

Wistron Cylinder Modifier and Its Application

H.Z. Chen, Michael Wen, Lawrence Huang

Wistron Packing Design Dept.

摘要

本成果針對Wistron針對一系列圓柱的應用進行說明，中分成三個部份，由幾何決定範圍內網格點；由網格點集合決定最適之圓柱；使用圓柱幾何對於模擬上的應用。首先幾何決定網格點是藉由幾何的判讀搭配Abaqus提供的內建函式進行網格點選取；網格點集合決定最適之圓柱則是利用廣義圓柱方程式後，建立價值函式後，利用演算法演算使得價值函式為最小的變數組合，就可以利用此廣義圓柱方程式建立出特定位置之圓柱；最後介紹目前針對此圓柱幾何進行的應用概念。

關鍵字：插件、圓柱、最適解

ABSTRACT

This study describes some cylinder application in Abaqus. There are three main components of this thesis. The first one is how to determine the mesh nodes in a specific cylinder region. The second one is how to create an approximate optimized cylinder with a set of mesh nodes. The final one is how to use these cylinders in the simulation. In the first topic, it shows how to find the cylinder geometry information that will input into Abaqus built-in function. In the second topic, it will create a cost function J by the general cylinder equation. What we need to do is to find the parameters that can minimize this cost function. Therefore, we can find out this cylinder is an approximate solution for these mesh points. In the final topic, it will introduce an application.

Keywords : Plug-in 、Cylinder 、Approximate Solution

A. Find out the mesh nodes by cylinder

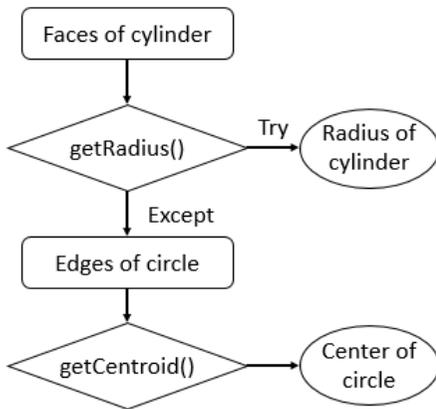


Figure 1. Program logic flow for the parameters of “getByBoundingCylinder()”

Here is a convenient built-in function called “getByBoundingCylinder()”. What user should need to input are “p1”, “p2”, and “Radius”, where “p1” and “p2” are central coordinate tuple of the top and the bottom surface. The region of any specific cylinder

geometry is closed by three main surfaces, two circle planes, and one cylinder surface. Based on this information, the program can get two circle planes in whole faces of a cylinder by “Try / Except” statement of “getRadius()”, then get two sets of center coordinate by “getCentroid()” for edges of these two circle planes. On the other hand, “getRadius()” also provides the user the radius of this cylinder.

B. Approximate optimized cylinder of mesh nodes.

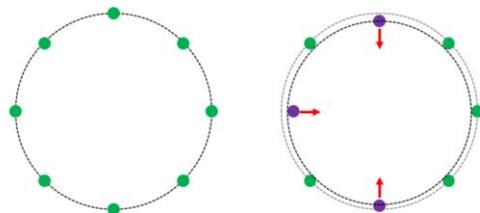


Figure 2. (Left) Exact circle of nodes, (Right) Approximate optimized circle of nodes

In figure 2, it describes why we need an approximate optimized solution but the exact

solution. In the CAE simulation, there are so many reasons that engineers have to modify the mesh nodes that might lose circularity.

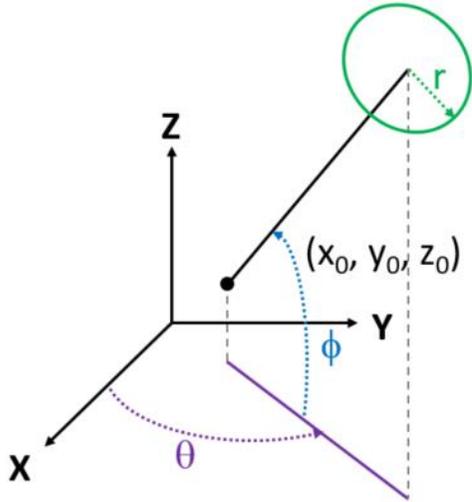


Figure 3. Math equation parameters for arbitrary cylinder

The first step to finding out an approximate optimized cylinder is to know the equation of a cylinder. As figure 3, the arbitrary cylinder can be separated into fix parameters x_0 , y_0 , z_0 , r , θ , and ϕ . And any point $p_i = (x_i, y_i, z_i)$ along the axis of this cylinder can be shown as below.

$$x_i = x_0 + s_i \cos(\phi) \cos(\theta)$$

$$y_i = y_0 + s_i \cos(\phi) \sin(\theta)$$

$$z_i = z_0 + s_i \sin(\phi)$$

Here we can get the axis unit vector $\mathbf{v}_a = (\cos(\phi) \cos(\theta), \cos(\phi) \sin(\theta), \sin(\phi))^T$. We also know the coordinate of the mesh nodes $p_n = (x_n, y_n, z_n)$. Next we can define a vector $\mathbf{v}_n = p_n - p_i$. It must have a specific value s_n that make

$$\mathbf{v}_n \cdot \mathbf{v}_r = 0 \quad \text{where} \quad s_i \rightarrow s_n$$

