TRIPARTITE SHOCK RESPONSE SPECTRA PLOTS

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Introduction

Shock response spectra are occasionally represented in terms of tripartite graphs in order to show the relative displacement, velocity and acceleration all on one graph. This format is useful for design purposes and for evaluating damage potential.

Earthquake Example

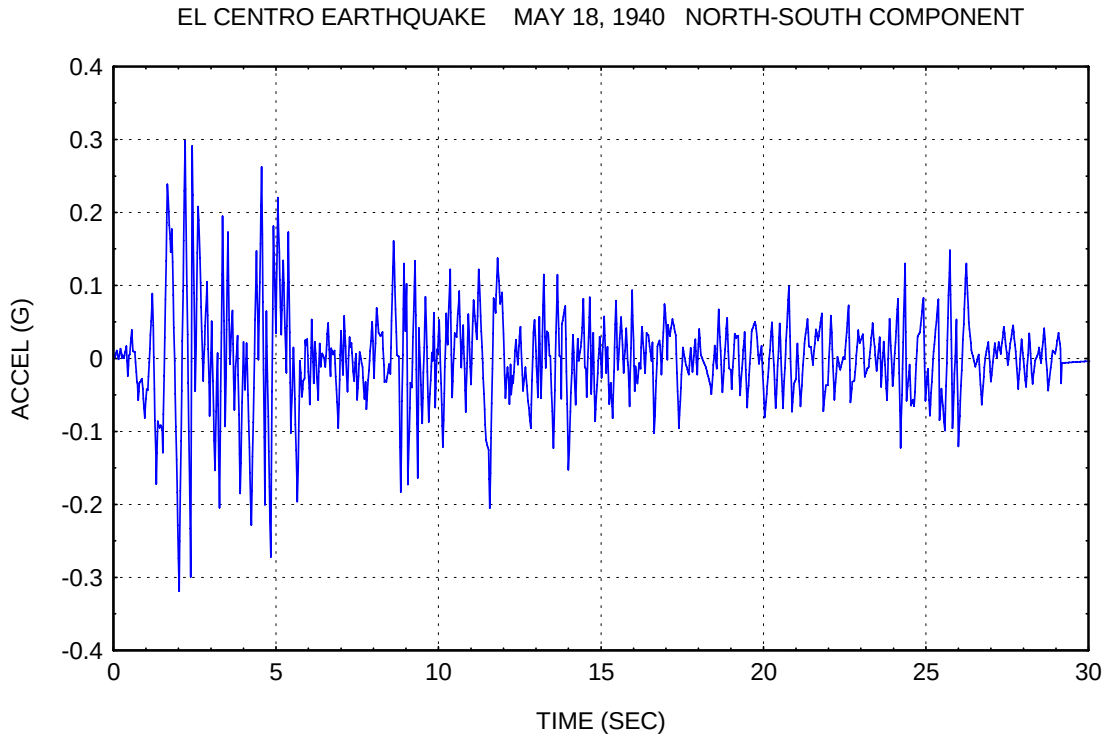

Figure 1.

A sample time history plot is shown in Figure 1. The corresponding tripartite shock response spectrum is shown in Figure 2.

