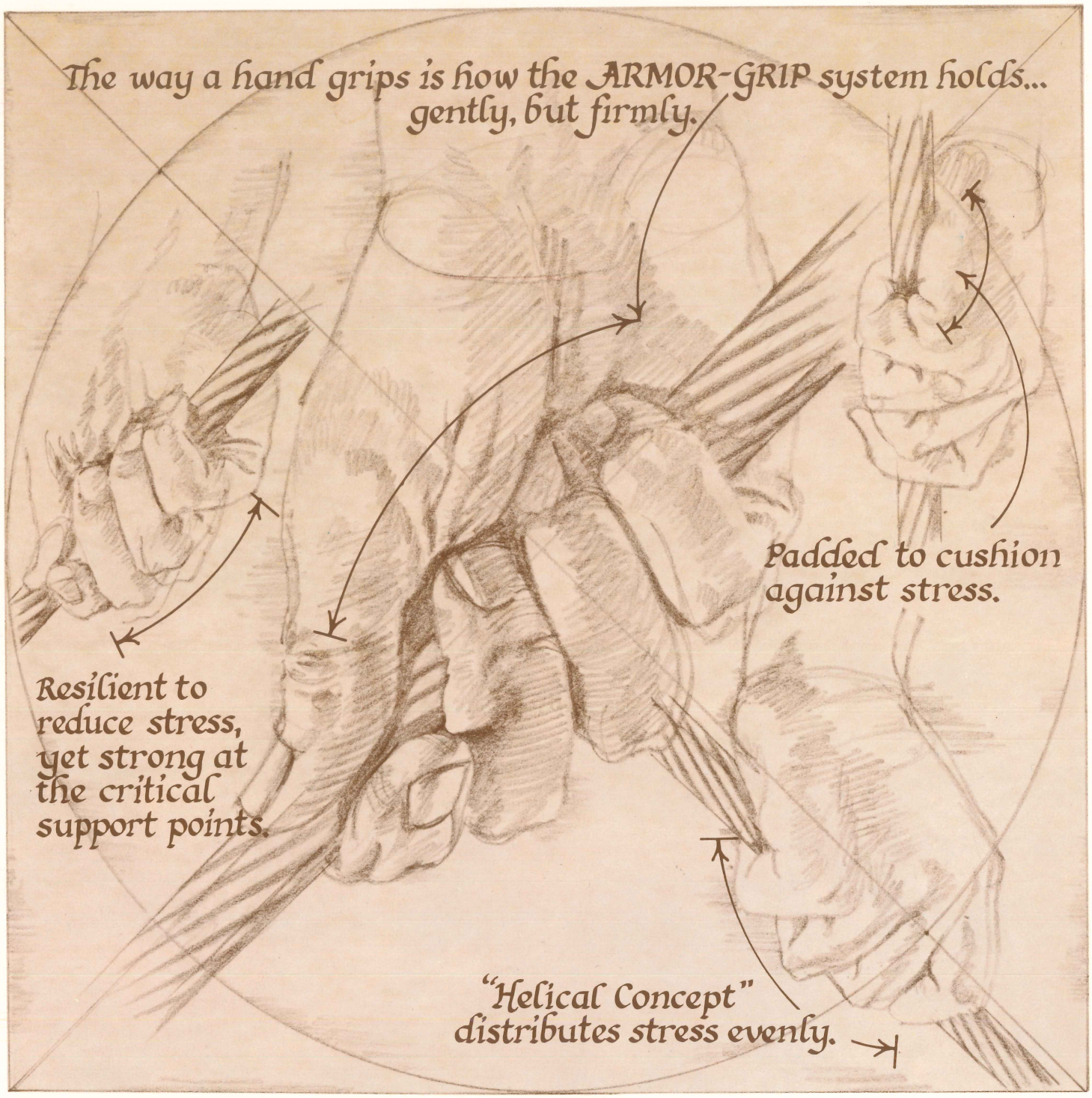
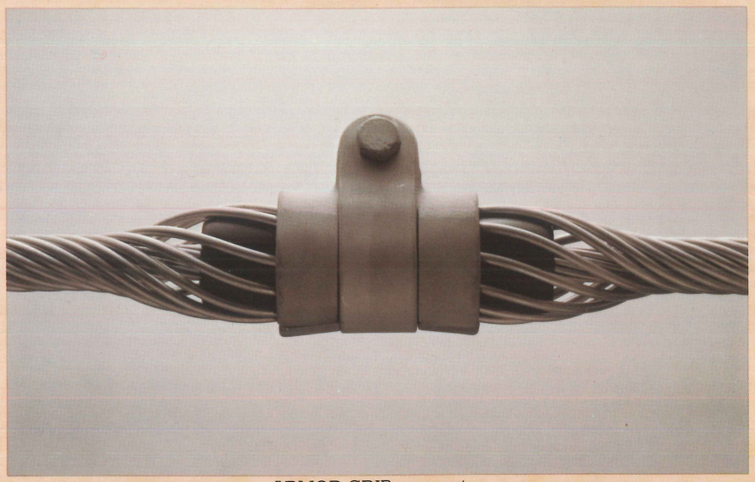
The gripping story of PLP's Armor-Grip system.



