Altair HyperWorks™

2022

Fastener Realization Methods

Overview of the fastener connector realization process and methods.

The following flow chart outlines a four-stage process used to select the best routine for fastener realization.
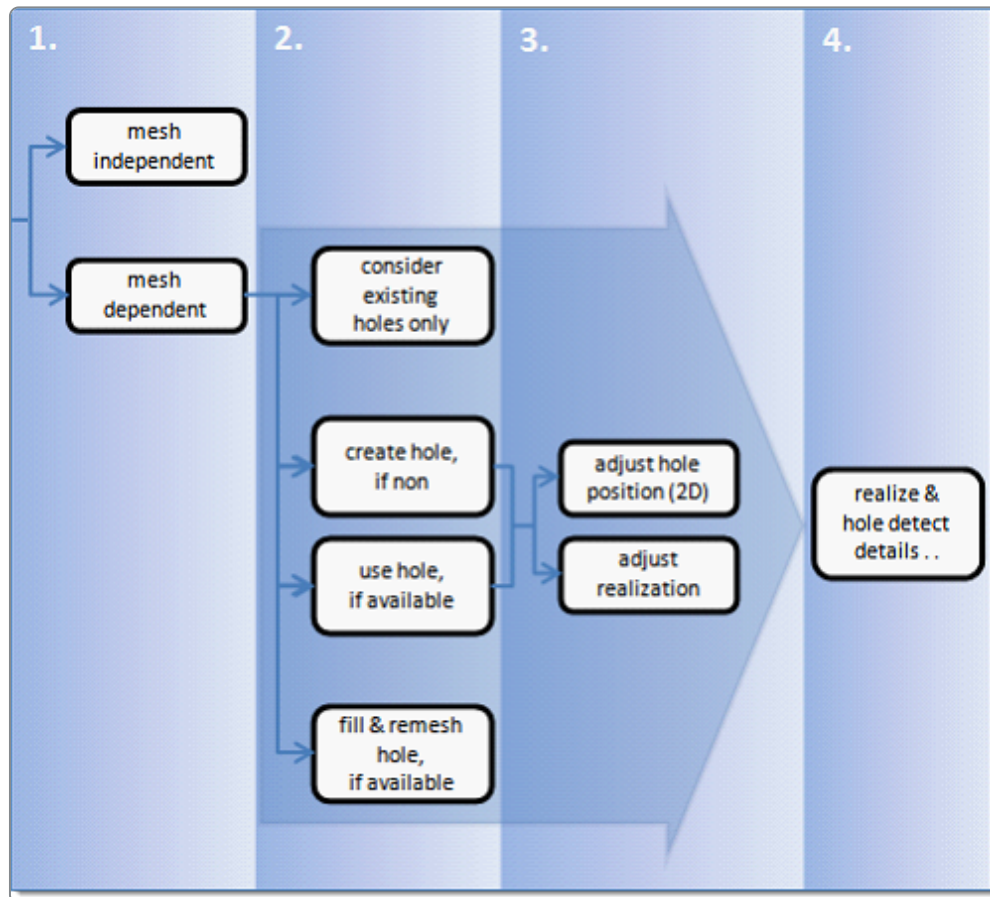

Figure 1.

Depending on the realization type, the mesh connectivity will automatically be assigned as independent or dependent.

mesh independent

Use for realizations which do not need any mesh changes, and the connection is primarily defined via a solver-specific card or the nodes which need to be connected are defined by a cylinder, such as Bolt (cylinder spring) for Radioss.

For all mesh independent fastener realization types, a cylinder is defined. Fastener hole detection is not performed because holes are not required. All of the nodes inside the cylinder are considered part of the fastener realization unless they also belong to a link defined on the connector.

The cylinder dimension is primarily defined by its diameter, length L1 and L2.

- L1 points in the same direction as the connector vector and describes the distance from the connector position to the first end of the cylinder.
- L2 points in the opposite direction and measures the distance between the connector position and the second end of the cylinder.

Therefore, the connector vector is essential for these types of realizations.

