IN•TOUCH

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Compression Modulus (Support Factor)

Support is a key function of flexible polyurethane foam. In many ways, it is the most important function foam can provide.

The dictionary definition of support is to "carry weight of, hold up, keep from falling or sinking." In upholstery, good support from foam means that cushions don't "bottom out," "feel through" or compress to the point where they no longer hold up the weight of a person. It also means that the cushion is capable of distributing the weight of the person for better comfort.

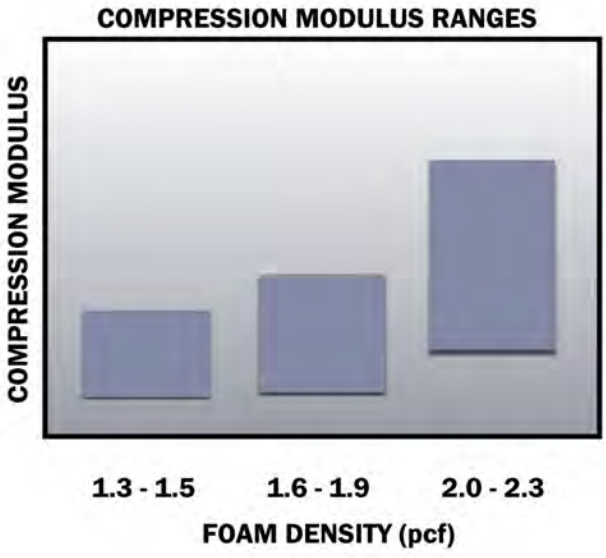
In many ways, support is the most important function foam can provide.

The most common foam specifications are density and 25% IFD (firmness). However, it's also possible to consider the deep down support of the foam. This is done by specifying foam having **compression modulus** or **support factor** within available ranges as shown on the accompanying chart. In some ways, the compression modulus measurement may be a more valid measurement of foam's cushioning ability than other specifications because one sits deeper than 25% into a seat cushion.

Higher foam densities can provide increased support. Support capability often varies within ranges with different densities, types and grades of foam. Some foam grades are formulated to have specific ranges of support.

Names for Compression Modulus (Terms for Support are Used Interchangeably)

There are a number of terms used to describe foam's ability to provide support. These include **compression modulus**, **support factor, modulus, sag factor**, and **sac factor.** All of these may be used to refer to the same properties. The Polyurethane Foam Association recommends that **compression modulus** or **support factor** be used when referring to foam support properties. This will allow your foam supplier to better understand your needs and provide the proper cushioning.



The Difference Between Support and Firmness

In many ways, foam support and firmness are interrelated. In fact, compression modulus is measured by taking the ratio of two foam firmness measurements. Foams with high levels of support can actually feel firmer than foams with the same density and surface firmness measurement but which have lower support levels.

Firmness, measured by 25 percent IFD, is an indicator of the surface feel of the foam. Support factor is an indicator of the foam's ultimate ability to support a load placed upon it. The surface firmness (or 25 percent IFD) of two foams may be identical, but their ability to provide support may differ dramatically. It is not unusual for a soft foam to have higher support properties than its surface feel (or hand) would indicate.

IFD (Indentation Force Deflection)

IFD is a measurement of foam firmness (see INTOUCH Volume 1, Number 1 for more details). It's taken by measuring the force in pounds required to indent (compress) a foam sample a specified percentage of its height across and indenter foot with a surface area of 50 square inches. Normally, a four-inch thick foam sample is tested. In the U.S., foams are typically measured at 25% and 65% indentation. The 25% IFD is the commonly agreed upon specification for surface firmness and is almost always specified by foam purchasers.

A Definition of Compression Modulus (Support Factor)

Compression modulus is not a measurement unique to foam. It can be determined for other components, such as springs or webbing. An explanation of how compression modulus is determined helps illustrate this. Compression modulus is the ratio of a foam's ability to support force at different indentation (or compression) levels. It is determined by taking the ratio of the foam's IFD at 65 percent indentation divided by 25 percent indentation (65% IFD /25% IFD). The ratio of a foam that has a 25 percent IFD of 30 pounds and a 65 percent IFD of 60 pounds is 2.0. This is considered a typical level of support for most conventional polyurethane foams. The 65 percent IFD measurement, although rarely specified by foam purchasers, is key to evaluating support, because it can vary significantly from one type of foam to another. Compression modulus measurements for foam range from about 1.6 to 3.0.

In foam, two things affect support factor:

1. **Foam density.** Usually, the higher the density of the foam, the better its support.

2. **Foam chemical formulations and the manufacturing process.** Foam cell structure can affect support. Foam producers can alter support by changing foam chemistry slightly, by utilizing specialty chemicals or by adjusting the manufacturing process. Fillers may be added during the formulation to increase support properties.

A number of "high performance" foams have been developed that offer higher than average support. Most foam suppliers offer one or more of these foam types.

How Support Affects Foam Function

Why be concerned about support? There are a number of reasons why different support levels can improve the comfort, support, or durability of finished goods using foam. In upholstery, support can affect a number of key design factors.

