APPENDIX SY

Sycamore, Illinois (2012)

Quarry Blasting

Abeel_2012

Figure SY-1 – Photograph of the residential structure in Sycamore, Illinois

Background

This report presents structural and crack response of a two-story wood-framed residential structure with a basement foundation (Figure SY-1) situated on the property of an aggregate quarry in Sycamore, Illinois. It is located approximately 300 feet (91m) away from the edge of the blasting zone. Structural and crack response is autonomously measured by the combination of sensors as shown in Figure SY-2. Context and details of the instrumentation are displayed in Figure SY-3.

Long-term crack response is measured every hour as the average of a burst of 1000 sample in one second. This hourly data is represented by the red, highly variable line in Figure SY-4. The less variable blue line is a 24-hour central moving average (CMA) of the hourly data, which shows the response to weather fronts. The even less variable black line is a 30-day CMA of the hourly data, which shows the response to seasonal trends.

SYCAMORE, IL

Time histories for both crack and structural responses are presented in Figure SY-5 for two blasts. The first (top graph) was recorded on September 20, 2010 with a maximum PPV of 0.219ips (5.6mm/s) in the vertical direction. The second (bottom graph) was recorded on May 19, 2011 with a maximum PPV of 0.523ips (13.3mm/s) in the transverse direction.

Crack responses to the unplanned entrance of someone into the house are shown in Figure SY-6. Comparison with planned events shows that the entrance was probably by the front door. The maximum zero to peak response in the shear crack is 111 μin, 123 μin for the ceiling crack, and 37 μin for the seam.

During the fall of 2012, the house thermostat was turned off, thus ending the temperature regulation inside the house. As shown in Figure SY-7 the inside temperature had a 13°F drop in one day on October 26th. After that, the temperature kept varying following a daily cycle, but at values much lower than when the heat was on. Peak values of the crack response can be measured relative to average values during the 5 week period presented on Figure SY-7 to show that the absence of inside temperature regulation caused a response comparable to the largest seasonal response observed during the 30 month study.

Weather patterns, particularly involving wind, induced crack responses that were often just as strong as the responses induced by blasting. Wind gusts triggered disturbances in the Air Overpressure sensor. Figure SY-8 shows an example of a response in the Air Overpressure sensor and the simultaneous crack displacements for all 3 cracks. Any crack displacements with corresponding activity of the Air Overpressure sensor were categorized as "wind events".

Blast induced crack responses are compared to long-term environmental effects and occupant induced activities in Figure SY-9. Long-term response is at least an order of magnitude larger than any of the dynamic responses, even those produced by ground motions as high as 0.5ips (12.7mm/s).

Crack response to environmental variations is overwhelmingly larger than that produced by blast induced ground motion and associated air overpressure pulses. Seasonal variations and even the passing of weather fronts can produce crack response that is larger by at least an order of magnitude. Turning off the heat inside the house in the fall can cause crack response of that order of magnitude as well, but over periods of time as short as a week. Observation of occupant activity and wind gust events shows that both can produce crack response as large as that produced by blast induced ground motions.

Reference:

Abeel, Pierre-Alexandre. *Building and Crack Response to Blasting, Construction Vibrations, and Weather Effects.* Thesis. Northwestern University, 2012.

