AR Mod 2-V and Mod 2-H Twin-Bundle Spacer/Damper
Dynamic and Mechanical Tests

Research Consulting Associates, Inc.

Project D95119, Revision 1

December, 1995

Requested By:	Mr. Al Richardson Research Consulting, Inc.
Mechanical Services:	P. L. Springer
Reviewed By:	D. E. Callaway

AR Mod 2-V and Mod 2-H Twin-Bundle Spacer/Damper Dynamic and Mechanical Tests

Research Consulting Associates, Inc.

Project D95119, Revision 1

December, 1995

Summary

Mr. Al Richardson of Research Consulting requested dynamic response and mechanical strength testing for two versions of the AR Mod 2 twin-bundle spacer/damper. The dampers were tested with and without rubber damping elements to determine if rubber improves damping. Test results show approximately equal damper performance with and without rubber damping elements.

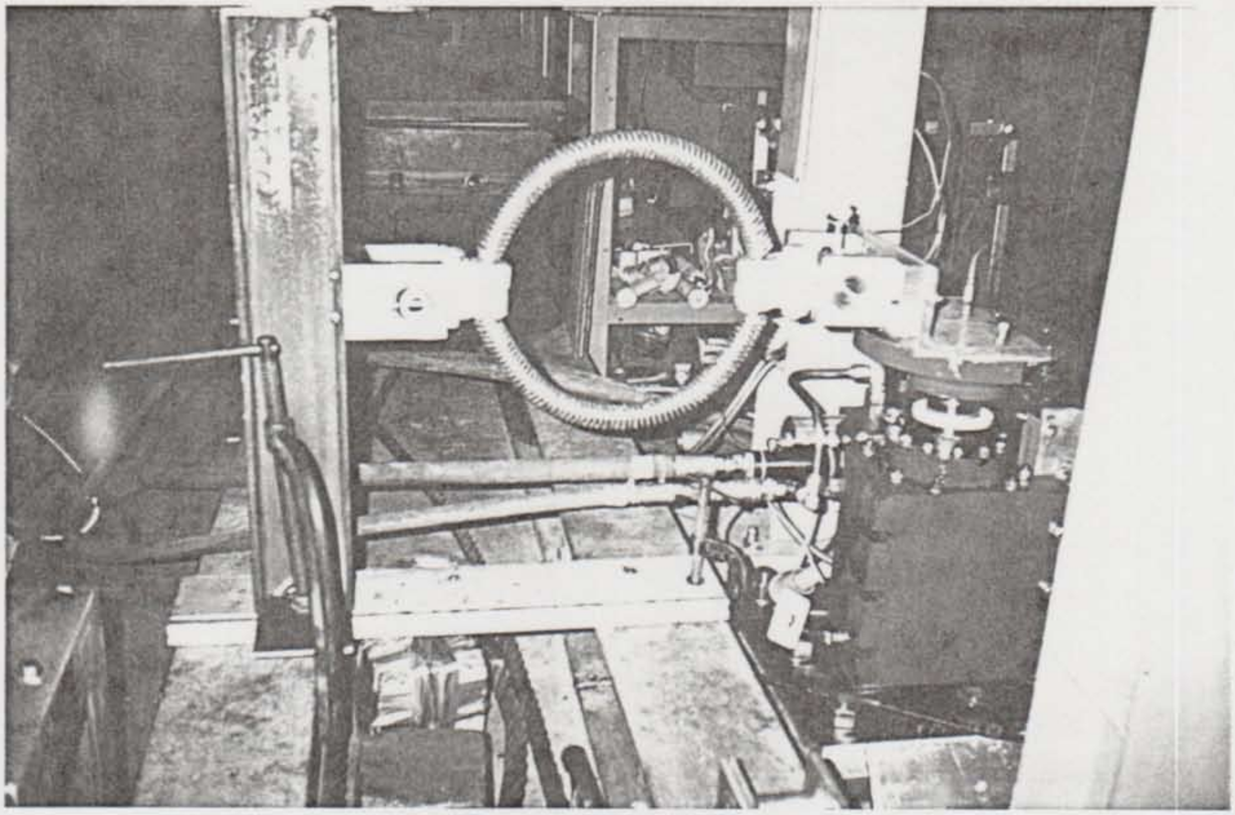
Mechanical testing demonstrates the steel hoop holding the damper components yields at 1,800 lbs, and then deforms several inches without failure. A second heat-treated ring was tested. Results show the more ductile non-heat-treated ring has better strength.

