

**Federal Building and Fire Safety Investigation
of the World Trade Center Disaster**

Post-Impact Frequency Analysis

September 14, 2005

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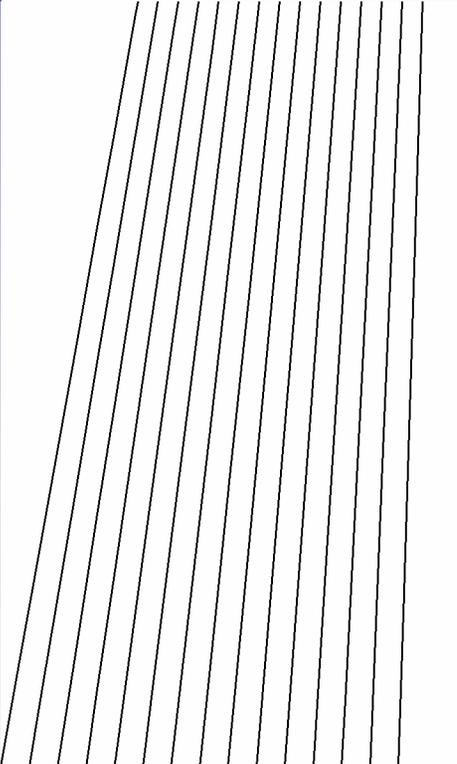
Video shot from east of WTC 1 and 2