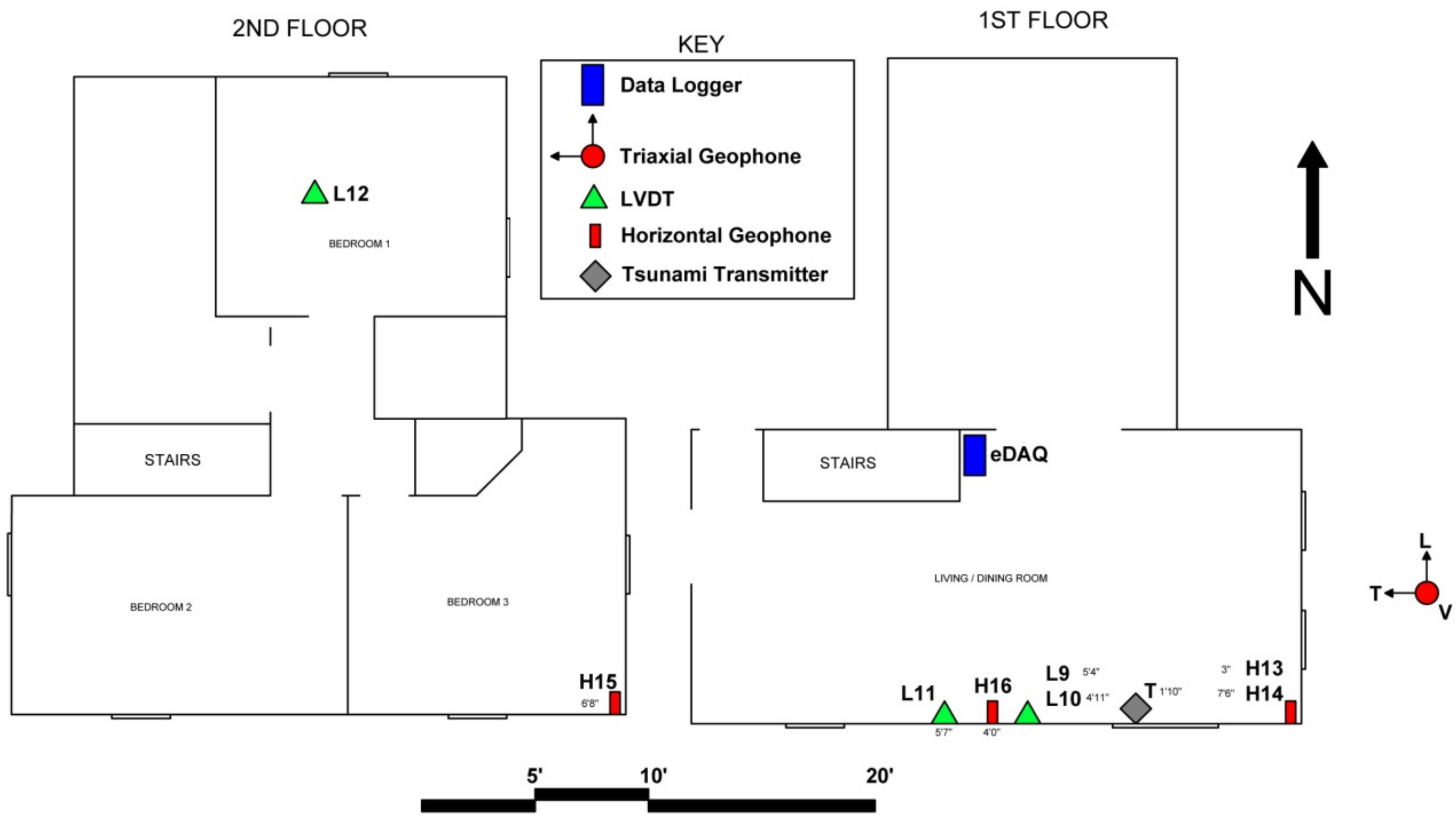
