APPENDIX AB

Albuquerque, New Mexico (2012)

Vibratory Roller Compaction

Abeel_2012

Figure AB-1 – Photograph of the residential structure in Albuquerque, New Mexico

Background

This report presents the structural and crack response of a 80-year old, one-story adobe house (Figure AB-1) to construction activities involving vibratory rollers and the long-term effects of weather on crack motions. The structure was instrumented with single-axis velocity geophones to measure whole structure and mid-wall vibratory motions during road compaction. Displacement-type gauges were used to measure the movement of an existing exterior wall crack and a section of un-cracked wall material. A single exterior tri-axial geophone was buried in the ground outside the structure to record ground motions. Locations of instrumentation are shown in Figure AB-2. Context and details of instrumentation are shown in Figures AB-3 and AB-4.

Ground and structure motions were recorded during roller compaction of the road adjacent to the house on April 18, 2011. The highest amplitude of ground vibrations at the structure was measured to be 0.48 in/s with a frequency of 32 Hz.

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Figure AB-5 compares the USBM RI 8507 vibration control limits to peak particle velocities (PPV) and frequency of ground motion at the PPV (peak frequency) by the house. The maximum ground velocities recorded adjacent to the structure fall below the control limit, shown as the thick line, at which cosmetic cracking may begin.

A total of 54 triggered events occurred during compaction using several types of vibratory rollers. Of these events, 4 typical occurrences were studied in depth. Table AB-1 presents the strain levels that were caused in the structure by the ground vibration excitation events. The values of strains are compared to the peak to peak crack response opening as well as the differential wall displacement and PPV's.

Long-term changes in the crack width due to fluctuations in temperature and humidity were measured and recorded on an hourly basis throughout the week between April 13th, 2011 and April 18th, 2011. Changes in crack width were plotted against time and shown in Figure AB-6 (bottom plot) in comparison to changes in temperature (top plot) and relative humidity (middle plot).

The largest half-day movement was 8081.5 micro-in, and overall movement was 9227 micro-in. These daily crack width changes are far greater than 595.5 micro-in, the largest dynamic change during any compacting event.

The instrumentation of the residential house and the observation of the structural and crack response occurred over a period of a week during which vibratory rollers were used to compact an adjacent road. These measurements showed that the change in temperature and humidity are more than 15 times greater than any ground motion that occurred during work.

Reference:
Abeel, Pierre-Alexandre. *Building and Crack Response to Blasting, Construction Vibrations, and Weather Ef-fects.* Master of Science Thesis, Department of Civil & Environmental Engineering, Northwestern University, 2012.

