

## Abaqus Extension for Filament Wound Composite Structures

Accelerate the modeling and analysis of pressure vessels

In industries such as aerospace, automobile, and petro-chemical, filament winding has become a popular technique for creating composite structures with high stiffness-to-weight ratios. The difficulty has traditionally been in accurately analyzing the structural behavior of a filament wound body due to the continuously varying orientation of the filaments. To overcome this challenge, engineering specialists at SIMULIA have developed an extension to Abaqus Unified FEA software that enables the modeling of spatial variation of fiber orientation in a practical way.

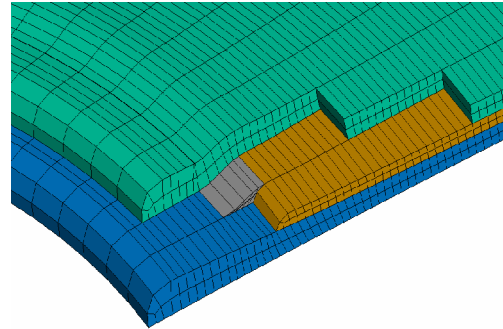
### Features and Benefits

SIMULIA's Wound Composite Modeler (WCM) extension allows Abaqus users to create models with detailed specification of structural geometry and winding layout parameters. Tools are provided to facilitate postprocessing of the stresses and strains in the fiber directions. Axisymmetric or three-dimensional models may be generated using continuum and shell elements.

The customized user interface enables users to quickly define the winding layout, and the application performs the geometry and mesh creation. The underlying geometry, which the filament wound layers are wrapped over, can be generated in a number of ways. The extension allows the user to define elliptical, spherical, or geodesic shapes; a table of individual points may also be entered. Additionally, the underlying geometry can be created from an existing part instance.

The WCM extension provides options for generating models of full or partial, symmetric or non-symmetric tanks. If the tank geometry and loading allows for reduced model sizes due to symmetry conditions, the tool automatically creates the symmetric geometry and mesh along with the proper boundary conditions on the symmetry planes.

If a given tank design has two different end dome geometries, it can be analyzed by creating two separate domes then combining them along with a cylindrical section, if necessary, to create a full non-symmetric tank model.



*Brick Model of Wound Composite Tank*

The extension accounts for the thickness buildup as the helical layers approach the turnaround point on the dome.

The finite element mesh is created automatically by the plug-in. Users may choose the number of mesh seeds through the thickness and the number of elements along the length of the dome.

The Wound Composite Modeler is available through your SIMULIA regional office on an annual lease basis.

### For More Information

Download the Filament Wound Composites Tech Brief at:

[www.simulia.com/products/wound\\_composites](http://www.simulia.com/products/wound_composites)

Or

Contact your SIMULIA Regional office  
[www.simulia.com/locations](http://www.simulia.com/locations)

## Dome (Mandrel) Geometries

- Geodesic
- Elliptical
- Spherical
- User-Defined (point-by-point)
- From mesh of existing Part-Instance

## Available Tank Geometries

- Axisymmetric continuum
- Axisymmetric laminated shell
- 3D laminated shell
- 3D continuum
- 3D laminated continuum shells consisting of layers merged from multiple sub-layers
- 3D geometries are available by assigning a sweep angle greater than zero and less than or equal to 360 degrees.
- Symmetry planes can be utilized with necessary boundary conditions automatically applied

## Layer Control

- Parameters for wind angle, material, thickness build up (band width factor) control layer geometry.
- End of layer controlled by
  - End type – shape of end
  - Thickness buildup at end
  - Void creation when overwrapped by another layer
- Different element types may be assigned to individual layers
- Proper element types are assigned based on procedure

## Material Calculations

- Orthotropic fiber materials are transformed from the direction along the fiber to a direction along the global hoop and meridional directions.
- Element properties can be grouped together based on increments in wind angle in order reduce the number of sections required, thus reducing run-time.

## CAD Import

- Import entire models by reading a mandrel file and multiple ply files defining geometry of each layer
- Ply files contain position along tank, diameter, wind angle, and layer thickness
- Layers may be chosen to abut the polar boss and assigned special end types.

- Automatic detection of whether tank is symmetric in order to allow option of modeling with symmetry planes
- Tools are available to compare sketches of raw CAD data to layers imported by plug-in.

## Output

- UVARM output variables generated automatically for wind angle, stress, and strain output along fiber direction and transverse to fiber direction
- Special functions are provided to automatically merge user-defined UVARM coding with UVARM coding of plug-in
- Automated path plots of variables along layer boundaries

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