If a vector is not predefined and is determined dynamically, the vector will always point from the connector position to the projection point on the farthest link.
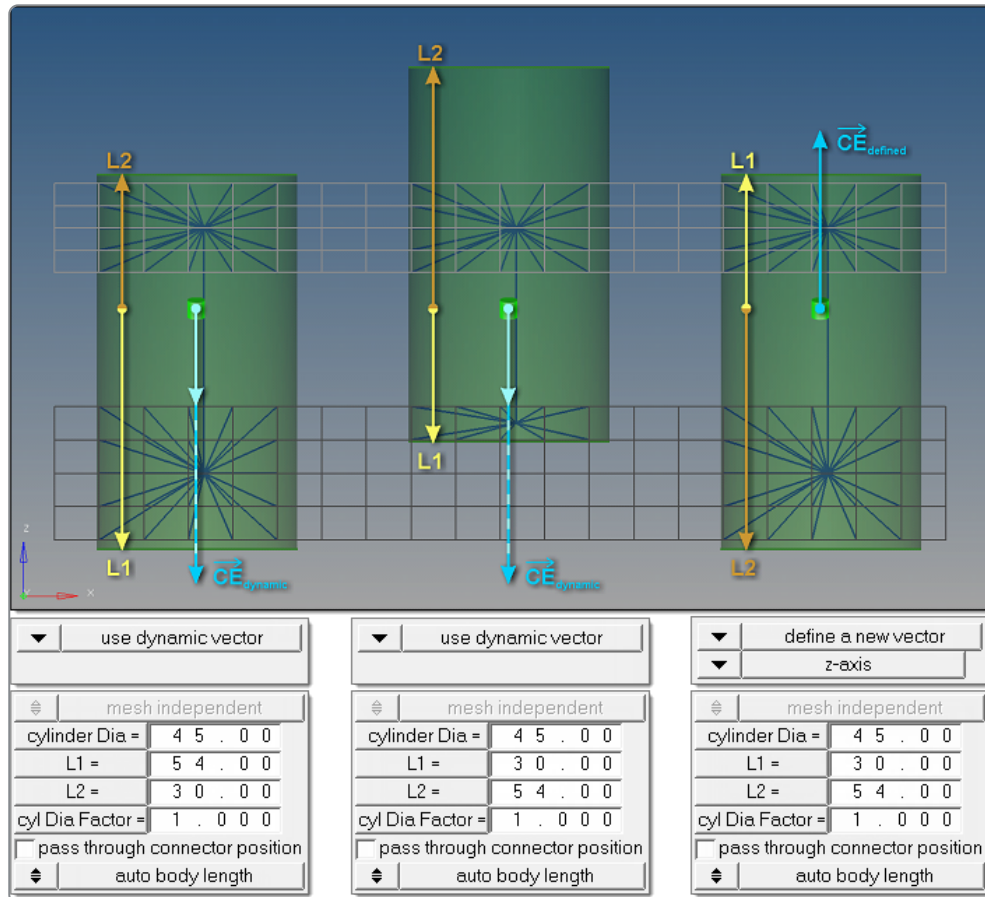

Figure 2. .

Dynamic vectors have been used in the first two cylinder. Interchanging the values for L1 and L2 leads to very different realizations. By comparison, the third cylinder uses the same values for L1 and L2 as in the second cylinder, but the result looks better because of the predefined connector vector in the global z-direction.

In some automated processes, the cylinder diameter is automatically set to the fastener shaft diameter. This leads to failed cylinder fasteners when the holes are properly modeled because the defined cylinder does not contain nodes. In such cases, the cylinder diameter factor has been introduced; this factor is set to 1.0 by default and is a multiplier for the cylinder diameter to increase the final cylinder diameter when necessary.