How to get a good grip on your conductor.

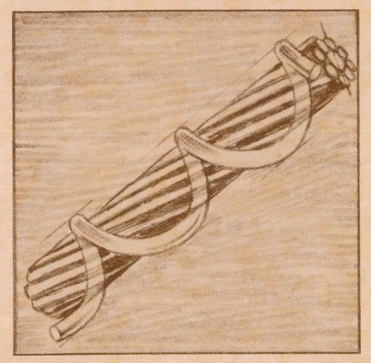


ARMOR-GRIP suspension

Almost all conductor fatigue occurs in the short section of each span where the conductor is suspended from the insulators. This short section is the most highly stressed section of the line. It's the area most exposed to danger and most easily damaged. With a cost of about $25,000 an hour, or more, for a single major outage along the line, it's important to protect this critical support area from the devastating effects of fatigue.

From the day PLP® introduced ARMOR-GRIP® Suspension in 1951, it has been found to be the most reliable suspension device available. The ARMOR-GRIP System has been designed to hold the conductor much the same way as your hand grips—firmly, yet gently and with built-in resilience. The result is a conductor support system that helps your conductor survive for its entire design life.

An idea that saves conductors.

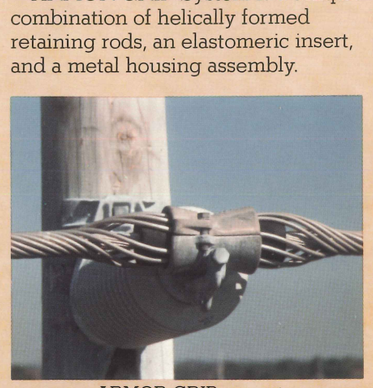


In the 1940's, Preformed started its business on the strength of a unique idea—our helical concept for securely gripping cable while minimizing concentrated static stress.

In addition to being easy to apply, preforming armor rods with an inner helix diameter about 20% smaller than the cable was a new technique to achieve a surprisingly strong gripping force.

We brought the same innovation to transmission conductor suspension and support with a design we call the ARMOR-GRIP System. Over the years our ARMOR-GRIP Suspension, ARMOR-GRIP Support, Static Wire ARMOR-GRIP Suspension, and ARMOR-GRIP for Line Repair have compiled an operating record unmatched in the industry.

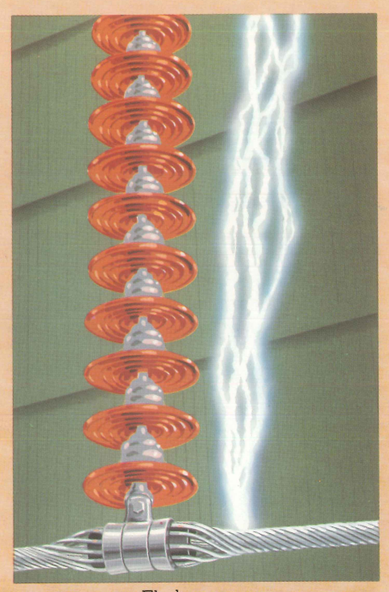
ARMOR-GRIP System is a unique combination of helically formed retaining rods, an elastomeric insert, and a metal housing assembly.