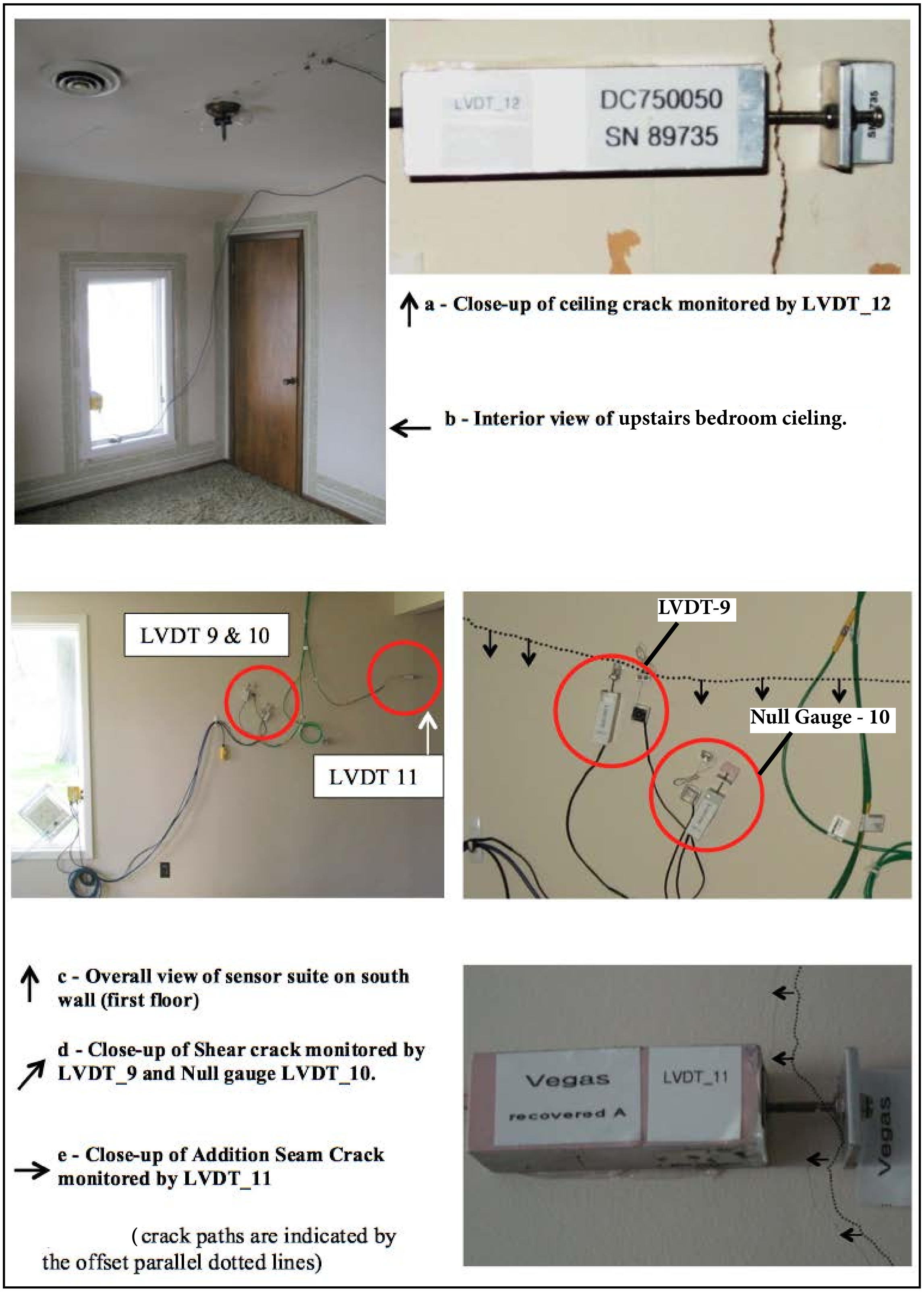