Note: The cylinder diameter as well as the cylinder diameter factor can be reviewed and modified in the Connector Browser. Connectors can also be rerealized with modified cylinder diameters and cylinder diameter factors without updating L1 or L2 in the browser. This is not possible from the panel.
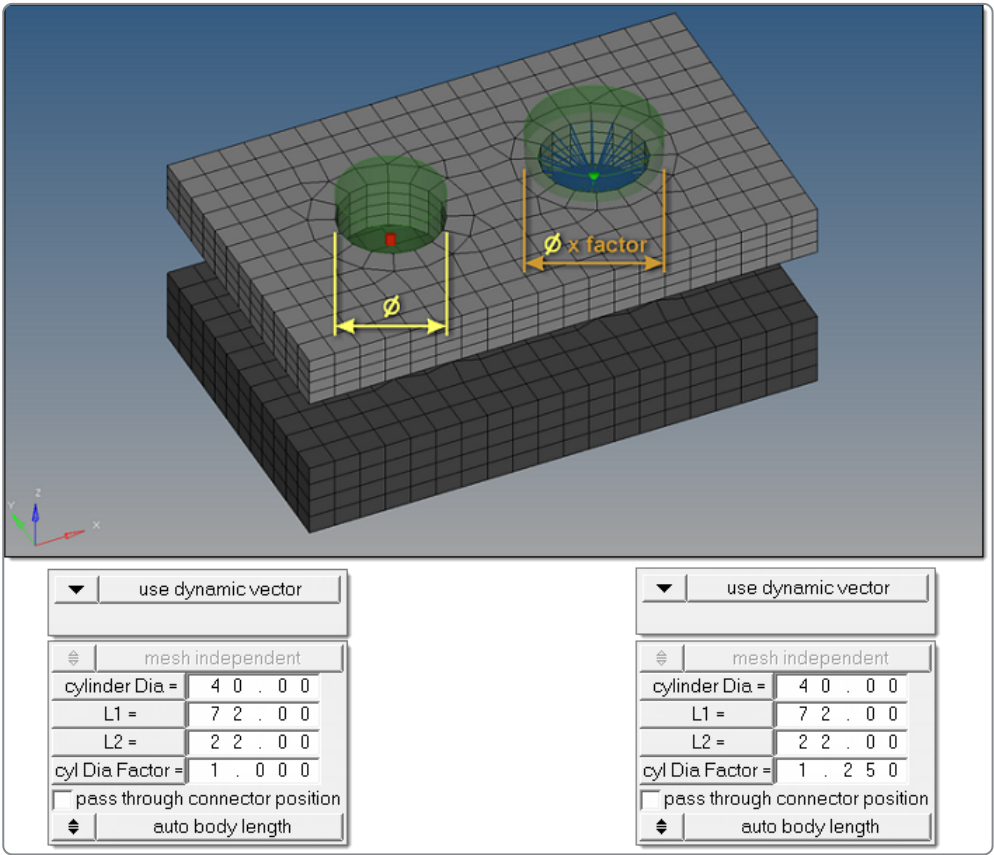
Figure 3.

mesh dependent

Use for all other cases.

1. For mesh dependent types, you must determine:

   ○ Is the existence of holes in each layer requested upfront?

   ○ How should the 2D mesh be prepared before the final realization is performed?

In the past, a fastener realization always required a hole for each layer in the initial mesh. This is no longer necessary for 2D meshes because the imprint capability punches the needed holes into the mesh before the final realization is performed, enabling the mesh to be manipulated in a pre-step. This makes it possible to punch holes, move holes, close holes, create washers, and so on.

Under the Connectivity heading, select one of the following:

consider existing hole only

A minimum of one hole per layer must be available in the origin mesh. If holes do not exist, the realization will fail. This is the default method and must be used for any type of solid meshes.
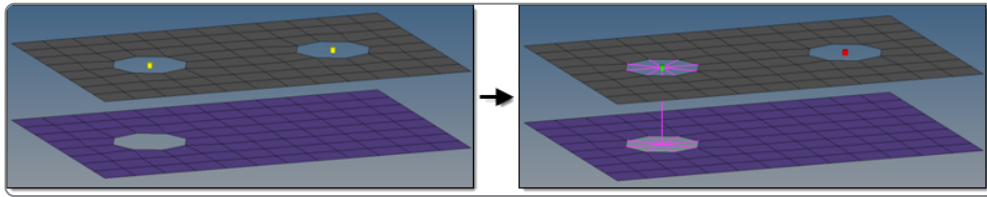
Figure 4.

