SPIROL® DETERMINING LENGTH AND TOLERANCE

The recommended maximum length of the compression limiter is the minimum thickness of the plastic component. The compression of the compression limiter at the recommended tightening torque assures that there will always be some compression on the plastic component.

The recommended minimum length of the compression limiter is the maximum thickness of the plastic component, minus the maximum allowable compression of the plastic component, plus the compression of the compression limiter at the proof load. Stated in formula mode:

$$Lc\ min = Lp\ max - d + c$$

Where:

Lc min is the minimum length of the compression limiter

Lp max is the maximum thickness of the plastic component

d is the maximum allowable compression of the plastic component determined as follows:

$$d = \frac{\sigma \times Lp\ max}{Ep}$$

Where:

σ is the allowable compressive stress, and

Ep is the modulus of elasticity, of the plastic specified

c is the compression of the compression limiter at the proof load, as noted in the Spirol specifications

Example:

The plastic component is 14mm +0.1/-0.0 thick, made from ABS 30% glass filled with a maximum allowable compression strength of 140 MPa and a modulus of elasticity of 5,500 MPa.

The bolt used is a M6x1 class 5.8.

The compression limiter is a BUSH M6 x 14 BK CL200, which is a non-heat treated steel split seam compression limiter. The length tolerance is +0.0/-0.15.

$$d = \frac{140\ \text{MPa} \times 14.1\text{mm}}{5{,}500\ \text{Mpa}} = 0.359\ \text{mm}$$

c = 14mm x .0018 = 0.025mm

Lc min = 14.1 – 0.359 + 0.025 = 13.77mm

Since the standard length tolerance of +0.0/-0.15mm for a split seam compression limiter is less than the -0.33mm allowable compression, the standard length tolerance meets the requirements of this application.

A further determination needs to be made to verify that at the recommended clamping load, the head of the bolt, or washer if one is used, will seat itself against the compression limiter at the maximum tolerance condition. Stated in formula mode:

$$Lc\ min = Lp\ max - \frac{Pclamp \times Lp\ max}{Ap \times Ep}$$

Where:

Lc min is the minimum length of the compression limiter

Lp max is the maximum thickness of the plastic component

Pclamp is the recommended clamping load

Ap is the stress area of the plastic component calculated as follows:

$$Ap = \frac{\pi}{4} \times (D_2^2 - D_1^2)$$

Where:

D_1 is the minimum hole in the plastic component

D_2 is the maximum bearing surface diameter of the bolt head, compression limiter head, or washer

Ep is the elastic modulus of the plastic

Example:

The plastic component is 14mm + 0.1/-0.0 thick made of ABS 30% glass filled with a maximum allowable compression strength of 140 MPa and a modulus of elasticity of 5,500 MPa.

The bolt used is a M6x1 class 5.8 with a head diameter of 12mm. The recommended clamping load for this bolt is 5.73 kN which is 75% of the proof load.

The compression limiter is a BUSH M6 x 14 BK CL200, which is a non-heat treated steel split seam compression limiter. The minimum recommended hole for this compression limiter is 9.0mm. The length tolerance is +0.0/-0.15.

$$Ap = \frac{\pi}{4} \times (0.012\text{m}^2 - 0.009\text{m}^2) = 0.00004948\text{m}^2$$

$$Lc\ min = 0.0141\text{m} - \frac{5730\ \text{N} \times 0.0141\text{m}}{0.00004948\ \text{m}^2 \times 5{,}500{,}000{,}000\ (\text{N/m}^2)} = 13.80\ \text{mm}$$

The assembly will require a compression limiter with a length tolerance ≤ +0.0/-0.2 to assure seating of the bolt against the compression limiter. A standard 14mm +0.0/-0.15 compression limiter will meet the needs of this application.