Wave Thread: Strength through Geometry

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The failure of seals and fasteners often cascades to other problems, so any technology that can make them stronger is worth considering. The wave thread is a stronger fastener; eliminates the need for glue or gaskets, and quick connect novel application that surpasses what is currently available in the market. Standard threads have a 30-35% surface contact; the wave thread has 95% or more depending on tolerances.

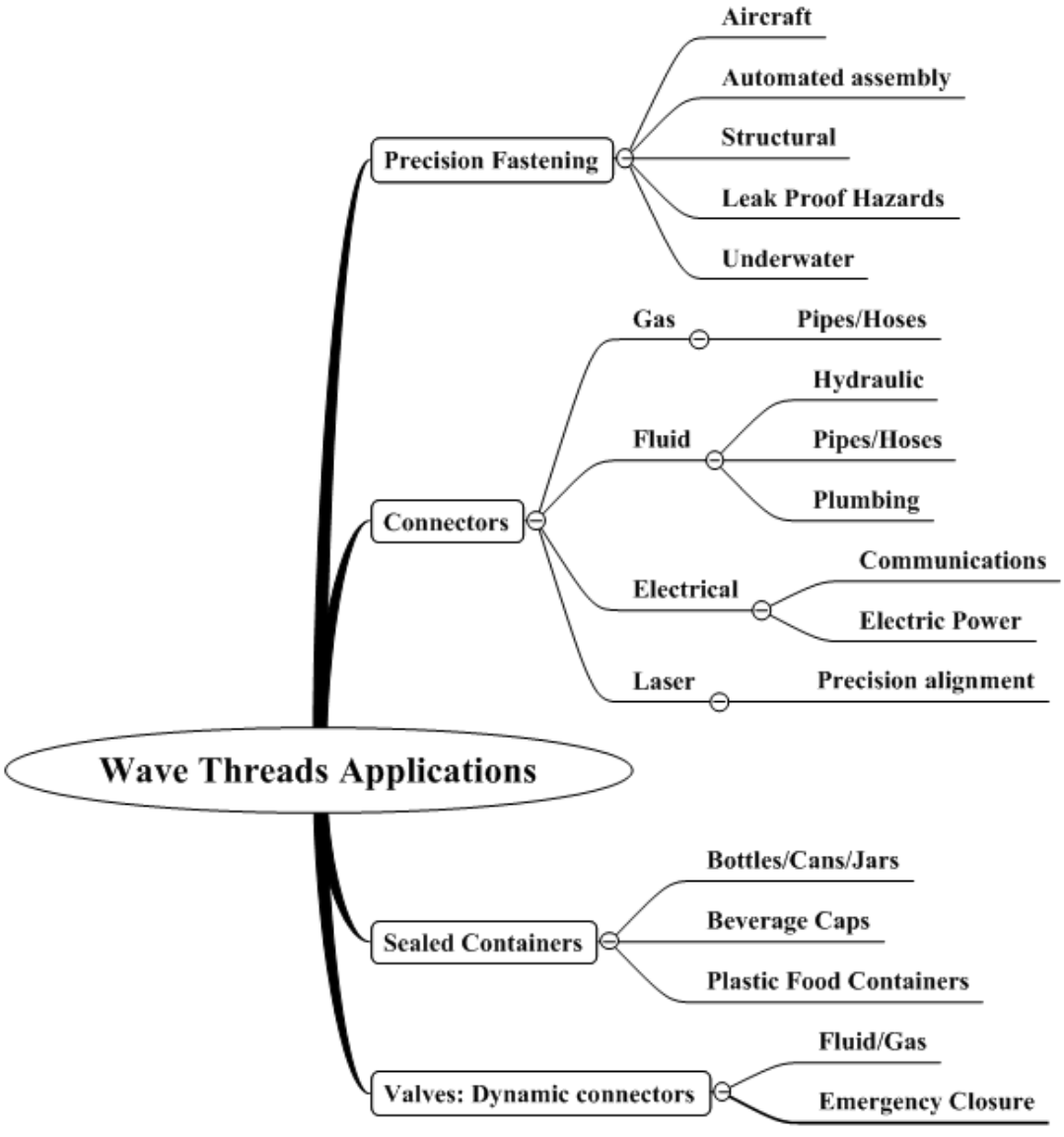


Figure 1.

This is accomplished with the combination of the physics of total surface contact incorporated with ability to structurally engineer the thread to withstand its specific application. This range of structural properties is inherent to the wave thread.

The wave thread will first be described in its nut and bolt fastening application. This application is the easiest to confirm its properties since the nuts and bolts are a mature technology with enormous engineering data.