create hole, if none

If there are not any holes on a certain layer, they will be punched into that layer at the position of the projection point. The diameter of the new hole is defined under the Realization Details heading. This method is used if the model does not contain the appropriate amount of holes per fastener, but holes are required for specific realization types.
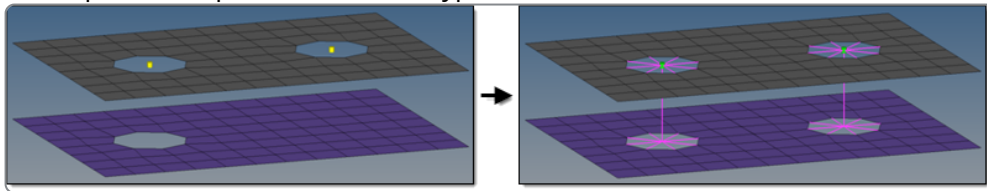
Figure 5.

use hole, if available

Creates hybrids (hole on one side only), but other combinations are allowed. On the mesh side (no hole), the connection is realized via the head elements defined in the chosen realization type. The head element(s) is/are created between the appropriate body element node and the nodes inside the diameter (**no hole connection dia**) defined under the Realization Details heading. This option is used for realization types which are not eager for holes.
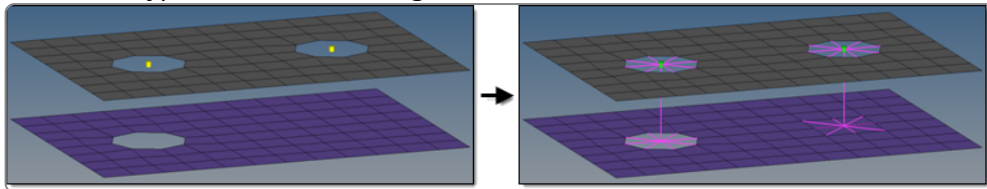
Figure 6.

fill & remesh hole, if available

Use this option when you do not want the shape of holes to interfere with the mesh flow in the fastener region. The detected holes are closed and a remesh of the new elements and a few additional rows of adjacent elements is performed. The connection is realized via the head elements defined in the chosen realization type. The head elements are created between the appropriate body element nodes and the nodes inside the diameter (**no hole connection dia**) defined under the Realization Details heading.
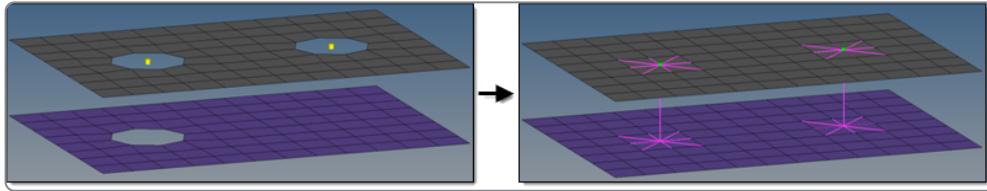

Figure 7.

Note: The hole detection mechanism for the last three options takes into account a cylinder which is defined under the Realization Details heading. The **hole consideration cylinder** option can be defined as a factor of the **no hole connection dia** option or as an exact diameter. Principally holes which are inside or touching the cylinder can be detected, but the hole consideration is reduced to one hole per link per connector. Additionally, holes need to fit to the requested dimensions, which are also defined under the Realization Details heading.

2. For the **create hole**, **if none**, and **use hole** options, a mesh modification including a hole movement is allowed. Therefore, you can determine whether to adjust the hole(s) or to adjust the realization.

adjust hole position (2D)

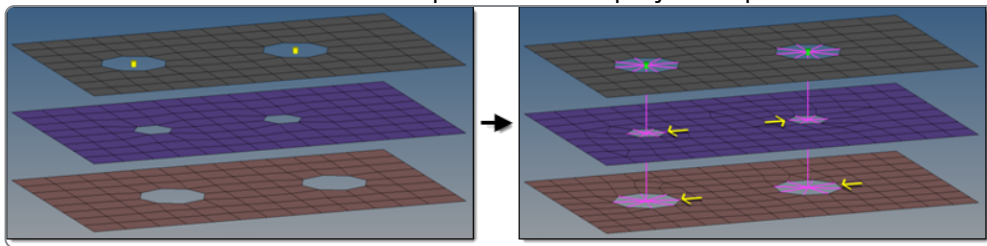Moves the center of a hole into the position of the projection point.