Samples Received for Evaluation:

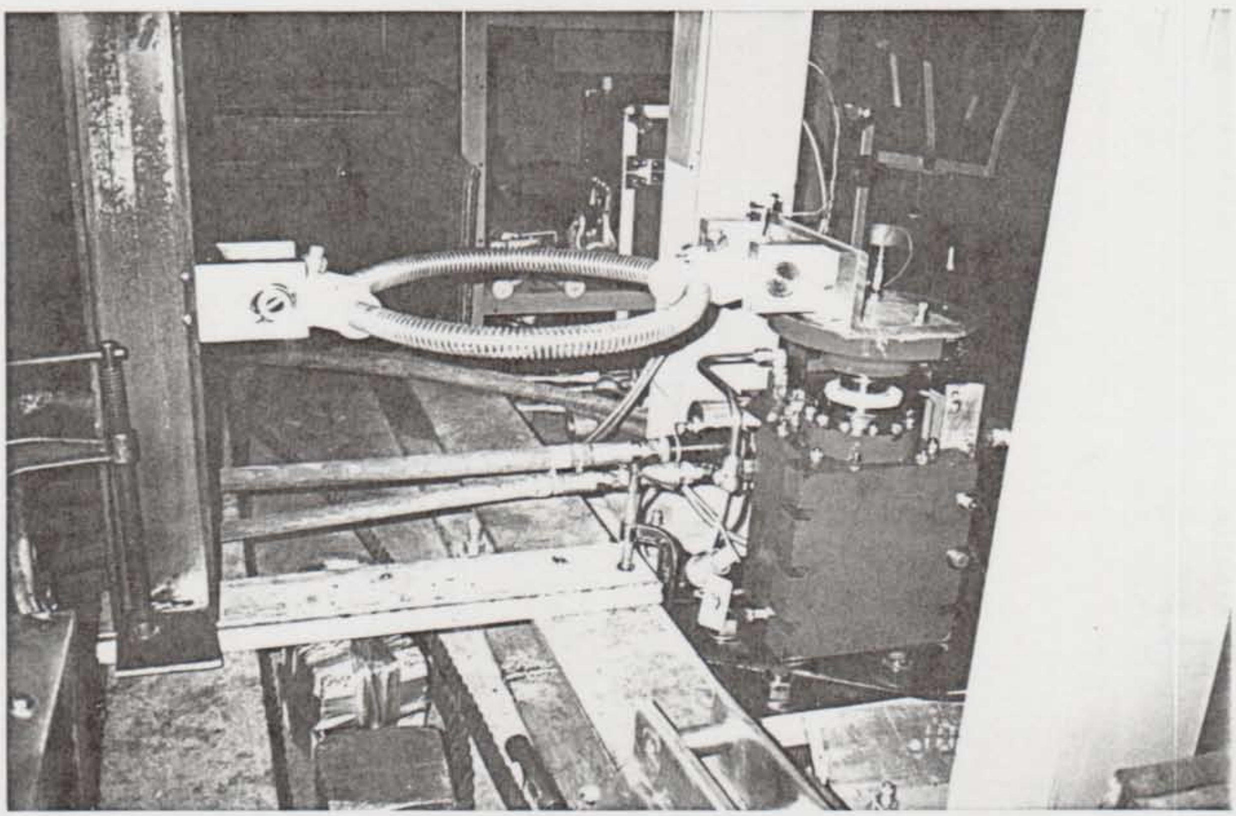
a) One AR Mod 2-V twin-bundle for 18" conductor spacing. As installed in the span, the ring lies in the vertical plane. See Photograph 1.

b) One AR Mod 2-H twin-bundle for 22" conductor spacing. As installed in the span, the ring lies in the horizontal plane. See Photograph 2.

c) One (1) bare steel ring, 12 1/2" diameter, formed from 5/8" diameter steel rod. There was a butt weld joining the rod ends to form a continuous ring.