Figure SY-2 - Exact sensor and equipment locations in the house.



↑ **a - Close-up of ceiling crack monitored by LVDT_12**

← **b - Interior view of upstairs bedroom cieling.**

↑ **c - Overall view of sensor suite on south wall (first floor)**

↗ **d - Close-up of Shear crack monitored by LVDT_9 and Null gauge LVDT_10.**

→ **e - Close-up of Addition Seam Crack monitored by LVDT_11**

(crack paths are indicated by the offset parallel dotted lines)

Figure SY-3 - Installation context and details for the house.

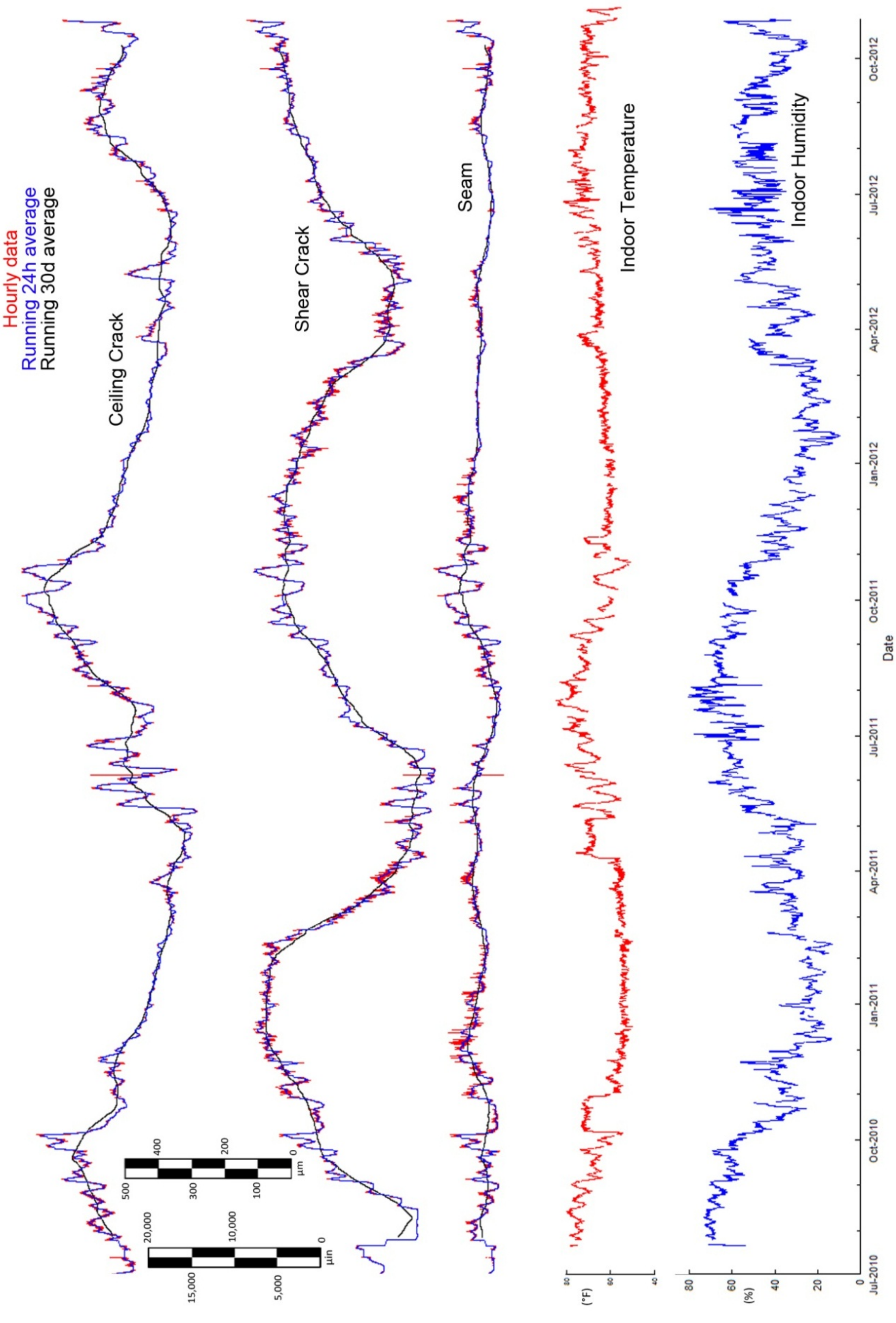


Figure SY-4 - Comparison of the crack response with the variation in indoor temperature and humidity

