WORKSHOP 2

ANTI-SYMMETRIC WORKSHOP

Aircraft Description

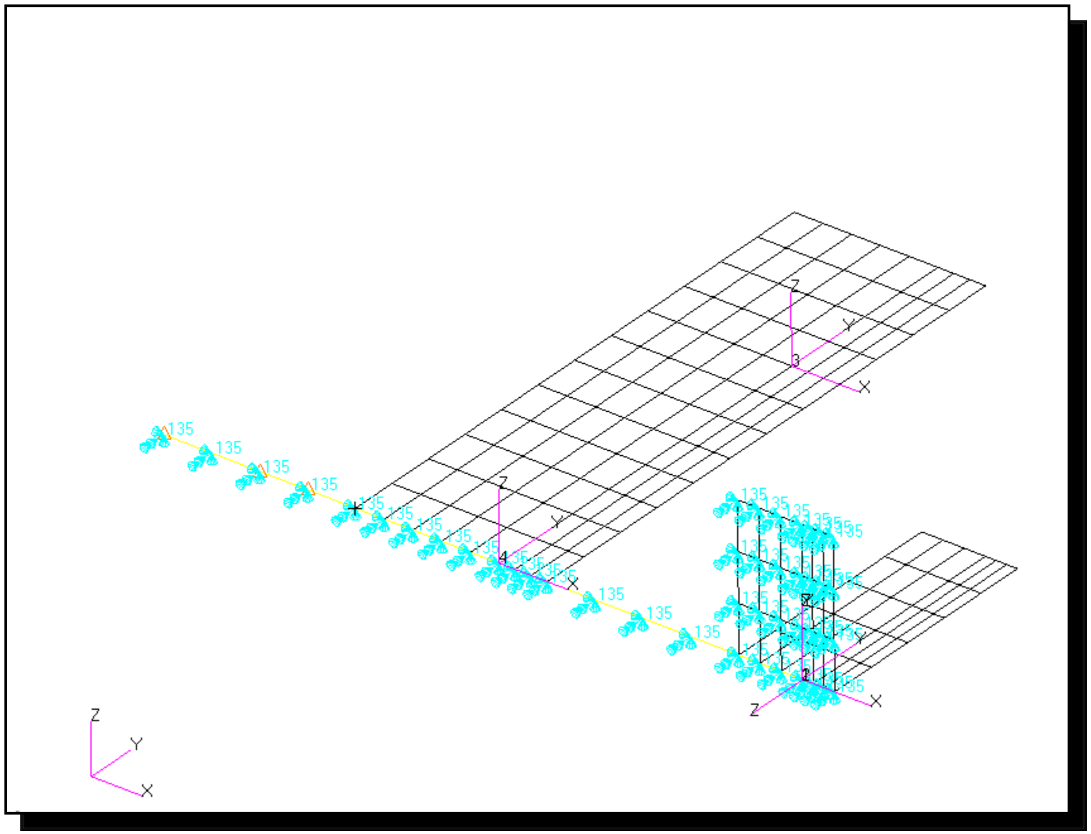
- **Wingspan:12 m**
- **Chord: 2 m**
- **Leading Edge: 0.3 m aft of datum**
- **Nodes:2 m forward of datum**
- **Length: 7 m**

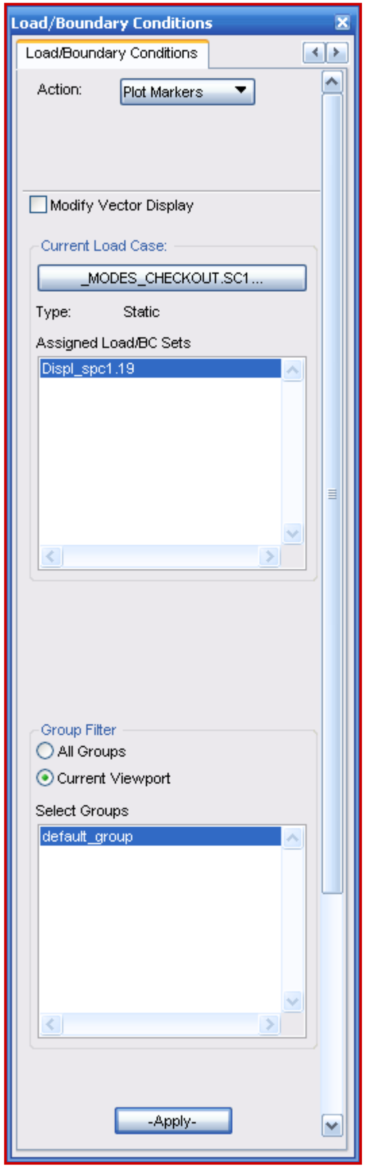
- **Workshop Objectives**
  - View elastic and rigid deformations and loads
  - Verify splines
- **Software Version**
  - Flightloads 2014
- **Files Required**
  - Sol_example_2a_modes.bdf
- **Problem Description**
  - Half model
  - Vertical surfaces
  - Control surfaces ‘Welded’ – apart from the aileron
  - Anti-symmetric about XZ plane
  - Flexible aileron hinge

- **Suggested Exercise Steps**
  1. Launch Flightloads
  2. Create a New Database
  3. Import Structural Mesh file i.e. sol_example2a_modes.bdf
  4. Run Normal Modes file
  5. Attach XDB file to Patran
  6. View Results
  7. Switch Preference to Aero-elasticity
  8. Create Flat Panel Modeling
  9. Create Splines
  10. Verify Splines
  11. Animate Splines
  12. Setup 7 Trim Case to study roll rate at varying speeds
  13. View Results

Step 1. Boundary Conditions

- **Import sol_example2a_modes.bdf into Patran**
- **Display boundary conditions**





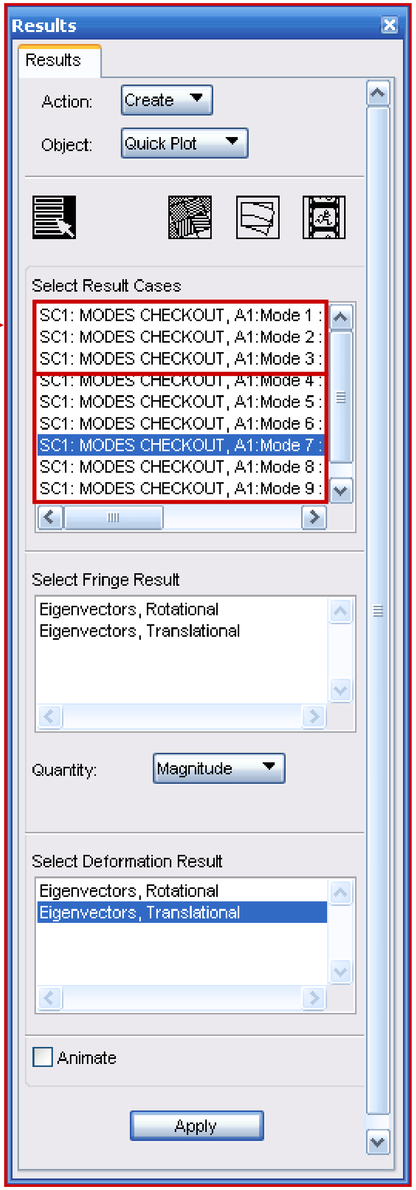
Step 2. Run File and Attach XDB to Patran

- **Run modal analysis (sol_example2a_modes.bdf)**
- **Check .f06 file**
  - Identify:
    - 3 rigid body modes
    - Elastic modes
- **Attach .xdb in Patran**
  - Identify :
    - 3 rigid body modes
    - Significant elastic modes

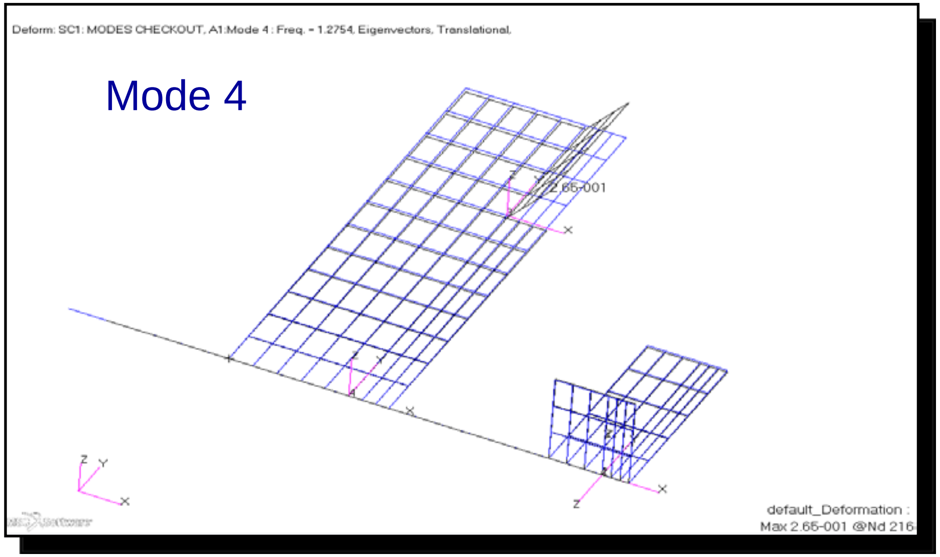
MSC Software

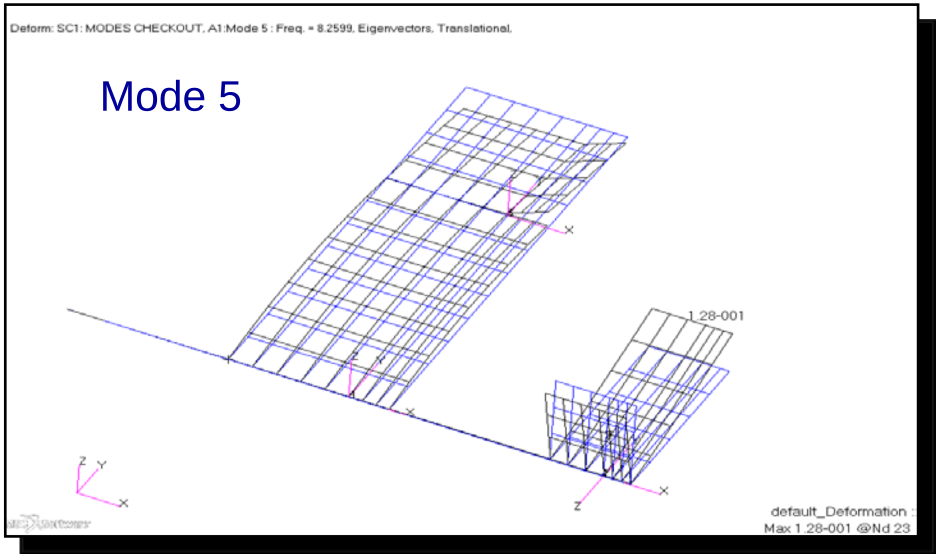
Step 3. Results

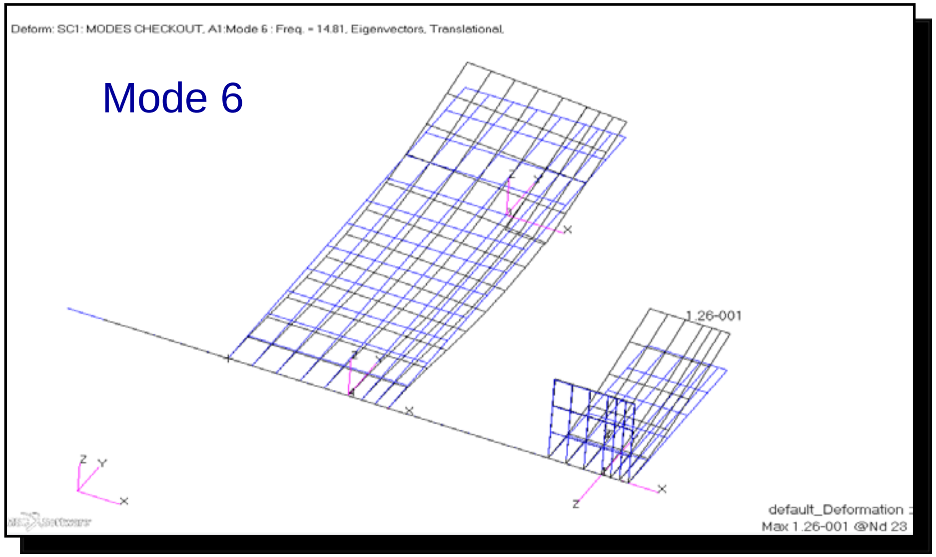
- **Results expected**
  - 3 rigid body modes
  - Significant elastic modes