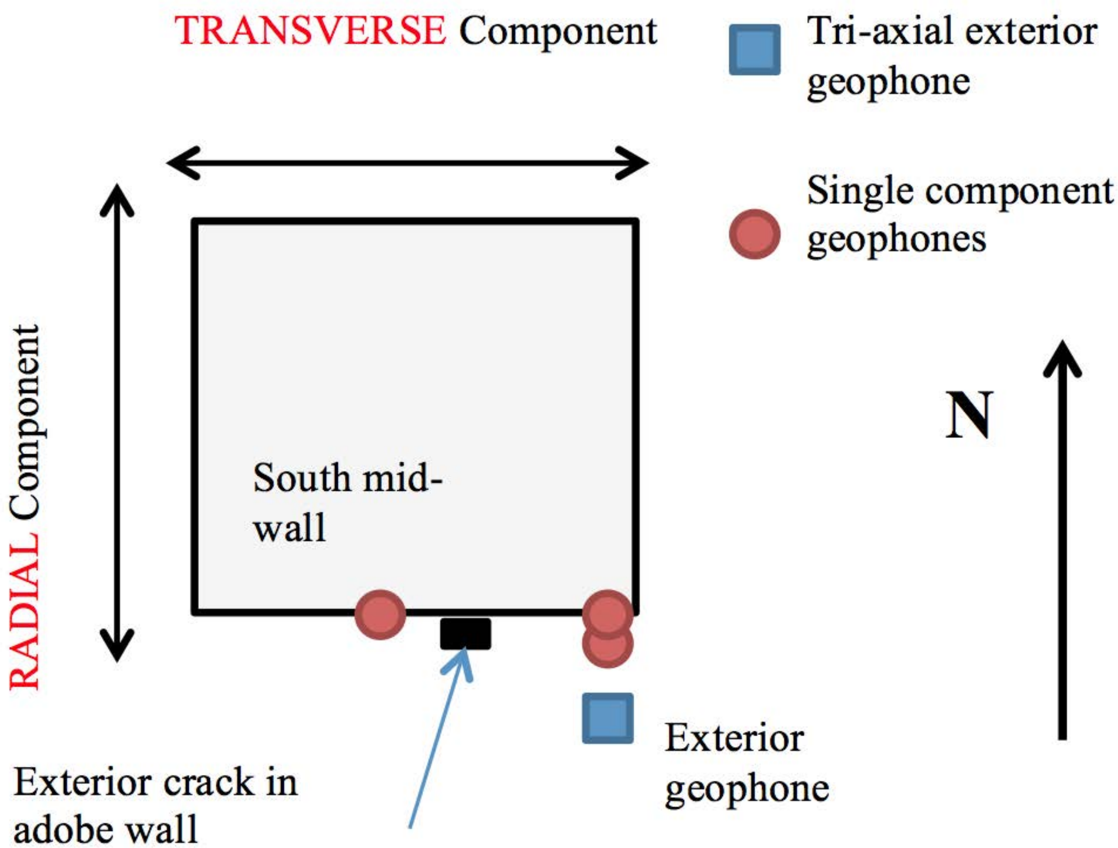

Figure AB-2 - Specific instrumentation locations on south wall

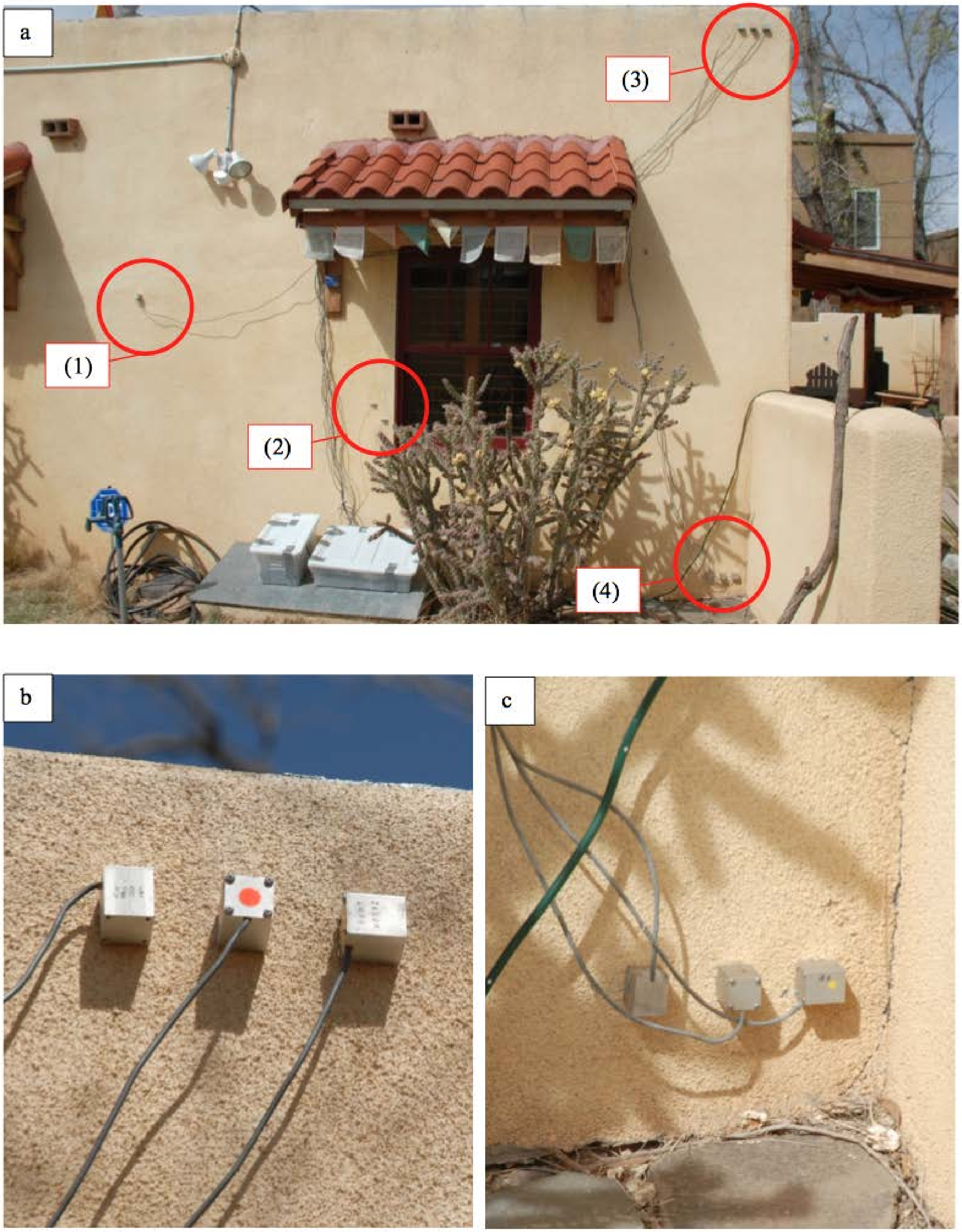

Figure AB-3 - Exterior south wall instrumentation (a), with Midwall sensor (1), Crack gauges (2) and upper (3)(b) and lower (4)(c) cluster of single axis motions sensors