Figure 8.

adjust realization

Hole positions are not modified, enabling the realized elements to compensate the nonaligned centers of holes.
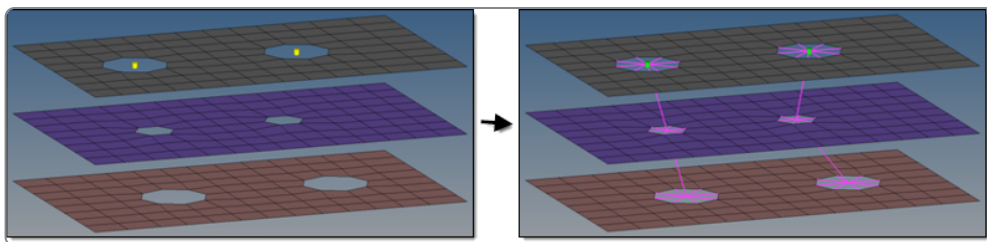

Figure 9.

3. Define behavior options.

After Imprint

During realization, if the mesh is altered to realize the connector, this option allows you to select between "Remesh" and "Rebuild" meshing algorithms.

Rebuild Washer

Perform a rebuild operation on the created washer in cases where the washer is very close to a feature edge. This will potentially change the shape of the washer to snap to feature edges to avoid poor mesh quality.

Unrealize Fill Hole Created

If the control is set to **Create hole, if none**, this fills the created hole when the connector is unrealized, returning the surface back to its original configuration before realization

4. Define realize and hole detection details

This stage cannot be skipped, as it has great influence on stages 2 and 3, which is expressed by the large arrow underlying those stages in the flow chart.

This stage contains all realize and hole detection details which need to be known before the final realization is done. The realize and hole detection are found under the Realization Details heading.

Hole Detection Details

Dimension and Feature Angle

The minimum and maximum dimensions define which holes should be considered during fastener realization. The minimum and maximum feature angle define the features to be considered as hole edges for solid elements.

Hole Consideration Cylinder

Not all of the holes found in the given connector tolerance can be considered for the various fastener realizations.

- The connector tolerance, especially when set to a large value, detects many holes. To prevent detecting holes which are far away from the connector position and are not aligned with the other hole(s), the consideration cylinder excludes outer holes from the detection.