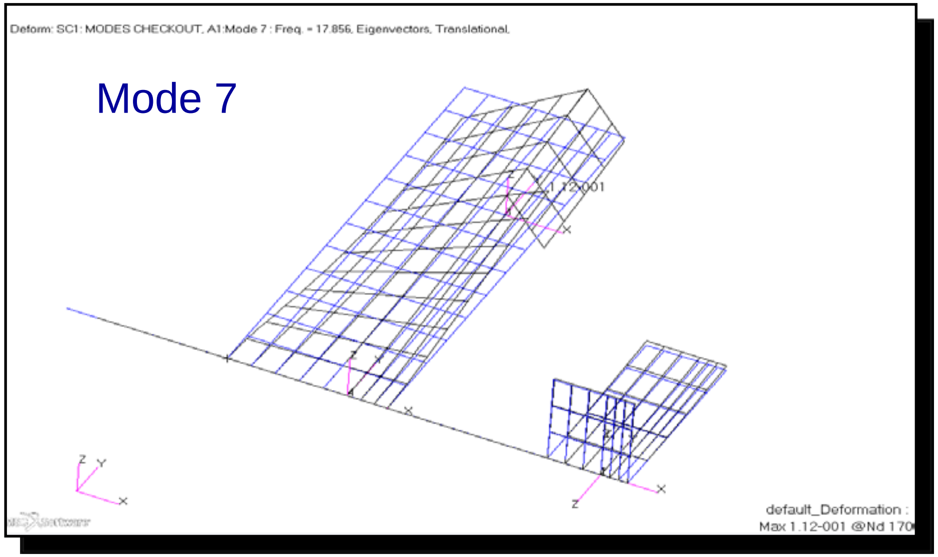


Significant Elastic Modes



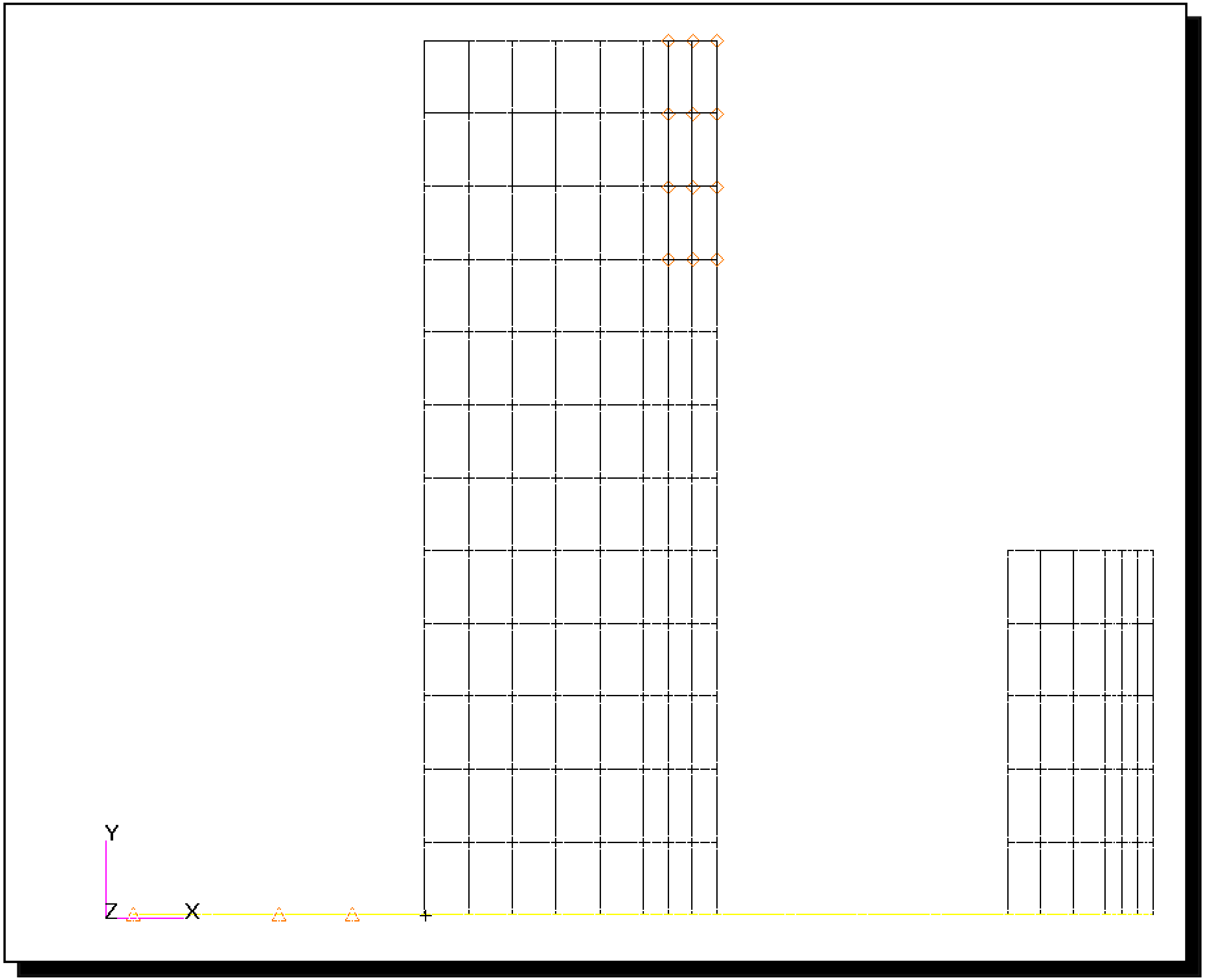




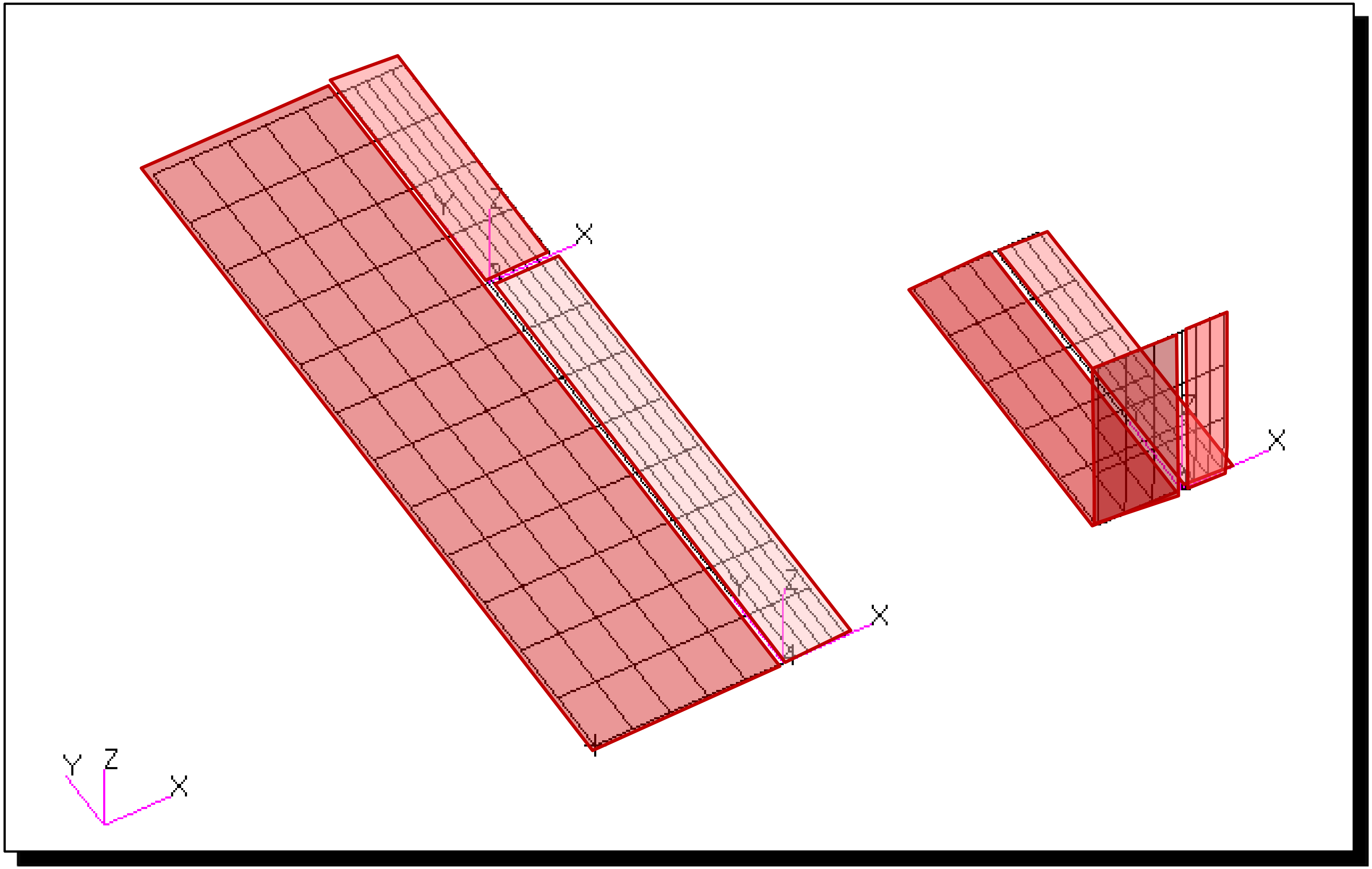


AERODYNAMIC MESH

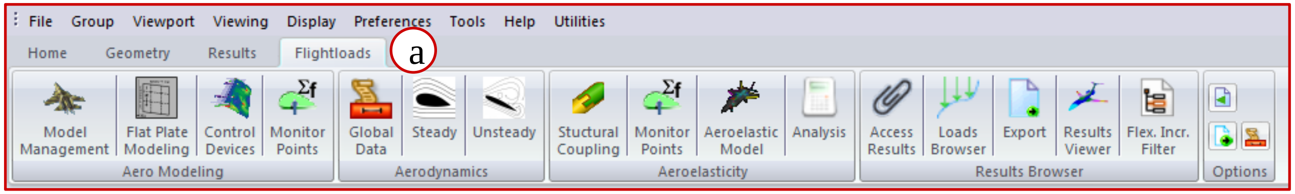
Structural Mesh



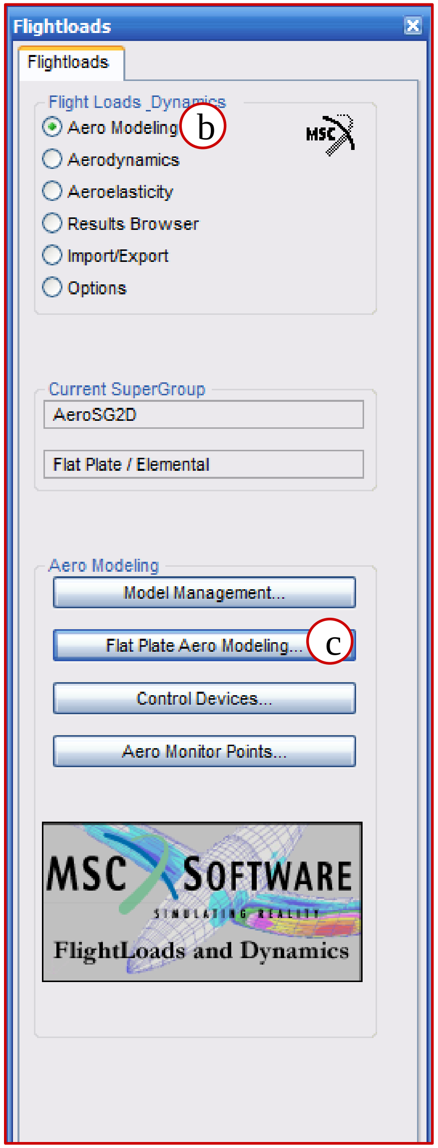
Suggested Aero Mesh



Create Flat Panel Modeling

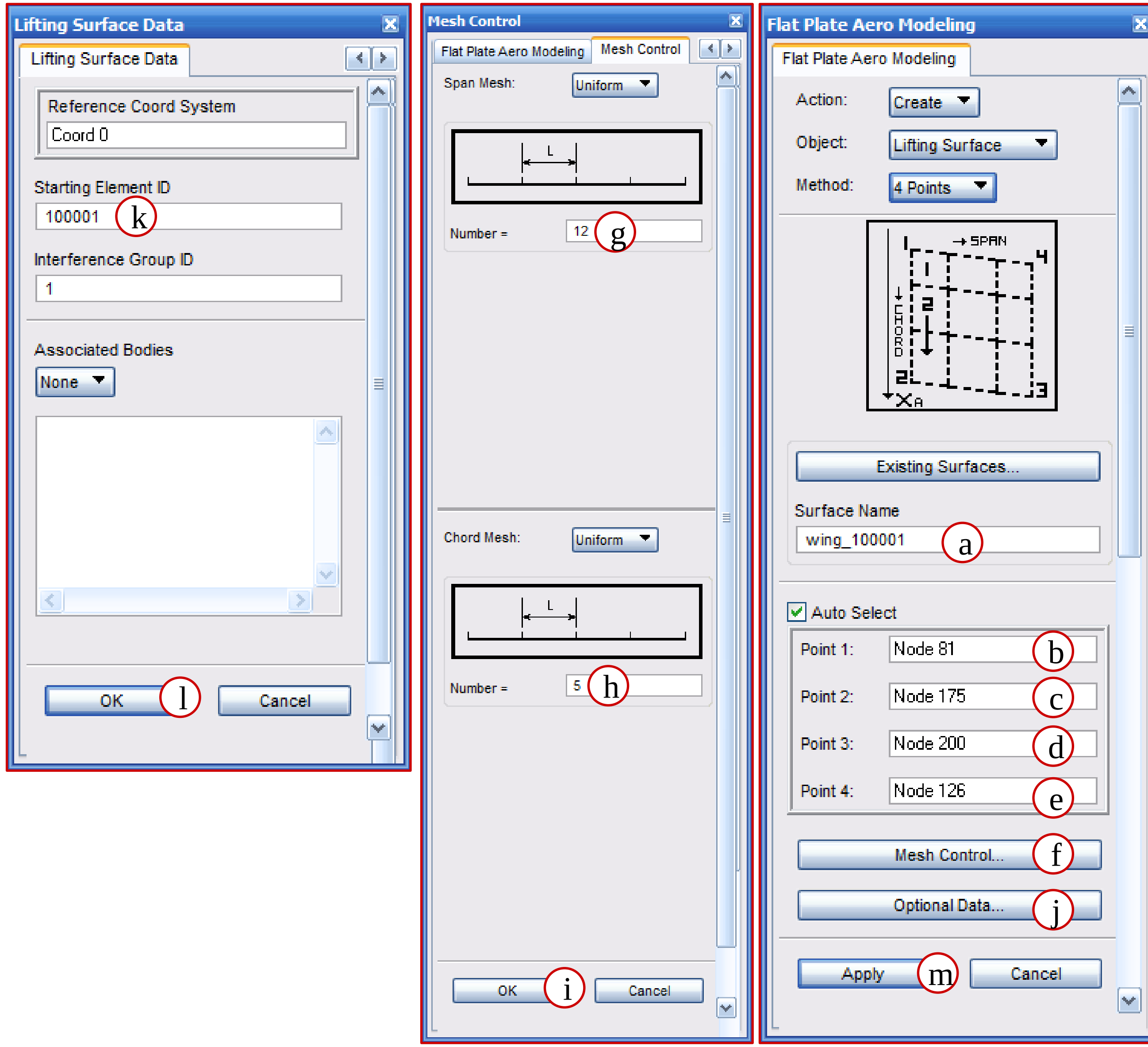


- **7 Aero-meshes need to be created.**
  - Main wing
  - Wing tail
  - Aileron
  - Tail
  - Elevator
  - Fin
  - Rudder



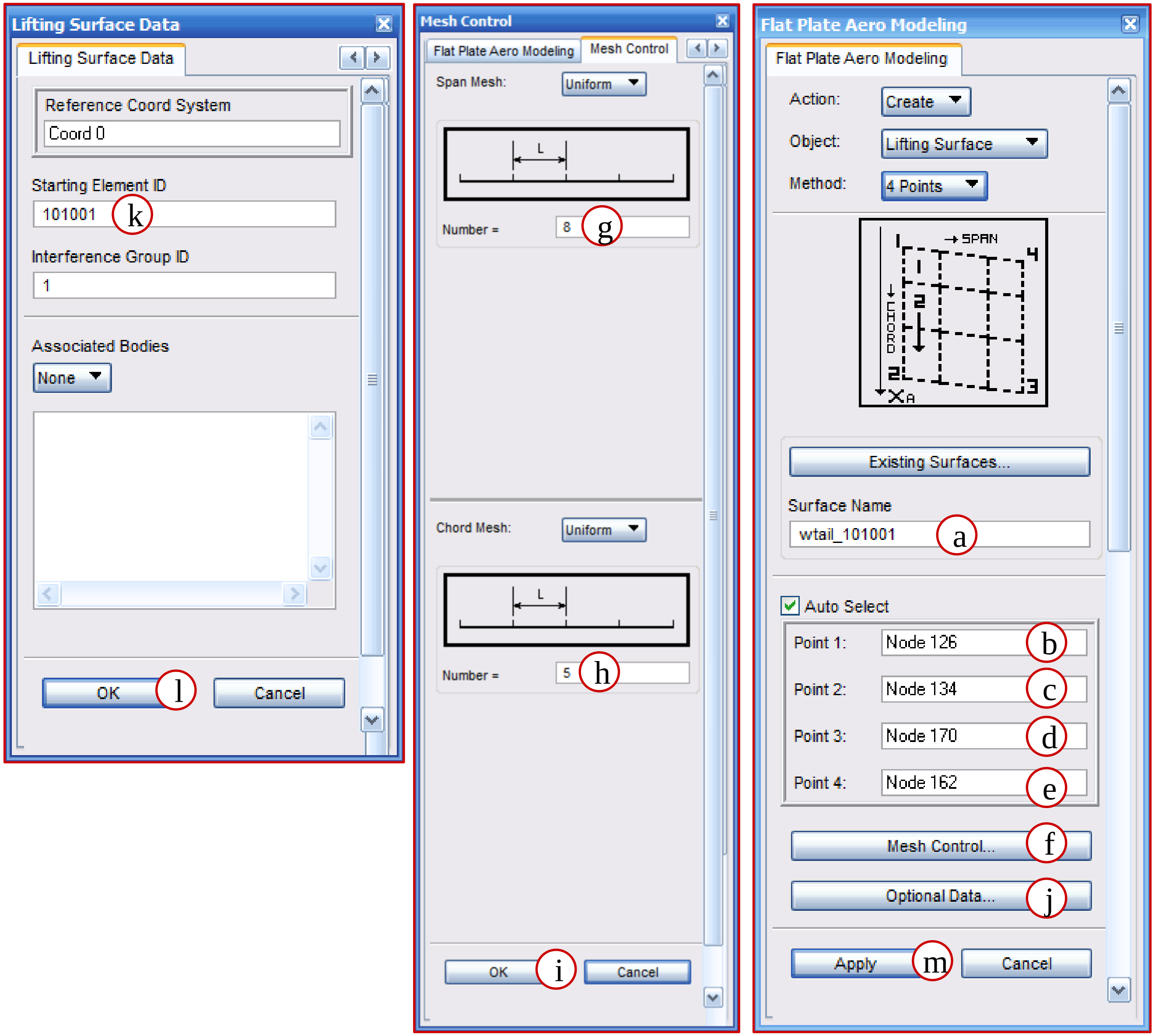
Create Flat Panel ID- 100001

- **This is Flat Aero Surface for Main Wing**



Create Flat Panel ID- 101001

- **This is Flat Aero Surface for Wing Tail**



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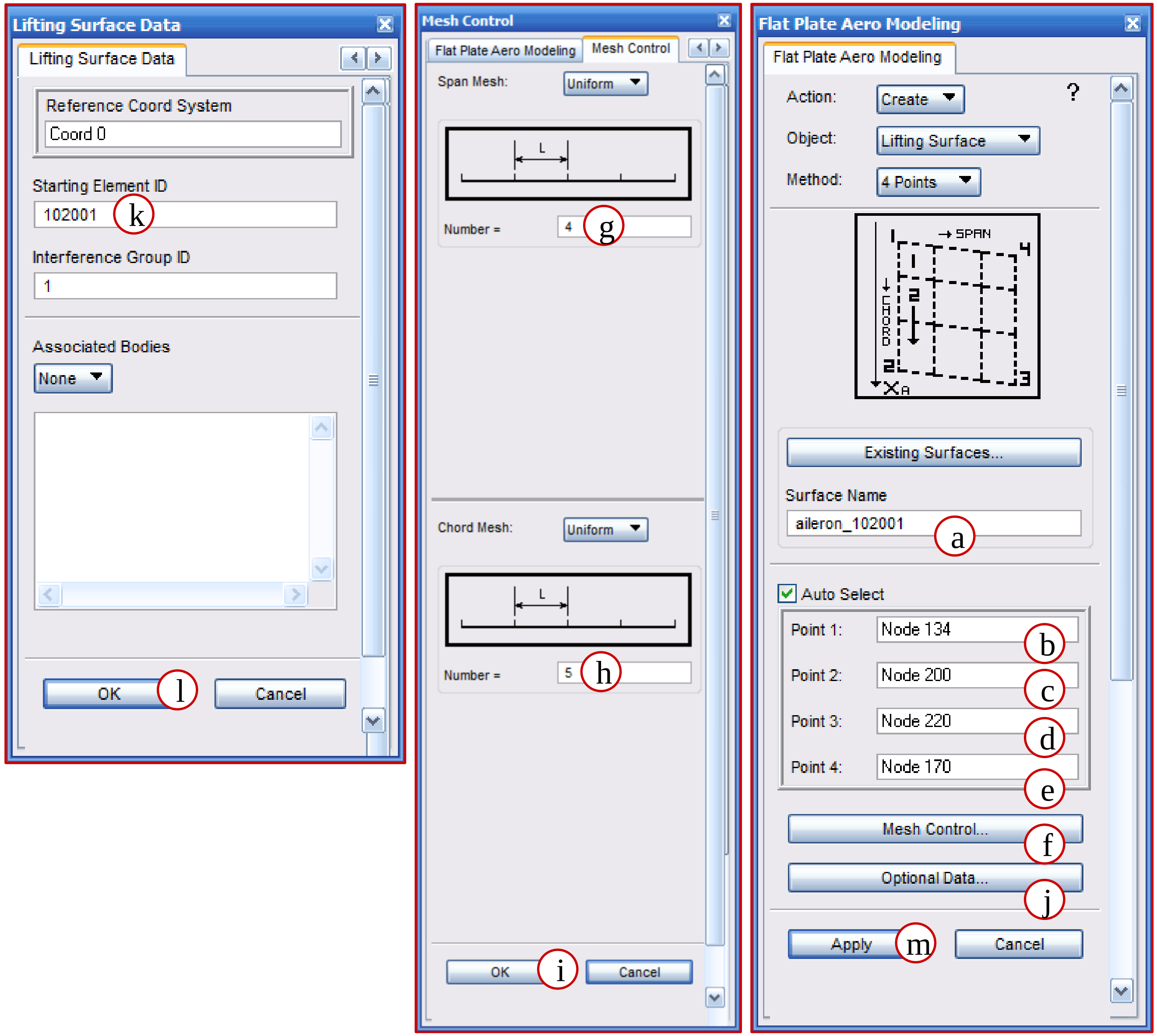
Create Flat Panel ID- 102001

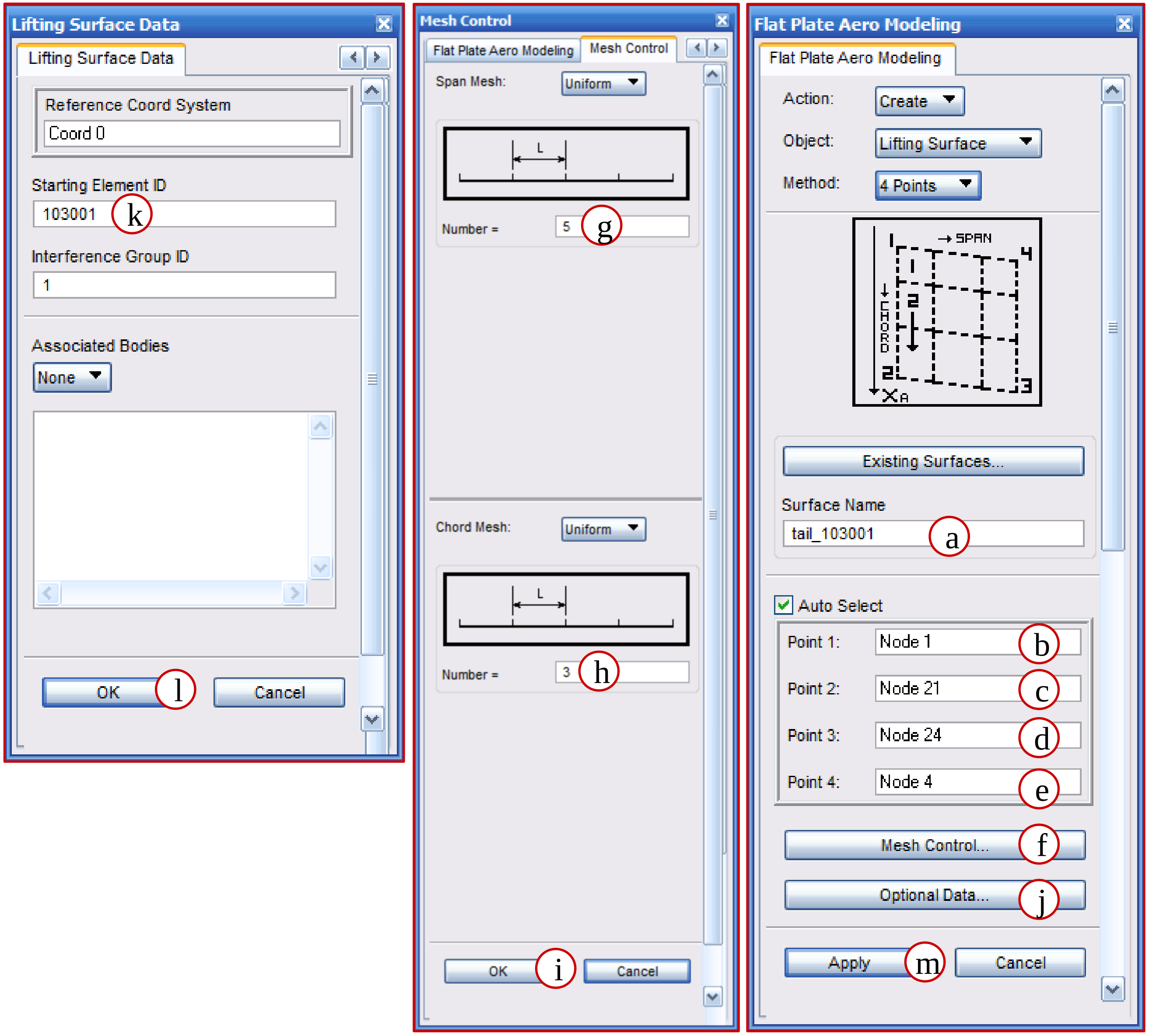
- **This is Flat Aero Surface for Aileron**