Foam support affects Total Vertical Movement (TVM), which has a direct influence on seating comfort (see INTOUCH Volume 2 Number 3: "Foam In Furniture Design"). A number of factors (including fabric, cushion thickness, and deck construction) also affect TVM, but by knowing the support range of the specified foam, a designer can increase or decrease TVM.

Another upholstery benefit is that proper support enhances cradling, or the ability of the cushioning to distribute body weight and reduce pressure to the skin. Proper cradling distributes body weight so there are virtually no areas of body contact where the weight/load is concentrated to restrict blood flow and cause discomfort. If cushions are thick, then softer, lower compression modulus foams may be used to improve cradling and to achieve more even distribution of body weight. If cushions are thin, higher compression modulus foams may be used to distribute the weight enough to prevent the cushion "bottoming out" against decking.

Compression Modulus (Support Factor) is the ratio of 65% IFD divided by 25% IFD.

When specifying compression modulus, it's also important to understand the relationship it has to foam firmness, especially when considering the **ratio** of seat to back firmness. A rule of thumb is that the more weight placed on the back cushion, the less difference there can be between the firmness of the seat and back cushion. The same holds true for compression modulus. The support capabilities of the back cushion should complement the seat cushion.

Another key benefit is that specifying foam for compression modulus (not just IFD) can be a better way to get consistent feels in multiple cushions, particularly when using foams at lower IFDs. The different in feel between very firm cushions (above 40 IFD) is usually not very noticeable, but differences can be more easily detected in foams in the 20 to 30 IFD range - the range most often used for upholstered furniture.

In upholstered pieces that have multiple seat cushions (sofas, loveseats, sectionals, or even matching chairs), there may be some variations in 25 percent IFD, or surface firmness. Even though cushions may be within specification tolerance, some people may still be able to feel differences between the cushions and think that there is a problem with them.

When higher than average (above 2.0) support ranges are specified, the variations in surface firmness (25% IFD) of the cushions tend not to be so noticeable when seated. What is felt is the support provided by the cushion instead of the surface firmness. This makes the cushion feel—and perform—in a more uniform manner.

Seating system foam, springs, webbing, and fiber will soften with use. However, the specification of a higher support level can help cushions continue to feel "new" even after some surface softening of the foam and other materials has taken place. This has the net effect of improving foam **durability**, an important feature of any high quality foam.

Specifying foams with higher support can also allow the use of softer foam to improve the "hand" or surface feel of the cushion without the extensive use of polyester fiber overwrap.

It's also possible to laminate hard and soft foams together to improve the support of the composite foam structure. However, the difference between the firmness of the two foams cannot be too great, or the softer foam may seem to "bottom out" on the firmer foam.

Compression Modulus Affects Firmness Specification

When changing the compression modulus specification of a foam, a corresponding change in the 25% IFD specification is often needed to achieve the proper feel. Switching to foam cushioning with higher support values may require a proportional reduction in surface firmness (25% IFD) to maintain comfort and Total Vertical Movement (TVM).

Example: To maintain 65% IFD at 60 pounds, while switching from conventional to high performance foam, an original 25% IFD specification of 30 pounds (for conventional foam with 2.0 Compression Modulus) would be reduced to a 25% IFD specification of 24 pounds (for high performance foam with 2.5 Compression Modulus).

In bedding or motion furniture where foam is used to insulate a hard mechanism, in addition to providing a comfort layer, a change in the specified support factor may be desirable. Softer foam with higher compression modulus can often be used to replace a lower support, firmer foam.

Other considerations may be affected by a change in support such as density, foam types and economics. Your foam supplier can help you select the right foam for your application.

Softer foam with higher compression modulus can provide comfortable seating over motion mechanisms.

Summary

- Support is perhaps the most important function of flexible polyurethane foam. Foam's ability to provide support has a direct effect on other key properties such as comfort and durability.
- The ability of foam to provide support can be measured and specified. This measurement is called compression modulus or support factors. Compression modulus is a ratio of foam's load bearing abilities at different indentation levels. Compression modulus is not a measurement unique to foam. It can be determined for other components, such as springs or webbing.
- Two key features affect foam support. The first is foam density. The higher the density, typically the better the ability of the foam to provide support. The second is foam chemistry and manufacturing process which affect the strength of the foam cell structure. Foams with high compression modulus (greater than 2.0) are often called "high performance" foams.
- Support may be a more valid measurement of foam's cushioning ability than other specifications. In upholstery, it will affect total vertical movement, cradling, and seat to back cushion ratio. Specifying foam with higher support can help make multiple cushions in an upholstered piece feel more consistent, even though surface IFD may vary slightly.
- Support factor is also important in that foam with higher support can be specified with softer surface IFD, without sacrificing the ability of the foam to bear a load. This can allow an upholstered cushion to have a good "hand" without extensive use of fiber.

Visit the literature section at www.**pfa.org** for a complete, downloadable library of IN•TOUCH Bulletins.

Specifying Support

Your foam supplier can provide you with more information on the steps to take when specifying foam with improved support factor. It is important to note that sample size can affect IFD and support measurements. A 15"x15"x4" foam sample will test lower in support than the identical foam tested as a 20"x20"x4" sample. Therefore, it is important to use consistent samples sizes when specifying support.

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