Making Contact

A single lead axial wave thread is a collection of circles. Take a slice anywhere and it will reveal a circle. The importance is a circle can rotate around a center axis. With this rotation a cutting tool can form this circle. Each circle increases in size. The center point of each circle moves up the axis in a spiral fashion. This spiraling of the expanding collection of circles forms the shape of the wave thread.

This constant expansion of the circles will give the wave threaded part a cone shape. When an external male cone is inserted into an internal female cone, there is penetration before contact is made. With the wave threads, this penetration reduces the number of turns needed to tighten it.

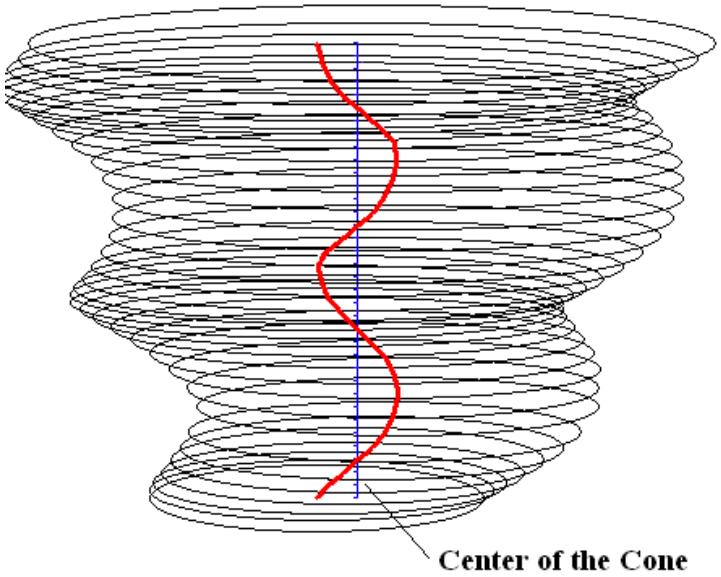


Figure 2

With a cone shape, there is a fixed stop which the threads can not be tightened anymore. This is the bases for the total clamp load control. What ever the load that is being squeezed, it can not exceed.

The wave thread is a ripple pattern on the surface of the cone. When the male and female sides are approaching each other, part of the ripple will be in contact, but it will not be in full contact until the cone is fully engaged. This is true even if the engagement is the rotation of the threads passing through each other until all the surfaces touch and it can not be rotated any more. This is the full contact of the mating surfaces. Prior to that full surface contact, the threads are loose.

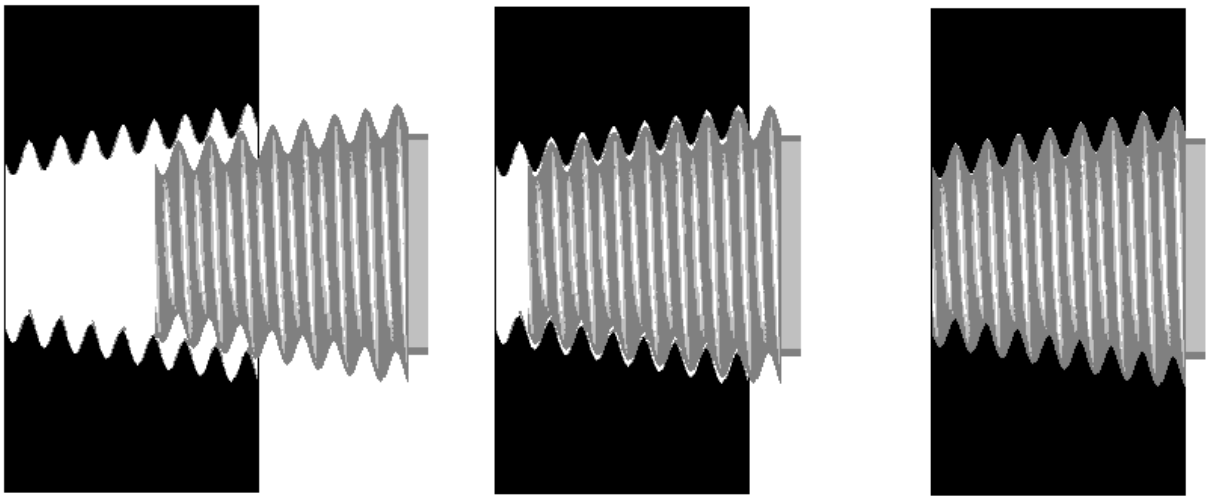


Figure 3

The Other Properties

A two leads will tighten at half the number of turns as a single lead, three leads at a third, and etc. This is how to make connections faster. The cone shape reduces the number to rotations, and the number of leads reduces what ever is left. Too many leads reduce the ability of the wave thread to hold. An example is a 16-lead model that screwed together with a 10-degree twist also easily came apart. The reason is that the wave thread has a lead angle and multiple leads increase that angle to the point where the threaded part will fall off if it is not externally locked in place.