MSC Software

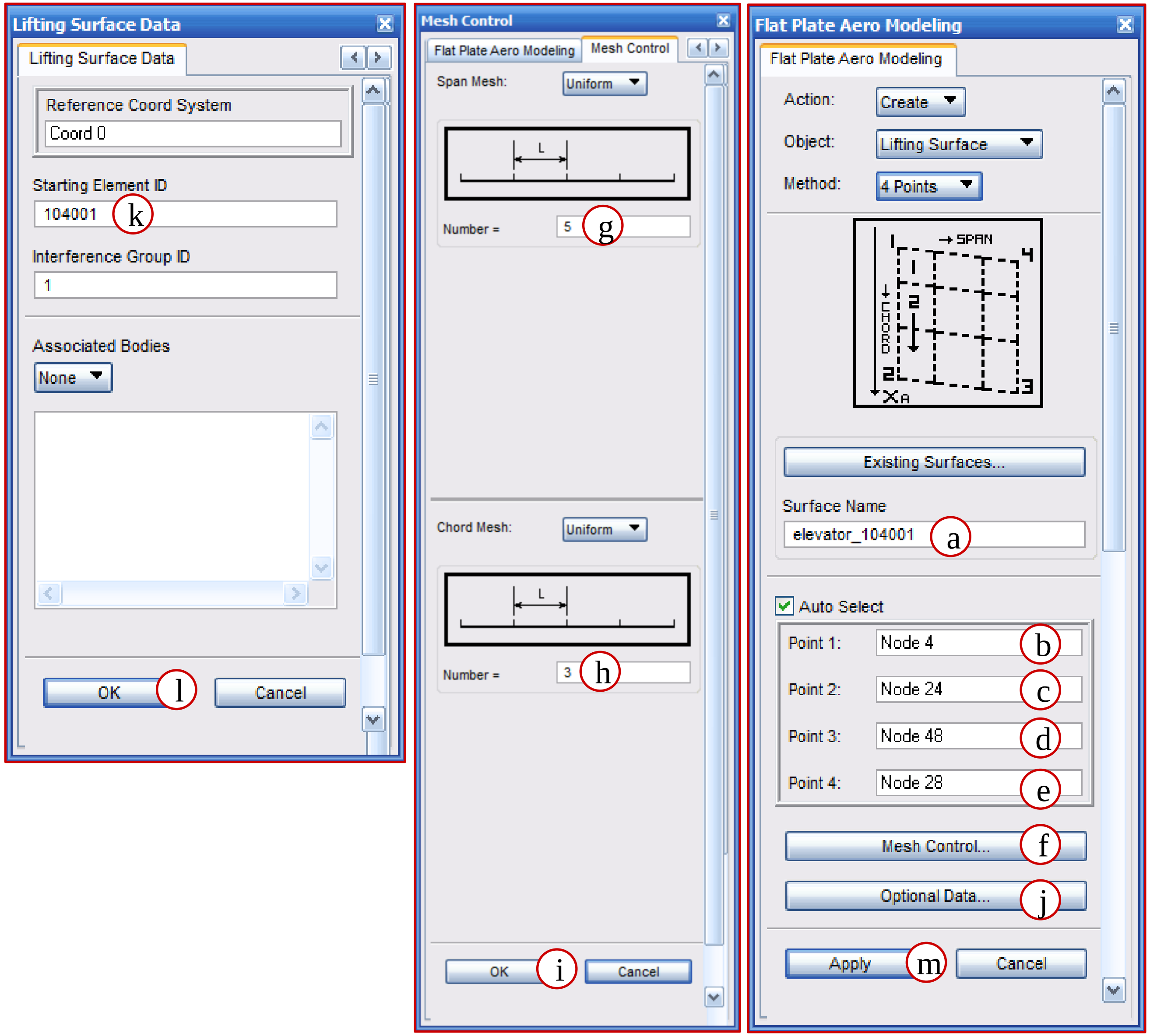
Create Flat Panel ID- 103001

- **This is Flat Aero Surface for Tail**



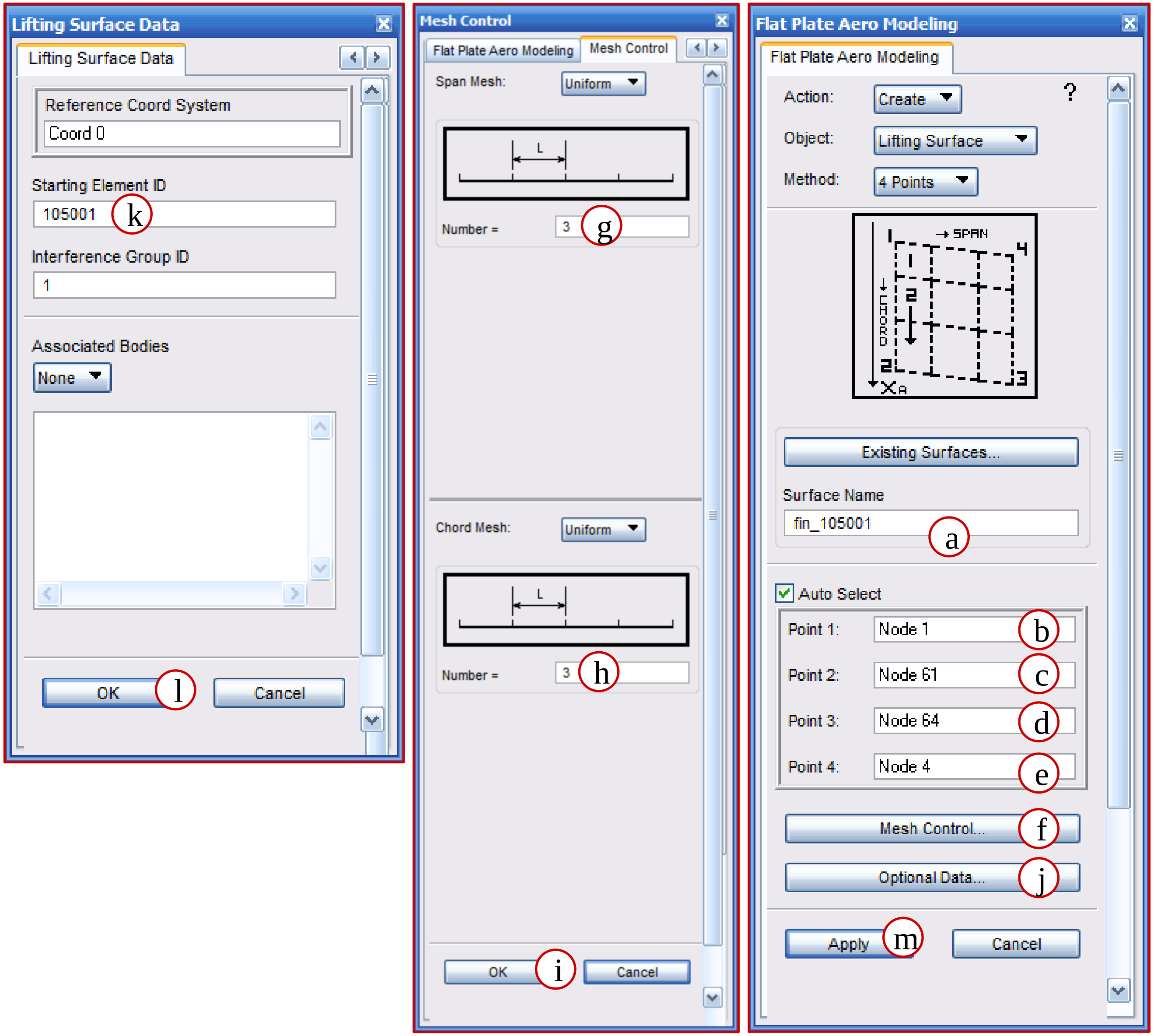
Create Flat Panel ID- 104001

- **This is Flat Aero Surface for Elevator**



Create Flat Panel ID- 105001

- This is Flat Aero Surface for Fin



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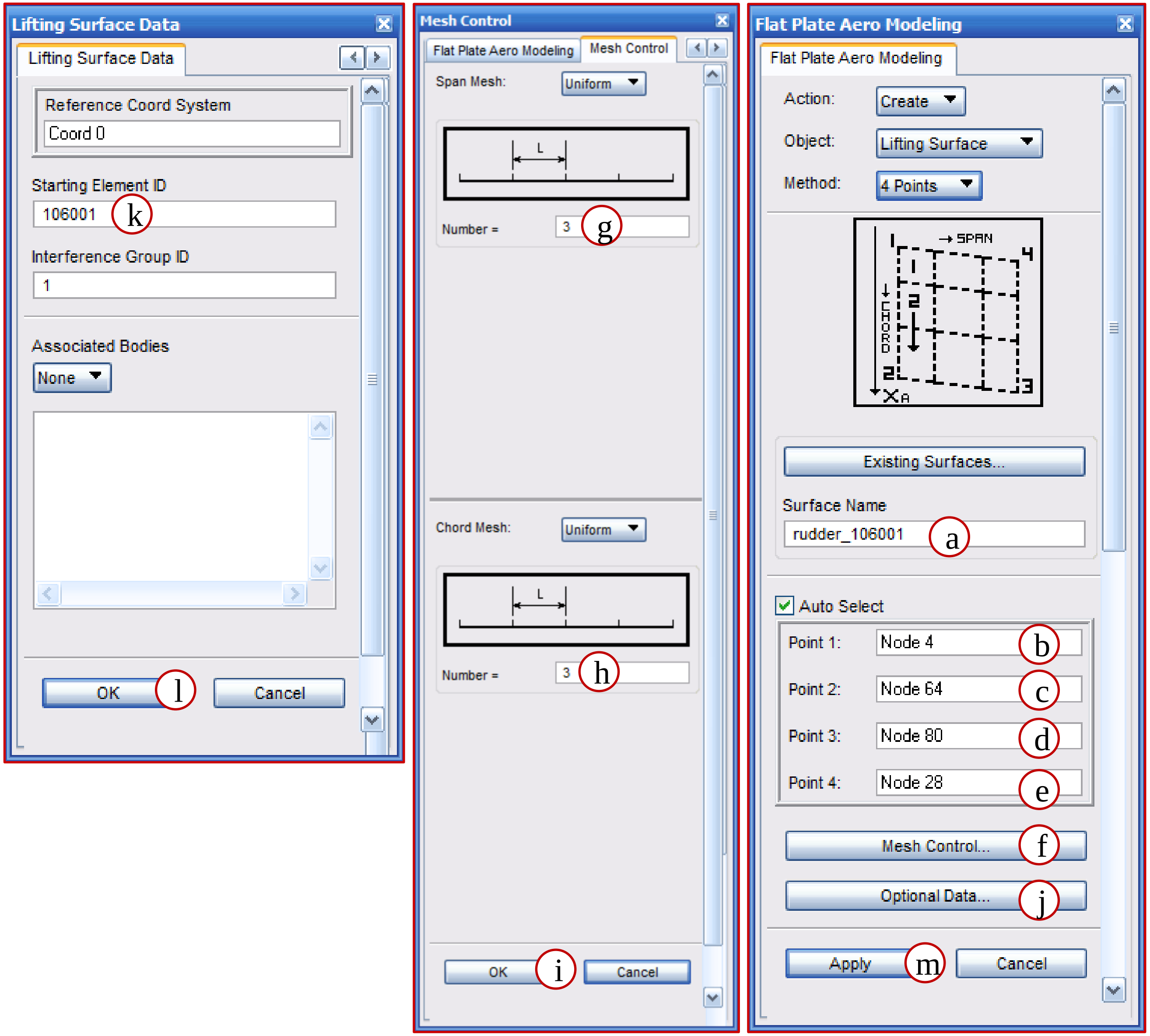
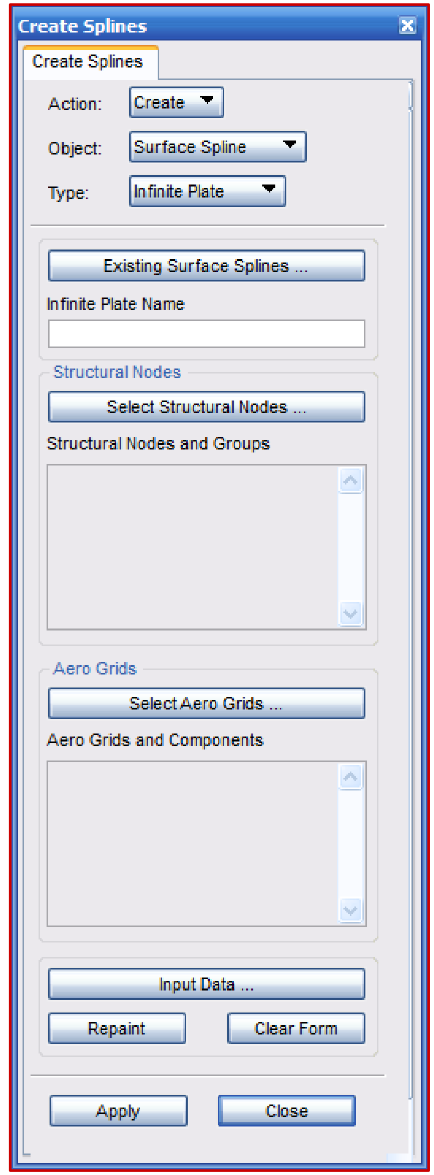
Create Flat Panel ID- 106001

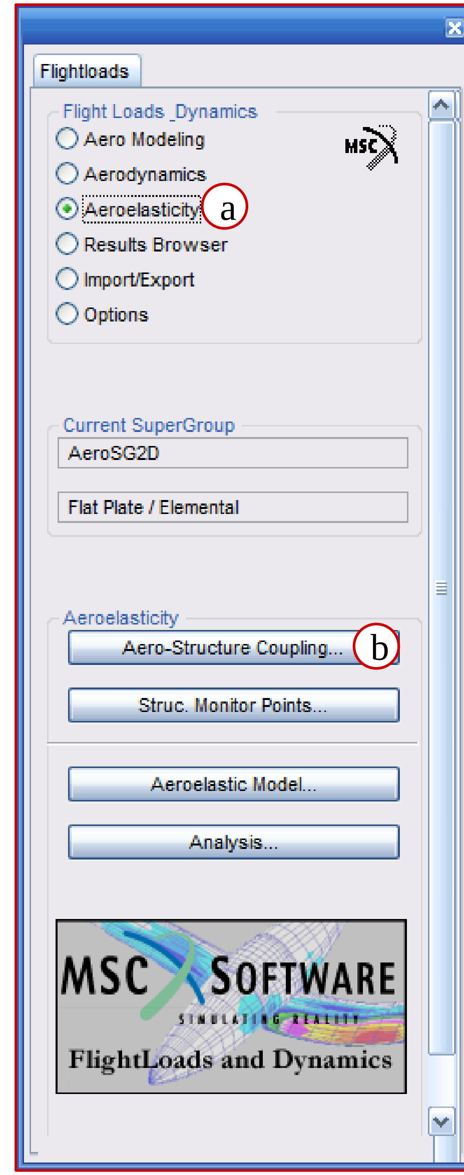
- **This is Flat Aero Surface for Rudder**



Creating Splines

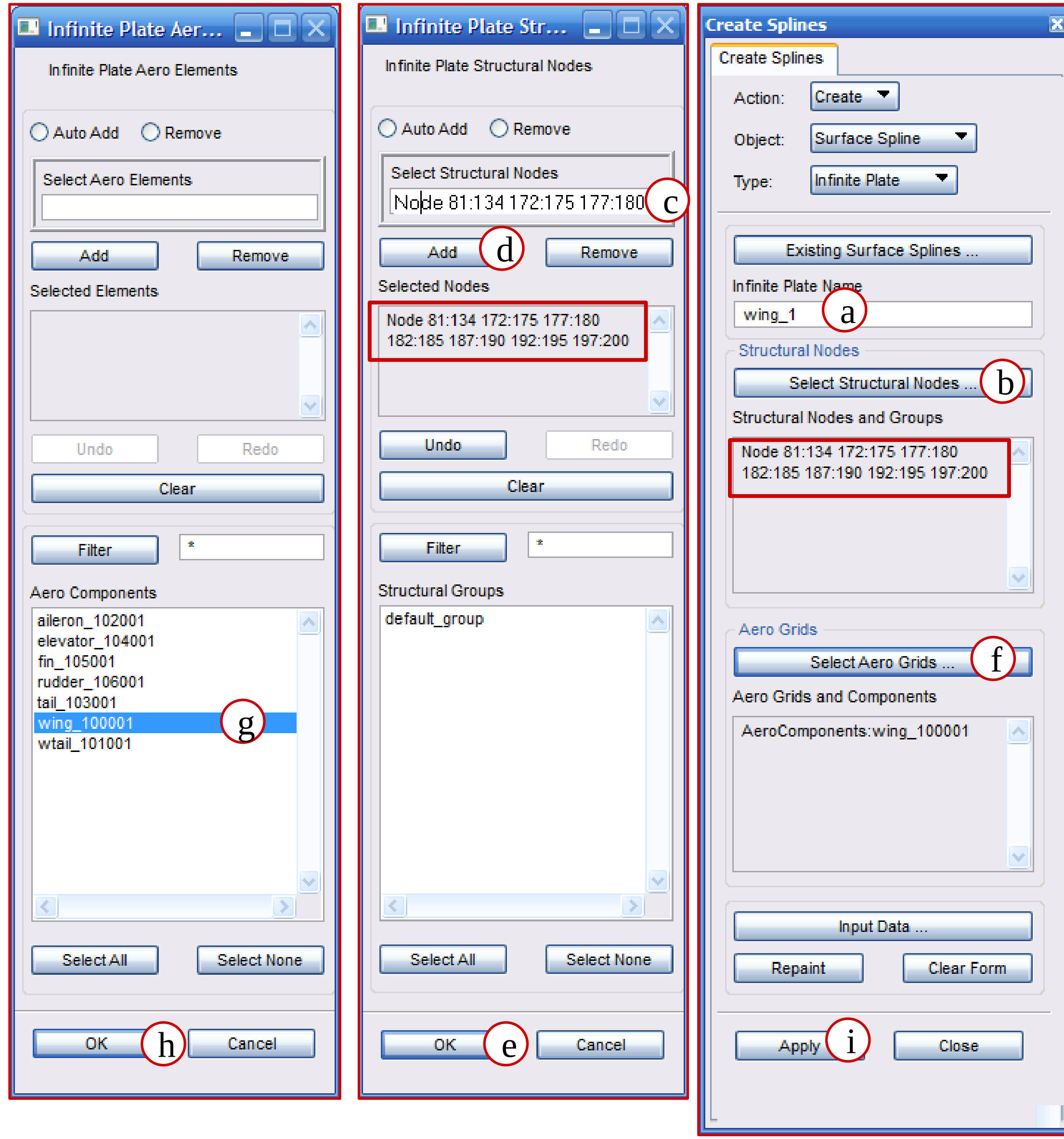
- **This is the step which needs to be executed in order the connect the structural nodes to the Aero Panel Elements.**





Create Spline for Wing ID - 1

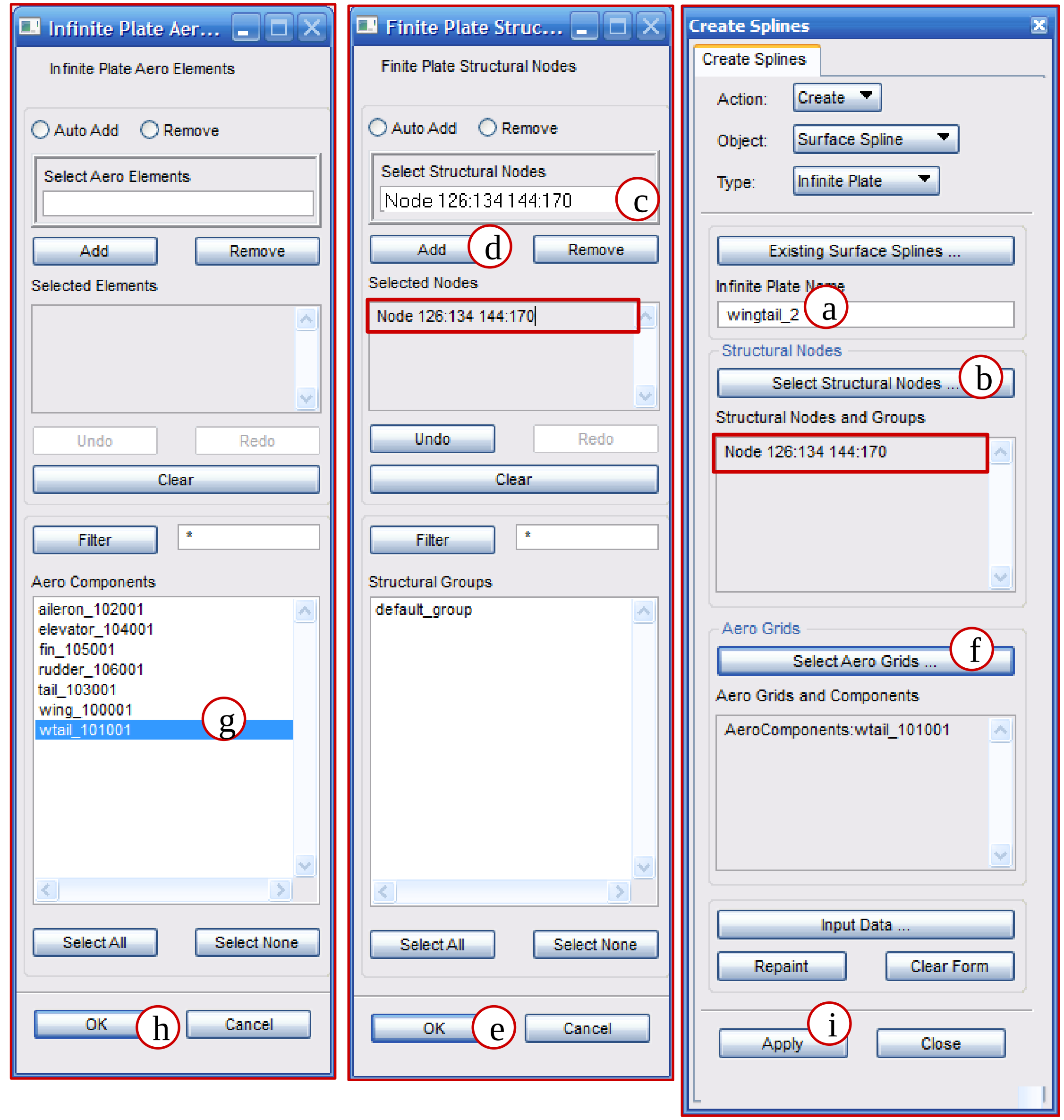
- **Insert the nodes shown below in step c as a first trial. The set of nodes will be refined as the workshop proceeds.**
- **In step d the structural nodes participating the splining with Aero elements are selected. The structural nodes to be used will be finalized using the verify spline operation discussed further.**
- **In step e the Aero- panel elements to be used in splining are selected. The flat panel have been created, so the specific group needs to be selected.**
- **Node 81:134 172:175 177:180 182:185 187:190 192:195 197:200**