Photograph 1
AR Spacer/Damper Mod 2-V



Photograph 2
AR Spacer/Damper Mod 2-H

Equipment Required:

Manufacturer	Model #	Serial #	Description, Use
Team	520/10	196	Servohydraulic shaker table system
Team	1532	671	Compressor, used for shaker level control
Team	1530	670	Vibration Monitor, used for reading Kistler accelerometer
Hewlett Packard	33120A	34006019	Function Generator, used to generate sine signals for vibration testing
Metrox	LP101	1411	Strain gage load pin, used to measure force input to damper clamp
Unholtz Dickie	D22PMB	10516	Dynamic strain amplifier, used to condition Metrox load cell
Unholtz Dickie	D22PMB	10517	Dynamic strain amplifier, used to condition Bell and Howell accelerometer
Unholtz Dickie	TF22-K-F1	976	Phase-and gain-matched tracking filter, used to condition accelerometer signal in impedance test
Unholtz Dickie	TF22-K-F1	977	Phase-and gain-matched tracking filter, used to condition force signal in impedance test
Kistler	8604A500	C5667	Quartz accelerometer, used for closed-loop control of shaker table velocity
Bell & Howell	4-202-0001	18128	Strain gage accelerometer
Fluke	97	DM5790166	Two channel digital oscilloscope
National Instruments/ ALR		AT/MOI-16XE-50	Computer interface for automated damper test control and data acquisition
Tinius Olsen		149080	Universal Testing Machine (UTM), used for mechanical tests

Test Procedure and Results:

I. Shaker Table Tests

Each damper was mounted in a test fixture on a load pin designed to measure the dynamic component of the force at one conductor clamp. The load pin was held in bearings to permit rotation as the conductor clamp was moved in the vertical direction. The second conductor clamp was attached to a pin. The second pin was fixed, but also fitted with bearings to permit rotation. The second pin was not instrumented. Photographs 1 and 2 show the test fixture with the dampers under test.

Shaker table controls were operated to provide a sinusoidal motion in the vertical direction. The acceleration of the shaker table was measured by an accelerometer. Force applied to the damper clamp was measured by the load pin. A computer interface controls the test, and records force, acceleration, and their relative phase angle. Mathematical relationships provided in IEEE 664 were used to calculate the power consumption (damping power) of the spacer/damper.

A total of eight (8) tests were run: the vertical ring damper at 100 mm/sec and 200 mm/sec (0-Peak), and with and without rubber bushings. The same set of tests were run on the horizontal ring damper. Figures 1 through 4 show the test results.