Figure AB-4 - Crack displacement gauges mounted over an existing crack and un-cracked wall section

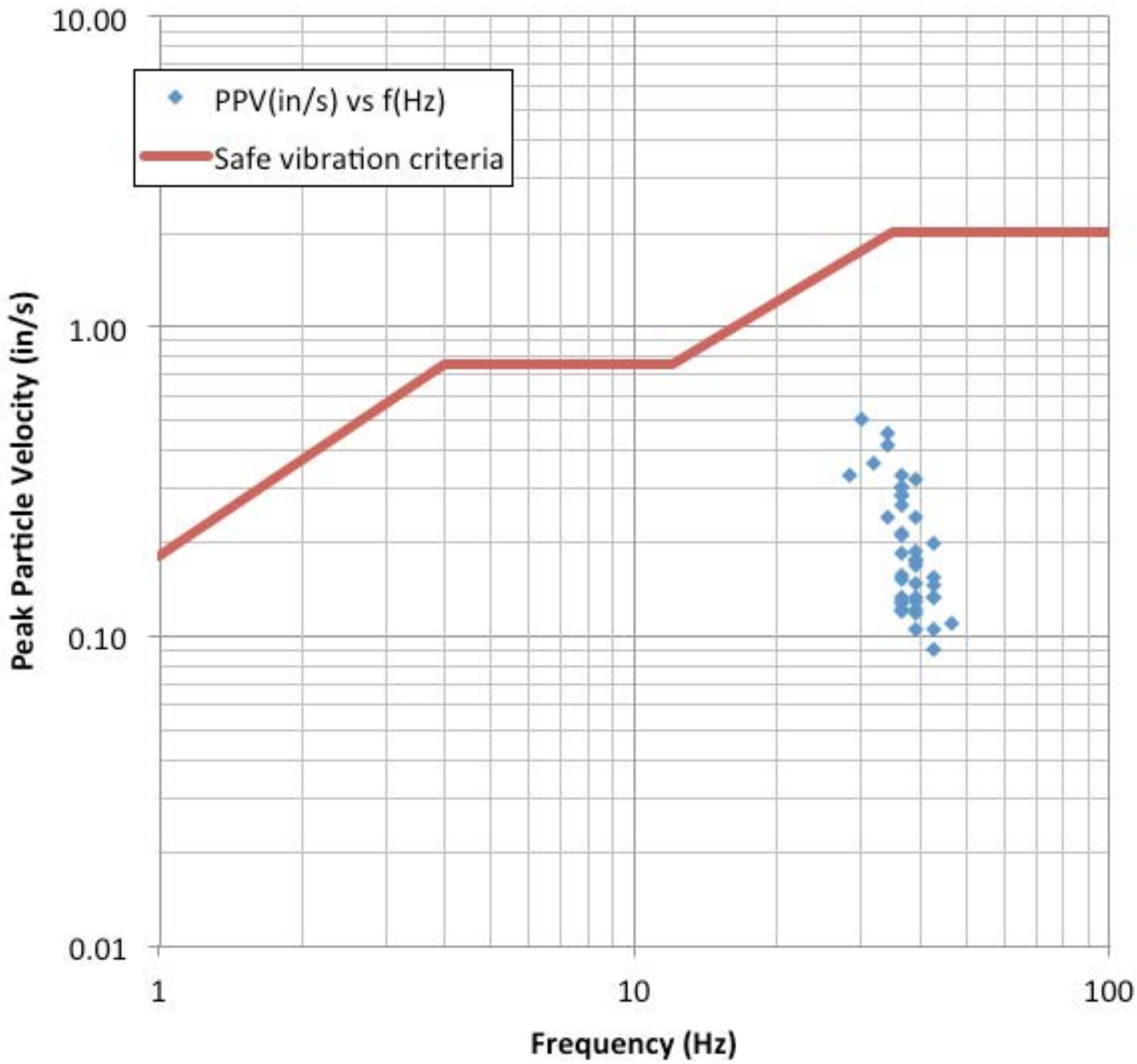

Figure AB-5 - Peak particle velocity versus frequency at the peak velocity showing threshold damage limits