MSC Software

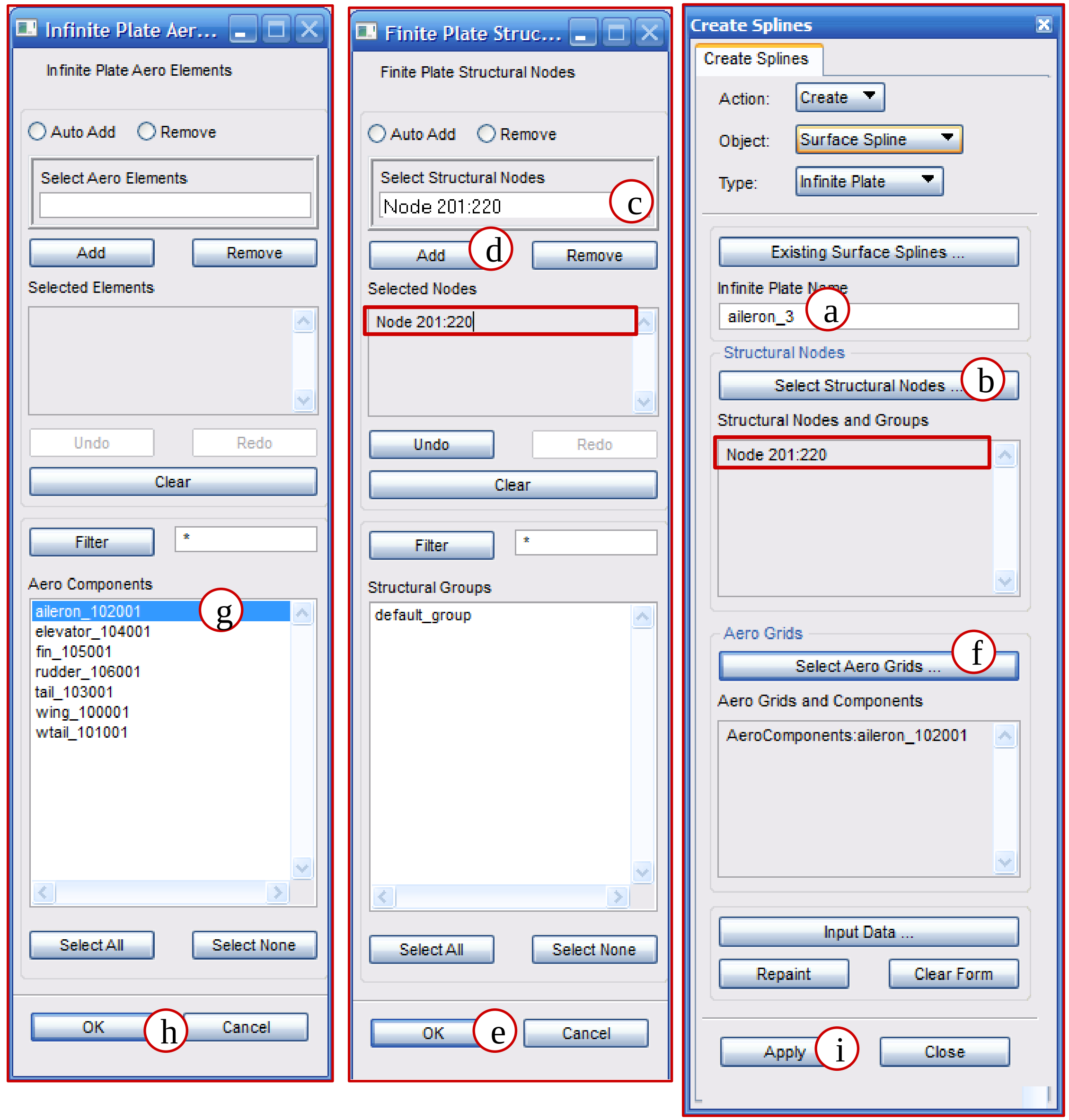
Create Spline for WingTail ID - 2

- **Insert the nodes shown below in step c as a first trial. The set of nodes will be refined as the workshop proceeds.**
- **In step d the structural nodes participating the splining with Aero elements are selected. The structural nodes to be used will be finalized using the verify spline operation discussed further.**
- **In step e the Aero- panel elements to be used in splining are selected. The flat panel have been created, so the specific group needs to be selected.**
- **Node 126:134 144:170**



Create Spline for Aileron ID - 3

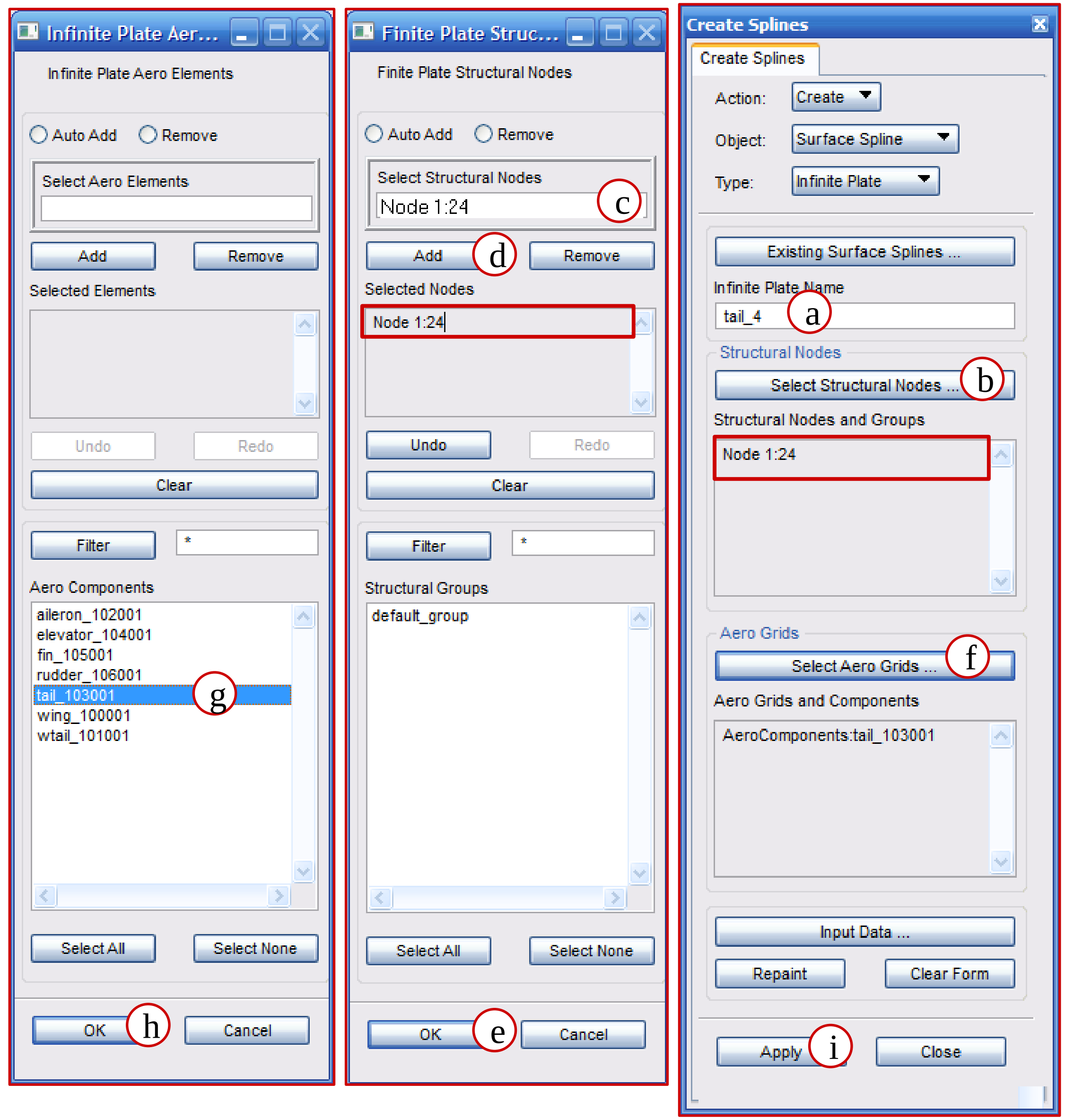
- **Insert the nodes shown below in step c as a first trial. The set of nodes will be refined as the workshop proceeds.**
- **In step d the structural nodes participating the splining with Aero elements are selected. The structural nodes to be used will be finalized using the verify spline operation discussed further.**
- **In step e the Aero- panel elements to be used in splining are selected. The flat panel have been created, so the specific group needs to be selected.**
- **Node 201:220**



MSC Software

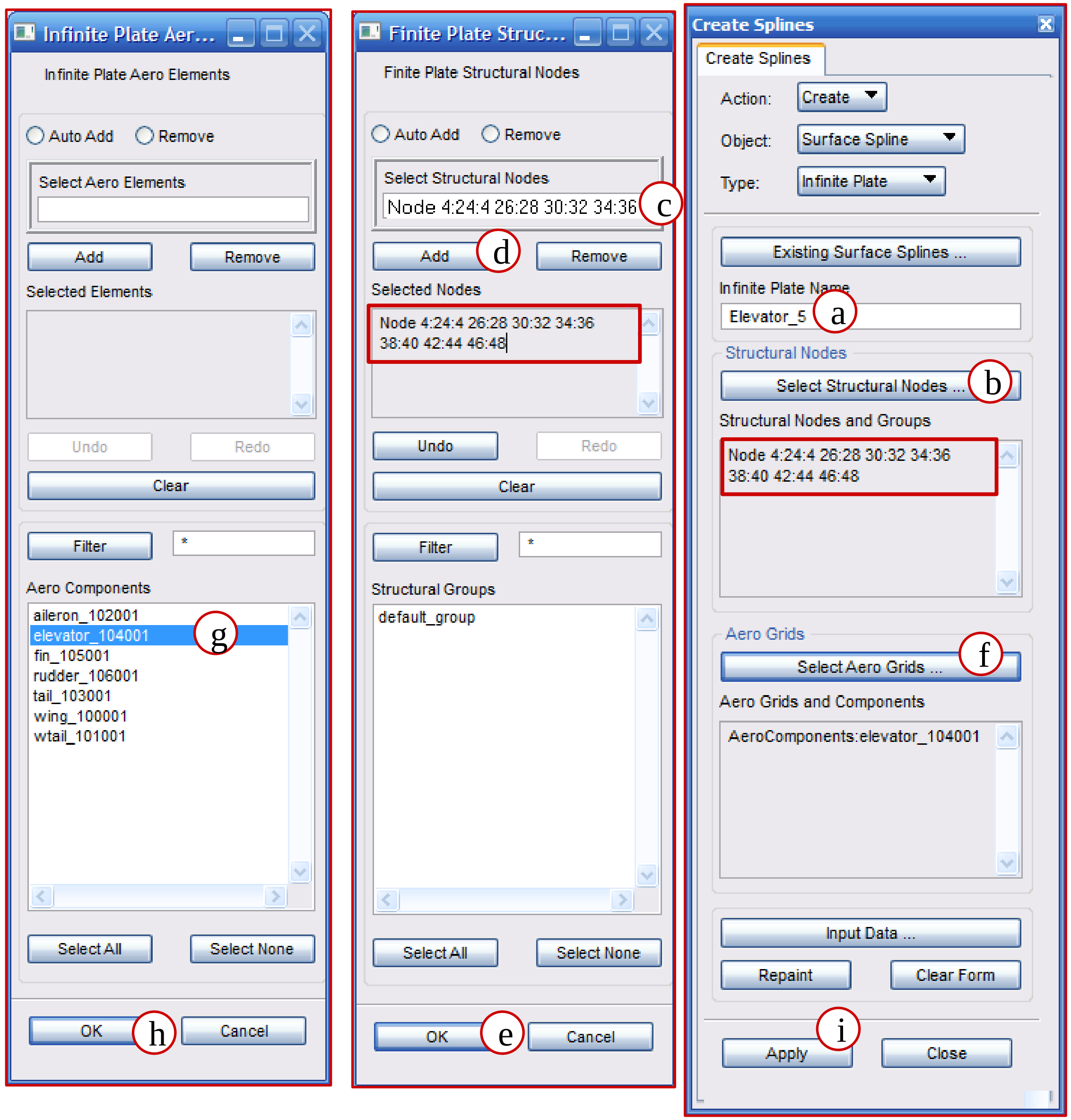
Create Spline for Tail ID - 4

- **Insert the nodes shown below in step c as a first trial. The set of nodes will be refined as the workshop proceeds.**
- **In step d the structural nodes participating the splining with Aero elements are selected. The structural nodes to be used will be finalized using the verify spline operation discussed further.**
- **In step e the Aero- panel elements to be used in splining are selected. The flat panel have been created, so the specific group needs to be selected.**
- **Node 1:24**



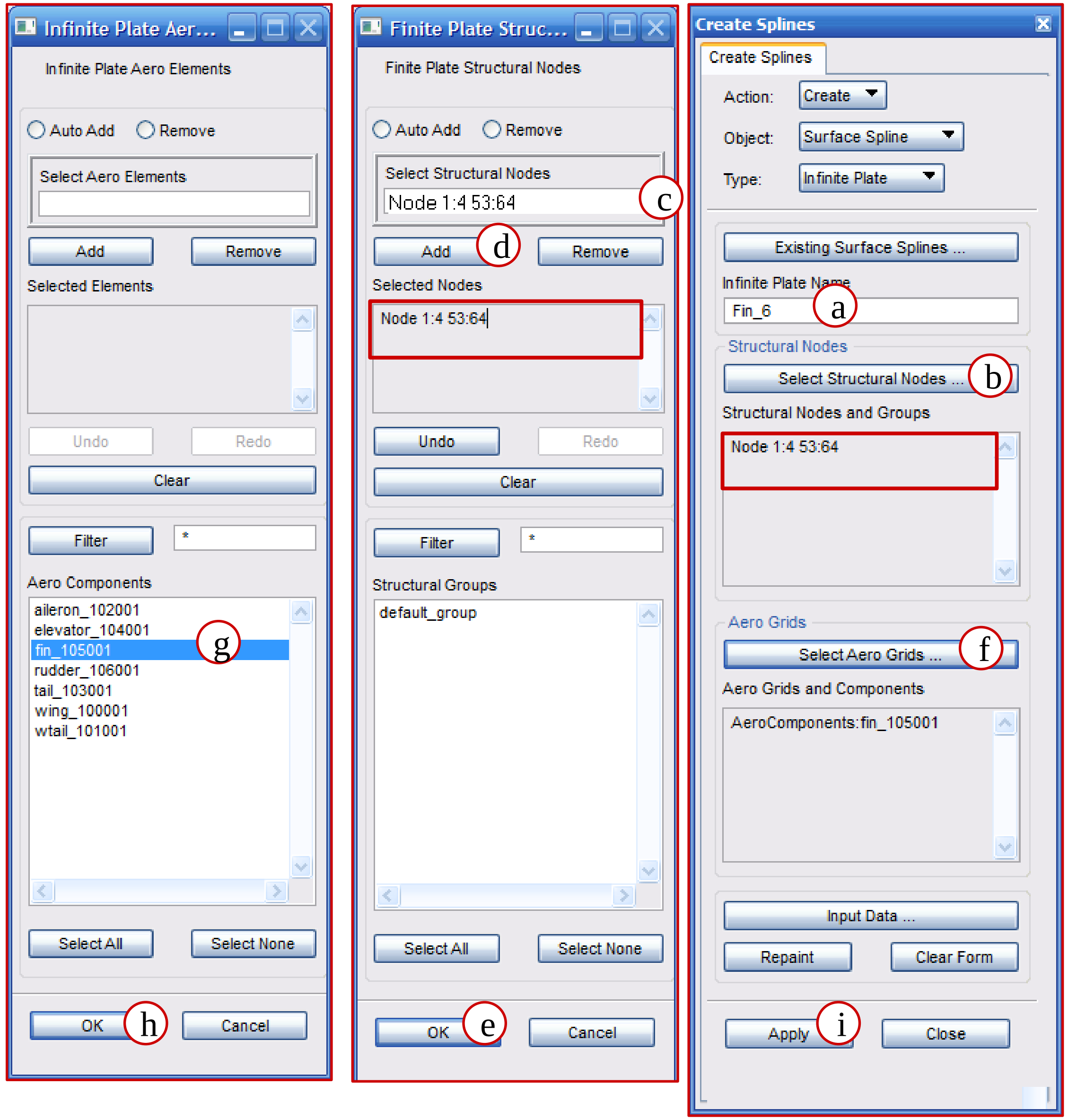
Create Spline for Elevator ID - 5

- **Insert the nodes shown below in step c as a first trial. The set of nodes will be refined as the workshop proceeds.**
- **In step d the structural nodes participating the splining with Aero elements are selected. The structural nodes to be used will be finalized using the verify spline operation discussed further.**
- **In step e the Aero- panel elements to be used in splining are selected. The flat panel have been created, so the specific group needs to be selected.**
- **Node 4:24:4 26:28 30:32 34:36 38:40 42:44 46:48**



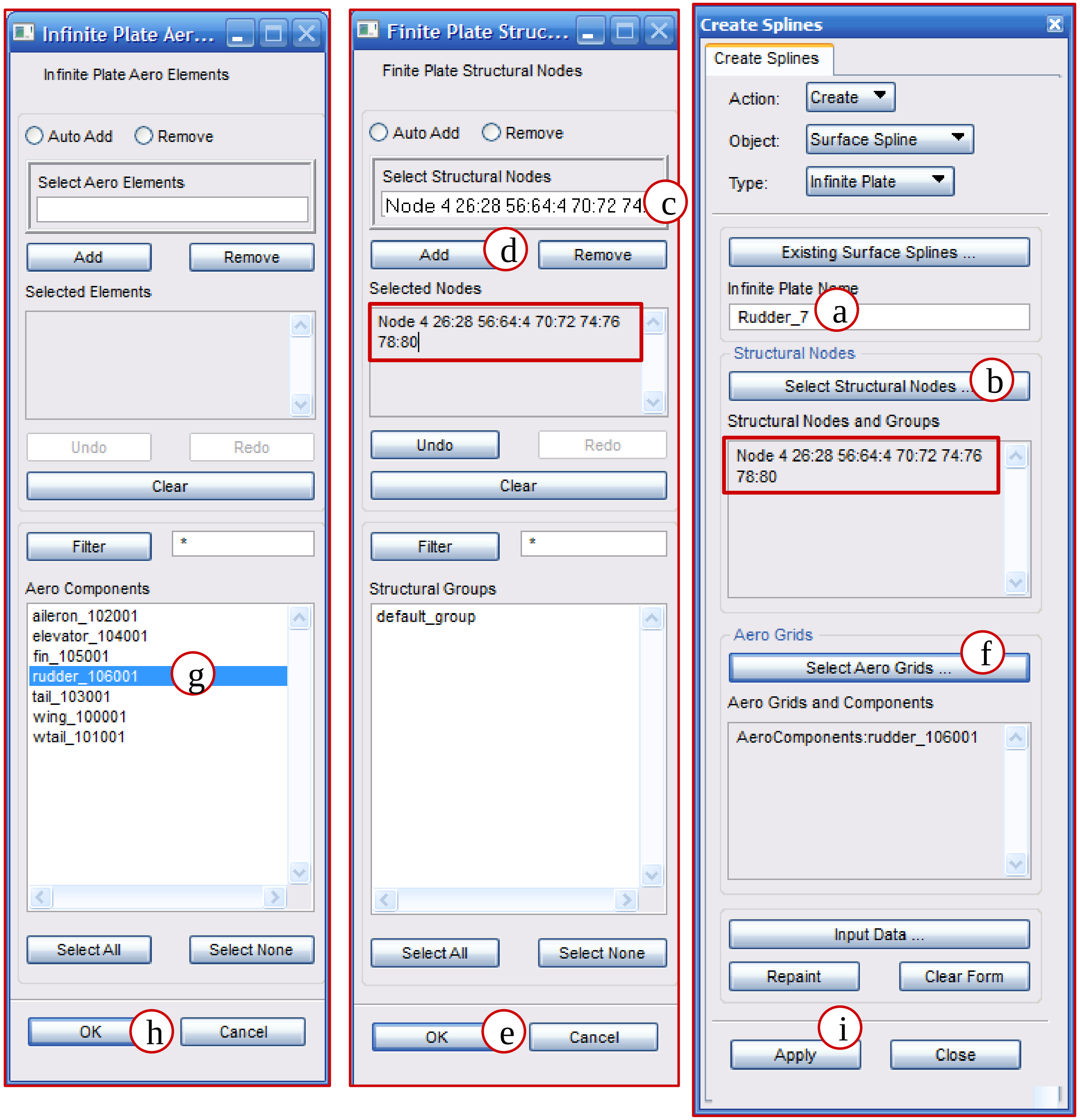
Create Spline for Fin ID - 6

- **Insert the nodes shown below in step c as a first trial. The set of nodes will be refined as the workshop proceeds.**
- **In step d the structural nodes participating the splining with Aero elements are selected. The structural nodes to be used will be finalized using the verify spline operation discussed further.**
- **In step e the Aero- panel elements to be used in splining are selected. The flat panel have been created, so the specific group needs to be selected.**
- **Node 1:4 53:64**