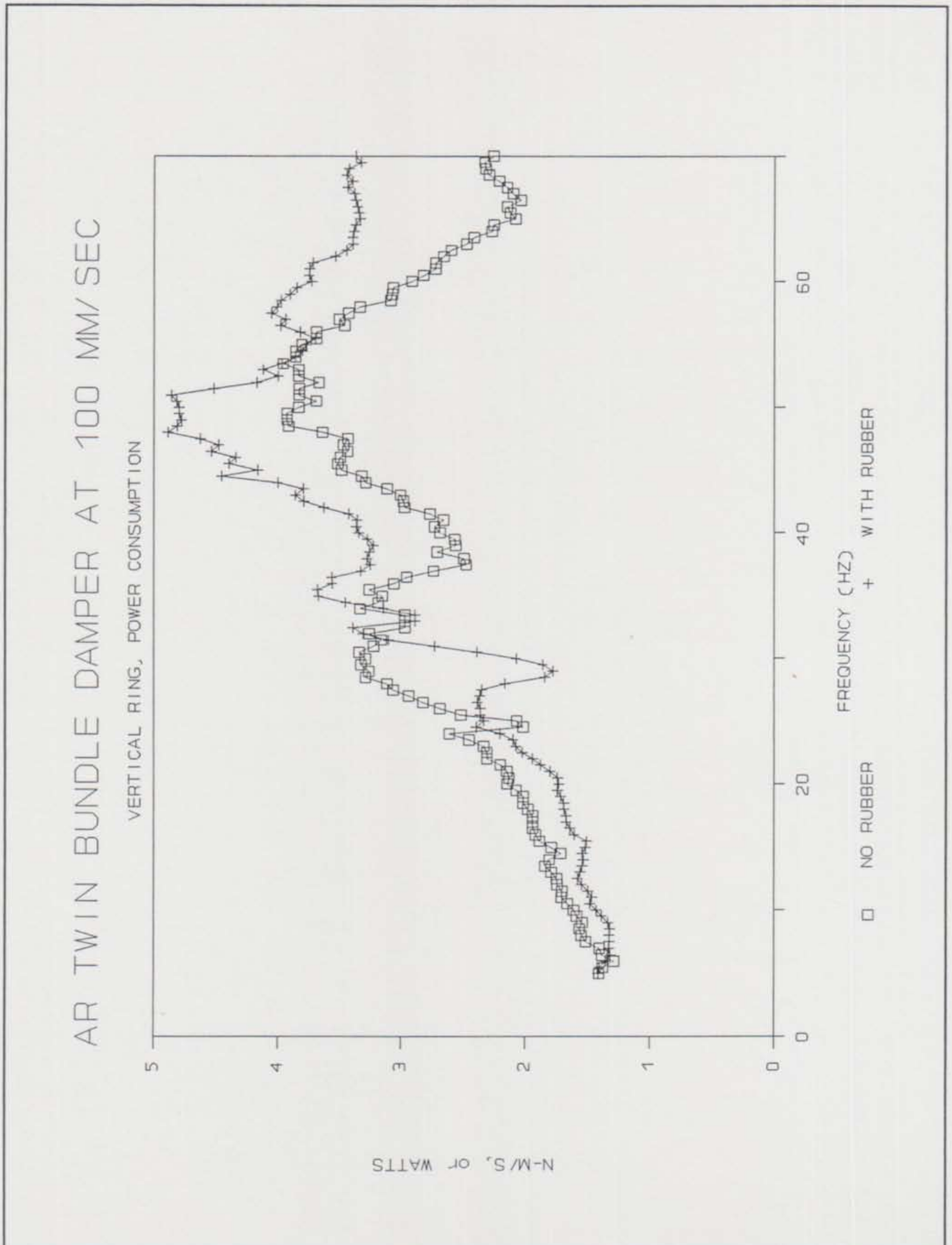


Figure 1, AR Mod 2-V Spacer/Damper, Comparison of Power Dissipation With and Without Rubber Elements, at 100 MM/Sec Peak Clamp Velocity