Event #	Shear (µstrains)		In-plane tensile (µstrains)		Bending (µstrains)	Maximum crack opening	Maximum differential wall displacement, S2-S1 (10^{-3}in)		Maximum ground velocity (in/s) (zero-to-peak)		
	South wall	East wall	South wall	East wall	South wall	(µinches) (peak to peak)	Radial (NS)	Transverse (EW)	[T]	[R]	[V]
1	33.72	28.87	14.93	11.79	13.95	595.5	2.934	2.512	0.11	0.48	0.14
2	27.88	26.00	12.34	10.62	11.53	108.6	2.425	2.262	0.12	0.13	0.08
3	6.68	2.83	2.96	1.16	2.76	103.6	0.581	0.246	0.024	0.116	0.055
4	3.78	7.25	1.68	2.96	1.57	255.7	0.329	0.631	0.040	0.085	0.070

Table AB-1 - Summary of wall strains and maximum crack motions for vibration events relative to excitations ground motions

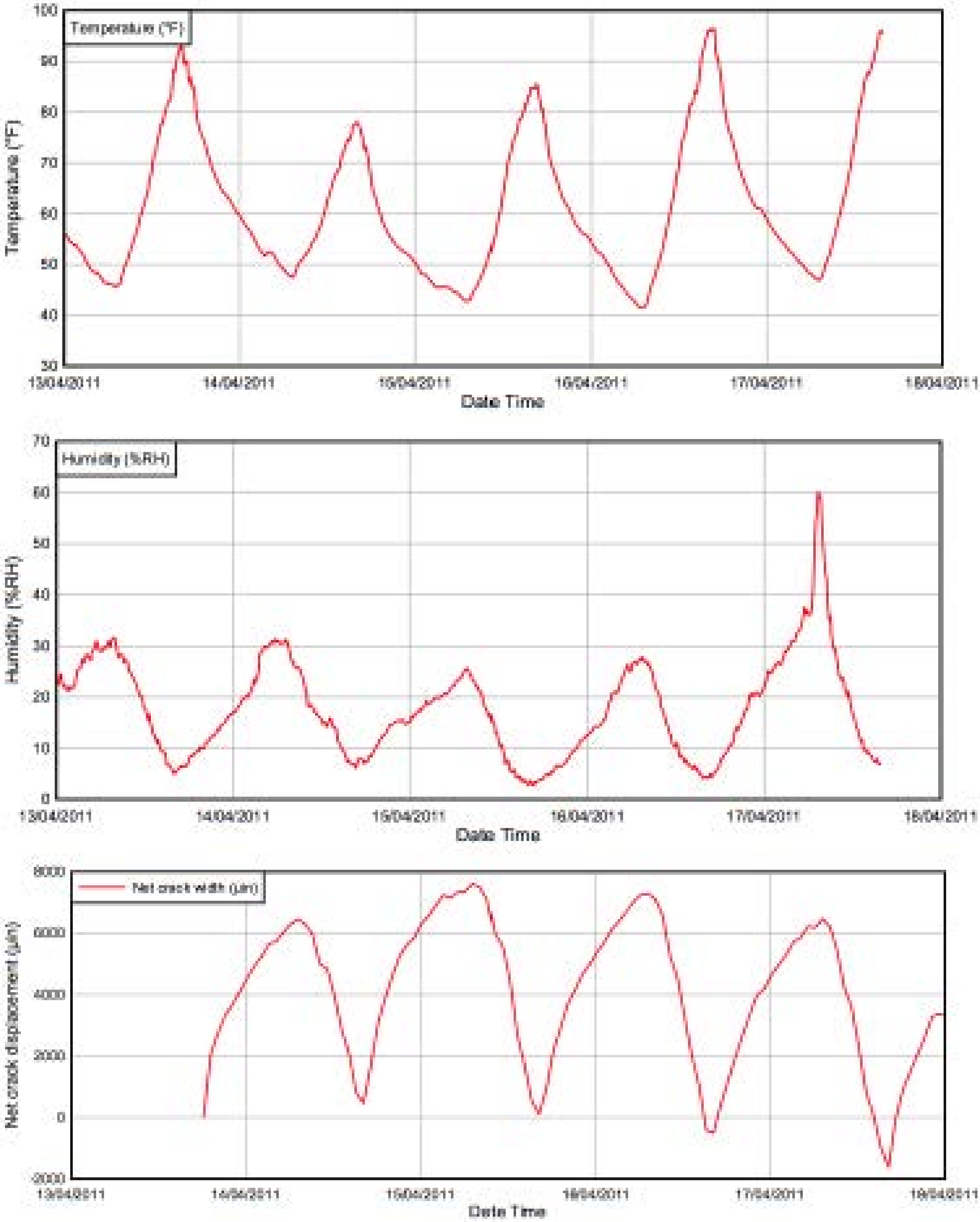

Figure AB-6 - Variations in ambient temperature, humidity, and corresponding net crack displacement over 6 days