RESEARCH CONSULTING ASSOCIATES
AR PRODUCTS LLC

Product Testing

Buckling and Strength Testing
AR Spacer Twister

Two sizes of Insulator rods were tested for strength and buckling. All tests were conducted at NEETRAC, an independent research facility of Georgia Institute of Technology located near Atlanta, Georgia.

Subject
Standard 0.675" and 1.0" insulator rods. Rods were supplied by Sediver and from inventory used in the manufacture of phase-phase spacers.

Purpose
To determine if the rods behave as an elastic column under load.

Rationale
The use of interphase spacer devices has become widespread in the electric power delivery industry. Sometimes referred to as insulators, these spacing devices are usually rigid and are used to maintain separation between phases of transmission lines. The primary benefit is to avoid flashover. Devices have been used on voltages ranging from a low of 15kV on distribution lines to a high of 500kV on transmission lines.

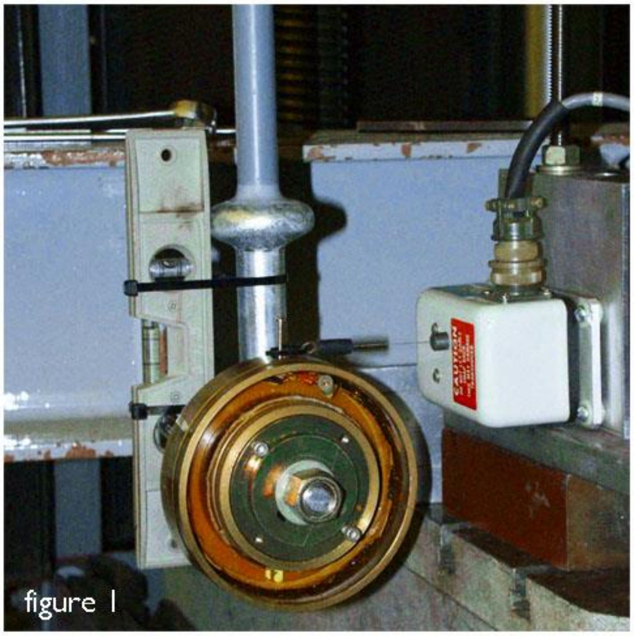
Frequently spacer devices are used to mitigate galloping of transmission lines. The industry recognizes that interphase spacers do not control galloping but they do prevent flashover [CIGRE 322]. Insulators are available from a wide range of suppliers. Generally all models are rigid in both attachment and between end fittings. Galloping that is not well controlled adds heavy loads on the phase spacers, diminishing the useful service life of the device. Average service life of a spacer device is 5 years.

The AR Spacer Twister is a spacing device that combines the spacing feature of an insulator with a galloping control feature of a clamp that will add a twist to the conductor. This device intends to guard against clashing of the phases and control galloping.

A critical design feature of the AR Spacer Twister is buckling of the insulator rod. Under compressive load, the rods behave as an elastic column. Euler Buckling is linear and repeatable. After the compressive load is released, the rod returns to its original position. These tests were to determine the impact of compression and tension loads on the insulator rods.

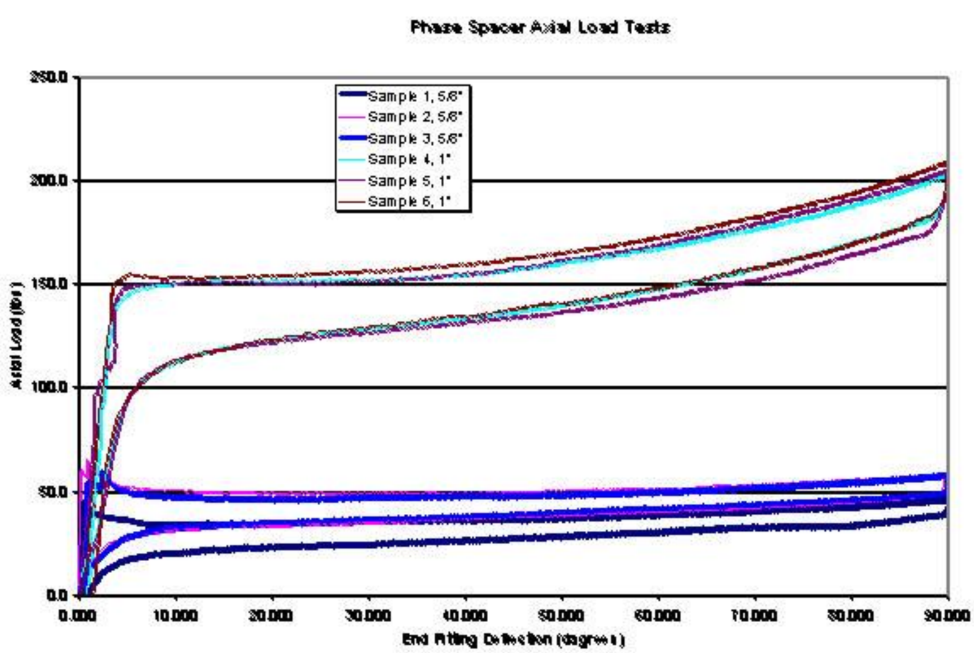
Testing
A standard production insulator was provided to NEETRAC for testing. The rods were fabricated by Sediver and are actual production versions of 5/8in and 1.0in diameter rods used to manufacture phase-phase spacers. Each end of the rod is bonded to a cast fitting having an eye for attachment to other hardware.

