Solids Lab: Vibrations

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Contents

Beam Properties

```
l = 43.375; % in, length
w = 1.002; % in, width
t = 0.264; % in, thickness
x_accel = 0.386; % in, distance from tip to accelerometer
d = l - x_accel; % in, distance from accel to shaker
A = w*t; % in^2, cross-sectional area

% rhoMetric2rhoImperial = 0.00112287; % g/cm^3 -> slug/in^3
% rho = 2.7*rhoMetric2rhoImperial; % g/cm^3 -> slug/in^3, density
rho = 0.0975; % lb/in^3
E = 10e6; % psi, Elastic Modulus
I = (w*t^3)/12; % in^4, moment of inertia of the beam cross-section
g = 3.86; % gravitational acceleration
```

Theory

```
kn = [3.52, 22, 61.7, 121, 200];
theory_wns = round((kn/2*pi)*sqrt((E*I*g)/(rho*A*l^4))*100)/100 % Hz, natural frequencies
```

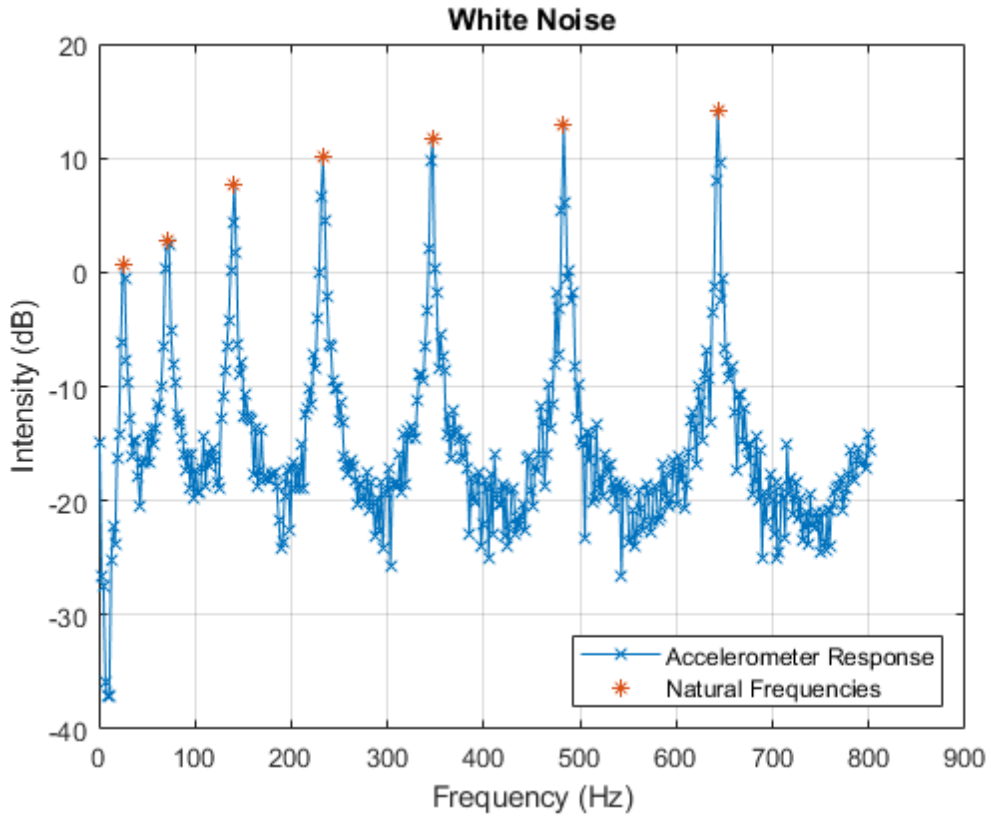
```
theory_wns =

    4.4600   27.8500   78.1100  153.1900  253.2100
```