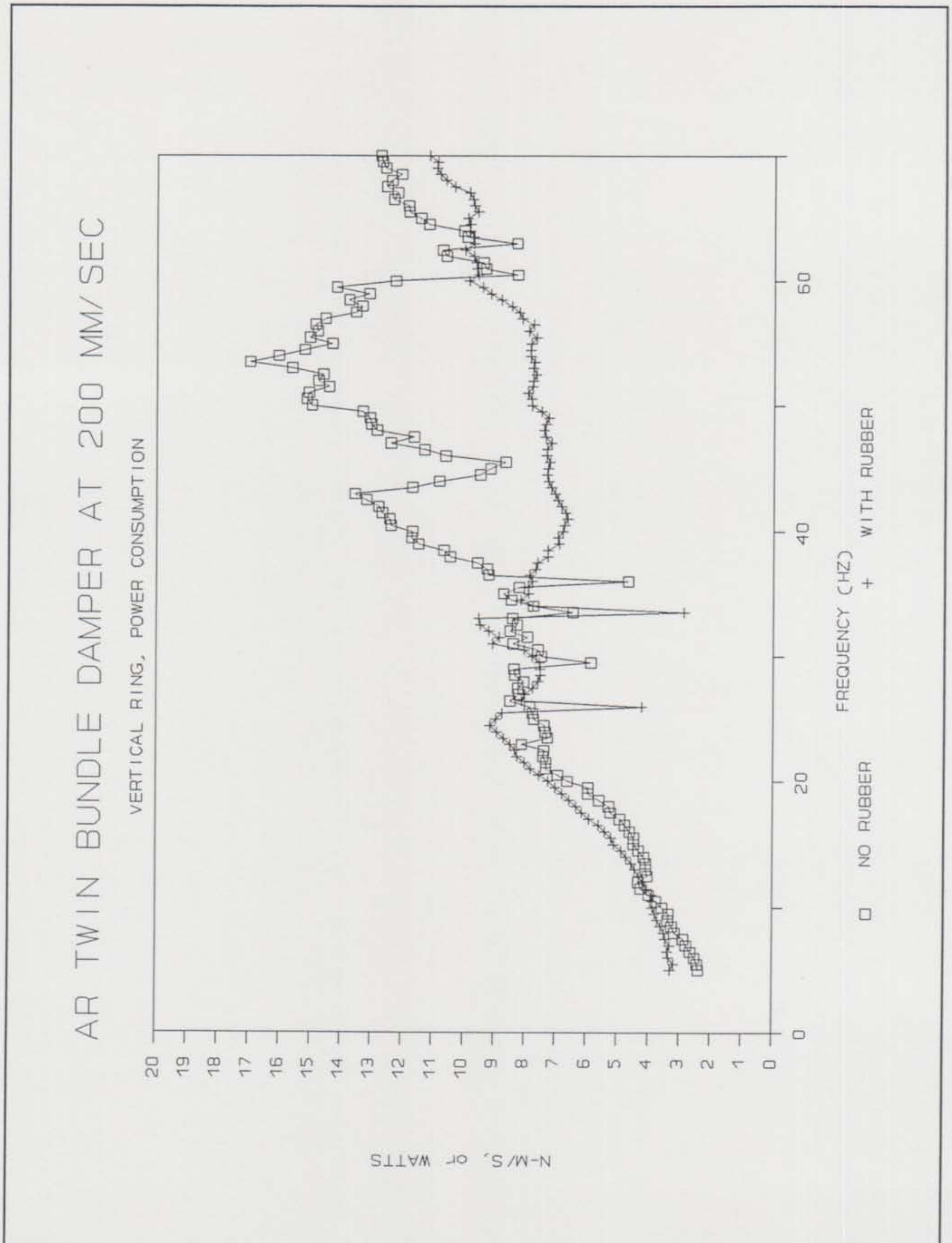


Figure 2, AR Mod 2-V Spacer/Damper, Comparison of Power Dissipation With and Without Rubber Elements, at 200 MM/Sec Peak Clamp Velocity