Create Spline for Rudder ID - 7

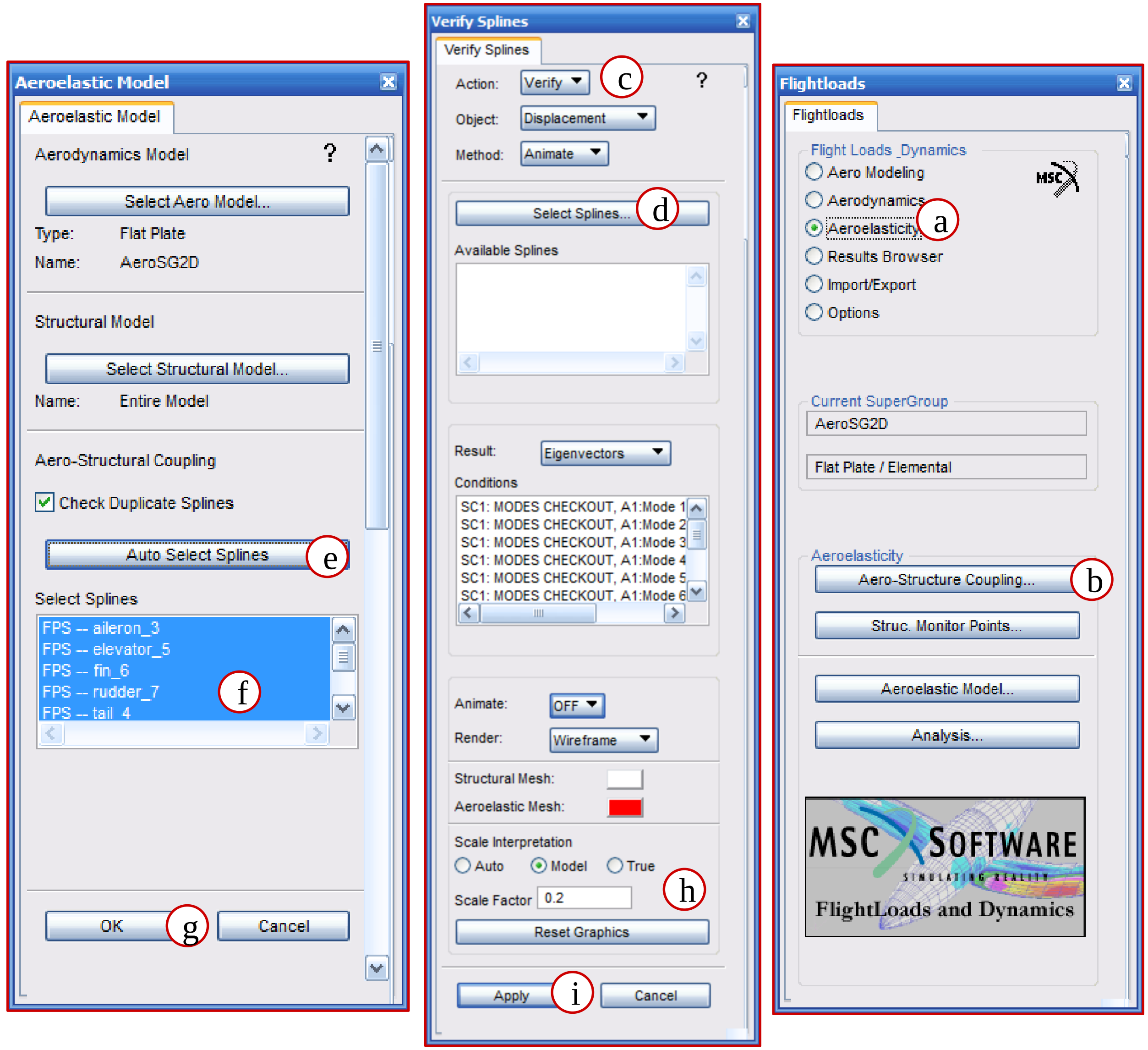
- **Insert the nodes shown below in step c as a first trial. The set of nodes will be refined as the workshop proceeds.**
- **In step d the structural nodes participating the splining with Aero elements are selected. The structural nodes to be used will be finalized using the verify spline operation discussed further.**
- **In step e the Aero- panel elements to be used in splining are selected. The flat panel have been created, so the specific group needs to be selected.**
- **Node 4 26:28 56:64:4 70:72 74:76 78:80**



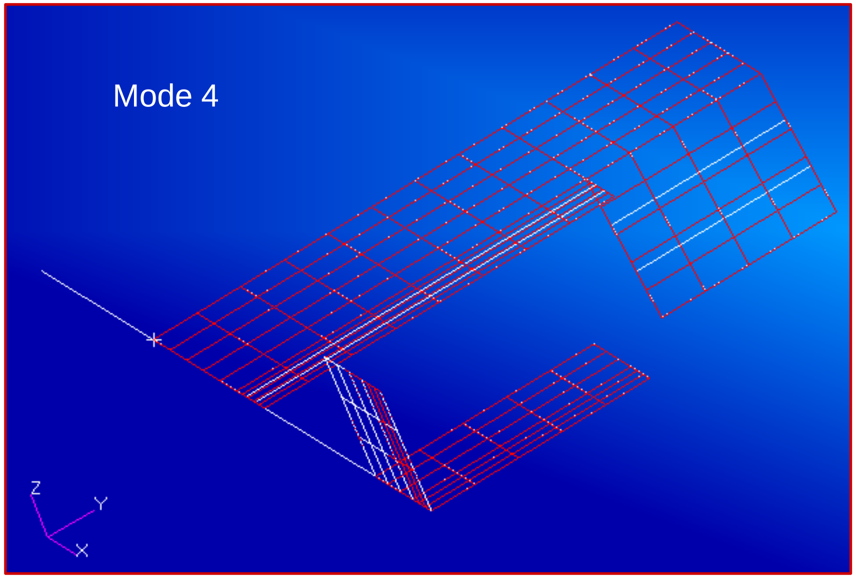
MSC Software

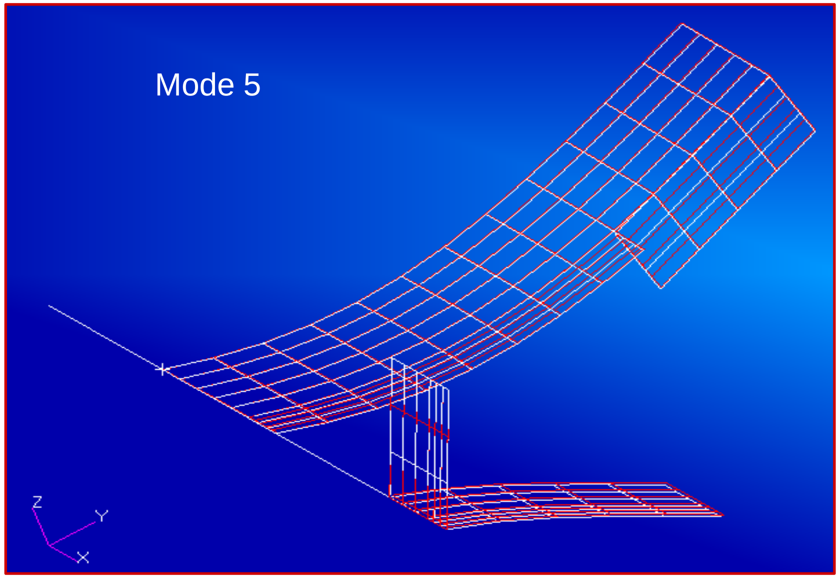
Verify Spline

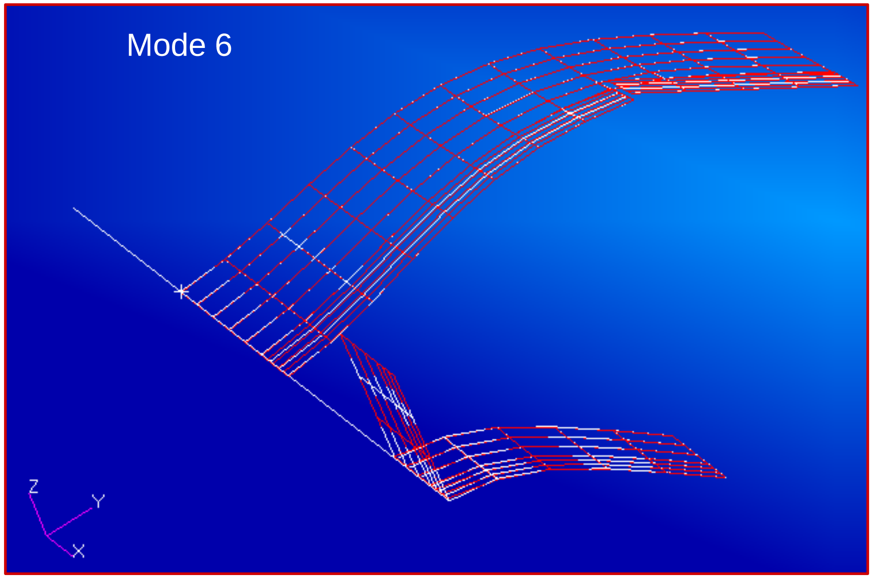
- **Animate**
  - Aeroelasticity click Aero-Structural Coupling
  - Select Splines
  - Auto Select Splines
  - Select from available splines and pick the first non-rigid mode
  - Click Apply to see the animation

