Effects of Hysteresis on TecsPak® Performance

Scope:

One key advantage with TecsPak is that like most rubbers and elastomers, we have hysteresis which provides a certain level of damping. In fact, compared to most elastomers, TecsPak has a greater amount of hysteresis. As is typical with most elastomers, when they are compressed there is internal friction that generates heat. This heat is energy that the bumper absorbs from the system. Subsequently, the return or release curve has a lower force.

In comparison, a steel coil spring has no hysteresis. When the spring is compressed, it follows a linear line. Upon release, the load deflection curve is the same line as compression.

Typical TecsPak applications involve situations where the bumper is struck by a mass and is used to decelerate the moving object. The object rebounds and the bumper is reset for the next impact or cycle. However, there are many applications where the bumper is used in applications where the bumper is compressed before being further compressed. The compression can be achieved by either a static weight or by physically restraining the bumper at a height.

The following is an explanation highlighting the factors to be considered in applying a TecsPak product for these types of applications.

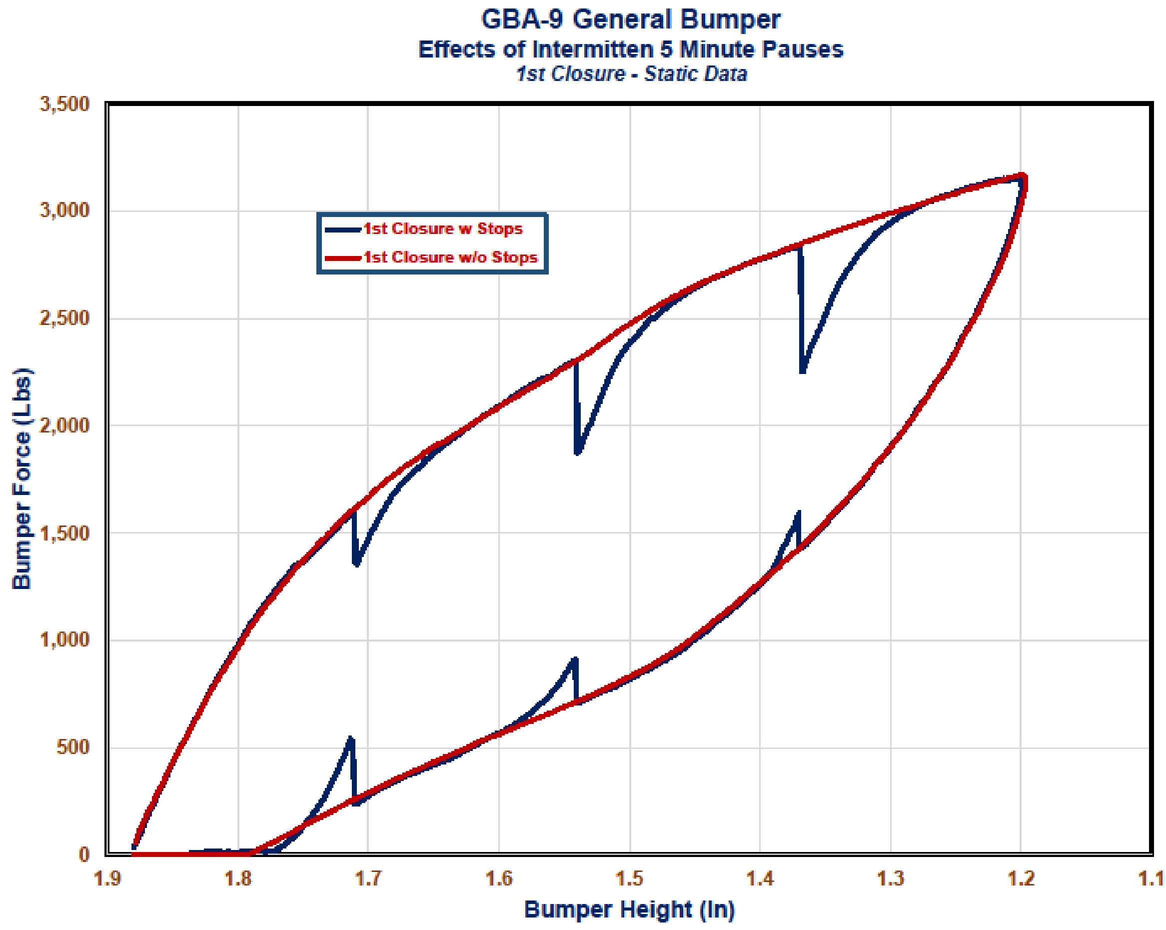
TecsPak Performance Curves

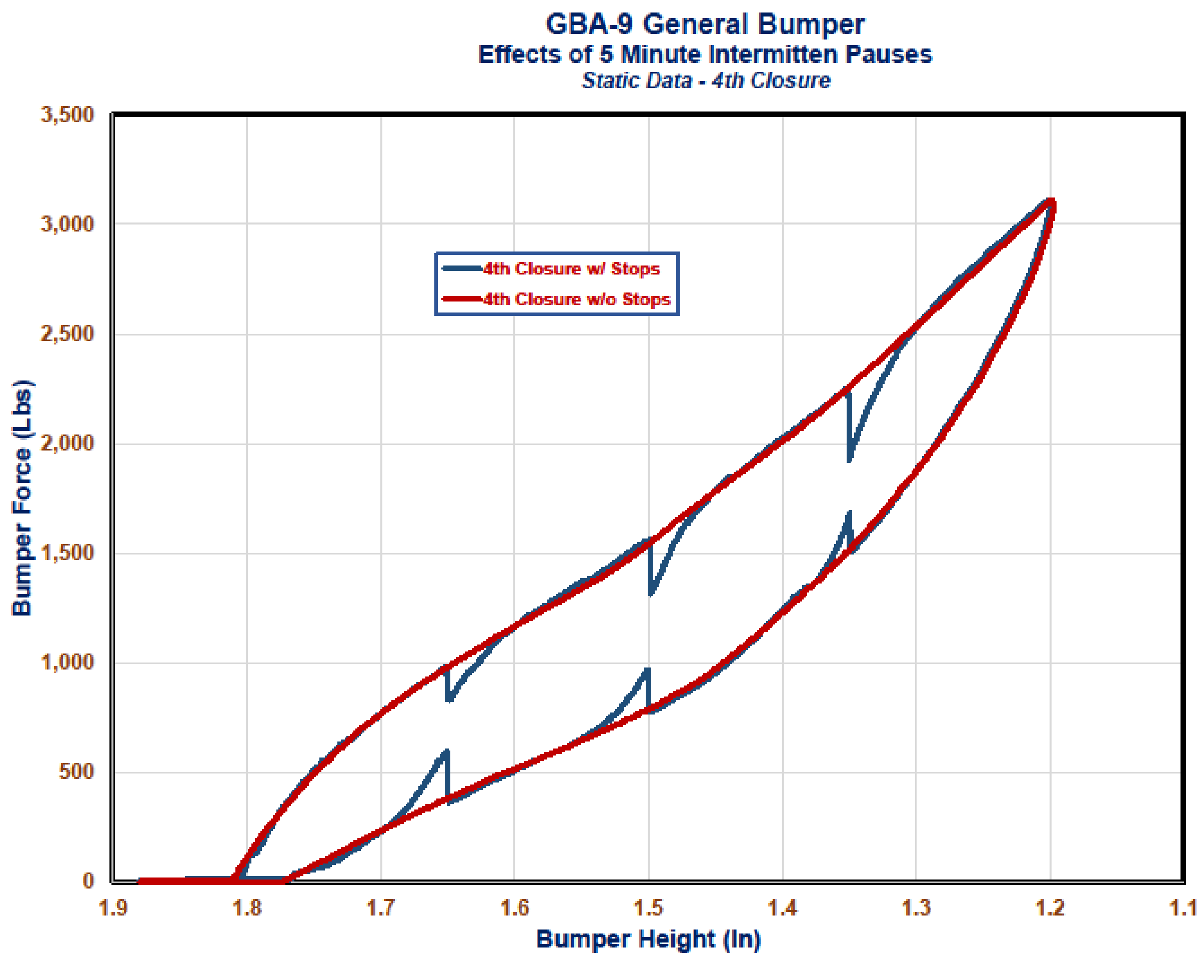
All rubbers and elastomers take a certain amount of compression set due to repeated compressions. For testing purposes Miner Elastomer Products Corporation has the policy of fully compressing our products four times. Our experience indicates that the TecsPak performance during the fourth compression is a fair representation of the typical performance the customer can expect after the bumper has been used and has completed the “break-in” period. We advertise this performance in our literature as we feel this is the typical performance our customers can expect from TecsPak.