White Noise

```
whiteNoise = struct();
whiteNoise.data = readtable('./Vibrations/whiteNoise-20samples.csv'); % HZ, DB

figure()
plot(whiteNoise.data.HZ, whiteNoise.data.DB, '-x', 'DisplayName', 'Accelerometer Response'); grid on;
[pks, locs] = findpeaks(whiteNoise.data.DB);
idxs = find(pks > 0.3);
```

```
whiteNoise.wns = whiteNoise.data.HZ(locs(idxs))' % Hz, frequencies of the peaks
hold on;
plot(whiteNoise.wns, pks(idxs), '*', 'DisplayName', 'Natural Frequencies')
xlabel('Frequency (Hz)');ylabel('Intensity (dB)');title('White Noise');
legend('location', 'southeast')
```

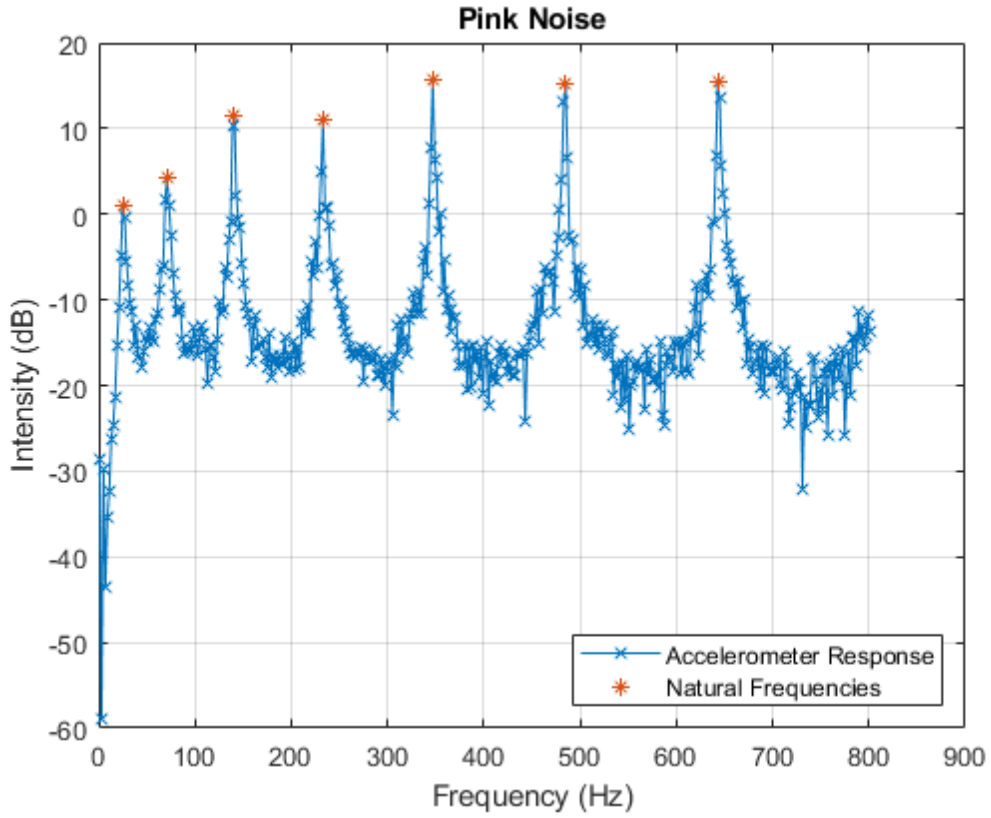
```
whiteNoise =

  struct with fields:

    data: [401×2 table]
     wns: [25 71 141 233 347 483 643]
```



Pink Noise

```
pinkNoise = struct();
pinkNoise.data = readtable('./Vibrations/pinkNoise.csv'); % HZ, DB

figure()
plot(pinkNoise.data.HZ, pinkNoise.data.DB, '-x', 'DisplayName', 'Accelerometer Response'); grid on;
[pks, locs] = findpeaks(pinkNoise.data.DB);
idxs = find(pks > 0.3);
pinkNoise.wns = pinkNoise.data.HZ(locs(idxs))' % Hz, frequencies of the peaks
hold on;
plot(pinkNoise.wns, pks(idxs), '*', 'DisplayName', 'Natural Frequencies')
xlabel('Frequency (Hz)');ylabel('Intensity (dB)');title('Pink Noise');
legend('location', 'southeast')
```

```
pinkNoise =

  struct with fields:

    data: [401×2 table]
     wns: [25 71 141 233 347 485 643]
```