The wave thread has been described as a cone shape. It can also be concave bowel shape or a convex whirlpool shape. These are curves where the cone is straight. These curves distribute forces acting on them differently then straight line. The concave is comparing a dome shape to pyramid shape. Downward acting force against the surface of the dome will be distributed along its surface, where as the pyramid shape will be into is surface. If the force is pulling away form the surface, then the reverse convex shape will distribute similar to the reverse dome.

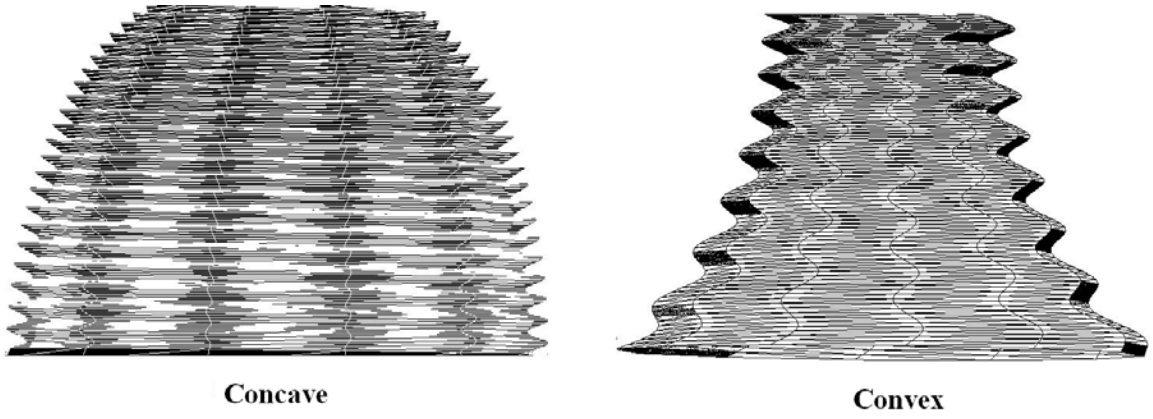
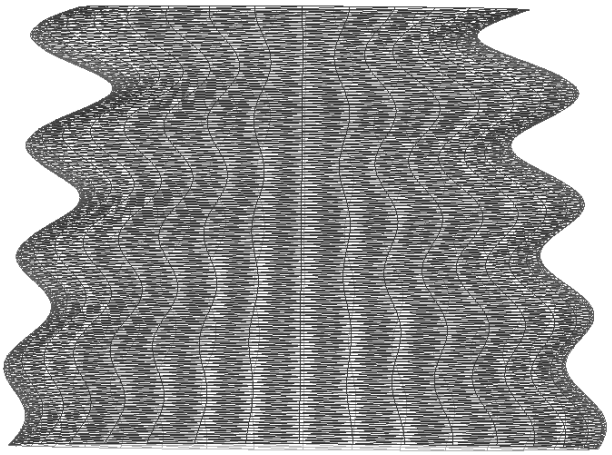


Figure 4

The wave in the wave thread has a length called the period and a height called the amplitude. These can be varied at a constant rate. Just changing the amplitude while keeping the period constant means that the thread will be short and stockier on one end then the other. When nuts and bolts fail, the most stress on the first rotation and is reduced other the succeeding rotations. Making the first rotation shorter will distribute the shear stress over more threads



Decrease Amplitude

Figure 5

Combining the concave/convex shapes with shorter threads is the strategy for making the threads more resistant to shearing forces then standard threads.

Concave Shape With Decreasing Amplitude

Figure 6

Another characteristic of the wave thread is that it is difficult to cross thread. It is inherently self centering. There is another type of wave thread called the surface wave thread. There are configurations where the surface wave thread is stronger then the axial wave thread.

Other applications

The wave thread can be a quick connect to a variety of applications.

Large pipes that are in hazardous or deep water environments could be assemble with 90-rotation. These would be aligned and screwed together remotely.

With multiple leads and a cone shape this thread can join surfaces in single a rotation or less making manufacturing assembly faster.

These threads can eliminate the plastic seal on bottle caps or any screw on top. Metal cans can be unscrewed instead of soldered covers eliminating the can opener and allowing for reuse or storage.

What is next?

The current engineering software can produce thousands to millions of points that constitute a wave thread. The data is in 16 decimal points to keep accumulative rounding errors out to 8-10 decimal places so models with 4 decimal places are very accurate.

Currently the data can output to an STL file format. It needs to go to Finite Element Analysis to optimize designs.