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How to Ensure Bolted Joint Integrity When Using a Compression Limiter in a Plastic Assembly

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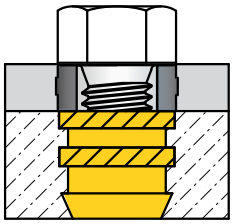
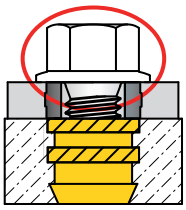
Compression Limiters are used to protect plastic components in bolted joints and maintain a threaded fastener's clamp load by eliminating plastic creep. To function properly, bearing surface beneath the bolt's head must extend over the Compression Limiter to contact the plastic component. If this bearing surface is too small, the host component may not be retained by the bolt resulting in a poor joint (*shown at left*).

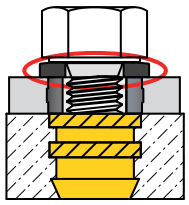


No Clamp

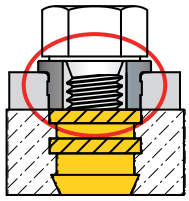
There are several methods to ensure sufficient bearing surface under the bolt's head. These include the use of a **flanged bolt**, **washer**, or **headed Compression Limiter** (*shown below*).



Flanged bolt



Washer



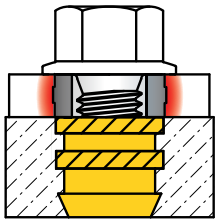
Headed Compression Limiter

The individual component cost, ease or complexity of assembly, and overall cost of each configuration influence which method is best suited for each application.

How Much Plastic Should be Compressed?

Ideally, Compression Limiter length is equal to or slightly less than the host thickness. The amount of material compressed under the bolt's head varies depending on the application's loading and plastic properties. This area of compression must be large enough to withstand forces attempting to pull the assembly apart, yet small enough to allow sufficient plastic compression so that the Compression Limiter contacts both the bolt and the mating component (*shown below*).

Plastic compressed by bolt's bearing surface area (highlighted in red)



Assembly Considerations

Several factors including speed and assembly method must be considered when determining the most cost effective solution for a specific application.

Assembly Speed

Various fastener combinations were manually assembled to determine approximate differences in efficiency. Results are as follows:

ASSEMBLY SPEED	
Fastener Configuration	**Average Speed (Seconds)**
Flanged Bolt, Symmetrical Compression Limiter	1.24
Bolt, Headed Compression Limiter	1.44
Washer, Bolt, Symmetrical Compression Limiter	2.48

Assembly with a flanged bolt was the fastest, followed by that with a headed Compression Limiter, which must be oriented. As expected, the addition of a third component (the washer) significantly slowed the assembly process — requiring twice the assembly time.

Automating Assembly

When an assembly is automated, it is imperative to ensure the design is as efficient as possible. The addition of a third component, such as a washer, may not be desirable when automating due to feeding and alignment challenges. Other common factors affecting efficiency include number of components and ease of orientation. All bolts, headed Compression Limiters, and some washers require orientation. Due to their relatively low head to outer diameter ratio and short length, headed Compression Limiters and washers are more difficult to mechanically orient than bolts. Conversely, symmetrical Compression Limiters do not need to be oriented. An assembly with a flanged bolt only requires one component's orientation while that with a headed Compression Limiter or washer requires two components be oriented.

Design Intangibles

Use of a headed Compression Limiter or flanged bolt in serviceable assemblies may be preferable as there would be no washer that could be accidentally omitted during reassembly. These are also preferable in applications where there are multiple assembly locations and/or poor quality control.

Individual Component Costs

Generally, fasteners are the least expensive components in an assembly. The following chart shows representative pricing for each component combination previously discussed based on an annual usage of 1 million assemblies incorporating an M6 joint.

ESTIMATED COST OF INDIVIDUAL COMPONENTS PER THOUSAND PIECES	
Component	**$USD**
Washer	$5
Bolt	$42
Flanged Bolt	$83
Symmetrical Compression Limiter	$20
Headed Compression Limiter	$100

ESTIMATED COST OF COMBINED COMPONENTS PER THOUSAND PIECES	
Fastener Configuration	**$USD**
Washer, Bolt, Symmetrical Compression Limiter	$67
Flanged Bolt, Symmetrical Compression Limiter	$103
Bolt, Headed Compression Limiter	$142

Relative cost differences between bolts and Compression Limiters vary depending on component supplier and bolt characteristics. Of these three potential combinations, the method with a washer, bolt, and non-headed Compression Limiter provides the *lowest component cost* for controlling bearing surface. However, as previously stated, the cost of the fastening components is often the least significant compared to the *overall cost* of the assembly.

Overall Cost

The following shows an estimate overall cost analysis of each configuration assuming a $50 USD/hour labor cost to assemble 1 million components:

Fastener Configuration	Component Cost Per Million (USD)	Average Assembly Speed (Seconds)	Total Cost of Assembly Per Million (USD)
Washer, Bolt, Symmetrical Compression Limiter	$67,000	2.48	$101,444
Flanged Bolt, Symmetrical Compression Limiter	$103,000	1.24	$120,222
Bolt, Headed Compression Limiter	$142,000	1.44	$162,000

Not captured in this analysis are the administrative costs associated with ordering, handling, and maintaining inventory of components as well as their suppliers. The addition of a third component may increase these costs. Additionally, if the assembly process is automated, the technology required to feed and orient a washer will also increase overall cost. Regardless, a flanged bolt or washer can replace a headed Compression Limiter in most applications to increase assembly efficiency and lower the overall cost of the assembly.

Conclusion

The best method to ensure adequate bearing surface on the plastic in a bolted assembly depends on an application's requirements and limitations. A washer may be preferred in lower volume and/or non-serviced applications. In higher volume, automated, and/or serviceable applications, a non-headed Compression Limiter with a flanged bolt is the easiest to assemble and provides the lowest total cost. Both configurations with a washer or flanged bolt will provide a lower cost solution than using a headed Compression Limiter.

Although this article offers general design guidelines, it is recommended that Application Engineers who specialize in fastening and joining be consulted to ensure a properly configured joint is employed for each application.

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