Use of Yerzley Oscillograph in Vibration Isolation

If you are working in vibration isolation with rubber pads and similar materials, you will find AYO-IV to be a versatile instrument. It allows you to estimate the natural frequency of your system as well as the static and dynamic spring constants and the amount of damping you can expect. By manipulating the location and number of weights, AYO-IV can be used to simulate the vibration isolation environment and determine the range of expected natural frequencies, spring constants, and damping. Figure 1 shows the results of a typical AYO-IV run.

Yerzley Resilience	42.733 percent
Resilience-SAE J16	62.108 percent
Yerzley Hysteresis	57.267 percent
Point Modulus	1387.583 lb./in2
Frequency	6.061 cycles/sec.
Dynamic Modulus	2665.075 lb./in2
Moment of Inertia	0.34660 slug-ft.sq
Impact Energy	22.538 in-lb/in3
Tangent of Delta	0.2343
Final Deflection	11.525 percent

Figure 1 Typical AYO-IV Analysis Results

Static spring constant (units lb./in) of a rubber pad can be defined as:

(Static Modulus) * Area / Height

Similarly, dynamic spring constant of a rubber pad is:

(Dynamic Modulus) * Area / Height

We use the parameters for "hard rubber B" as measured by AYO-IV and displayed in Figure 1. Let's say we have a 6000 lb. machine to be isolated by three rubber pads. Let's assume that we place these pads such that each pad carries roughly 1/3 of the weight; thus, each pad carries 2000 lbs. Let's say we are going to use round pads that are 1 inch thick with a diameter of 4 inches. Area = 12.566 in^2.

Static Spring Constant = 1387.6 lb./in^2 * 12.566 in^2 / 1 in. = 17,437 lb./in

Static Deflection = 2000 / 17437 = 0.115 in.

Interestingly, this is the same static deflection that was observed in the AYO-IV test shown in Figure 1.

The natural frequency of the spring-mass system is given by: $fn = \frac{1}{2\pi} * \sqrt{\left(\frac{Kg}{W}\right)}$

Where "fn" is cycles/sec. K is (lb/in), g is the acceleration of gravity 386in/sec. sq and W is the weight in lb.

In this case, we use the Dynamic Spring Constant Kd = 2665*12.566/1 => 33,488 lb/in.

The calculated natural frequency is: 12.795 cycles/sec. We can reduce the natural frequency by increasing the height and/or reducing the area of our pads.

Controlling the natural frequency is not the only means of vibration isolation; the other is damping. Damping is the dissipation of energy. In the case of elastomeric materials, energy is dissipated by internal friction by a mechanism known as "hysteretic damping". *Yerzley Hysteresis*, among the results, is a measure of this property.

--- Dynamic Parameters Compression Test Results
Machine ID: AYO-IV s/n: 131200C

Material Hard Rubber B
Test ID Verification test
Operator Nuri & Ismail
Test Date 12/07/13
Test Time 15:07:48

Specimen height:	0.500 in
Specimen area:	0.442 sq.in
Sampling Rate:	100.00 samples/sec
Test Duration:	3.00 seconds
Weights Forward:	8.00
Weights Middle:	0.00
Weights Rear:	0.00

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Figure 2 Dynamic Parameters Compression Test Results