Typically, we show the compression of the bumper from its free height to its solid height, and back to the free height. At this point, if the bumper is recompressed, it can again follow the compression curve on additional closures or cycles.

However, if the bumper is compressed to a height, and held at that height, the load will change. The performance curves show the limits of the bumper. Specifically, if the bumper is being compressed and is held at a height, the load will decrease. This may be a case where the customer would use the bumper to create a preload on the assembly. The bumper is compressed to a height and mechanically held so that it cannot release to a greater height.

The other situation is when a bumper is compressed to its solid height and then released to a required height. Under this situation when the bumper is held at a height on the release portion of the performance curve, the load will increase. The following are graphical examples of this phenomena for both the first and fourth closures.



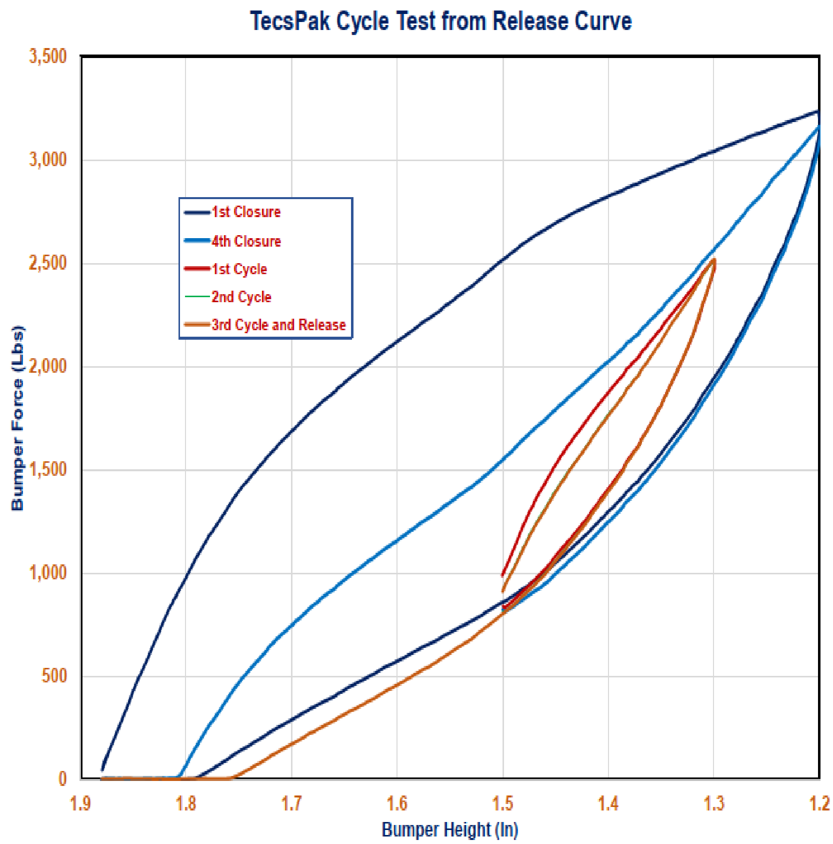


For each static test, the bumper was tested using the standard procedure except that periodic pauses were made at certain intervals. The pauses were made for 5 minutes and were at heights equal to 25%, 50% and 75% of travel. There have been several creep tests conducted where there is a static load applied to a bumper. This load was maintained, and the height of the bumper monitored. These tests were typically conducted over a time of approximately two weeks. During these tests, the majority of the creep occurred over three to four days, with the vast majority (75 – 90%) occurring almost immediately.

As can be seen, once the bumper compression continues, the curve returned to the original shape. Also, it can be noted that on the compression curve, the higher the load value, the more the load dropped off during the pause. However, on the release curve, just the opposite occurred. The amount the load increased was greater at the lower levels. In summary, the compression and release curves indicate the boundaries where the product will operate.