SRS Q=10 El Centro Earthquake May 18, 1940 North-South Component

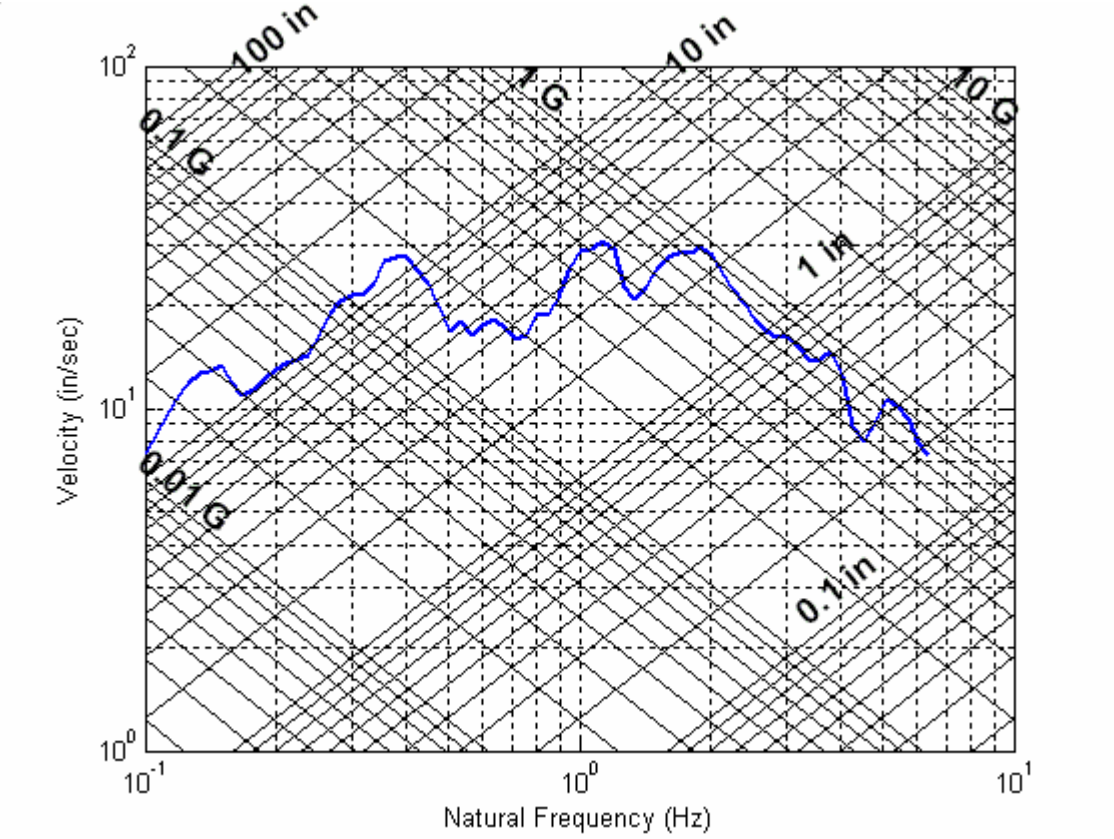

Figure 2.

Table 1. SRS Sample Coordinates		
Metric	1 Hz	2 Hz
Relative Displacement (in)	4.6	2.2
Velocity (in/sec)	28.6	28.0
Acceleration (G)	0.47	0.91

Both the velocity and relative displacement are pseudo entities.

The pseudo velocity is calculated by dividing the acceleration by the natural frequency in (radians/sec). Another method is to calculate the pseudo velocity by multiplying the relative displacement by the frequency in (radians/sec). The second method may be more conventional, but each is an approximation.

The relative displacement is calculated by dividing the velocity by the natural frequency in (radians/sec), although it could have been calculated directly.

The values in Table 1 show that the pseudo velocity is nearly the same for the two frequency cases.

The 1 Hz case has a higher relative displacement but a lower acceleration than the 2 Hz case.

More weight would be given to reducing the relative displacement if, say, the stress at the interface between the building and its foundation is the primary concern.

On the other hand, reducing the acceleration would be the priority if the main concern is the equipment in the building.