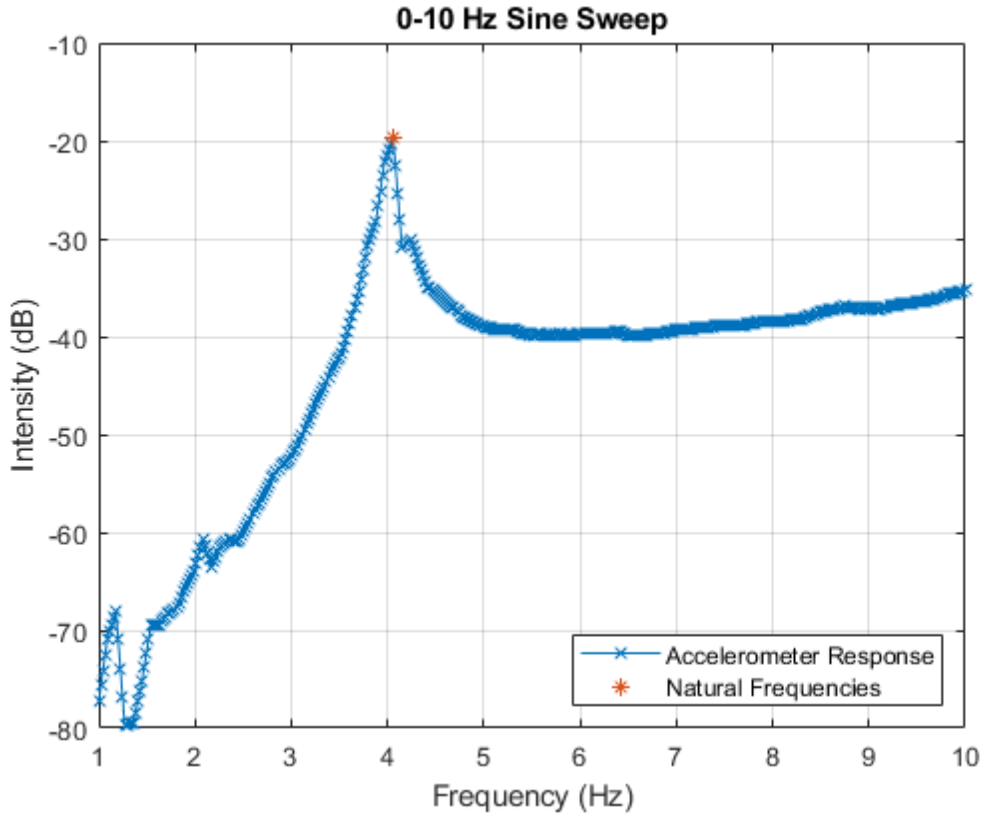


0-10 Hz Sine Sweep

```
sweep10 = struct();
sweep10.data = readtable('./Vibrations/SineSweep10Hz.csv'); % HZ, DB

figure()
plot(sweep10.data.HZ, sweep10.data.DB, '-x', 'DisplayName', 'Accelerometer Response'); grid on;
[pks, locs] = findpeaks(sweep10.data.DB);
idxs = find(pks > -20);
sweep10.wns = sweep10.data.HZ(locs(idxs))' % Hz, frequencies of the peaks
hold on;
plot(sweep10.wns, pks(idxs), '*', 'DisplayName', 'Natural Frequencies')
xlabel('Frequency (Hz)');ylabel('Intensity (dB)');title('0-10 Hz Sine Sweep');
legend('location', 'southeast')
```

```
sweep10 =

  struct with fields:

    data: [401×2 table]
```