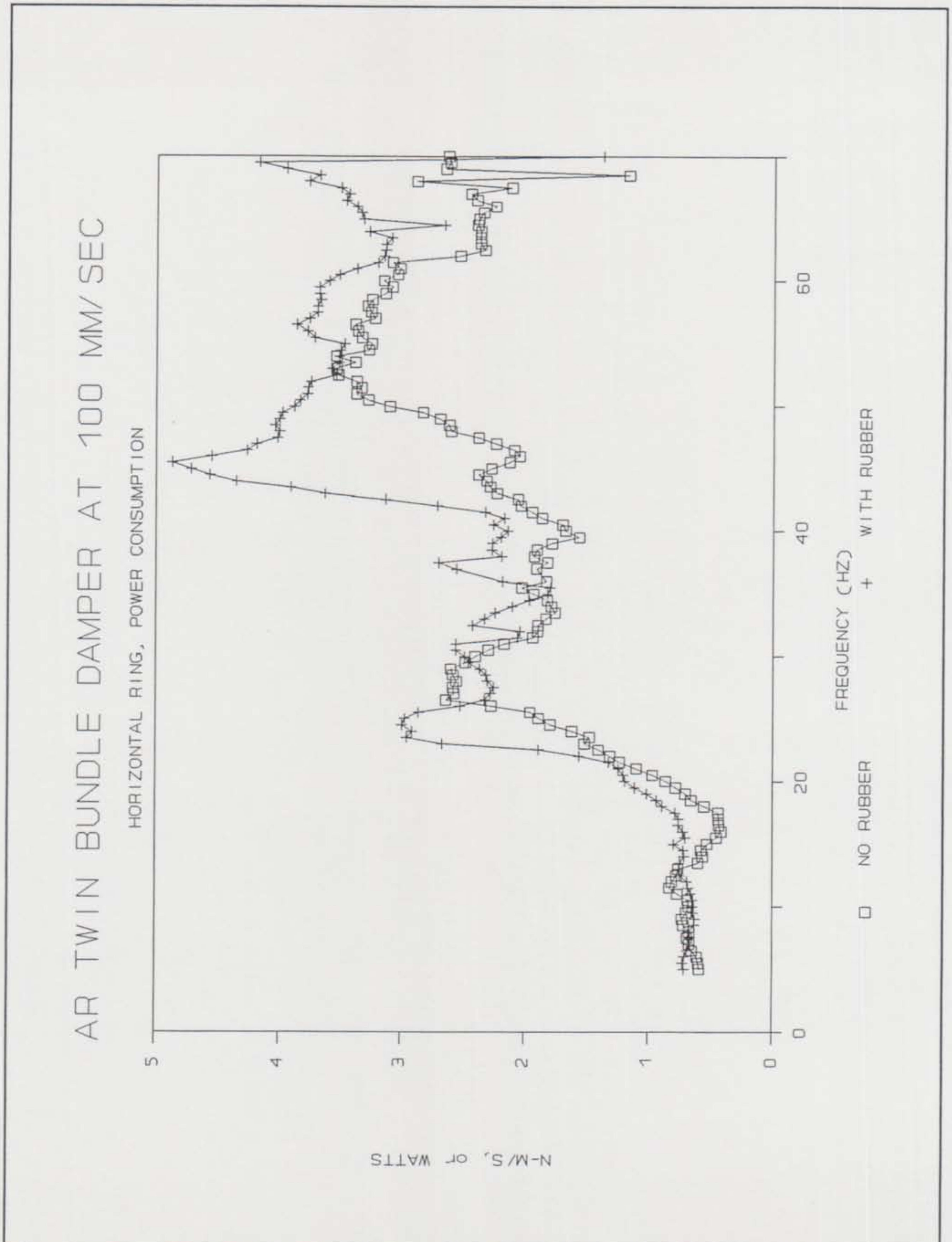


Figure 3, AR Mod 2-H Spacer/Damper, Comparison of Power Dissipation With and Without Rubber Elements, at 100 MM/Sec Peak Clamp Velocity