Rocket Motor Example

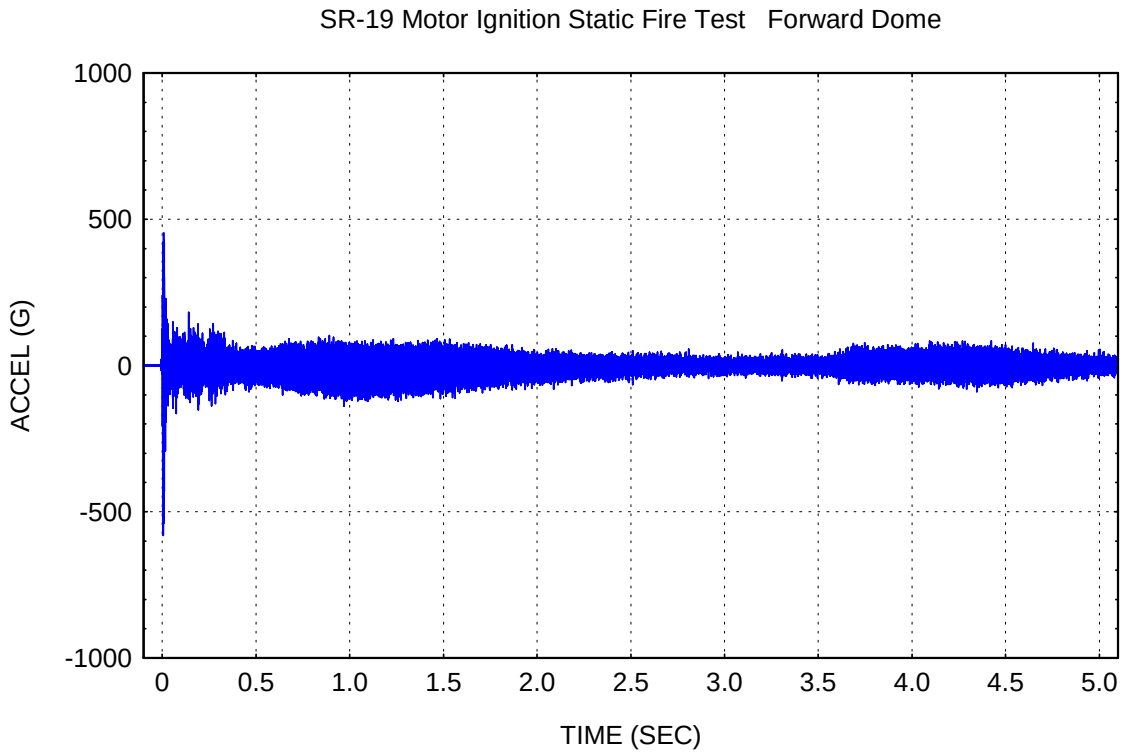

Figure 3.

SRS Q=10 SR-19 Motor Ignition Static Fire Test Forward Dome

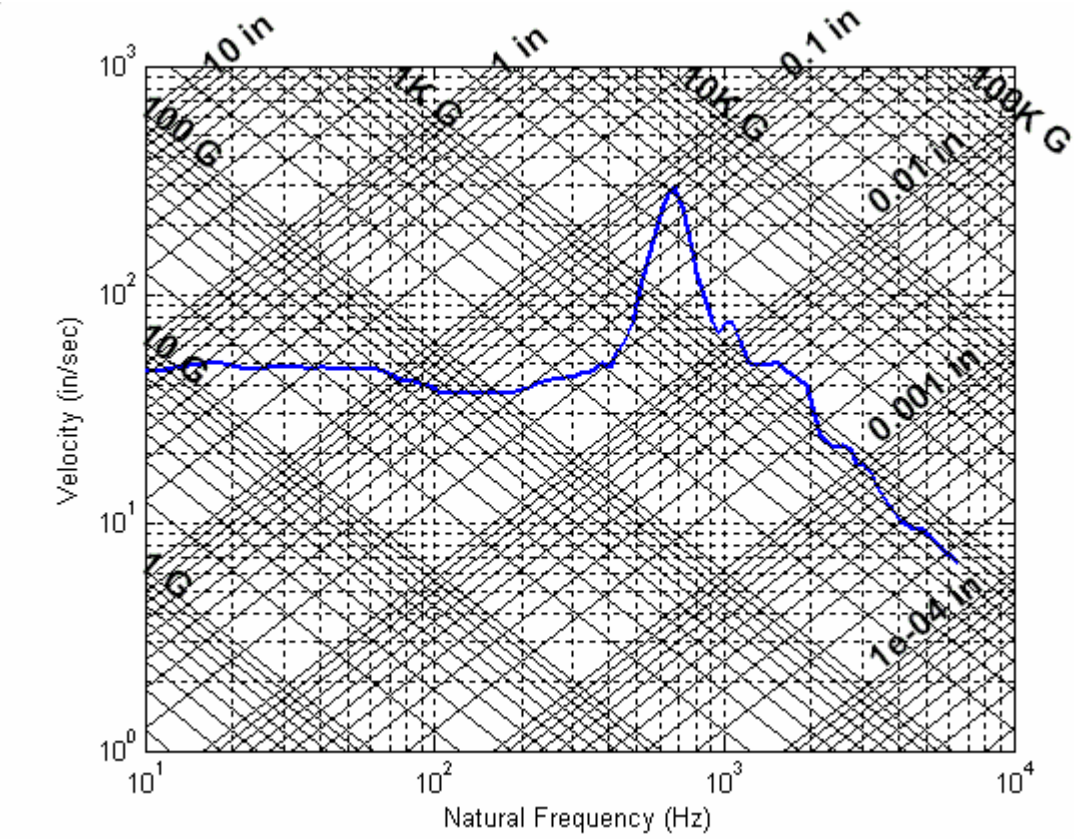

Figure 4.

Table 2. SRS Sample Coordinate	
Metric	680 Hz
Relative Displacement (in)	0.69
Velocity (in/sec)	294
Acceleration (G)	3250

The peak at 680 Hz is due to the SR-19 motor oscillation which results from a standing pressure wave in the combustion cavity.

References

1. T. Irvine, The Pseudo Velocity Shock Response Spectrum, Vibrationdata, 2007.
2. T. Irvine, Relative Displacement & Absolute Acceleration, Vibrationdata, 2007.