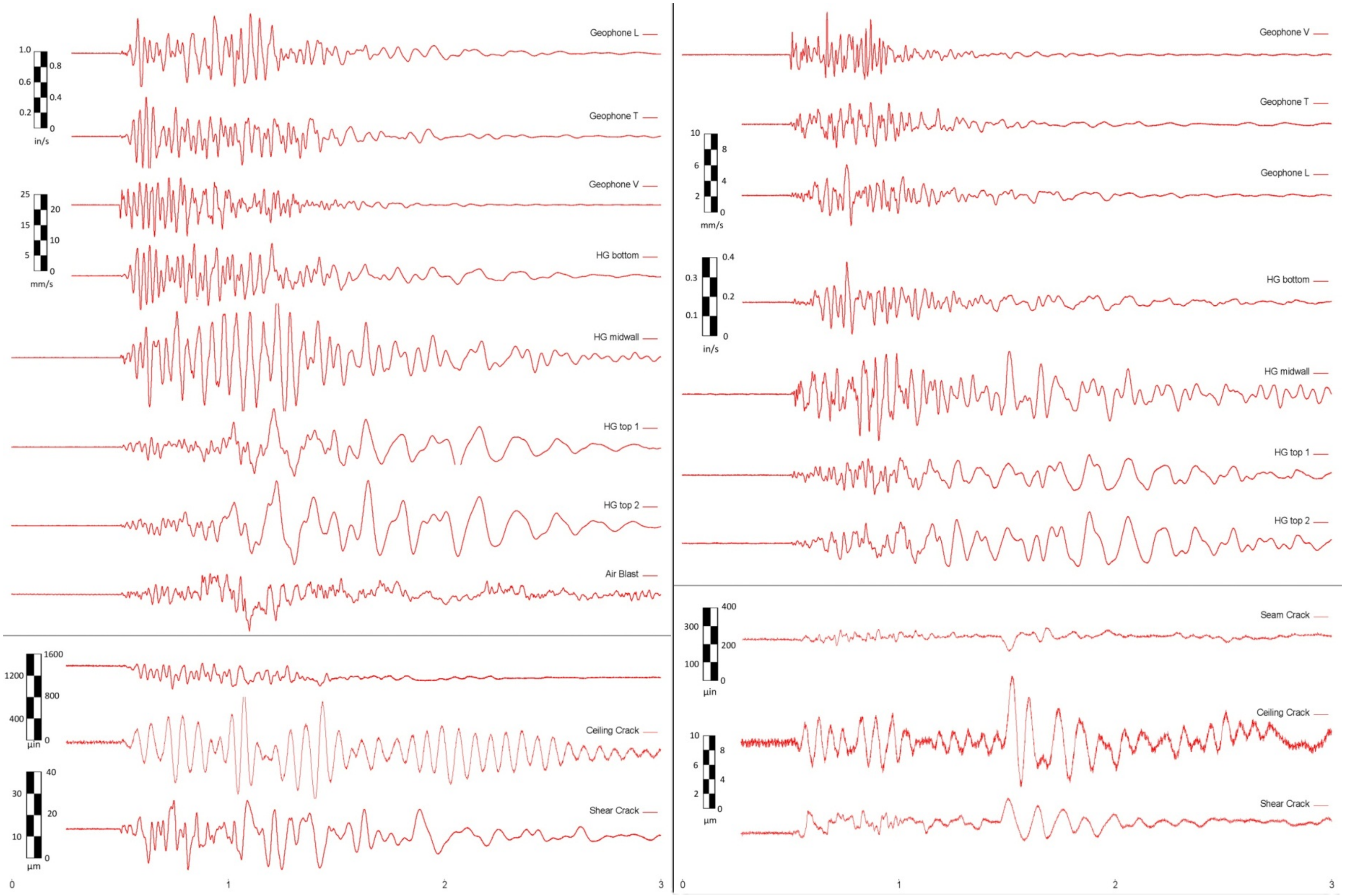


Figure SY-5 - Structural and crack response time histories to blast events on Sep 20, 2010 (top) and May 19, 2011 (bottom). All measurements are zero-to-peak.