ARMOR-GRIP support

Static wire ARMOR-GRIP suspension

ARMOR-GRIP System combats fatigue damage by distributing and minimizing stresses acting on the line. Radial compressive forces are dramatically reduced, thus lowering overall static stress. The specially engineered AGS or retaining rods of the assembly reinforce the conductor for several feet on each side of the support point to both stiffen the conductor and distribute gripping stress, while the elastomeric core cushions the conductor over a wide area at the point of attachment.

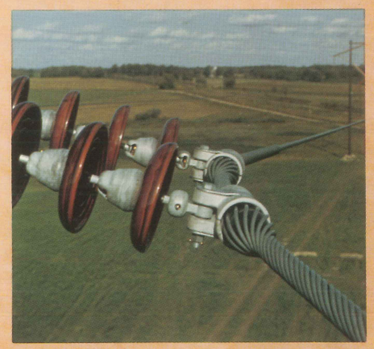


Flashover

Although there is no way to eliminate all stresses, stress reduction is the key to long, trouble-free life.

Electrical performance of the ARMOR-GRIP System has not been ignored. Exhaustive testing has led to design features which reduce radio interference and minimize the effects of flashover.

The ARMOR-GRIP System can help your conductors survive for their entire design life.



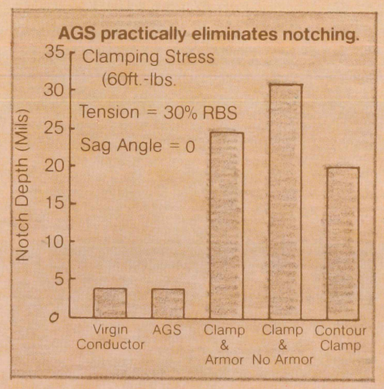
Neoprene insert between conductor and housing drastically reduces compressive clamping stress on conductor.

How to survive conductor stresses.

Almost all conductor fatigue failures occur at the point where the conductor is attached to the insulators. The dynamics of conductor motion result in complex stresses that can lead to fatigue, and fatigue means conductor failure.

The total stresses on a transmission line are partly static and partly dynamic. The higher the static stresses, the lower the dynamic stress that can be tolerated.

Bolted, clamp-type suspension assemblies concentrate these stresses at the small area on the conductor



where it is suspended from the insulators. Severity of the resultant conductor notching depends on the amount of clamping force. Static and dynamic stresses combine in this area to accelerate fatigue. When a conductor fails mechanically, the failure location is confined almost exclusively to the place where the hardware is fastened to the conductor. Here is the point where your overhead transmission lines are the most vulnerable.

The struggle against tension, bending, compressive and residual stresses.

Every day your conductors are in a life and death struggle against four types of static stresses:

Tensile stress due to design tension in the line.

Bending stress due to curvature of the conductor at the point of suspension.

Radial Compressive stress due to the radial clamping force developed by bolted, clamp-type suspensions.

Residual Stresses due to cable stranding and coiling operations.

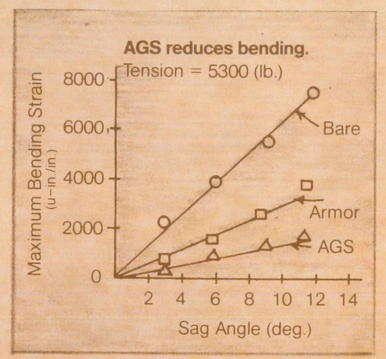
Bolted, clamp-type suspension clamps concentrate these stresses at one area on the conductor—the critical support point.

ARMOR-GRIP is a conductor's life preserver.

The elastomeric core of ARMOR-GRIP Suspension and Support systems cushions the conductor at the point of attachment significantly reducing clamping compressive stress. This contributes to a dramatic reduction in total static stresses at the support point and results in fatigue-free conductor life.