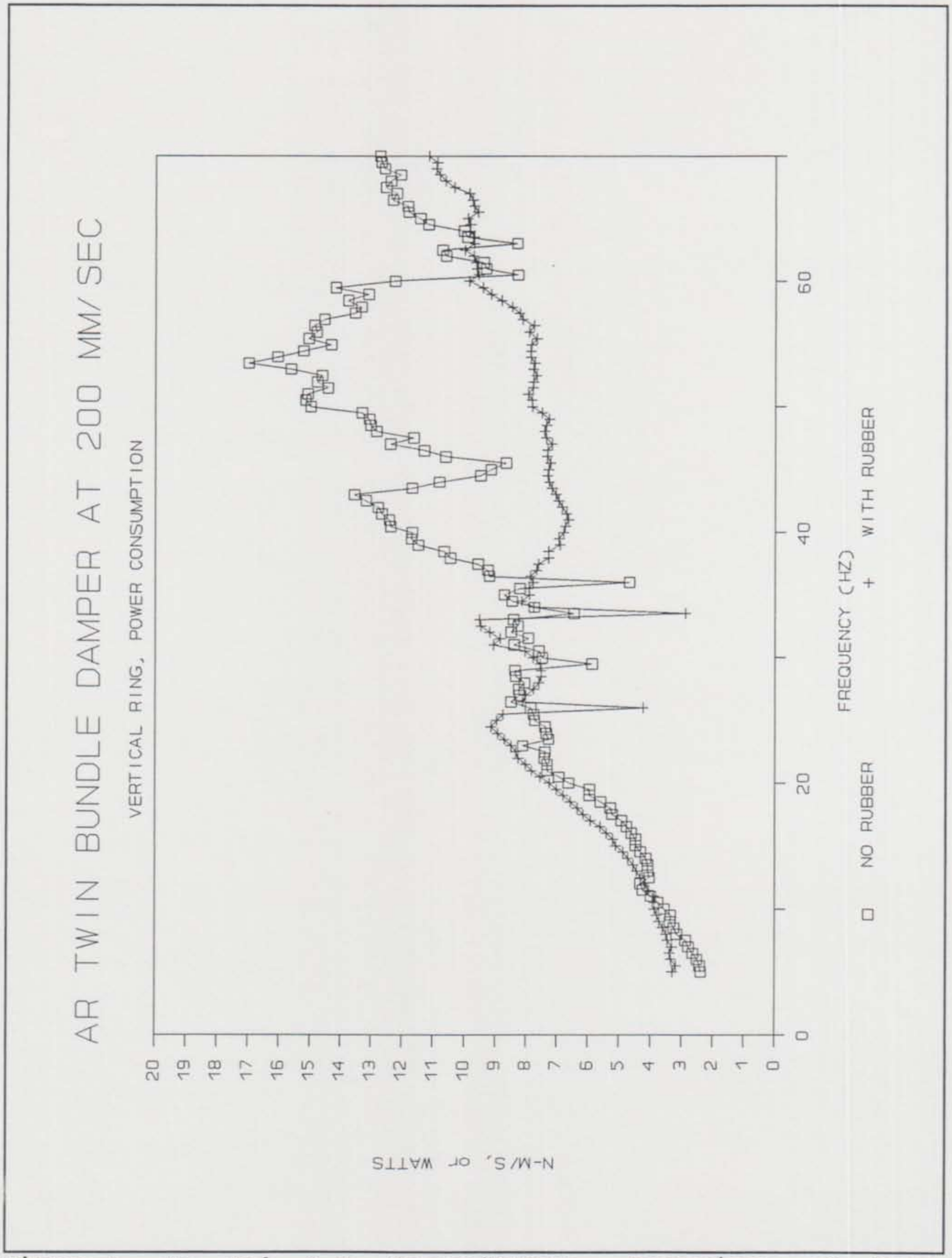


Figure 4, AR Mod 2-H Spacer/Damper, Comparison of Power Dissipation With and Without Rubber Elements, at 200 MM/Sec Peak Clamp Velocity

II. Mechanical Load Tests

The assembled damper was attached to the testing machine using a bolt through the conductor clamp. The bare ring was attached to the testing machine using anchor shackles. Crosshead travel was set to 0.5 inches per minute. A computer interface is used to record time, force, and crosshead displacement six times each second. Figure 5 is a plot of deflection versus force for the two tests.