Both compression and tension loads were applied. Compression testing was to establish column-buckling behavior, while testing in tension was to establish tensile strength of the rod.



Static Load Tests (figure 1)

The static load tests are seen in the first photo (figure 1). Each test revealed the same features. The load increased linearly with end-point bending angle up to a maximum value, then gradually increases over a wide range up to 90 degrees angle rotation at the tips. Upon reduction of the compressive load the curve follows a different path lower than the increasing load path. This could be identified as a hysterisis loop, typical of non-linear phenomena. For any given rod this curve is repeatable, which indicates elastic behavior in agreement with the Euler column buckling theory.



Phase Spacer Axial Load Tests

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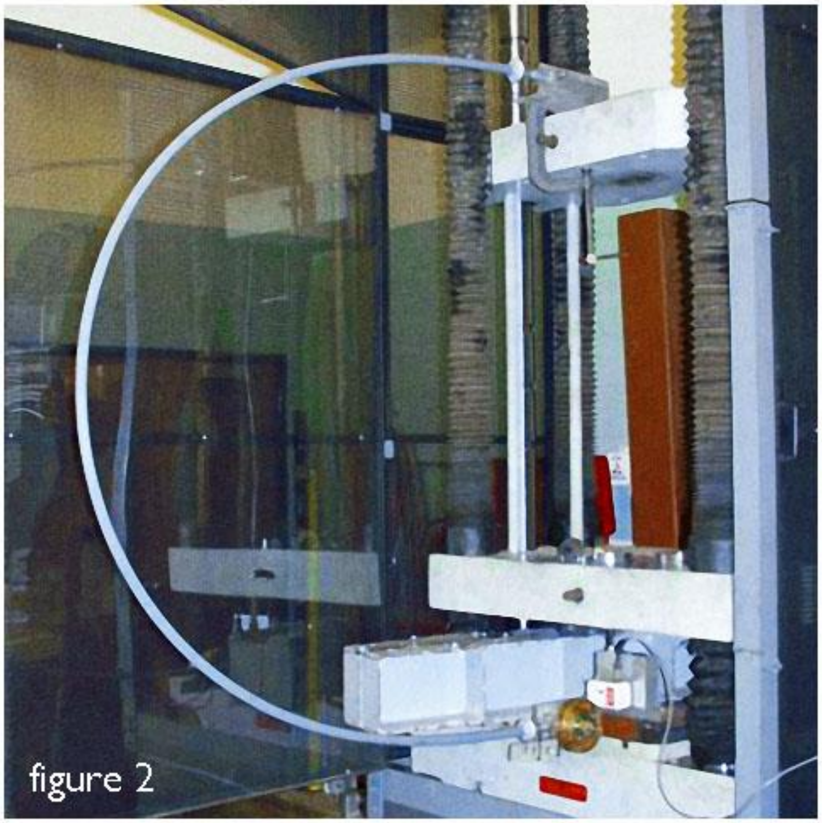

Curvature of the rod at point of maximum load and deflection

90 degrees angle at the tips is the point of maximum load and deflection. The curvature of the rod illustrates the column buckling behavior: deformation is linear, maximum twist angle at each end is 90 degrees, end positions return to initial position after load is removed.

There were six rods, eleven feet between eyes. Three were 5/8 in. size, and three were 1.0 in. size. Otherwise the construction was the same. The tensile test of the 5/8 in. rod revealed an ultimate load of about 35,000lb. While the tensile test of the 1.0 inch rod revealed an ultimate load of about 50,000 lbs. In both cases the failure was at the joint between the rod and the clamp, and not along the body of the rod itself.

Results

Tensile load	5/8” rod	35,000 lbs.
	1.0” rod	50,000 lbs.

CONCLUSIONS

1. The load testing proves that, while the buckling loads are relatively small the rod will continue to support increased load while rotating at its ends through large angle deflections up to 90 degrees.

2. Upon reversal of the load, the path followed by the curve is different from the path of increasing load, yet upon repeating the load from zero the characteristic curve is the same as before.

3. Both sizes of rods tested demonstrated sufficient strength and elasticity to support a twisting mechanism for galloping control.

4. Elasticity of the rods is a feature that when applied to the phase-spacing purpose of an insulator, could extend the useful service life of the device.