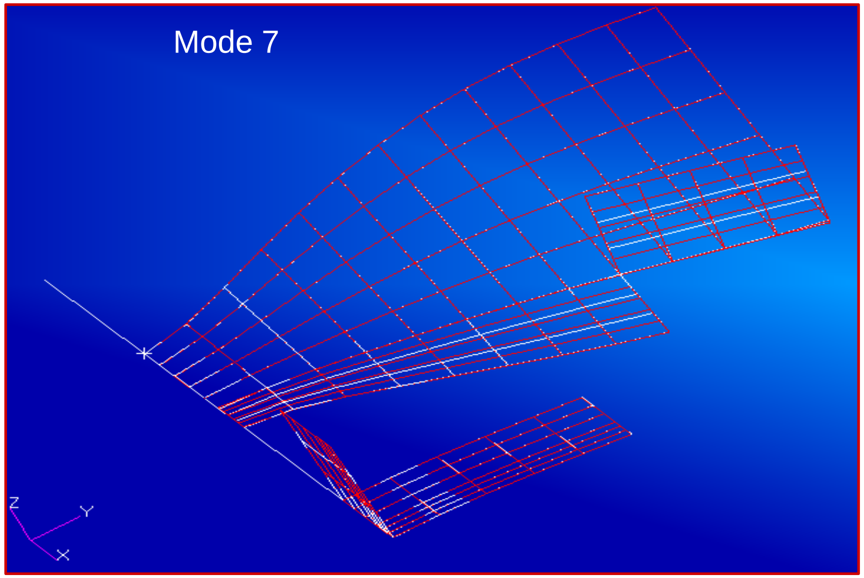


Verify Spline → Results

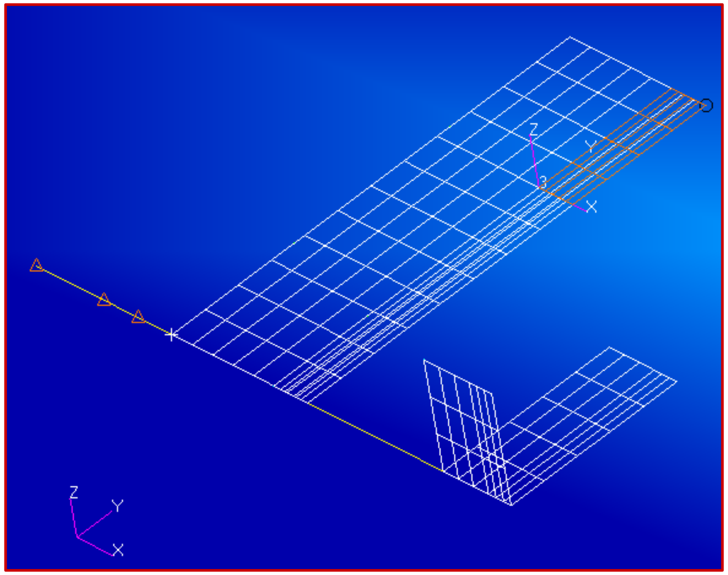


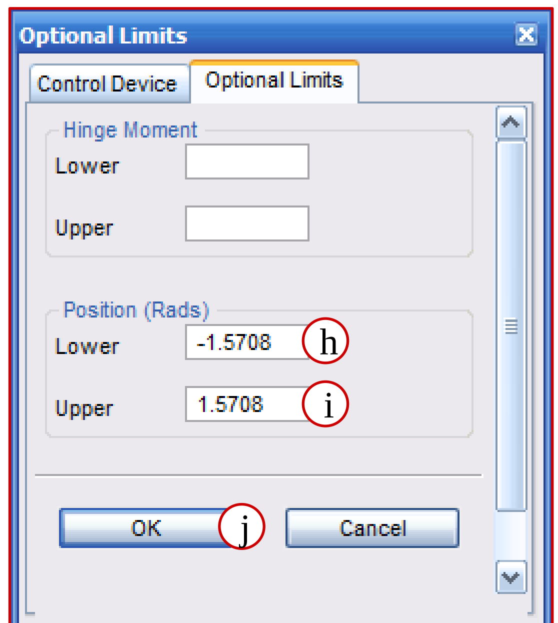


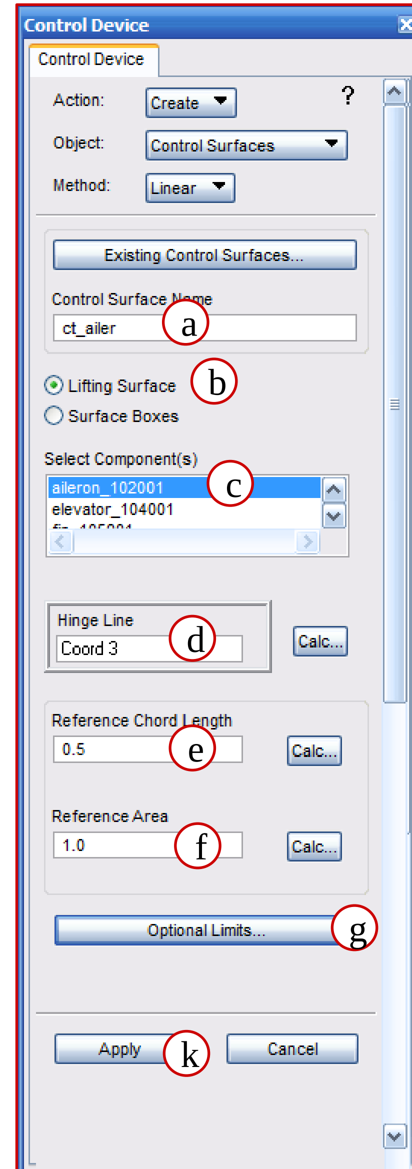




Define Control Surface for Aileron

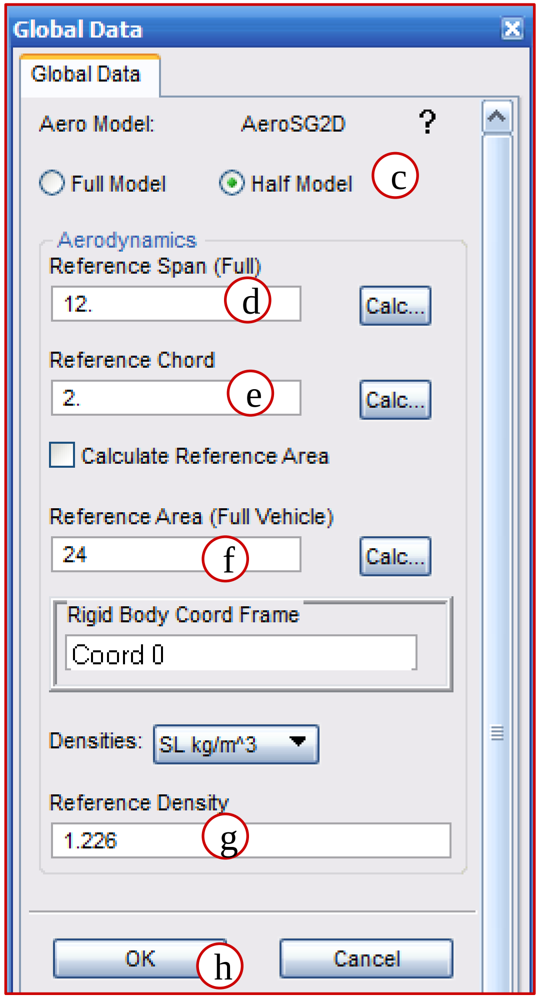


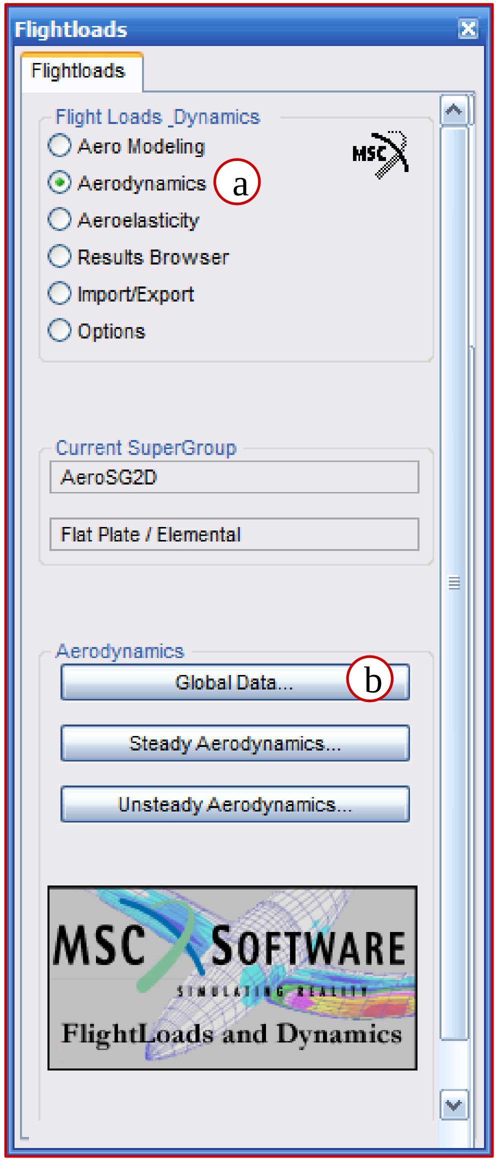




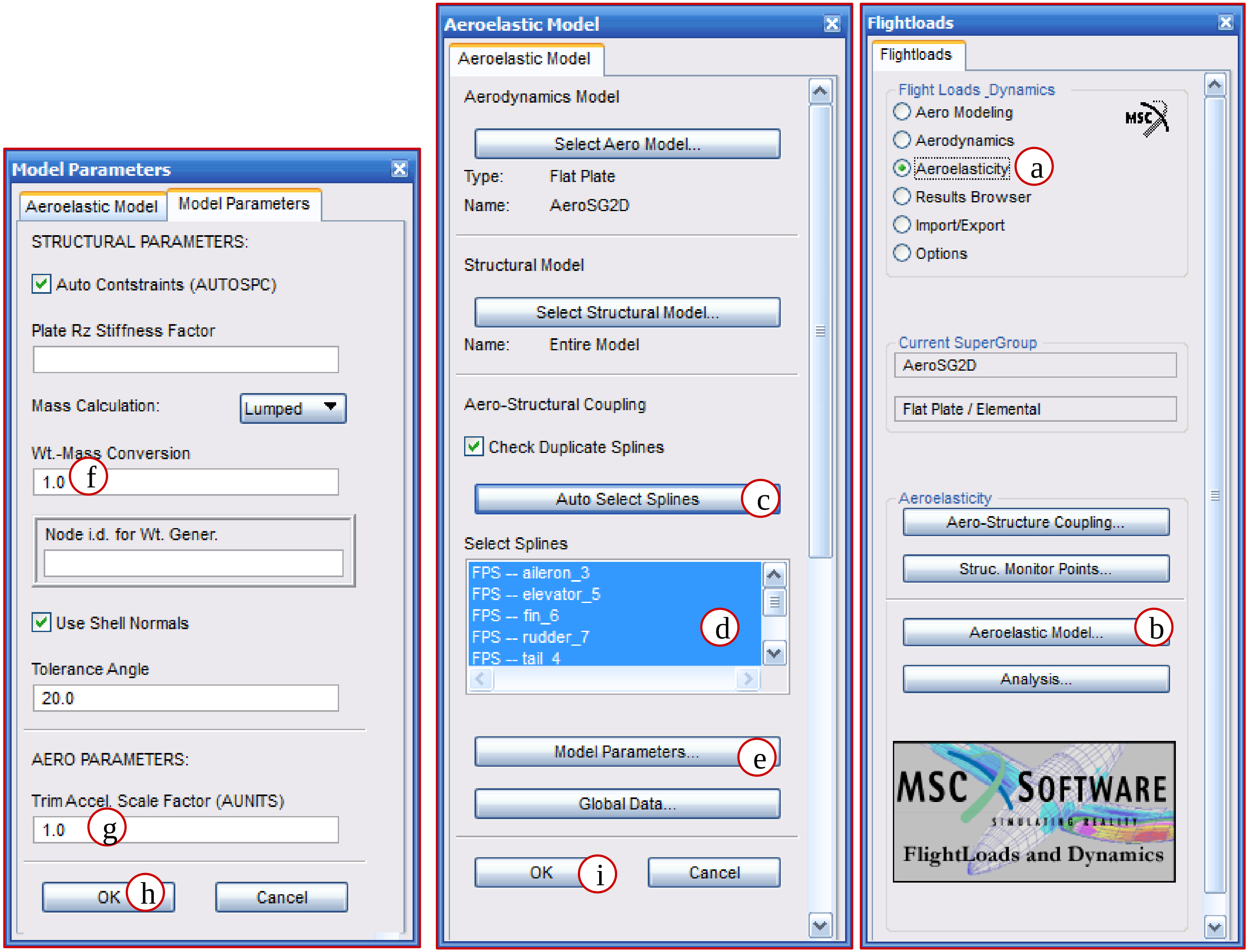
MSC Software

Define Global Data for Aircraft





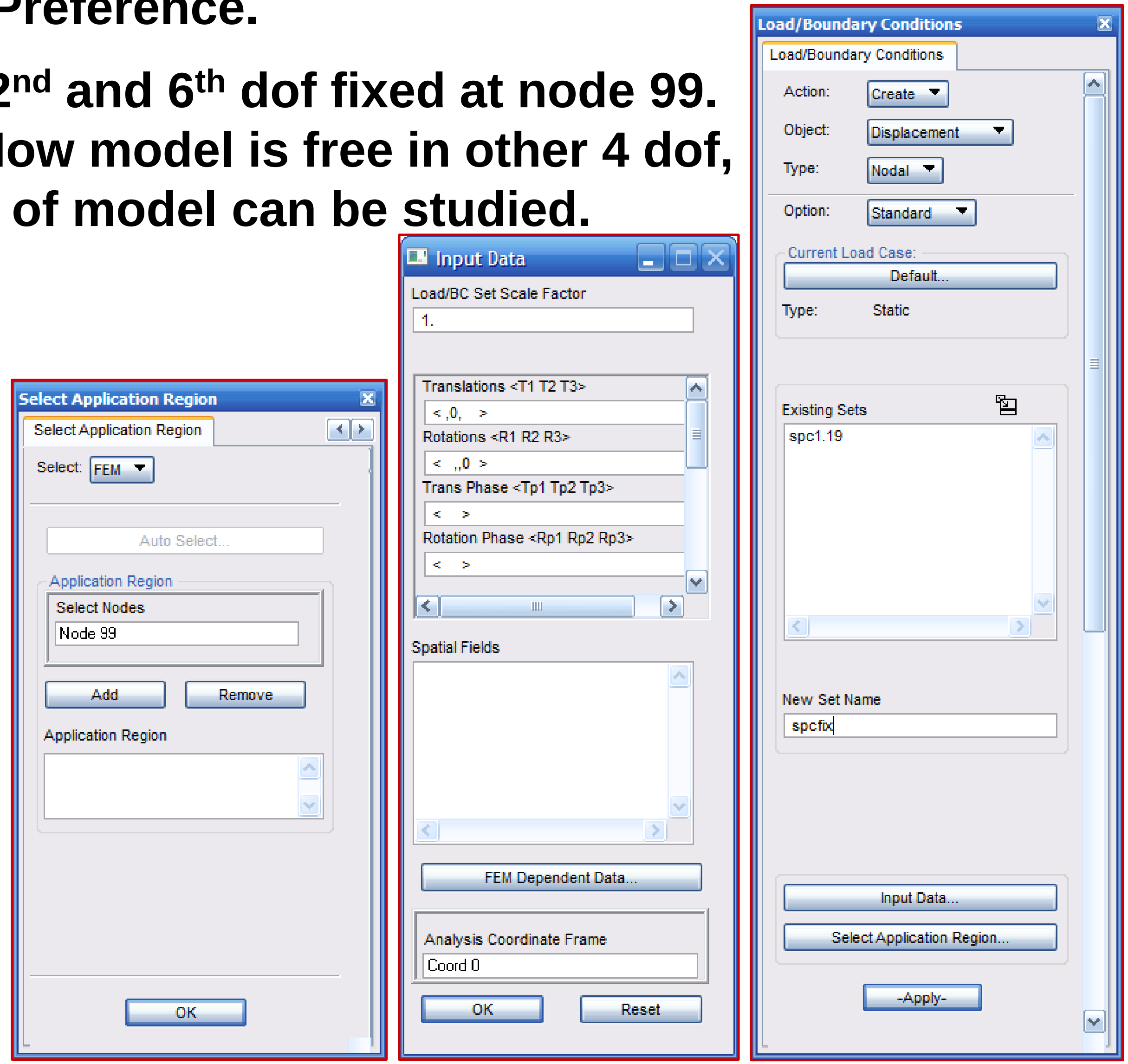
Define Model Parameters



MSC Software

Add Structural BC to study Roll motion

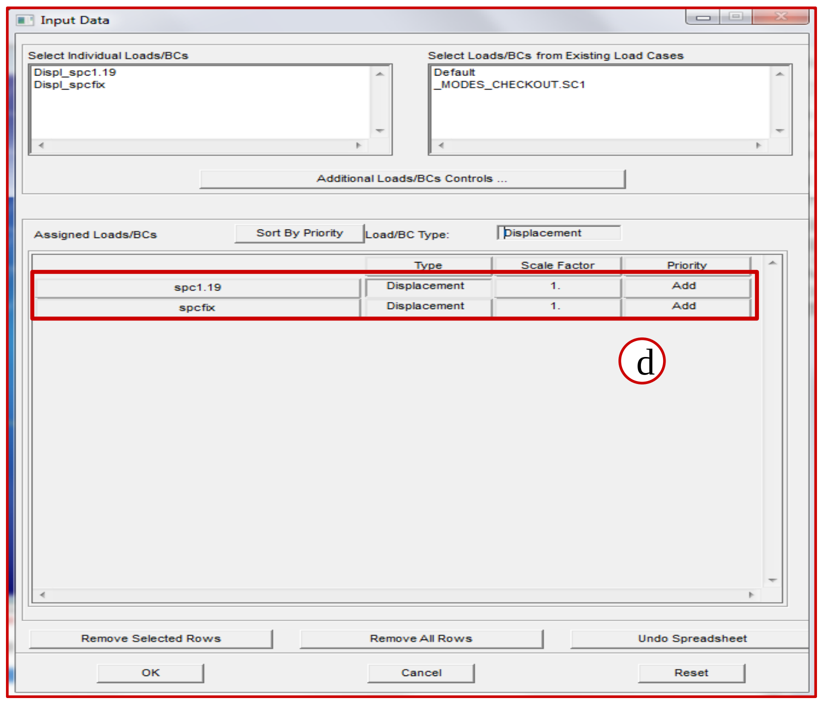
- Switch to Structural Preference.
- Add constraint with 2nd and 6th dof fixed at node 99. Named it as spcfix. Now model is free in other 4 dof, so the rolling motion of model can be studied.

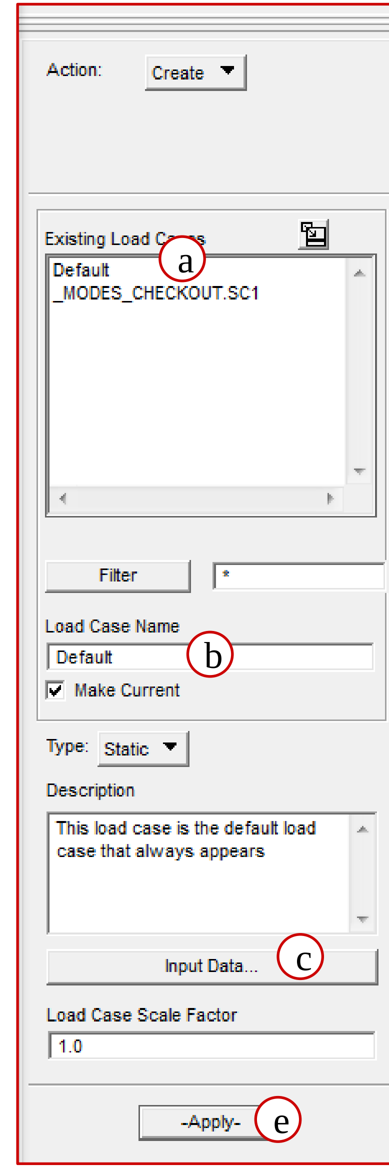


MSC Software

Create Loadcase

- **Create Default Load case with Symmetry BC and Constraint in 26 Dof's at Node 99.**

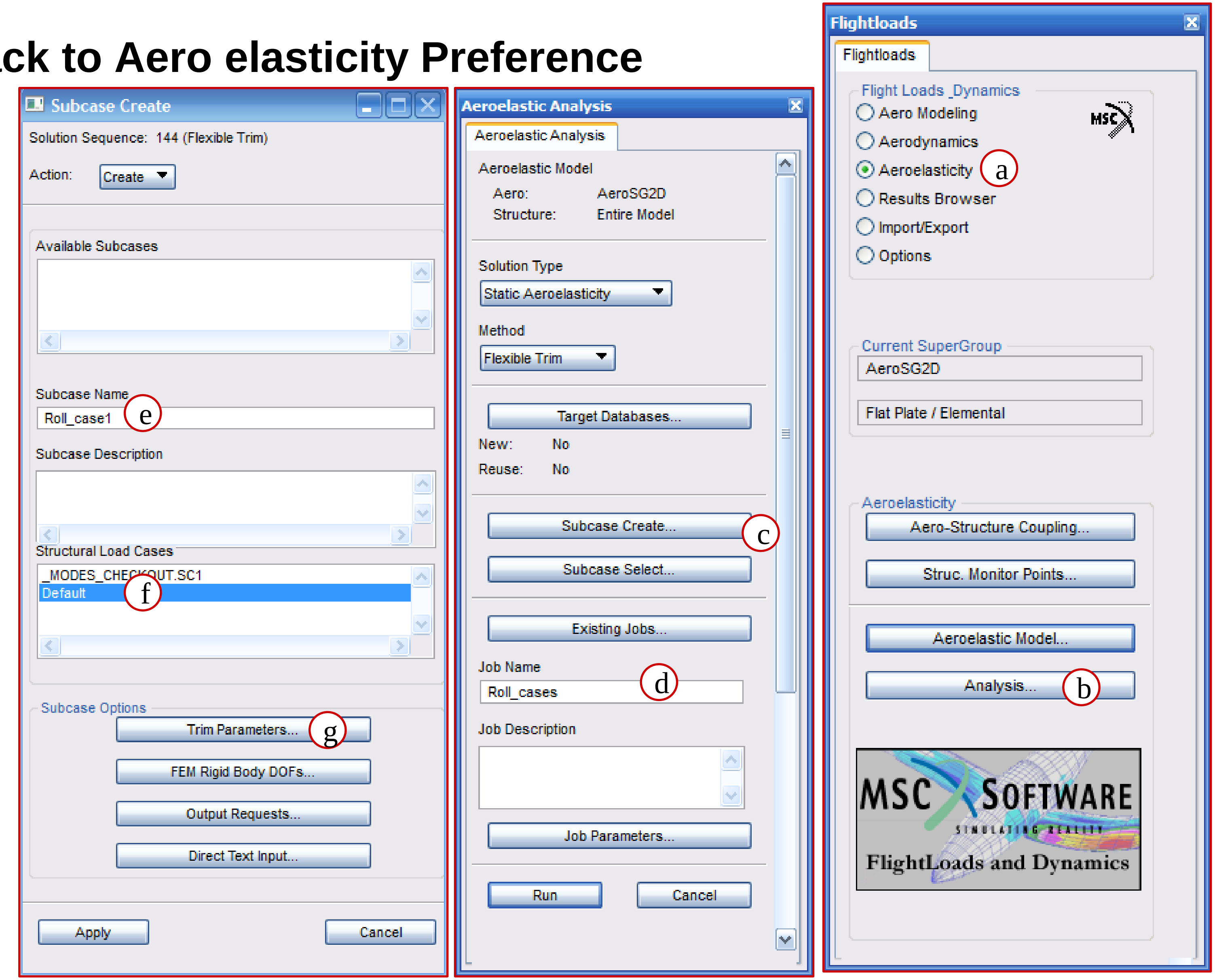




MSC Software

Setup For Trim Case

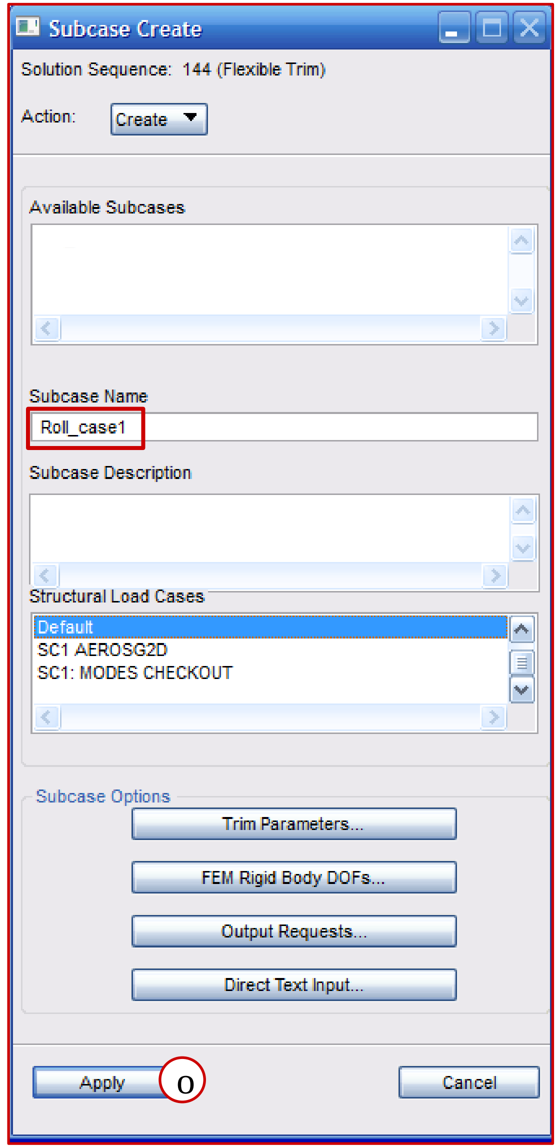
- **Switch back to Aero elasticity Preference**

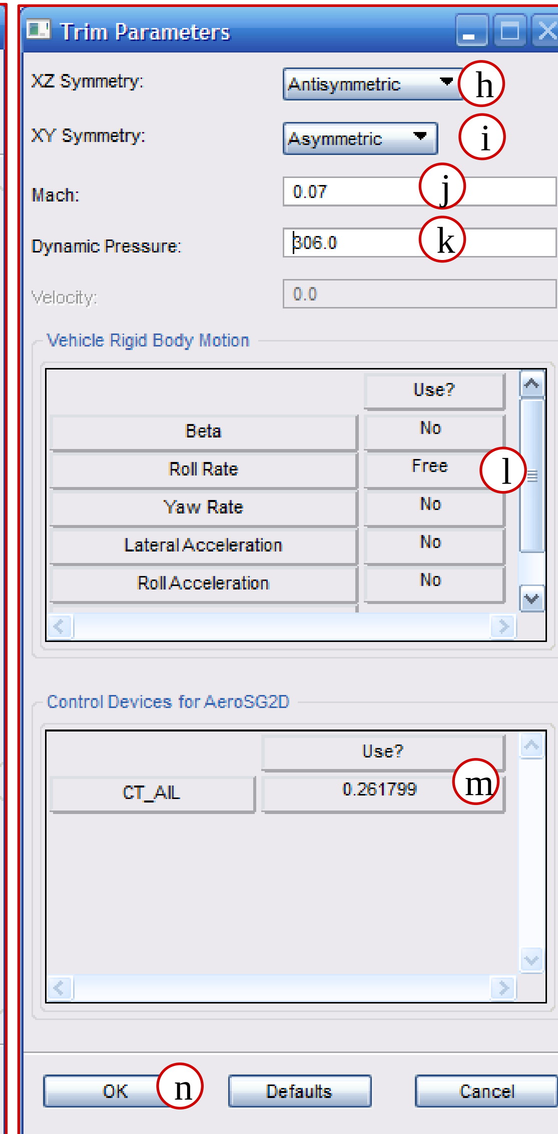


MSC Software

Job Setup for Roll Trim Analysis (Cont.)

