STARTING STUFF

1. Open Workbench
2. Under “Analysis Systems” drag the “static structural system into the project schematic pane
3. SAVE to temporary files in Apps on Demand
4. ARCHIVE as .wbpz file in Apps on Demand
    a. Make sure that when you finish working, you save, archive, and download the .wbpz file from AoD before quitting the session.
    b. Similarly, you can upload your .wbpz file to AoD and pick up where you left off.

INPUT PROPERTIES

5. Go into “engineering data”
6. click to add new material, call it “cartilage”
7. under “linear elastic” drag “isotropic elasticity” into the properties and enter values for elastic modulus and Poisson’s ratio
8. add another material called “muscle tissue” and add properties
9. close out engineering data and go back to project
10. SAVE

CREATE GEOMETRY

11. double click on geometry to open spaceclaim
12. go to file, spaceclaim options, units, set to mm
13. click on “sketch mode” and then click on the z-axis to sketch in the xy-plane. click on “plane view”
    a. create a 300 degree arc diameter 20 mm centered at origin
    b. draw lines from origin to endpoints of the arc
    c. create the 60 degree arc to complete the circle
    d. click on 3D mode and go back to trimetric view
14. select the pull tool
    a. select the 300 degree arc
    b. click on “pull direction” and select the z-axis
    c. click “options-pull” and select “no merge”
    d. extrude the edge 5 mm (width of cartilage ring)
    e. click on the 60 degree arc and extrude it 5 mm
15. select the two parts that make up the circle and delete them
16. select the pull tool
    a. select BOTH arcs on the extruded edge of the cylinder
    b. select the z-axis as pull direction, set no merge
    c. extrude both edges 10 mm (width of connective tissue)
17. name all the surfaces - ring, tissue_gap, tissue_band
18. select the linear pattern tool
    a. control click to select all three surfaces
    b. under “options” select 7 for X count and enter 15 mm for X pitch (width of cartilage+tissue)

    c. click the z-axis to set the pattern direction and click the green arrow
19. select all faces using the select via box tool
    a. right click and make independent
20. delete the last muscle tissue band
21. click oat the top of the tree
    a. under “share topology” select share
22. file, save project, close spaceclaim

MESHING ETC

23. double click on “model” to open mechanical
24. open up “geometry” in the tree
    a. select all the rings
    b. set thickness and material
    c. repeat the process for the tissues
25. right click on mesh
    a. insert -> “sizing” -> element size 1.5mm
    b. generate mesh.

PHYSICS SETUP

26. right click on “static structural” and under “insert” select “fixed support”
    a. select the FOUR edges that make up the TWO ends of the cylinder
    b. under “fixed support” next to “geometry” click apply
27. right click on “static structural” and under “insert” select “pressure”
    a. select an internal face and then go to “extend” and to “limits”
    b. next to “geometry” click apply

NUMERICAL SOLUTION

28. right click on “solution”, insert -> deformation -> total
29. click on “solve”

NUMERICAL RESULTS - extracting volume of deformed trachea

30. right click on “total deformation”, export -> STL file
31. close spaceclaim
32. under “component systems” drag in geometry
33. double click on geometry to open in spaceclaim
34. file -> open -> all files -> import saved STL file
35. right click on facets, select “convert to solid”, and then “merge faces”
36. go to “repair”, “missing faces”, and add the faces on each side of the trachea. Spaceclaim will convert to a body.
37. go to “measure”, “mass properties”, click on the body, and it will report the volume.

GEOMETRY UPDATE for tracheotomy

38. open geometry
39. create a plane at the appropriate height

40. split the fourth ring using the plane
41. rename all pieces