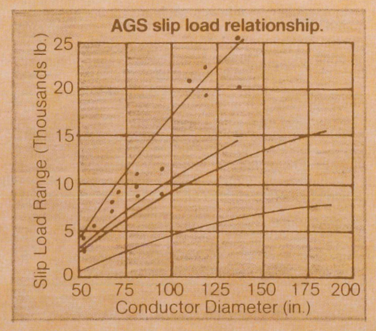
The helical rods of the ARMOR-GRIP System securely grip the conductor to provide high resistance to slip.

Also, the rods distribute stress and stiffen the conductor in the area of



support. By stiffening the conductor, its bending radius is more generous. In addition, the elastomeric core cushions the conductor, eliminating metal-to-metal clamping of the conductor.

Notched conductor.



The inside story of ARMOR-GRIP protection.

SYMMETRICAL DESIGN with no protuberances minimizes corona emission and radio and TV interference and meets EHV requirements.

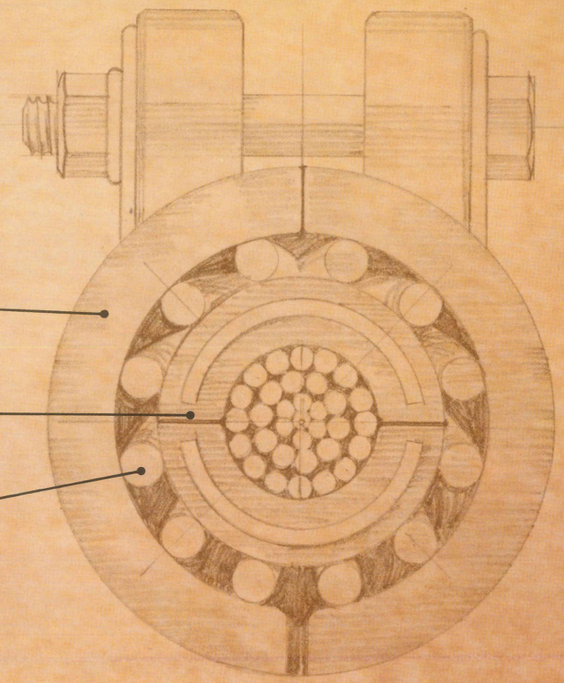
ARMOR-GRIP PROTECTION extends for several feet on each side of the support to reduce bending stress and also reduces conductor damage in the event of arc-over.

QUICK INSTALLATION and, with the exception of one bolt-nut assembly that is secured with an ordinary wrench, it is applied by hand without tools.

HOUSING provides positive stop closure which, along with the resilient core, minimizes radial compressive stresses.

ELASTOMERIC CORE cushions the conductor over a wide area to help reduce both compressive stress and dynamic stresses.

ARMOR-GRIP RETAINING RODS, using Preformed's helical concept, provide high slip strength, distribute and minimize gripping stresses acting on line and provide electrical protection to meet corona free and RIV requirements at each operating voltage level.



COMPARISON OF STATIC STRESS

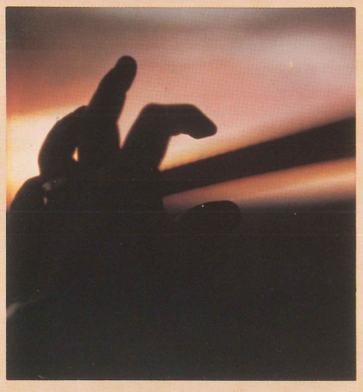
	Bare Conductor	Conductor with Armor Rod Only	ARMOR-GRIP Suspension
Tension	constant	constant	constant
Bending	high	1/2 bare	1/2 armor rod only
Compression	high	medium	minimal

This simple chart shows you at a glance the advantages of the ARMOR-GRIP System over no protection at all and armor rod protection only.

ARMOR-GRIP Rods firmly grip the conductor on each side of the neoprene insert to evenly distribute gripping stress and provide slip strength.

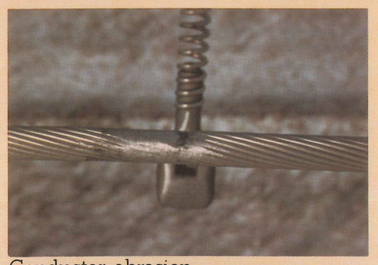
There is no such thing as a gentle breeze.

