1. Elastic adhesives vs rigid adhesives

Rigid adhesives, those that become solid when cured, are more commonly used in everyday life. The contact surfaces are very close to each other and the adhesive layer is few tenths of a mm thick.

The arrival of elastic adhesives, on the other hand, gave rise to "thick-layer bonding" and, with this, bonds also began serving other purposes, e.g.:

- dampening of vibrations or noise,
- waterproofing,
- preventing corrosion,
- distributing loads more uniformly across uneven contact surfaces / bridging higher manufacturing tolerances,
- absorbing bond stress due to bimetal effect.

For a given strength, elastic adhesives can absorb much greater fracture energy than rigid adhesives, as a result of greater deformation before fracture.

2. Elastic bonding vs other bonding / joining methods

Elastic bonding has matured in recent decades and, in conjunction with the development of new design and fabrication methods with new synthetic and lighter weight components, has found many applications, initially in home appliances and transport and later in the marine sector.

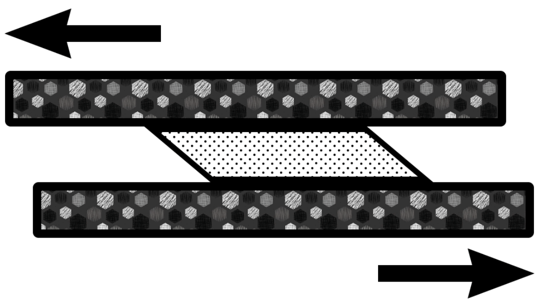
A key advantage of elastic bonding, compared to other established joining methods, is its ability to accommodate for different materials with different expansion and contraction behavior or with chemical reactions between them. The table below summarizes the pros and cons of the various methods.

	bolts & screws	riveting	welding	spot welding	clinching	clip fastening	structural bonding	elastic bonding
joining dissimilar materials	+	+	0	–	+	++	++	++
accurate calculation of joint strength	++	++	++	++	+	0	+/0	+
thermal distortion	++	+	–	–	+	++	++	++
health and safety	+	0	0	0	0	++	+/–	+/0
sealing of joint	–	–	+	0	0	0	++/+	++
corrosion prevention	0	–	+	0	+	0	+	+
time to adequate strength attainment	++	++	++	++	++	++	+/0	+/0
temperature resistance	++	++	++	++	++	+/0	+	+/0
ease of disassembly	++	+	0	0	+	+	0	+
++ highly suitable, + suitable 0 neutral – unsuitable								

In practice, when considering elastic bonding, the main points to note are surface preparation, calculation of the bond area required for a given joint strength and the time needed for curing to reach processing and / or service strength.

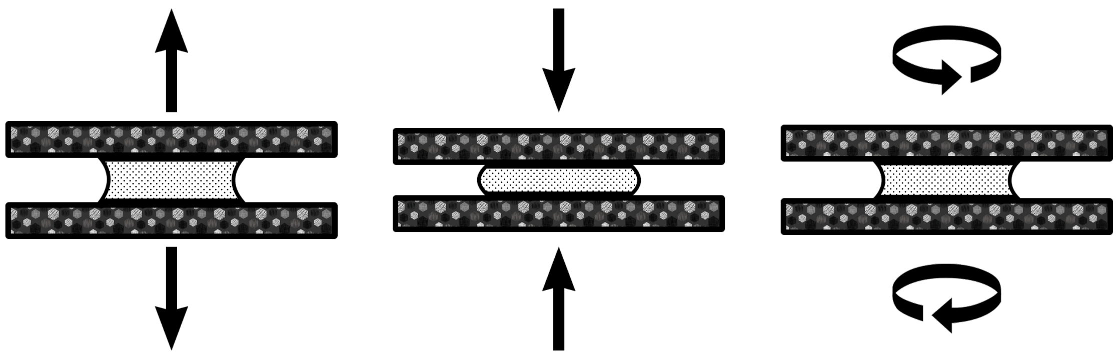
3. About bonding joints & joint design

The performance of elastic adhesives is greatly affected by the joint layout and more precisely the direction of the forces on the joint constituents. The most appropriate joint design is considered to be that in which the loads act in shear mode:

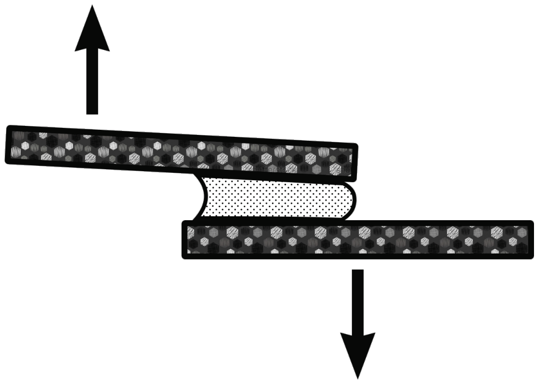


The following configurations are also acceptable:

Tensile **Compressive** **Torsional**



Configurations with peeling forces should be *avoided*. Peeling forces very quickly cancel one of the main advantages of elastic bonding, that of even distribution of loads, as they move the stresses to the edges of the bond area.



4. Calculation of the required bond area

The basis for calculation of the bond area is usually the shear strength (and shear modulus). It is, however, very important not to use the bond strength figures produced in the lab at face value. In practice, there are a number of factors which can limit the full potential of the adhesive, from conditions during application and curing to lifetime fatigue and ageing especially as a result of exposure to higher temperatures and continuous loads. Therefore, bond strength values taken from data sheets are usually multiplied by a factor of 3%.

For simple applications the determination of the required bonding area is relatively straightforward. As an example, let's calculate the required bond area of two aluminum parts with max load of 50kg (approx. 500 N) in shear mode. Assume that the bond strength on aluminum is given as 5 N/mm^2. At 3%, this becomes 0.15 N/mm^2. Using,

$$\text{Stress} = \text{Force} / \text{Area}$$

and,

$$\text{Area} = \text{Stress} / \text{Force}$$

then,

$$\text{Area} = 500 / 0.15 = 3{,}333 \text{ mm}^2$$

or about 33 cm^2, which is 3x11 cm or 5x6.5 cm.

With regards to bond layer thickness, this usually ranges from 2 to 5 mm for simple applications. In the case of continuous cyclical joint movement (e.g. expansion / contraction), this must estimated and the layer thickness must be twice that of the expansion-contraction differential so as to limit the resulting stresses to about 50% of the maximum.

References

1. *"Elastic Bonding, The basic principles of adhesive technology and a guide to its cost-effective use in industry"*, Verlag Moderne Industrie, 2006.