Video Closeup of WTC 2

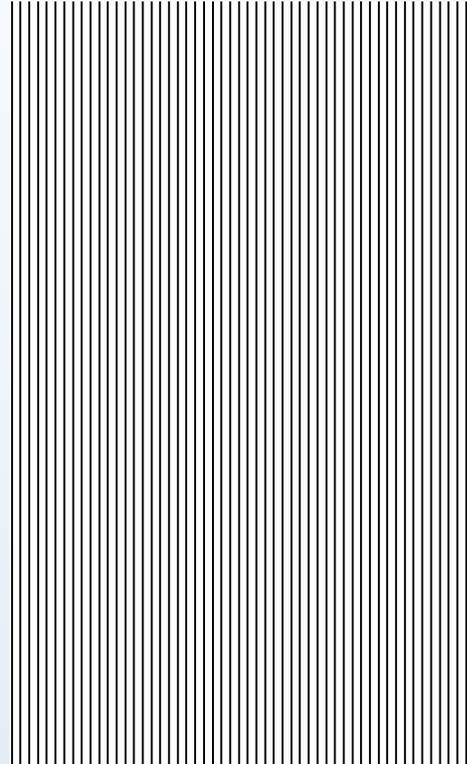


Moiré Pattern



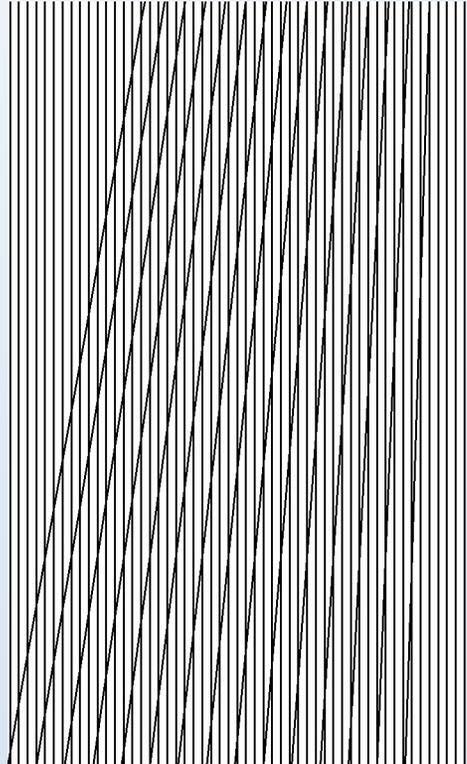
Window Lines

+



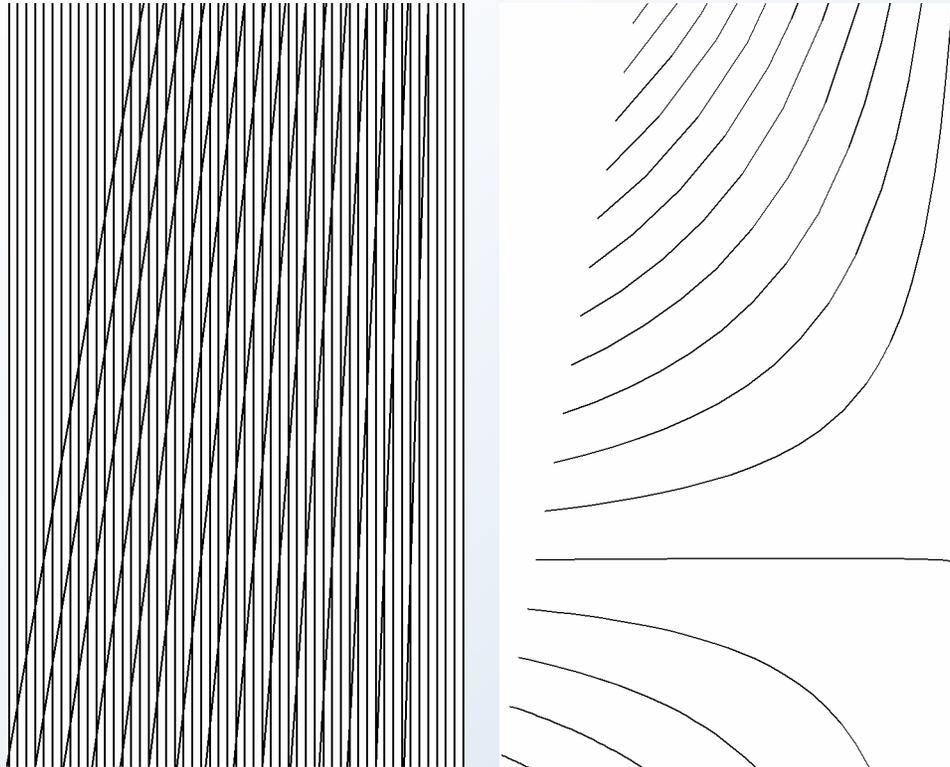
Pixel Columns

=



Moiré Pattern

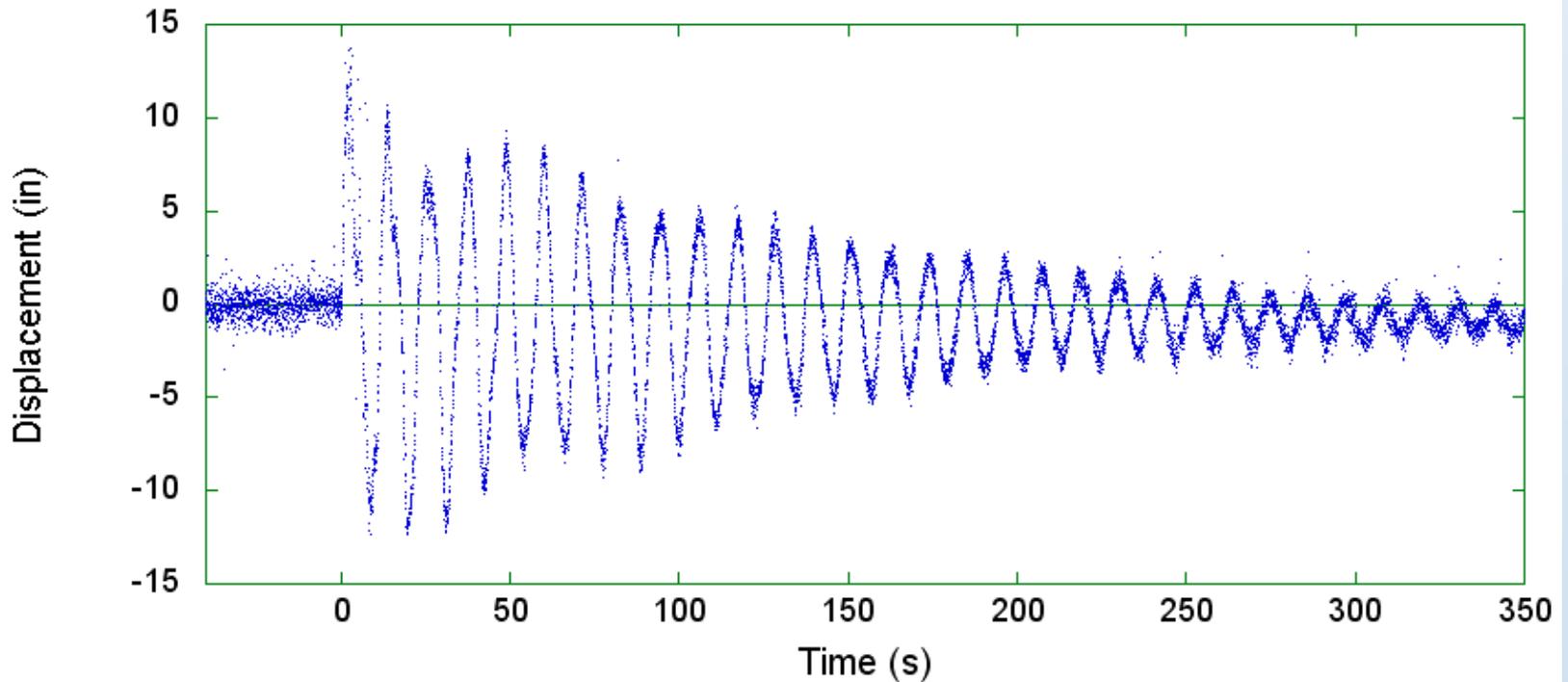
Moiré Pattern Equation



Parameters:

Displacement
Window spacing
Left angle
Angle increment

Displacement at 70th floor of WTC 2



Results

Mode of vibration	Structural Model	Video Analysis
Fundamental N-S mode with P-Delta Effects	11.2 s	11.4 s
First torsional mode	5.2 s	5.3 s
Second translational mode	3.8 s	3.9 s
Second torsional mode	2.4 s	2.1 s

Initial sway in N-S direction	Amplitude
70th floor	12 in. ± 1 in.
Roof level	22 in. ± 5 in.

Contributors

- NIST
 - ❑ **Dr. William Pitts** led the collection of visual material under Project 5 and identified the potential of one videotape to study building vibrations
 - ❑ **Dr. James Filliben** performed the spectral analysis to extract vibrational modes from the raw data