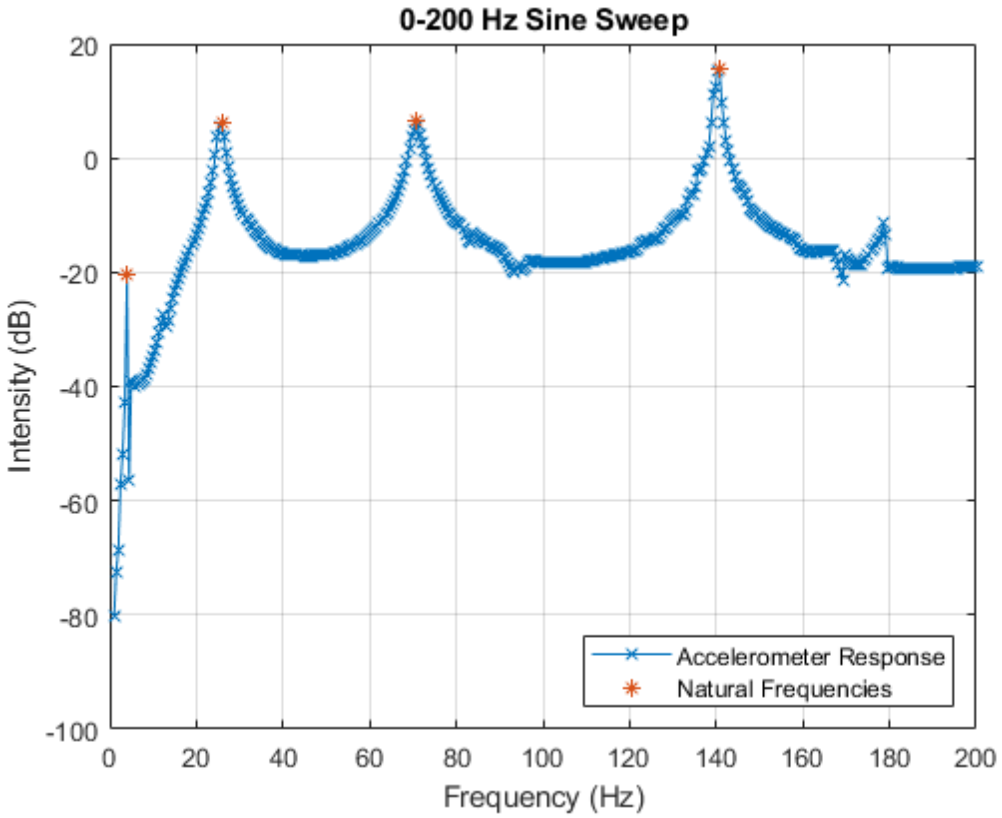
```
    wns: 4.0600
```



0-200 Hz Sine Sweep

```
sweep200 = struct();
sweep200.data = readtable('./Vibrations/SineSweep200Hz.csv'); % HZ, DB

figure()
plot(sweep200.data.HZ, sweep200.data.DB, '-x', 'DisplayName', 'Accelerometer Response'); grid on;
[pks, locs] = findpeaks(sweep200.data.DB);
idxs = 1; % Keep first peak as well, even though it's smaller
idxs = [idxs, find(pks > 0)'];
sweep200.wns = sweep200.data.HZ(locs(idxs))' % Hz, frequencies of the peaks
hold on;
plot(sweep200.wns, pks(idxs), '*', 'DisplayName', 'Natural Frequencies')
xlabel('Frequency (Hz)');ylabel('Intensity (dB)');title('0-200 Hz Sine Sweep');
legend('location', 'southeast')
```

```
sweep200 =

  struct with fields:

    data: [401×2 table]
     wns: [3.9850 25.8700 70.6500 140.8000]
```



First Five Natural Frequencies

```
wns = [
    mean([sweep10.wns(1), sweep200.wns(1)]),...
    mean([sweep200.wns(2), whiteNoise.wns(1), pinkNoise.wns(1)]),...
    mean([sweep200.wns(3), whiteNoise.wns(2), pinkNoise.wns(2)]),...
    mean([sweep200.wns(4), whiteNoise.wns(3), pinkNoise.wns(3)]),...
    mean([whiteNoise.wns(4), pinkNoise.wns(4)])...
]
```

```
wns =

    4.0225   25.2900   70.8833  140.9333  233.0000
```

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