- Since the existence of a hole is not necessarily requested anymore, a space has to be defined where the holes are expected to be. It is no longer sufficient to use just the connector tolerance, therefore the **Hole Consideration Cylinder** option performed along the projection path becomes necessary. All of the holes the cylinder touches or contains can be considered for the various fastener realizations.
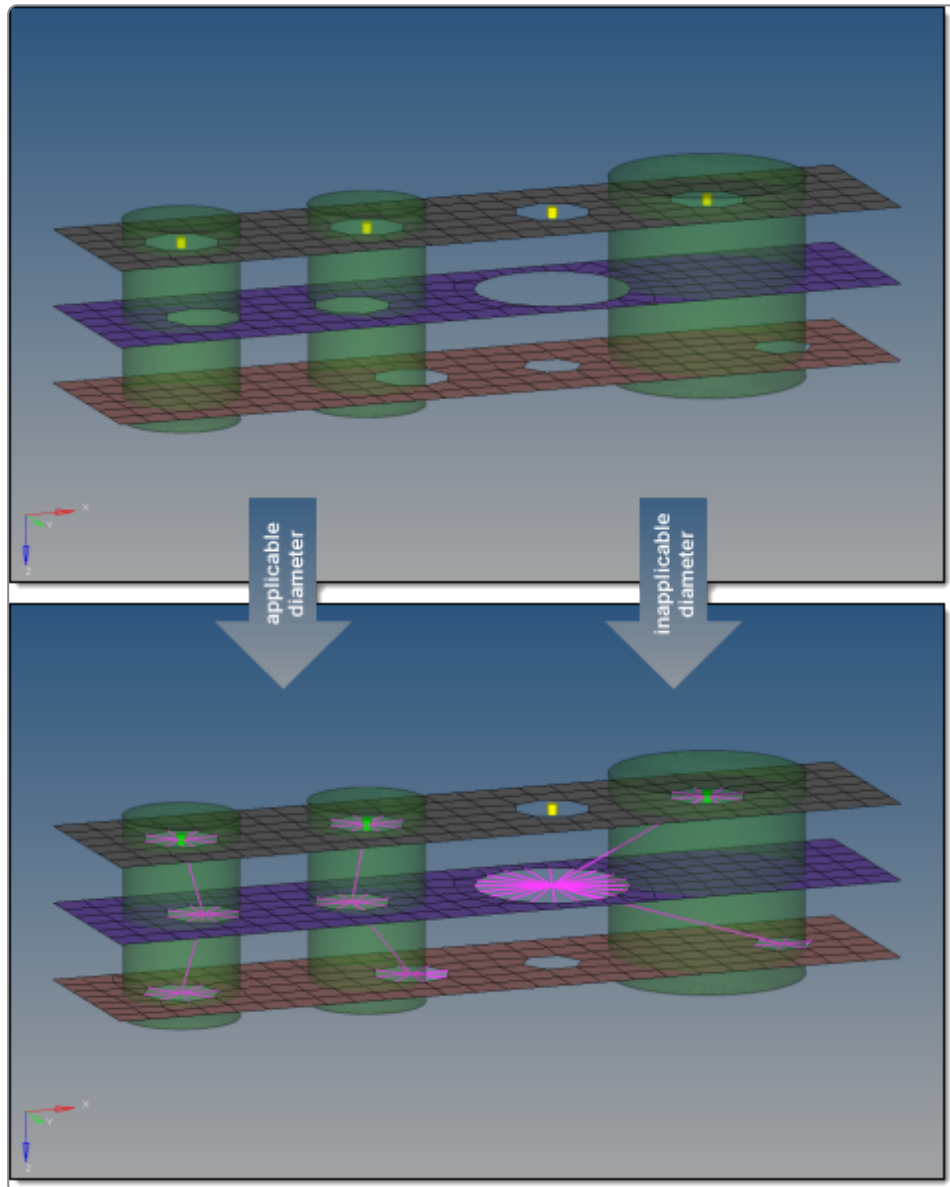

Figure 10.

Define cylinder diameters in the following ways:

auto cylinder diameter (factor)	Factors given diameters, which include: **create hole diameter (2D)**, **create/adjust hole diameter (2D)**, **adjust hole diameter (2D)**, and **no hole connection diameter**. The first available diameter is used. The default factor is 1.5.
exact cylinder diameter	Specify an exact diameter. The default diameter is 15.0 **Note:** The hole consideration cylinder option is not offered when using the **consider existing holes only** option.

Realization Details

Depending on the options selected in stage 2, varying subsets of the options are offered.

Diameter and adjustments options include:

create hole diameter (2D)

Create new holes with the specified diameter. Used if holes are required by the **create hole, if none** option.
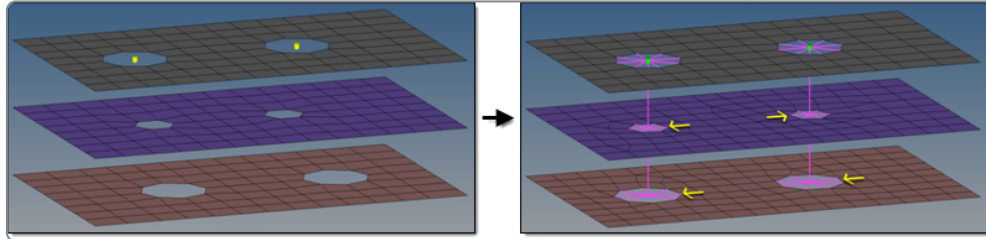

Figure 11.

create and adjust hole diameter (2D)