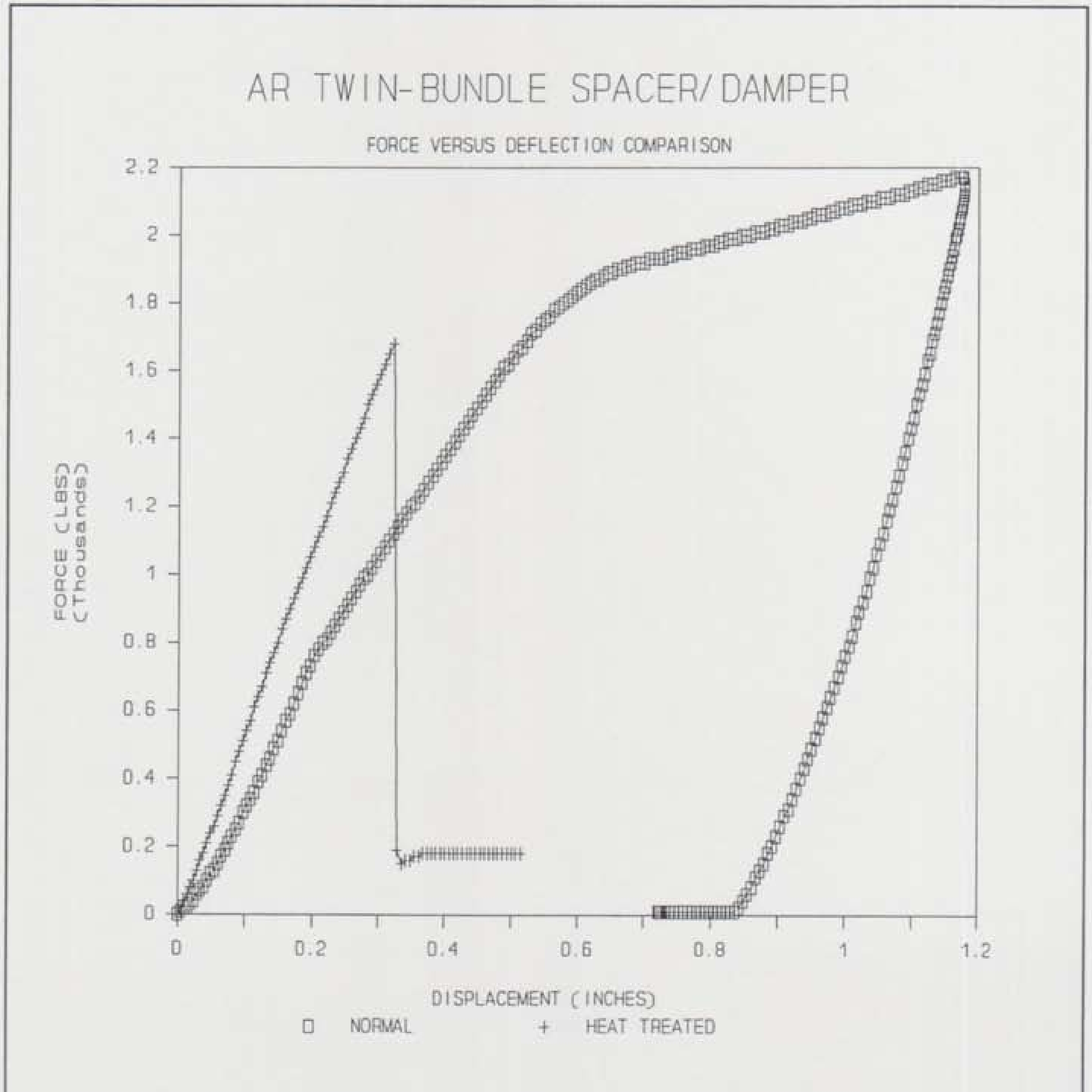


Figure 5, Force versus Deflection for Two Damper Rings

Conclusions:

Shaker table tests show the power dissipation of the damper in response to vibration of one of its clamps. The test is a simplification of the complex conductor/damper system. However, the test is simple, repeatable, and provides a basis of comparison for different damper designs. The tests show approximately equal performance for the damper in the vertical and horizontal configuration. Adding rubber damping elements changes the shape of the response curve. Overall damper performance is approximately the same both with and without the rubber washers.

Load tests show that heat treating is counterproductive, as it appears the weld was embrittled. If additional strength is needed, a different welding procedure should be used to ensure the ring is still ductile.