- **This procedure will write out the TRIM entry into the Nastran input deck**
- **Steady roll:**
  - Aileron deflection: 15º
  - Roll rate to be determined

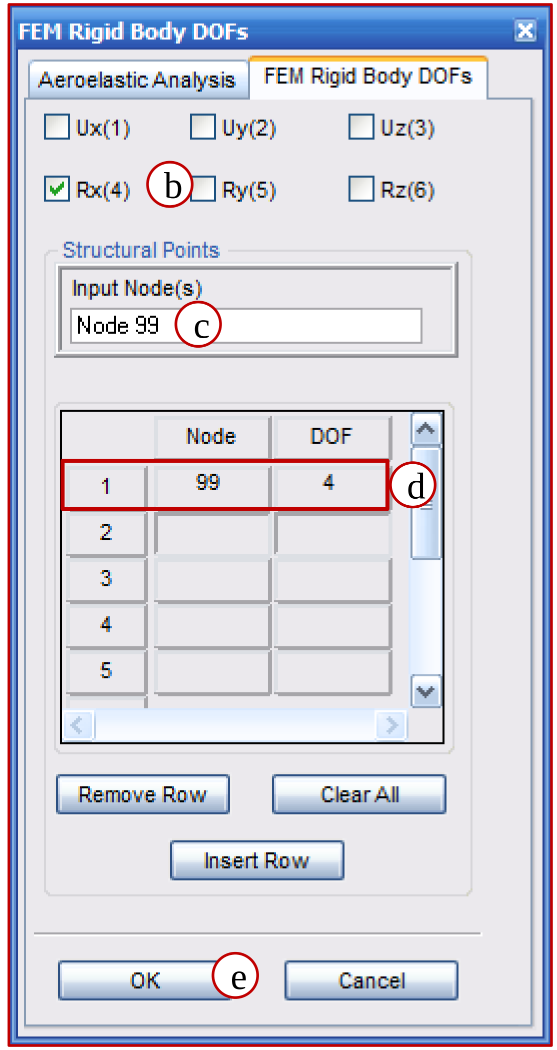




MSC Software

Define FEM Rigid Body DOFs

- **This will write the SUPORT1 entry in the Case control and Begin Bulk Section**



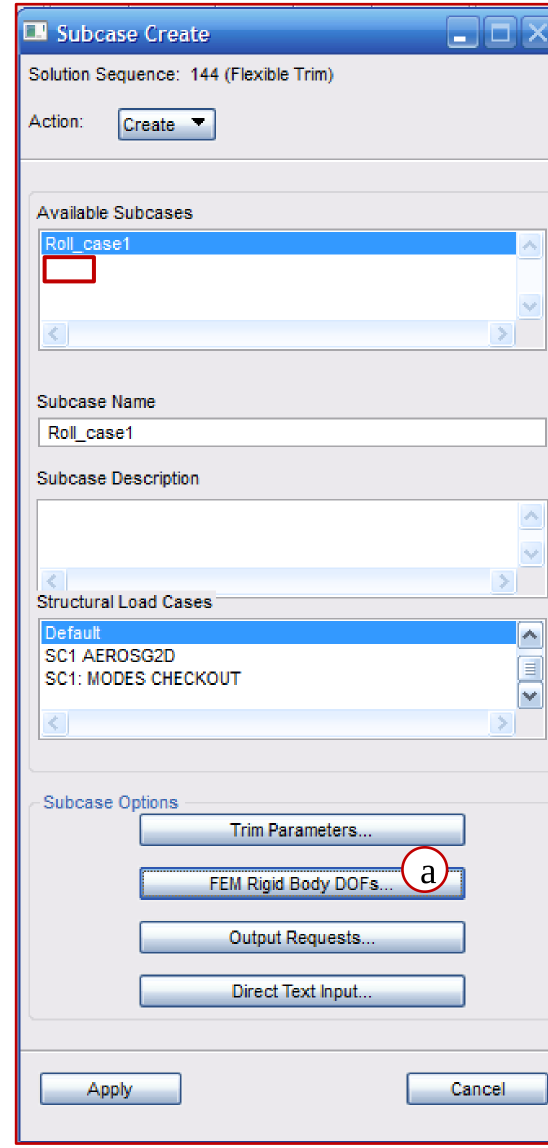


Table of Remaining 6 → Roll trim cases

- **The same procedure as shown for Roll_case1 needs to be repeated for 6 different mach no's and Dynamic pressure as shown in Table below.**
- **Steady roll:**
  - Aileron deflection: 15º
  - Roll rate to be determined
- **Investigate roll rate at varying speeds**
  - Roll Rate is derived from Trim Variable ROLL

$$\mathrm{ROLL} = \frac{\text{roll rate} \cdot \text{semi span}}{\text{Velocity}}$$

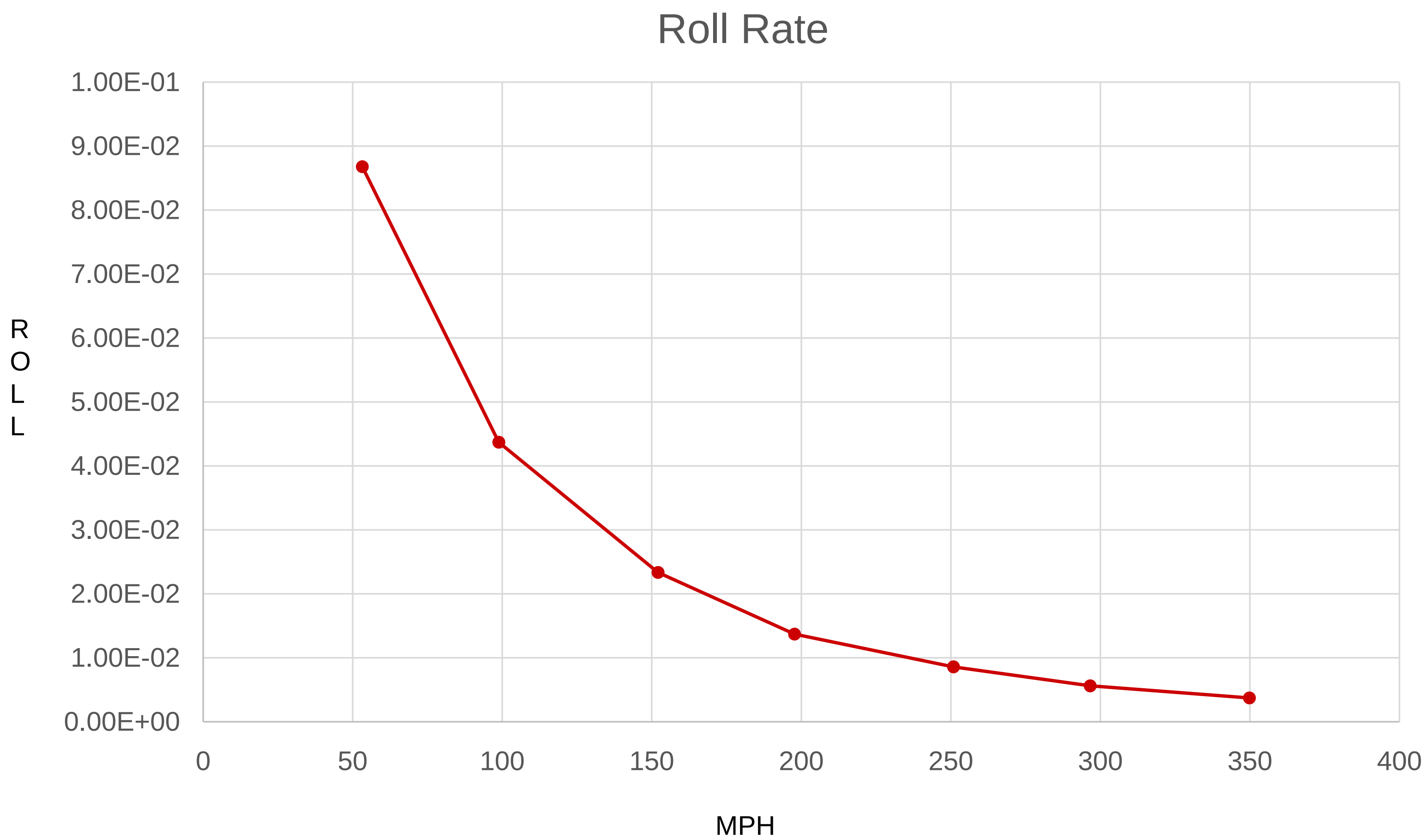
Mach No	Q
0.07	306.01
0.13	1224.05
0.20	2754.11
0.26	4896.20
0.33	7650.31
0.39	11016.44
0.46	14994.60

Roll Results from F06 file for Subcase 1

```
0                                                                                                             SUBCASE 1

                              A E R O S T A T I C   D A T A   R E C O V E R Y   O U T P U T   T A B L E S
                        CONFIGURATION = AEROSG2D     XY-SYMMETRY = ASYMMETRIC     XZ-SYMMETRY = ANTISYMMETRIC
                                    MACH = 7.000000E-02                    Q = 3.060000E+02
                        CHORD = 2.0000E+00          SPAN = 1.2000E+01           AREA = 1.2000E+01

         TRIM ALGORITHM USED: LINEAR TRIM SOLUTION WITHOUT REDUNDANT CONTROL SURFACES.


                                                  AEROELASTIC TRIM VARIABLES

                               ID      LABEL                TYPE        TRIM STATUS      VALUE OF UX

                                       INTERCEPT         RIGID BODY          FIXED      1.000000E+00
                                1      CT_AIL        CONTROL SURFACE         FIXED      2.617990E-01  RADIANS
                                1      ANGLEA            RIGID BODY          FIXED      0.000000E+00  RADIANS
                                2      SIDES             RIGID BODY          FIXED      0.000000E+00  RADIANS
                                3      ROLL              RIGID BODY           FREE      8.677795E-02  NONDIMEN. RATE
                                4      PITCH             RIGID BODY          FIXED      0.000000E+00  NONDIMEN. RATE
                                5      YAW               RIGID BODY          FIXED      0.000000E+00  NONDIMEN. RATE
                                6      URDD1             RIGID BODY          FIXED      0.000000E+00  LENGTH/S/S
                                7      URDD2             RIGID BODY          FIXED      0.000000E+00  LENGTH/S/S
                                8      URDD3             RIGID BODY          FIXED      0.000000E+00  LENGTH/S/S
                                9      URDD4             RIGID BODY          FIXED      0.000000E+00  RADIANS/S/S
                               10      URDD5             RIGID BODY          FIXED      0.000000E+00  RADIANS/S/S
                               11      URDD6             RIGID BODY          FIXED      0.000000E+00  RADIANS/S/S


                                         CONTROL SURFACE POSITION AND HINGE MOMENT RESULTS

                           ACTIVE LIMITS ARE FLAGGED WITH AN (A),  VIOLATED LIMITS ARE FLAGGED WITH A (V).

                                               POSITION                                          HINGE MOMENT
         CONTROL SURFACE       LOWER LIMIT       VALUE       UPPER LIMIT        LOWER LIMIT       VALUE        UPPER LIMIT
             CT_AIL          -9.000020E+01   2.617990E-01   9.000021E+01            N/A       -1.663455E+01        N/A
1    MSC.NASTRAN AEROELASTIC JOB CREATED ON 02-APR-17 AT 15:52:33            APRIL   2, 2017  MSC Nastran  7/ 3/15   PAGE    16
     DEFAULT
```

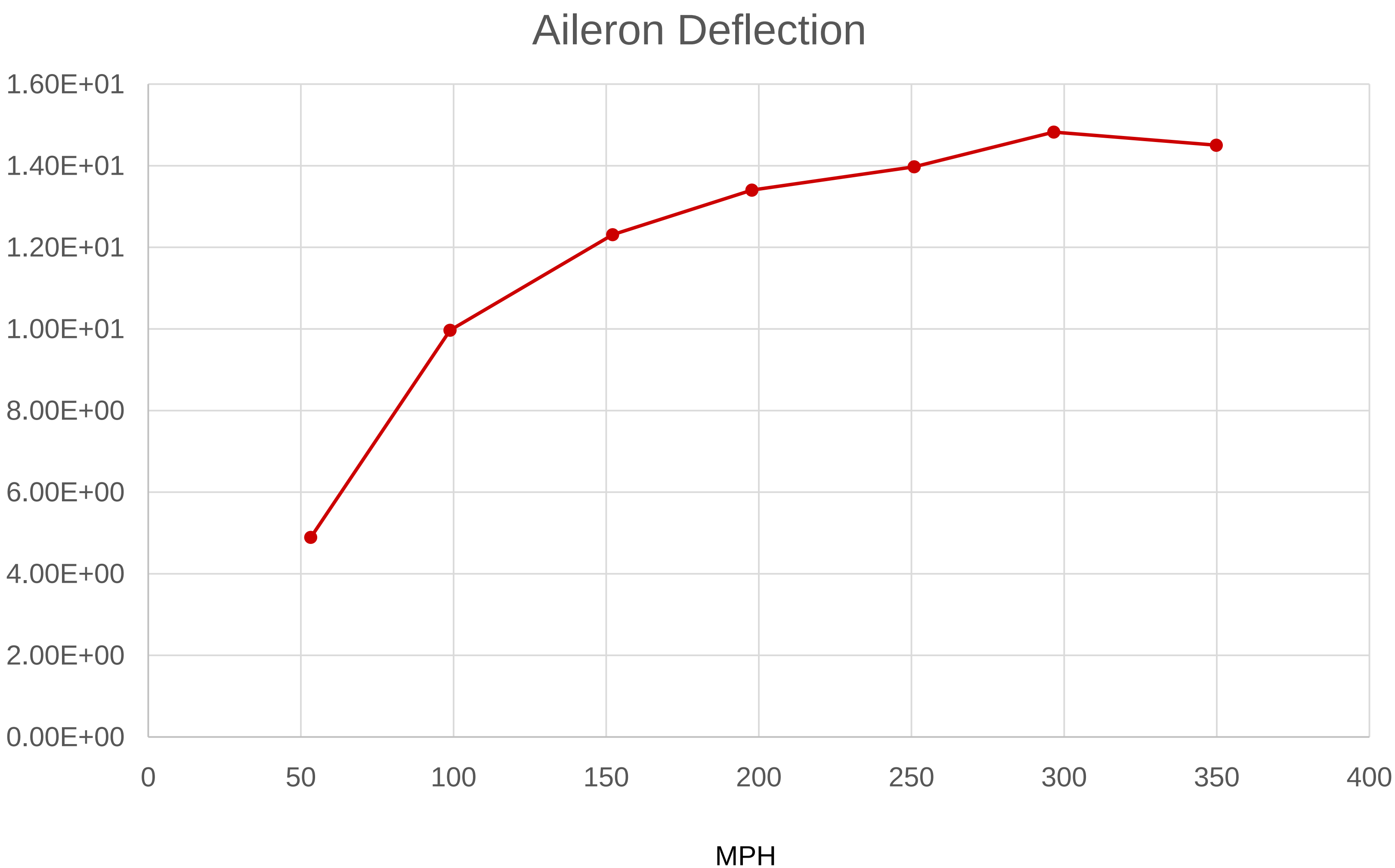
- **The roll rate value needs to be noted for each subcase to create a Graph of the Roll at analysed Speed**

Roll Rate



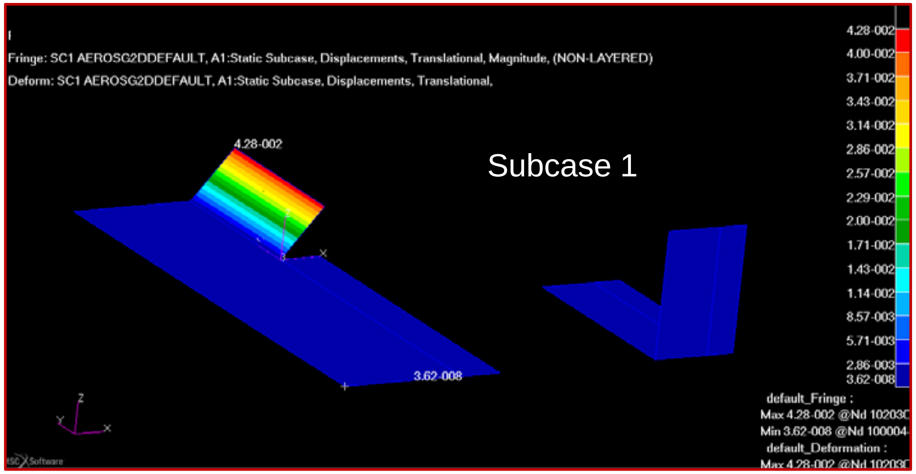
MSC Software

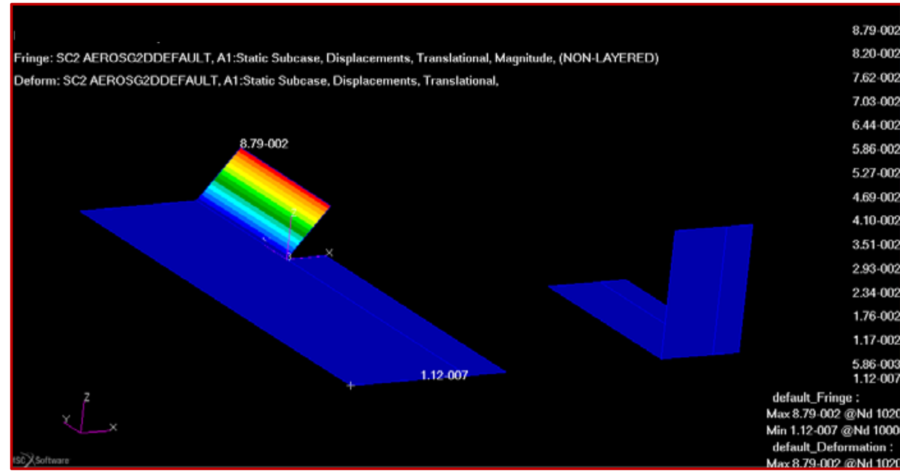
Aileron Deflection

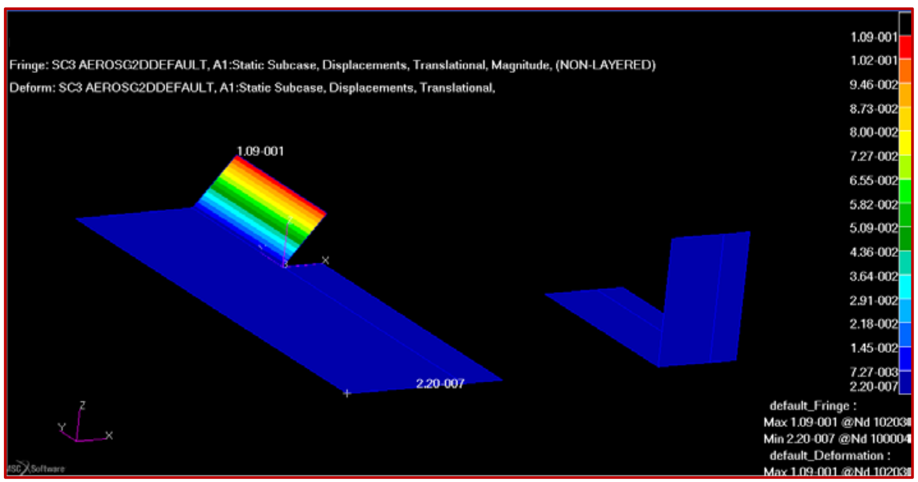


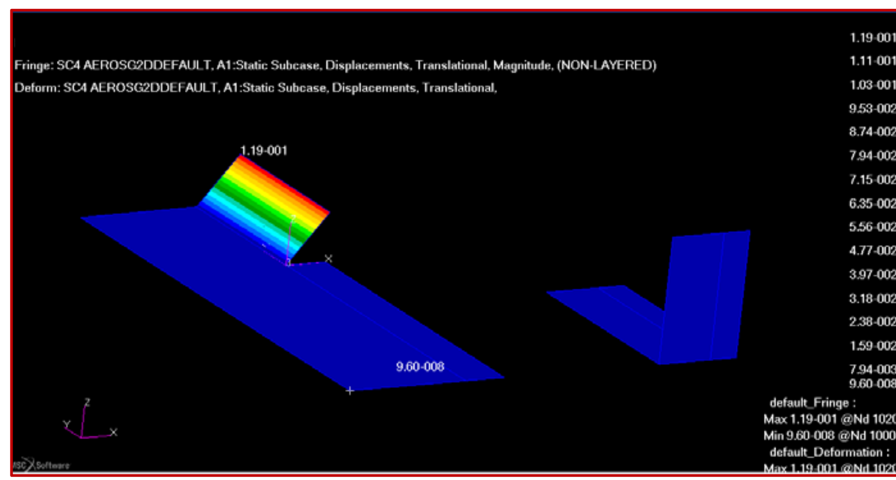
This values can be got by measuring the deflection angle of aileron wrt flat surface. Procedure for doing this has been added as an appendix section.