Now we set $p_n' = (x_n, y_n, z_n, s_n)^T$. Base on the p_n' , we can define another vector of mesh nodes as below

$$\mathbf{r}_n(p_n', x_0, y_0, z_0, \theta, \phi) = (x_n - x_0) \mathbf{x} + (y_n - y_0) \mathbf{y} + (z_n - z_0) \mathbf{z}$$

So the radius of mesh node p_n is $(\mathbf{r}_n \cdot \mathbf{r}_n)^{0.5}$.

So far, we have known the radius for

each mesh node, and we also get the equation for the arbitrary cylinder. What we need to do is to define a cost function J as below.

$$J(x_0, y_0, z_0, \theta, \phi, r) = \frac{1}{n} \sum_{i=1}^n (\sqrt{r_i \cdot r_i} - r)^2$$

Consequently, when we find out a set of parameters that make cost function J to be a global minimum value, the cylinder is an approximate optimized for these mesh nodes.

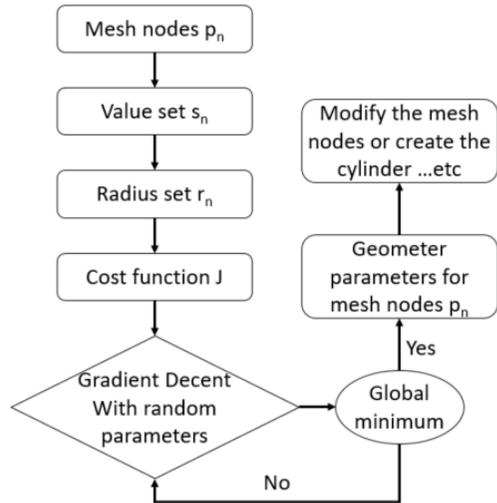


Figure 4. Program logic flow for the approximate optimized cylinder

C. Cylinder application

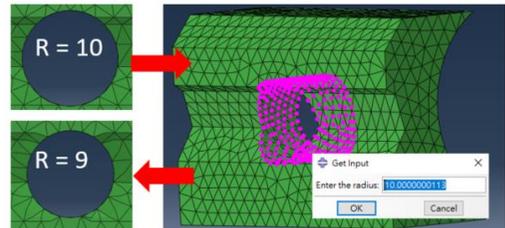


Figure 5. Re-modify the cylinder mesh quick and easy.

The first application is to remodify radius the cylinder mesh nodes. The advantage of it is quick, easy, and applicable for all kinds of the end surface (the end nodes of the cylinder should not on the same plane). As figure 5, the end nodes of this cylinder are not on the same plane, so it is hard to find a cylinder by a circle on the end. But this is not a question for the approximate method. This method can find out the cylinder even if some of these nodes had to be moved.

The other application is to create an exclude simulation cylinder at the proper position. As figure 6, it is a common screw feature. One method to simulate the screw behavior is coupling. This cylinder geometry can be used in another cylinder automatic plug-in in Wistron.

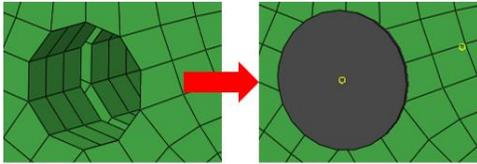


Figure 6. Create a cylinder that exclude in the simulation and couple the mesh nodes.

As Figure 7, that is how we instead screw 3D model by simply cylinder and using the plug-in that can help engineer automatic couple the thread and hole.

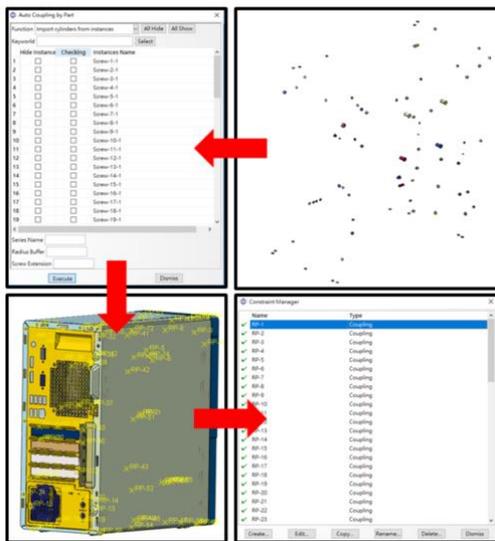


Figure 7. The work flow of how to use cylinder plugin that reduce the pre-process time.

Overall, this study provides some examples of cylinder application, and also provide a math model that can be used to find the approximate optimized cylinder by mesh nodes. Based on this study, it might be a useful way to complete automatics' process in Abaqus.