Various types of wind-induced oscillations induce dynamic bending stresses in a conductor. These, together with the ever-present static stresses, combine to form a complex accumulation of stresses in a conductor. The ARMOR-GRIP System minimizes these static stresses so your conductors can tolerate higher dynamic stresses.



Aeolian vibration, by far the most common wind-induced vibration, occurs to some degree in nearly all overhead conductors. Aeolian vibration varies from barely discernible to severe and is characterized by a standing wave of relatively high frequency and low amplitude, usually less than the conductor diameter. Two types of damage occur: abrasion and fatigue.

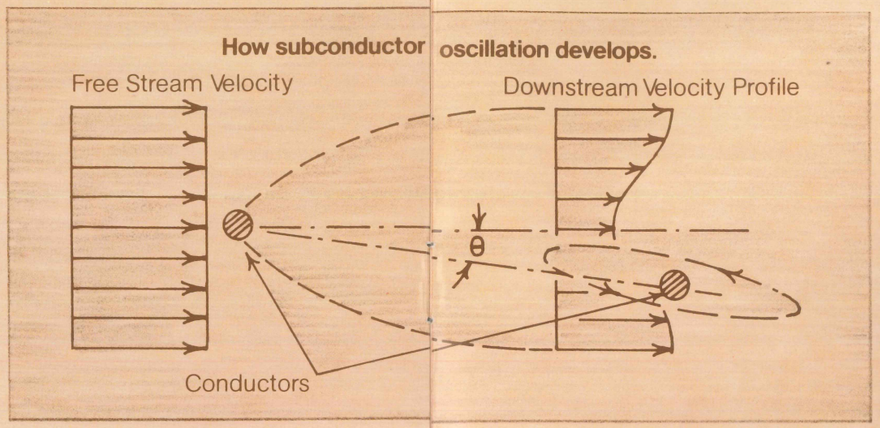
Galloping is an aerodynamic instability most commonly caused by an accumulation of snow, sleet or ice on conductors. Galloping exhibits waves of relatively low frequency and high amplitude—up to 20 or 30 feet. Once



Conductor abrasion

started by wind action, galloping may be sustained by the motion of the conductor itself for a long period of time. Severe galloping and the resulting high tensile forces can quickly destroy support hardware and bring down a line.

Subconductor oscillation results from the proximity of bundled conductors in high winds. Destructive oscillations are created in a conductor that is in the unstable wake of another, upwind conductor. Subconductor oscillation often causes spacer damage and puts additional stress on the support point leading to conductor failure or abrasion from mid-span clashing.



Because of the low frequency, conventional dampers designed to suppress aeolian vibration are not effective in reducing these oscillations.

With the reduction in static stress provided by the ARMOR-GRIP System, long line life without undue attention is possible.

AEOLIAN VIBRATION TESTS

Conductor Size	Vibration Cycles (millions)	No. of Conductor Wire Failures	
		AGS	Bolted Clamp & Armor Rod
336.4 MCM 26/7	50	0	5
336.4 MCM 26/7	58	0	1
336.4 MCM 26/7	108	0	—
336.4 MCM 26/7	102	0	2
477 MCM 26/7	21.7	0	15
1272 MCM 54/7	177	0	17

SIMULATED GALLOPING TESTS*

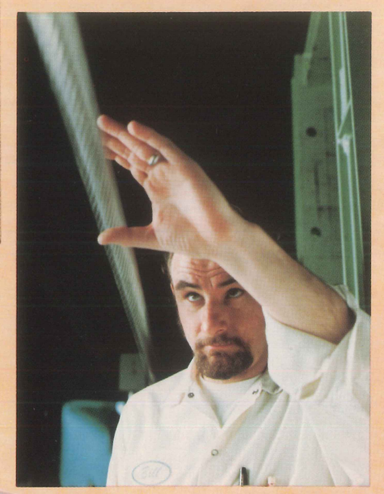
Support Hardware	Approximate Cycles	Remarks
Contoured Clamp, No Armor	300,000	6 conductor breaks, 1 steel core wire break
Contoured Clamp, No Armor	100,000	3 conductor breaks
Bolted Clamp + Armor Rods	700,000	5 conductor breaks
Bolted Clamp + Armor Rods	400,000	2 conductor breaks
AGS	700,000	0 conductor breaks
AGS	700,000	0 conductor breaks