Create new holes with the specified diameter and adjust existing holes with the specified diameter, which leads to fastener realizations with the exact same diameter on all links. Used if holes are required by the **create hole, if none** option.
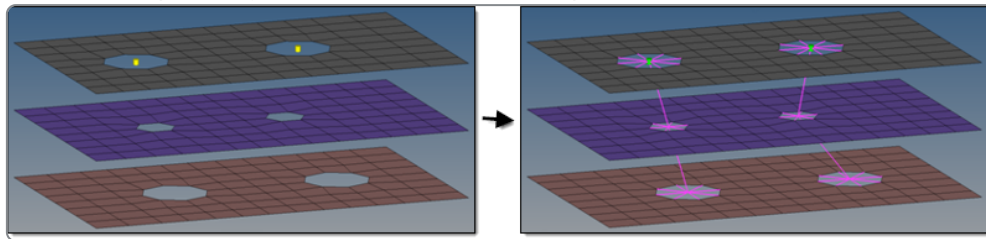

Figure 12.

adjust hole diameter (2D)

Adjust existing holes to the specified diameter. The **do not adjust hole diameter** option switches off the adjustment and uses the holes with their origin size. Used if holes are not necessarily required when using the **use hole, if available** option, but the existing holes need to have a specific diameter.
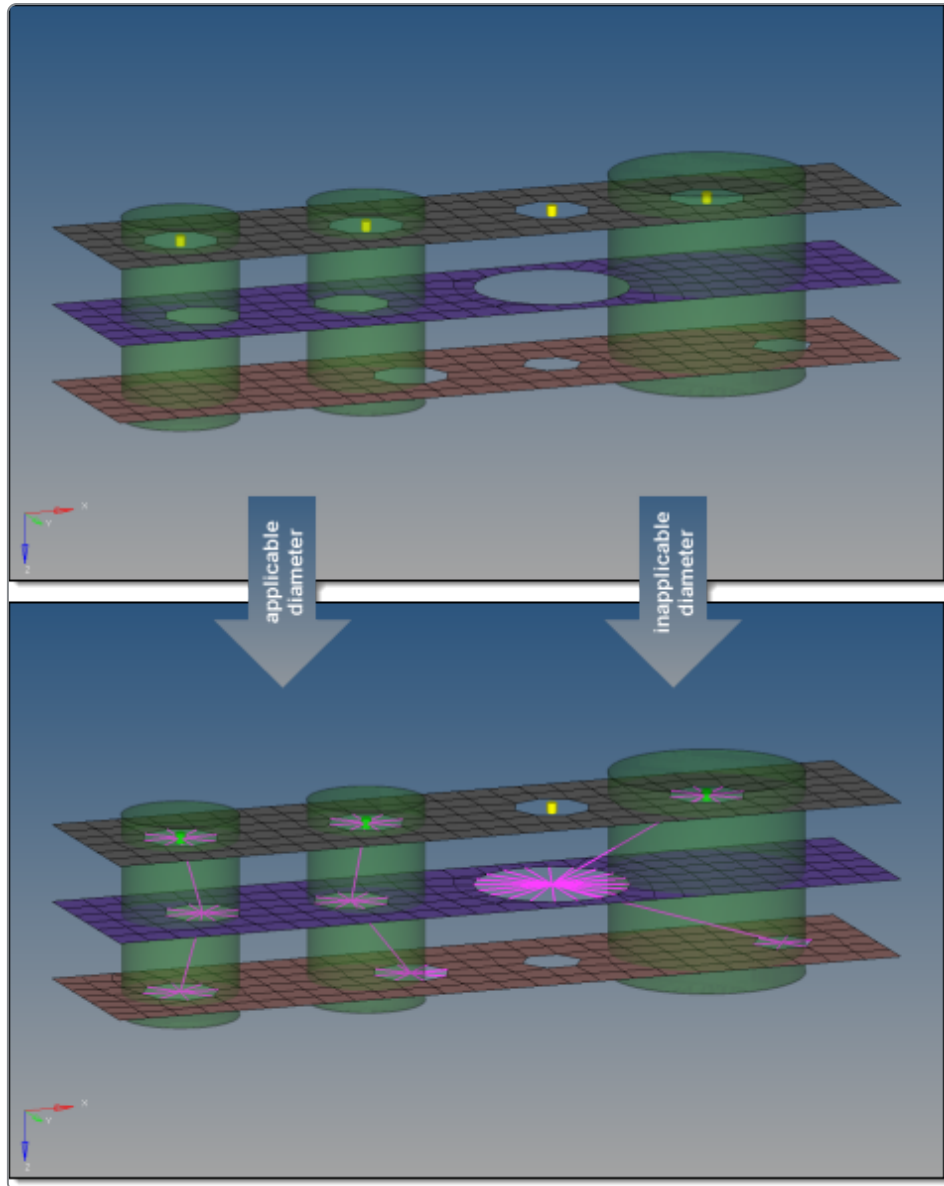
Figure 13.

