		Initial Sizing Input I	Data	Ref. Values Settings	STATIC
Density				GENERATE	MODAL
Mach number 0.5		Open aircraf	t EDIT		
Mach number 0.5	Apply Cancel	Open aircraf Sizing mode	t EDIT	ASSEMBLY	TRIM
Mach number 0.5	Apply Cancel	Open aircraf Sizing mode Open techno	EDIT	A SSEMBLY Read Analysis Input Data	FLUTTER

Running a 'TRIM' analysis



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Running a 'TRIM' analysis



- Solver input data file: C:\NeoCASS_PG\Examples\PROVA\static_3cond\static.inc.

- Exporting parameters for steady VLM solver...done.

- SMARTCAD file: C:\NeoCASS_PG\Examples\PROVA\static_3cond\static.dat.

Loading the SMARTCAD file *static.dat* enables the TRIM and Rigid AERO analysis.

承 NeoCASS				_		×		
File	s	ettings	Run	Results				
LOAD NeoCA	SS project	Solver Input Data		Enabled Solvers				
Initial Sizing Input D)ata	Ref. Values	Settings	ST.	ATIC			
Open aircraft	EDIT	GENE	MO	DAL				
Sizing mode		ASSE		IM				
Open techno	EDIT	Read Analysis Inpu	FL	UTTER				
RUN G	UESS	Open SMART	CAD EDIT	<mark>∕ Rig</mark>	J. AERO			
RUN G	UESS	Open SMART	CADEDIT	<mark>∕ Rig</mark>	J. AERO			



Running a 'TRIM' analysis



		_		×
File	Settings Run	F	Results	
	===== Interactive Mode =====			
STATIC	MODAL TRIM FLUTTER	RIC	GID VLM/C	DLM
	==== Automatic Mode =====			
	START			

Start running the TRIM process that equilibrate the ac in the selected flight condition.

TRIM Conditions Selection —		×
Loaded Maneuver List:		
Cruise/Climb = ID=1,Sym=1,MACH=0.5,ALT=5000,URDD3=34.3 (Trim Variables: alpha,acc_x,Elevator,vgust,vsink,stroke,LandGEff)		^
<	>	×
Ok Cancel		
	2.	
A BEAL	1.	a service



In the command window the solver tells you about the actual process.

Solving linear static unrestrained trim (ID 1)
- Setting internal databasedone.
- Building aero-structural interpolation matrices
- Method: 1.
- Assemblying collocation points interpolation matrixdone.
- Assemblying nodes interpolation matrixdone.
- Assemblying vorticies interpolation matrixdone.
- Assemblying vortices midpoint interpolation matrixdone.
- Assemblying body collocation points interpolation matrixdone.
done.
- Assemblying stiffness matrixdone.
- Assemblying mass matrixdone.
etc





The trim condition is solved.

Solving deformable aircraft trim condition	
- X acc: -6.88203e-12 [m/s^2].	
$-Y = 0 [m/s^2].$	
- Z acc: 39.3 [m/s^2].	
- P-DOT: 0 [rad/s^2].	
- Q-DOT: 0 [rad/s^2].	
- R-DOT: 0 [rad/s^2].	
- Alpha: 38.1965 [deg].	
- Sideslip: 0 [deg].	
- Roll rate: 0 [-] (p*BREF/(2VREF)).	
- Pitch rate: $0 [-] (q*CREF/(2VREF)).$	
- Yaw rate: 0 [-] (r*EREF/(2VREF)).	
- Control flapir: 0 [deg].	
- Control flap2r: 0 [deg].	
- Control aileronr: 0 [deg].	
- Control elevir: -6.25167 [deg].	
- Control rudder1: 0 [deg].	
done.	
- Updating vim model in Aero.lattice defodone.	
- Solution summary exported to C:\NeoCASS FG\Examples\PROVA\static 3cond\static man 1.txt fil	le.
completed.	
	10 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
	and the second second
	The second
Static aeroelastic analysis – V2.2.790 - Rel.1 August 2017 - pag. 24 🍼	and the second



Now one could also run the 'Rigid VLM/DLM analysis'. By clicking it the analysis will start automatically.

承 NeoCASS		– 🗆 X
File	Settings Run	Results
	===== Interactive Mode =====	
STATIC	MODAL TRIM FLUTTER	RIGID VLM/DLM
	===== Automatic Mode =====	
	START	



Running a 'Rigid VLM/DLM' analysis





Running another 'TRIM' and 'Rigid VLM/DLM' analysis

In order to analyze another loading condition, return to the $\underline{18}$ th slide and repeat the procedure for 'sideslip'.

איי <u>ר</u> יי ד	xamples > 3cond >	V Ö Cer	rca in	م ر	
rganizza 🔻 🛛 Nuova	cartella		[== • ?	
Computer	Nome	Ultima	modifica Tip	0	
📃 Desktop	3trimcond.inc	04/07/2	016 09:49 File	INC	
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📧 Immagini	🗋 static.inc	04/07/2	016 10:18 File	INC	
👌 Musica					
📑 Video					
🛀 OS (C:)					
👝 Volume (X:)					
🎒 Rete 🗸	< <			>	>
Nome file: stat	ic2			~	
Salva come: Solv	er input data file (*.inc)			~	~
Manage di anatalla			Salva	Annulla	

Running another 'TRIM' and 'Rigid VLM/DLM' analysis

The new trim condition is solved:

```
Solving deformable aircraft trim condition...
- X acc: -3.36379e-12 [m/s^2].
- Y acc: 1.04461 [m/s^2].
- Z acc:
            9.81 [m/s^2].
- P-DOT:
           0 [rad/s^2].
- Q-DOT: 0 [rad/s^2].
- R-DOT: 0 [rad/s^2].
- Alpha: 10.2084 [deg].
- Sideslip: 20 [deg].
- Roll rate: 0 [-] (p*BREF/(2VREF)).
- Fitch rate: 0 [-] (g*CREF/(2VREF)).
- Yaw rate: 0 [-] (r*BREF/(2VREF)).
- Control flapir: 0 [deg].
- Control flap2r: 0 [deg].
- Control aileronr: 18.9543 [deg].
- Control elevir: 4.89144 [deg].
- Control rudder1: 19.3475 [deg].
dome.
- Updating vlm model in Aero.lattice defo...done.
- Solution summary exported to C:\NeoCASS PG\Examples\PROVA\static_Scond\static2_man_1.txb file.
completed.
```

Running another 'TRIM' and 'Rigid VLM/DLM' analysis