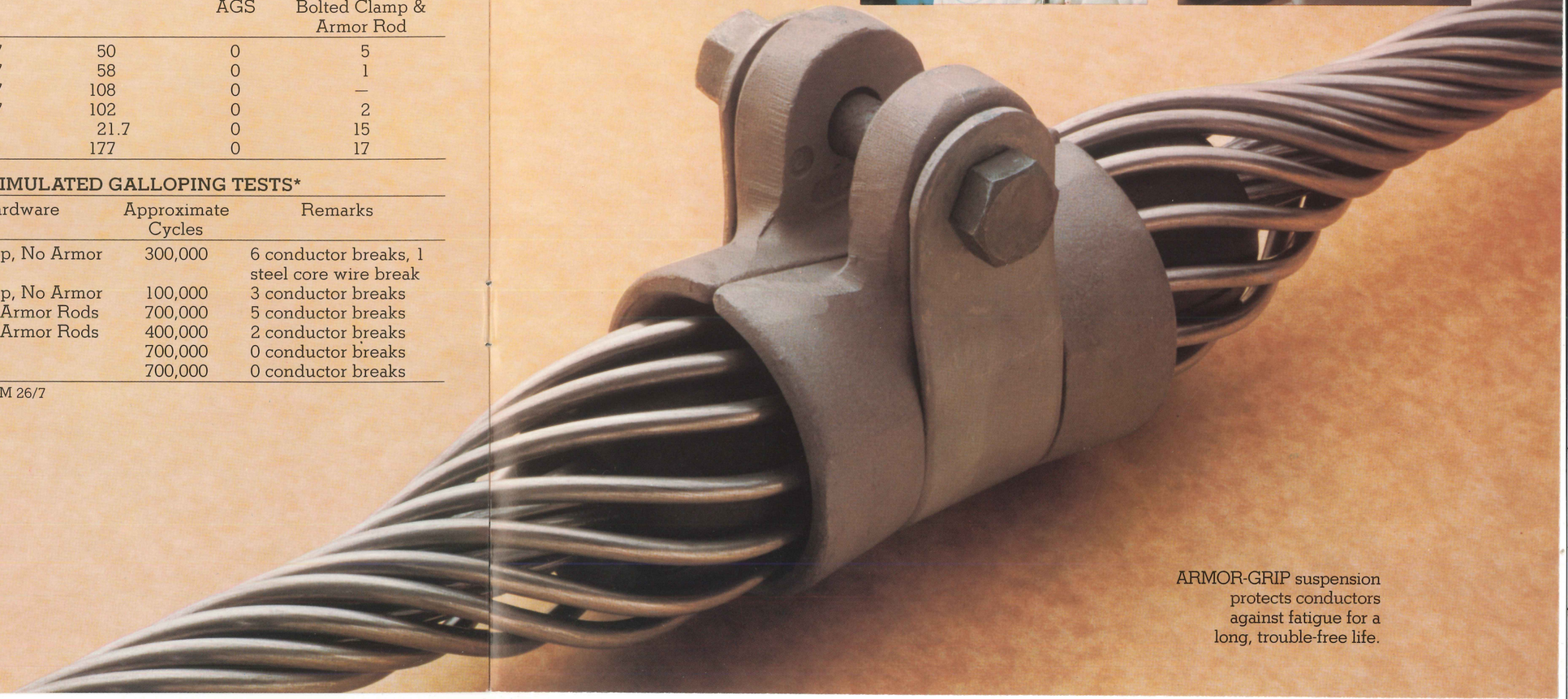
*Conductor: 795 MCM 26/7

Our "library" on conductor survival.