no hole connection diameter

> Connect a link without an available hole by joining the nodes found inside the circle with the specified diameter around the projection point via head elements. Used if holes are not required when using the **use hole, if available** option or **fill and remesh hole, if available** option.

Hole filling and number of nodes around holes options include:

Fill Holes (2D)

> Fill detected holes during fastener realization. There are various quad patterns available, which cause a remeshing of the area around the hole.
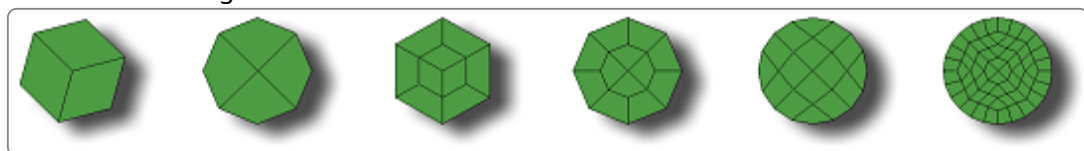

Figure 14.

Holes can also be filled with pie pieces. If the number of pie pieces is defined, the surrounding mesh is remeshed. The **pie pieces preserve** option also creates pie pieces, but takes the existing hole nodes into account and prevents the remeshing.

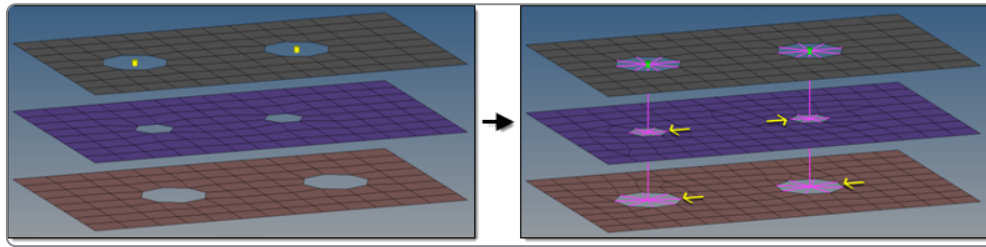**Note:** Activating the fill holes (2D) option deactivates the no. of nodes around hole option.

Figure 15.

Nodes around Hole

preserve	Use the number of nodes of the appropriate origin hole. This is the default option which prevents the surrounding mesh from being remeshed. For new holes, the **auto** option is used.
density	Specify the exact number of nodes (default is 8). The surrounding mesh gets remeshed.
elem size	Specify an element size (default is 5.0). The number of elements around the hole is calculated based on this size. This is the preferred option for extremely different hole diameters. The surrounding mesh gets remeshed.
auto	Perform a node distribution based on the underlying mesh size. The number of nodes is always rounded to an equal number.

Create washer layer options:

For 2D holes, one or two washer layers can be created, after which the surrounding mesh gets remeshed.

The width of the washer can be defined by:

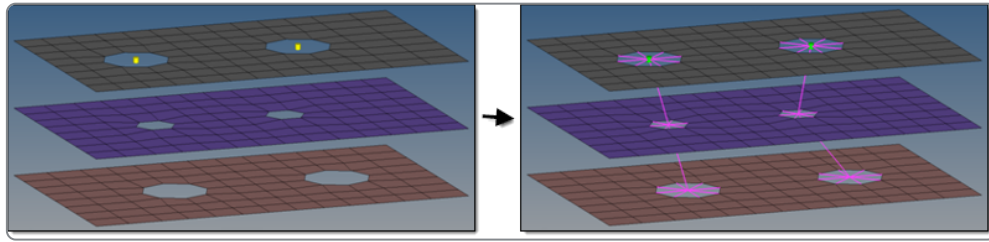- Factoring the hole radius.

- Directly specifying the exact width.

Figure 16.