Results → Displacements



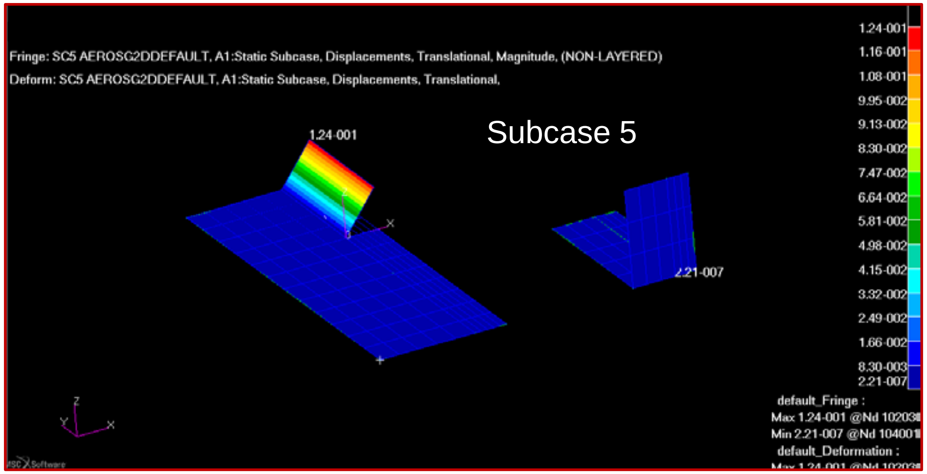


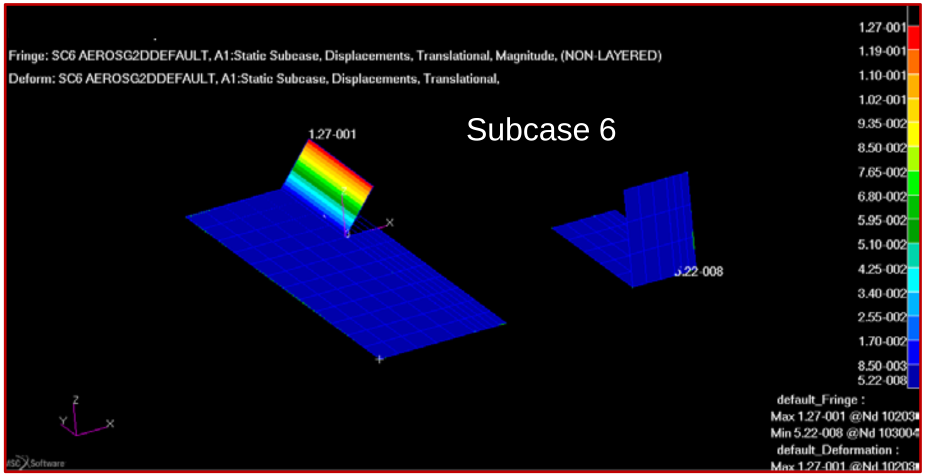


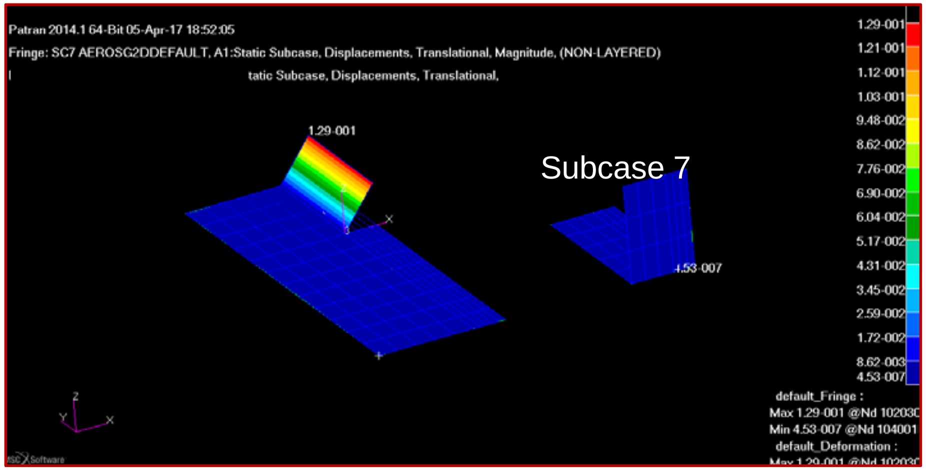


Only Aero-Mesh Posted

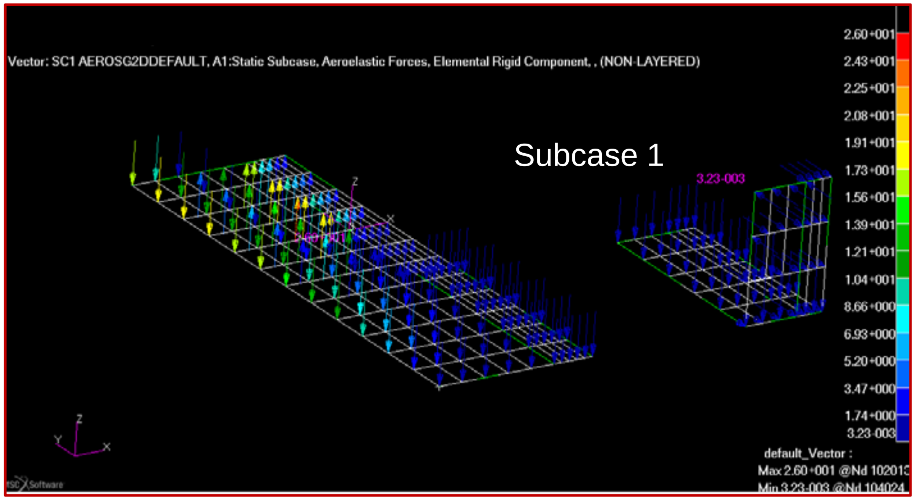
Results → Displacements (Cont.)

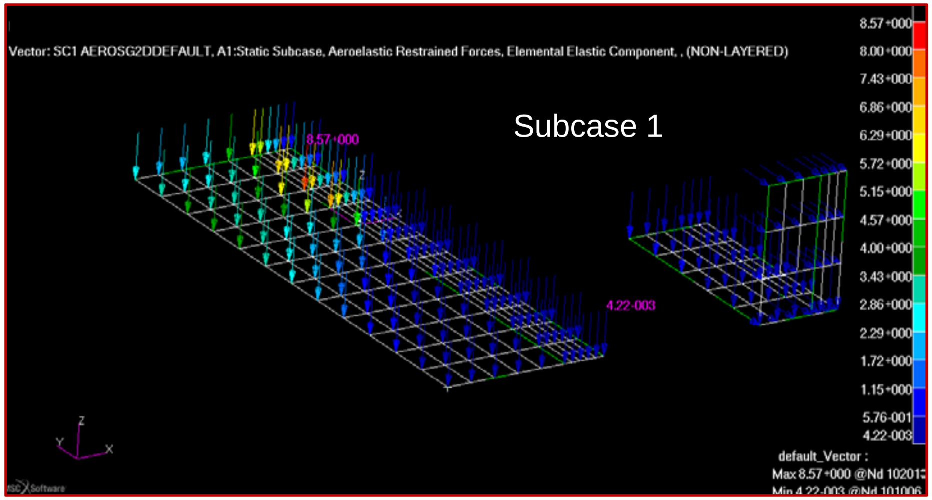


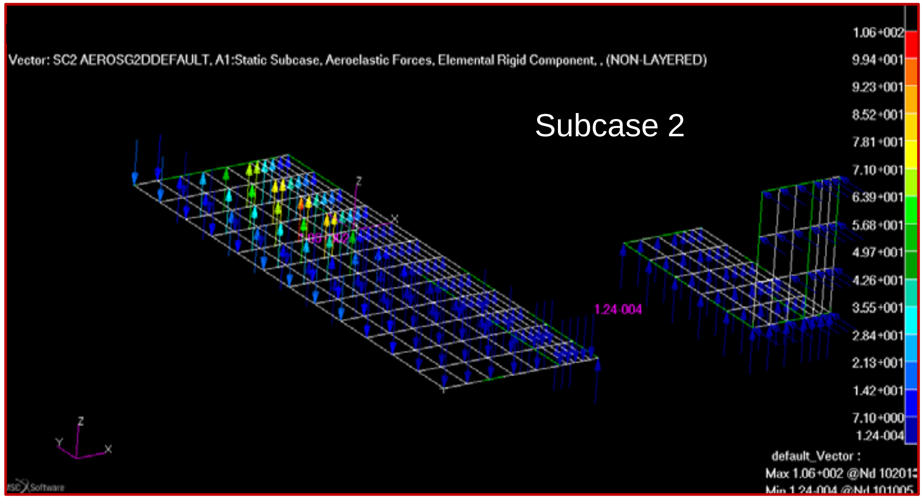


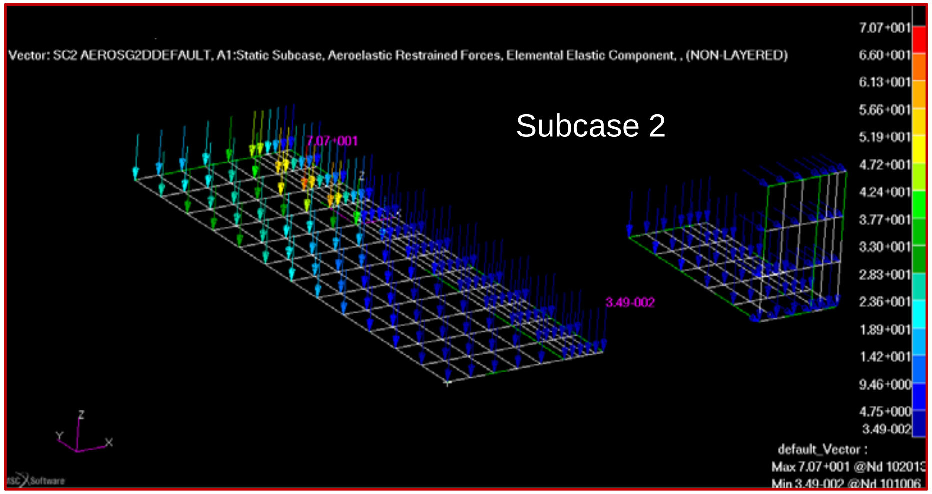


Results → Aero Forces, Elemental Rigid & Aero Restrained Forces, Elemental Elastic

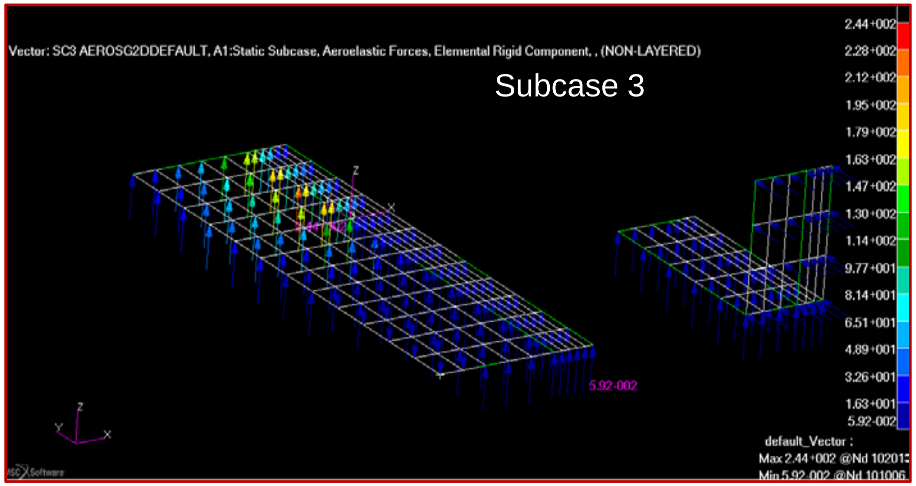


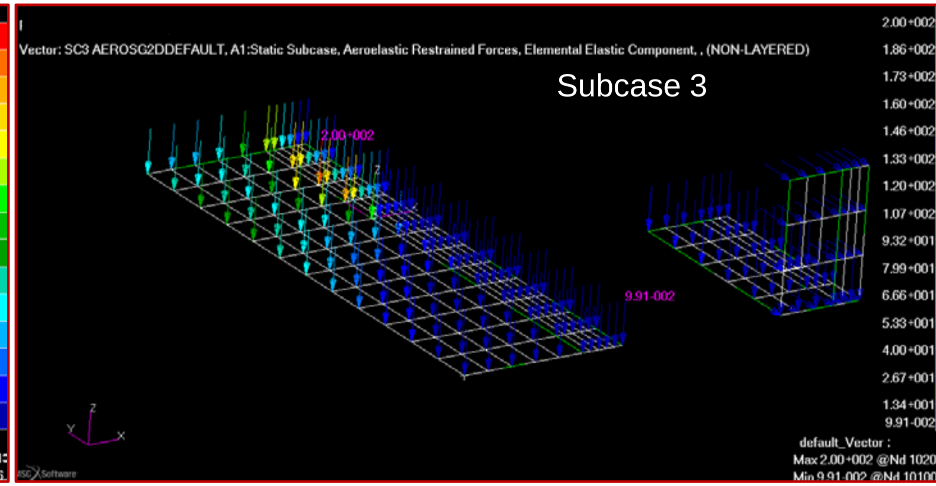


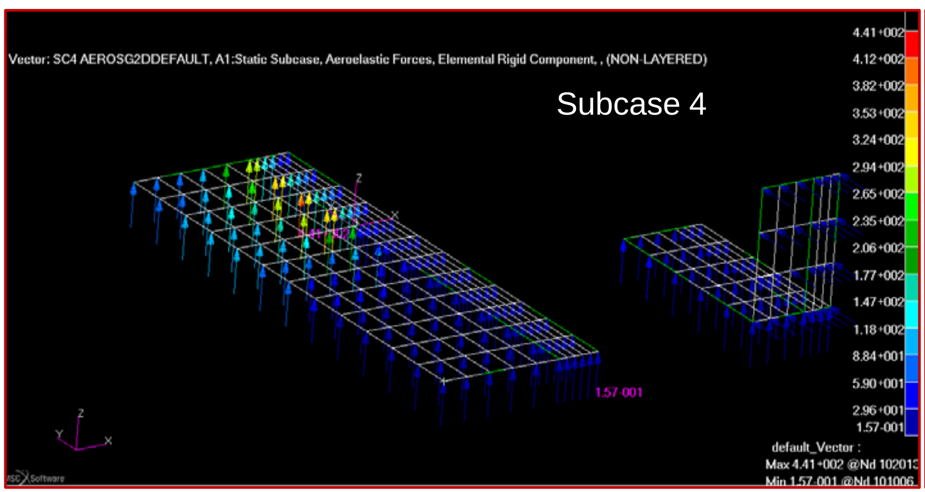


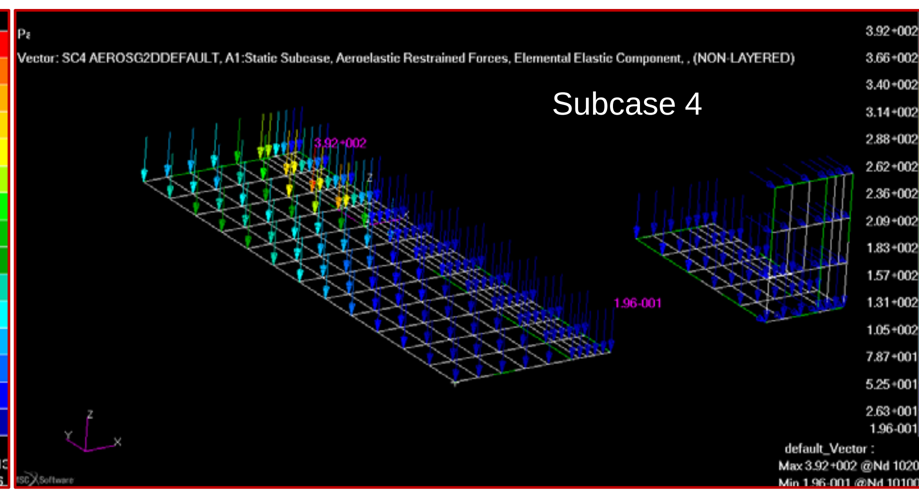


Results → Aero Forces, Elemental Rigid & Aero Restrained Forces, Elemental Elastic

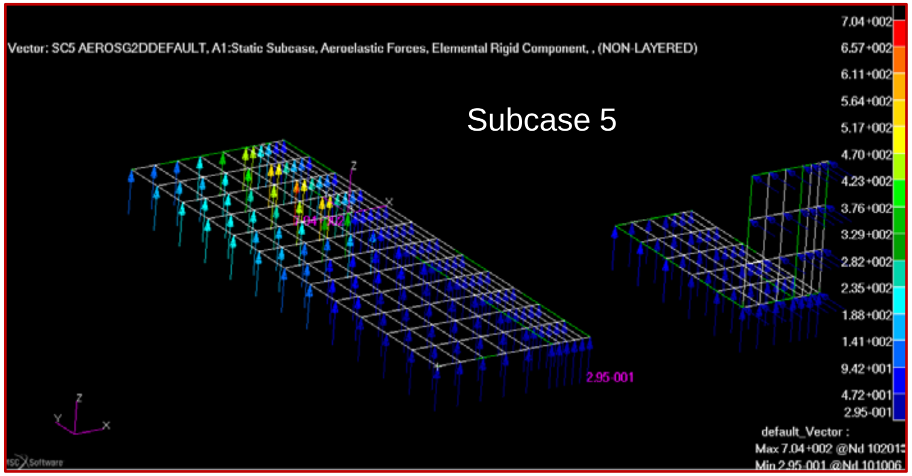


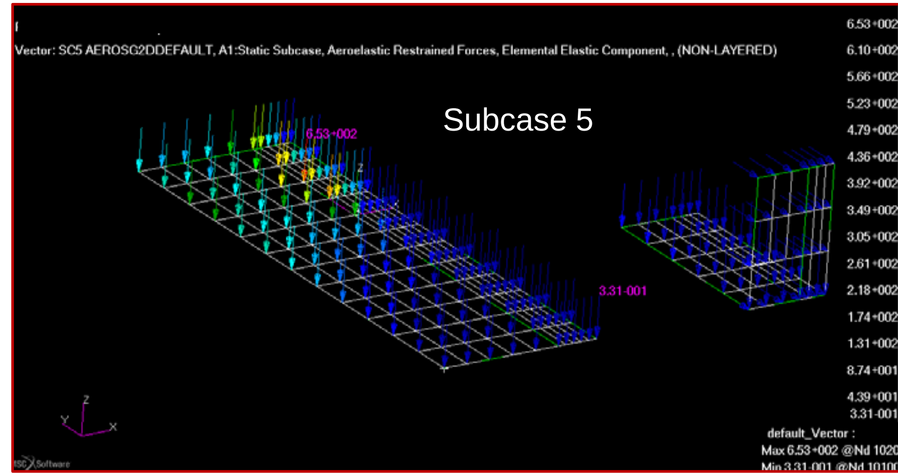


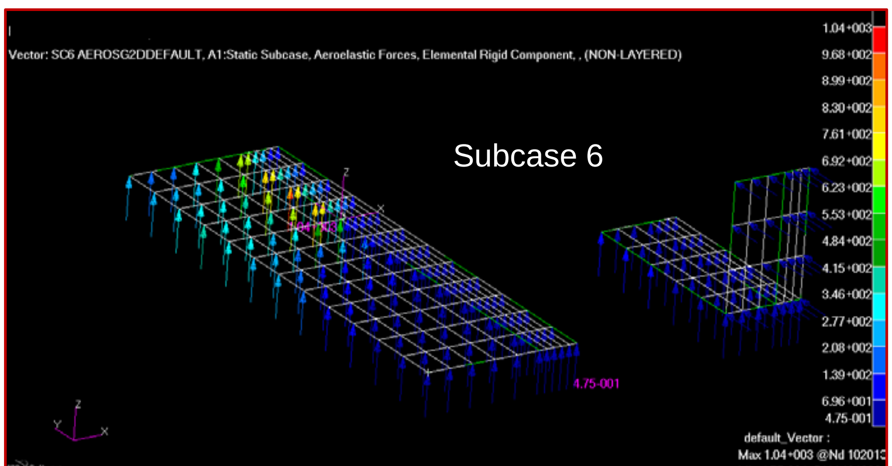


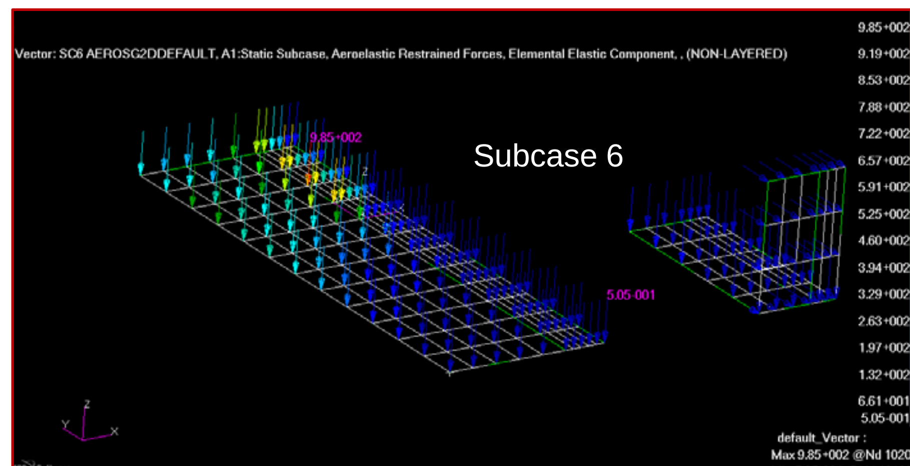


Results → Aero Forces, Elemental Rigid & Aero Restrained Forces, Elemental Elastic









Results → Aero Forces, Elemental Rigid & Aero Restrained Forces, Elemental Elastic