Preformed has spent over 30 years studying the static and dynamic forces that help to destroy conductors. From our field and lab experience we have filled a library with the important data concerning their properties, characteristics and corrective actions. It's one of the finest collections of information of its kind in the world

We invite you to spend some time in the Preformed Research and Engineering Center. Over the years we've kept our position as the leader in product innovation because of our extensive research, testing and design engineering programs. We'd like to show you some of these programs first hand.



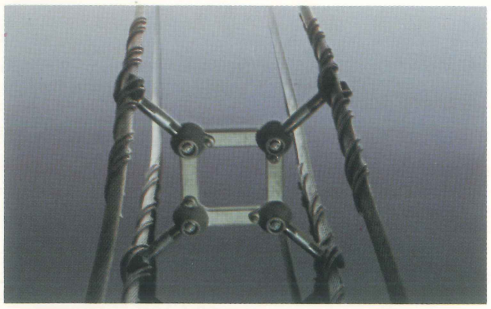


ARMOR-GRIP suspension protects conductors against fatigue for a long, trouble-free life.

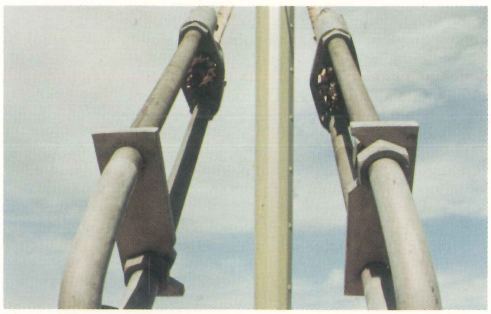
Preformed Line Products: We help transmission lines carry on.

For over 30 years, Preformed has been supplying you with the products that bring safety, reliability and long life to your overhead lines.

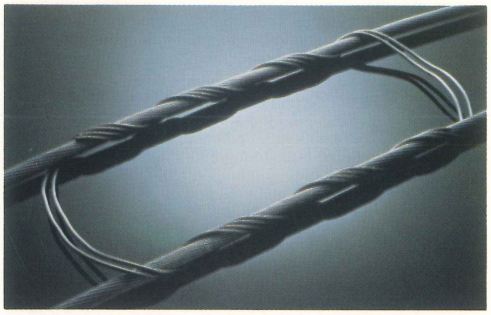
Big-Grip™ dead end is a one piece dead-end for terminating long-length, large-diameter guy strand on transmission towers and communications antennas. Millions of Preformed dead-ends have been installed all over the world.



ARMOR-GRIP® Spacer Dampers space a number of bundled conductors while its cushioned attachment protects against horizontal sway oscillation. At the same time, a built-in damper suppresses higher frequency, smaller displacement vibrations.

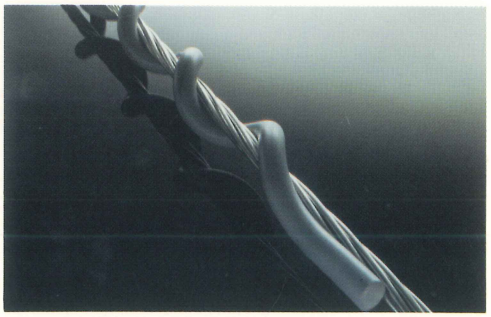


Vari-Grip™ dead-end has been specially designed to allow up to 18" adjustability on tower guy strands for easy adjustment during and after installation. A nonadjustable model is also available.



Helical Rod Spacers give extra protection to bundled conductors while providing uniform spacing.

ARMOR-GRIP® Spacer for spacing bundled conductors maintains line separation and provides cushioned attachment to protect against abrasion from horizontal oscillations.



Spiral Vibration Damper is a helically formed, plastic rod designed to fit on static wires. It damps aeolian vibration over a wide range of frequencies.

All PLP products are backed by PLP service. We have plants and people located throughout the world and in five strategic U.S. locations.

Look to Preformed Line Products for the products, experience, facilities, and people to help your transmission lines live longer and safer.

PREFORMED LINE PRODUCTS

P.O. Box 91129 Cleveland, Ohio 44101 (216) 461-5200

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