



What is "Dihedral" and Why Would I Want Some?

The word "dihedral" [die HEE drull] means

- A. a prehistoric animal that looked like a camel
- B. the inner layer of an acorn shell
- C. a zigzag without the zig
- D. You're bluffing—none of the above



Geometric Cellular Kite

Photo by The Drachen Foundation

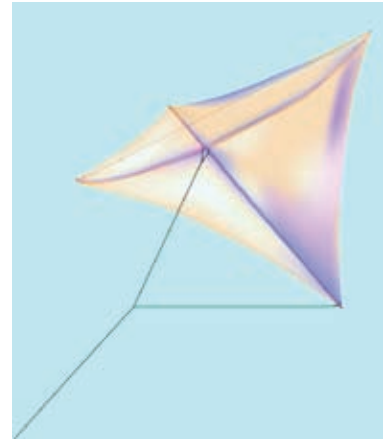
Dihedral is actually a word from the world of math. It means the angle where two planes (or flat surfaces) come together. In a cube the sides or planes come together at 90 degrees, in a right angle. Some kites, such as the box kite, do have planes that meet at 90 degrees. But the sides of many kites meet at a smaller angle on either side of the spine, or vertical spar.

Visualize dihedral this way. Open a picture book, and lay it on your desk. Think of the open book as a flat kite, without any dihedral. Start to close the book by lifting each cover toward the other. Stop when you have moved each cover toward the other a little bit. Now you have made an angle (the dihedral angle) between the top of your desk and the cover of your book on each side of the spine. If your book were a kite, it would be a kite with dihedral. The dihedral angle in a kite is often 15 to 30 degrees on each side.



Photo by Cathy Palmer

You may want dihedral in a kite because a kite that is bowed or bent against the wind will fly differently than a flat kite. A flat kite can have trouble adjusting to small changes in the force of the wind flowing around it. Wind spills off one side of the kite or the other, and the kite can easily start to roll. A flat kite is naturally so unsteady that it must have a tail (or other stabilizing elements, such as a vent or a keel) to fly well. A kite with dihedral can retain or regain stability more easily. The wind presses harder on one side of the kite until any rolling stops. Each side of the kite sail can then present itself evenly to the wind.



Dihedral in a Kite



Kite with a Bow

Photo by Kiyomi Okawa

How can you make dihedral in a kite? Sometimes a lively wind flexes the cross spar and sail in a flat kite and creates dihedral all by itself. A master Japanese kite maker may pull a spar from side to side across the top of his head a few times to adjust the bend in a spar before he flies his kite. Or you can bow a kite to make dihedral. Tie a string to either end of a cross spar at the top of the kite, then tighten the string by winding it once or twice around the spar until it bends one to two inches at the depth of the curve. Kite makers can also use a special device of metal or plastic to hold horizontal spars at an angle to the vertical spar.

American William Eddy was the first Western kite maker to use the bowed spar and to publicize its effect on kite flight. In the 1890s Eddy wanted to lift meteorological instruments to great heights. Kites flown in a train could do this job. But tails interfered with the train lines. How could he eliminate the kites' tails but keep the train flying stably?



William Eddy



Eddy and his Kite

Eddy began to experiment with bowed cross spars on his kites. The bowed spar worked like the keel on a boat. It kept the kites from slipping from side to side. In 1893 Eddy traveled to the World's Columbian Exposition in Chicago. At the exposition's International Bazaar he came across a Javanese kite with a bowed spar. He could compare his design and materials with this kite. He also learned about this design feature from a friend who had flown bowed kites in South Africa. Those kites had been imported from Java.

In 1900 Eddy patented his kite. Even though kite makers in Asia had used bowed spars long before he did, Eddy had conducted many experiments with different proportions to make a unique kite design. He also kept very careful records of all his experiments.

Kite designer Greg Kono wanted to create dihedral in a kite that young students would make. He had to use materials that would be light, inexpensive, and easy to find. A device of metal or plastic would be too heavy, too expensive, and too difficult for school teachers to locate. He decided to try a paper clip to hold straws for the spars in place.



Greg Kono

Photo by Cathy Palmer



First he bent a paper clip 20 degrees on each side, and slipped a straw over one side. The straw fit snugly, like a glove. When he slipped a straw on to the other side of the paper clip, it fit more loosely. But taping the spar to the sail would hold both the clip and the spar in place. Greg made a drawing to show students the dihedral angle he

recommends for best kite flight in light wind. Students can measure their clips against the drawing, or they can try a different angle, to see how kite flight is affected.



At a Kite Workshop

Photos by Kiyomi Okawa

Key Vocabulary for the reading

Dihedral: having two plane faces; two-sided

Exposition: a public exhibition or show

Keel: a main longitudinal beam of the hull of a vessel, which can extend vertically into the water to provide lateral stability. In a kite the keel extends vertically into the air.

Java: an island of Indonesia south of Borneo
Meteorological: pertaining to atmospheric phenomena, especially weather and weather conditions.

Spar: one of the parts of the kite frame

Stabilizing: to make stable or steadfast; to keep from fluctuating, or moving around



Bowed Spars in a Kono Kite



Vent in a Kite

Photos by Cathy Palmer

Vent: a hole, opening or slit. In a kite it allows wind to escape or be released.

Visualize: create a mental picture