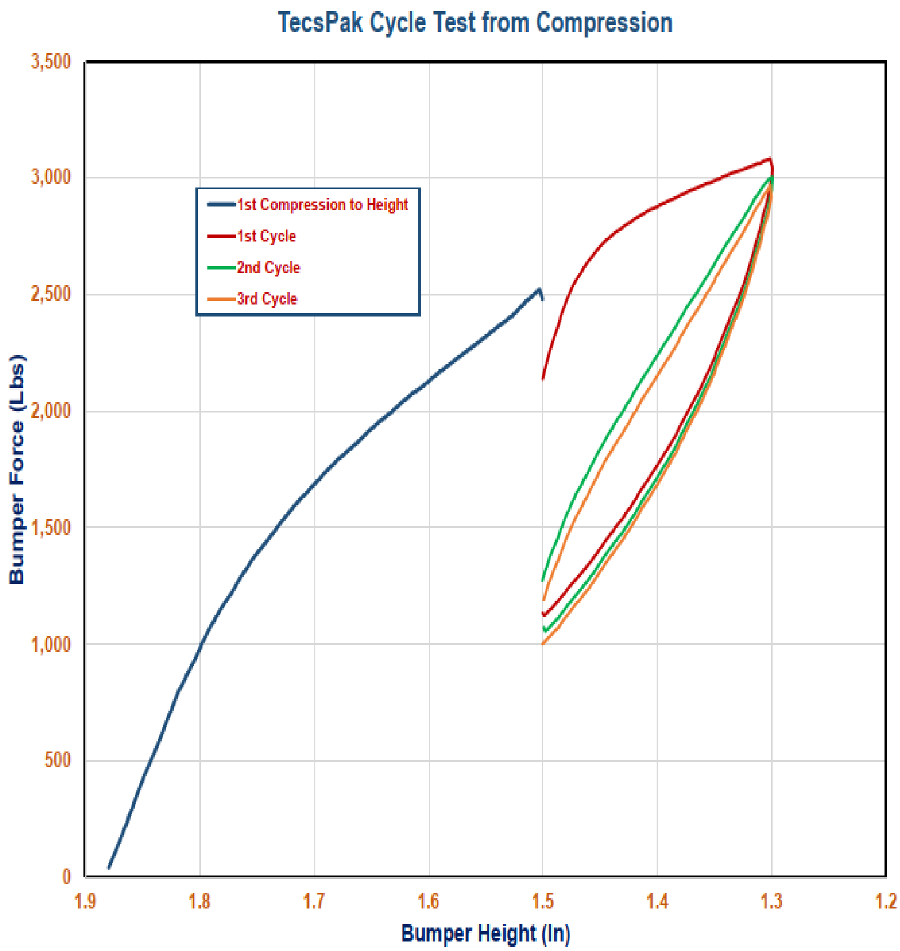
When engineering is provided the opportunity to use a bumper (or other TecsPak product) where the bumper is preloaded, we must take this information into consideration. However, it is preferred by engineering to utilize the release curve as a basis for the performance. We use the bumper based upon the assumption it can be compressed to the solid height and the load then released to the desired height.

To demonstrate the procedure, please reference the graph below.



For this test, the bumper was compressed to the solid height four times, and on the fourth closure it was held at a height of 1.50 inches. The bumper was held at this height for five minutes. It was then cycled from a height of 1.50 inches to 1.30 inches for three cycles. The fact that the test was based upon using the fourth closure rather than the first closure is not significant. Experience has shown that the release curve from the first closure to the fourth closure has always remained consistent.

There are other examples where Miner Elastomer Product ships the TecsPak to the customer and they compress the bumper to the installed height. The customer does not always have the equipment to compress the bumper to the solid height and then released to the installed height. The graph below shows the effect this has on the performance of the bumper.



For this example, the bumper was compressed to the installed height (1.50 inches) and allowed to dwell for five minutes. The bumper was then cycled between heights 1.30 and 1.50 inches for three cycles. As can be seen, with this method, the bumper continues to take a lower load at the installed height of 1.50 inches.

Additionally, the peak force at the 1.30 inch height is greater than the situation where the bumper is compressed and released to the installed height. Over time, and with additional cycles, the performance curve may eventually approximate the performance curve for compressing the bumper and releasing to the installed height. However, this also creates a situation where there would be an extended "break-in" period where the bumper would function at higher load levels. In many cases, this could be problematic. In some cases, the mechanism may not have the capability to achieve the higher loads, resulting in reduced travel and lack of intended performance. Also, being stiffer may not be acceptable – especially for applications where an operator is involved. The stiffer forces would result in a stiffer ride that is unacceptable to the operator. At a minimum. The break-in period would be extended.