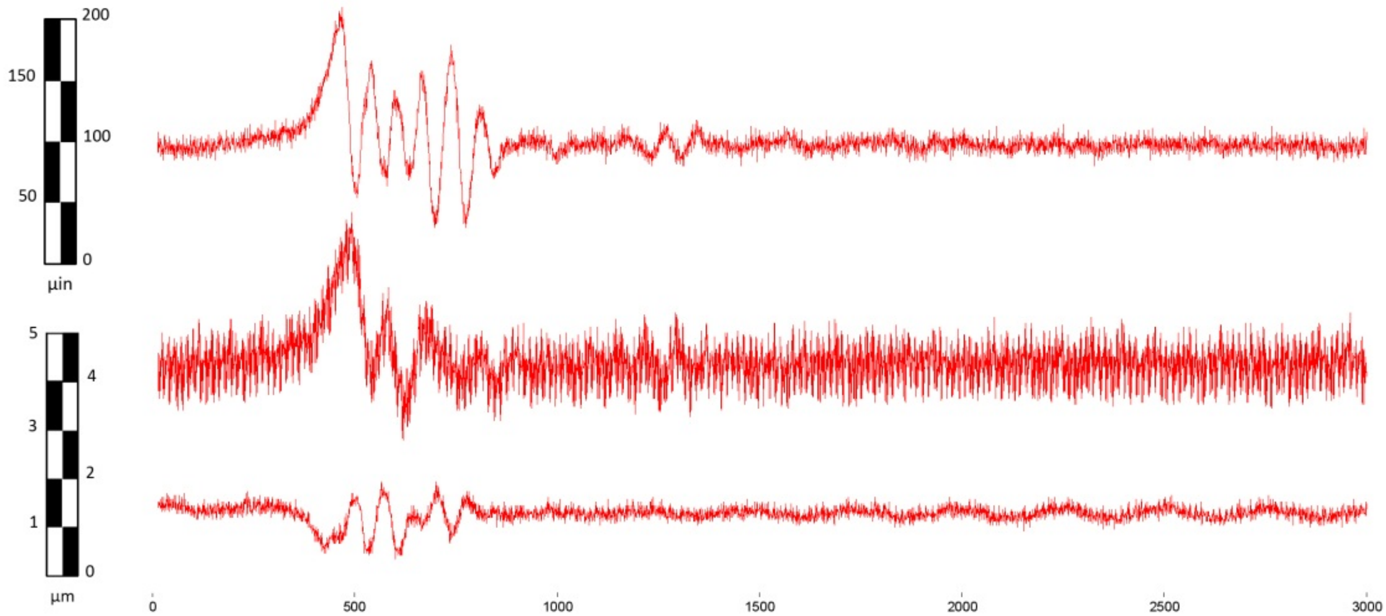


Figure SYI-6 - Crack response from opening the front door on the first floor

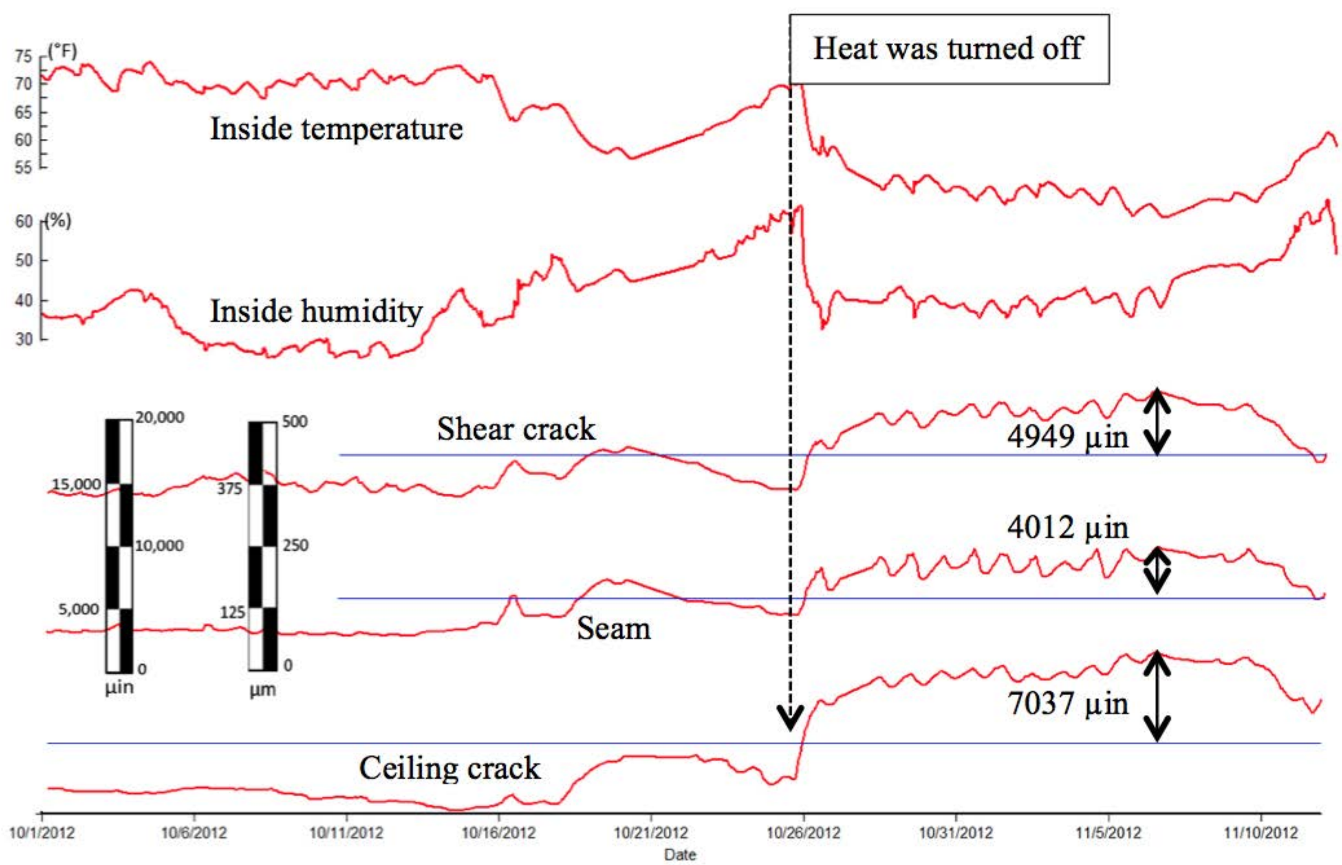


Figure SY-7 - Influence on the inside temperature regulation during the fall of 2012

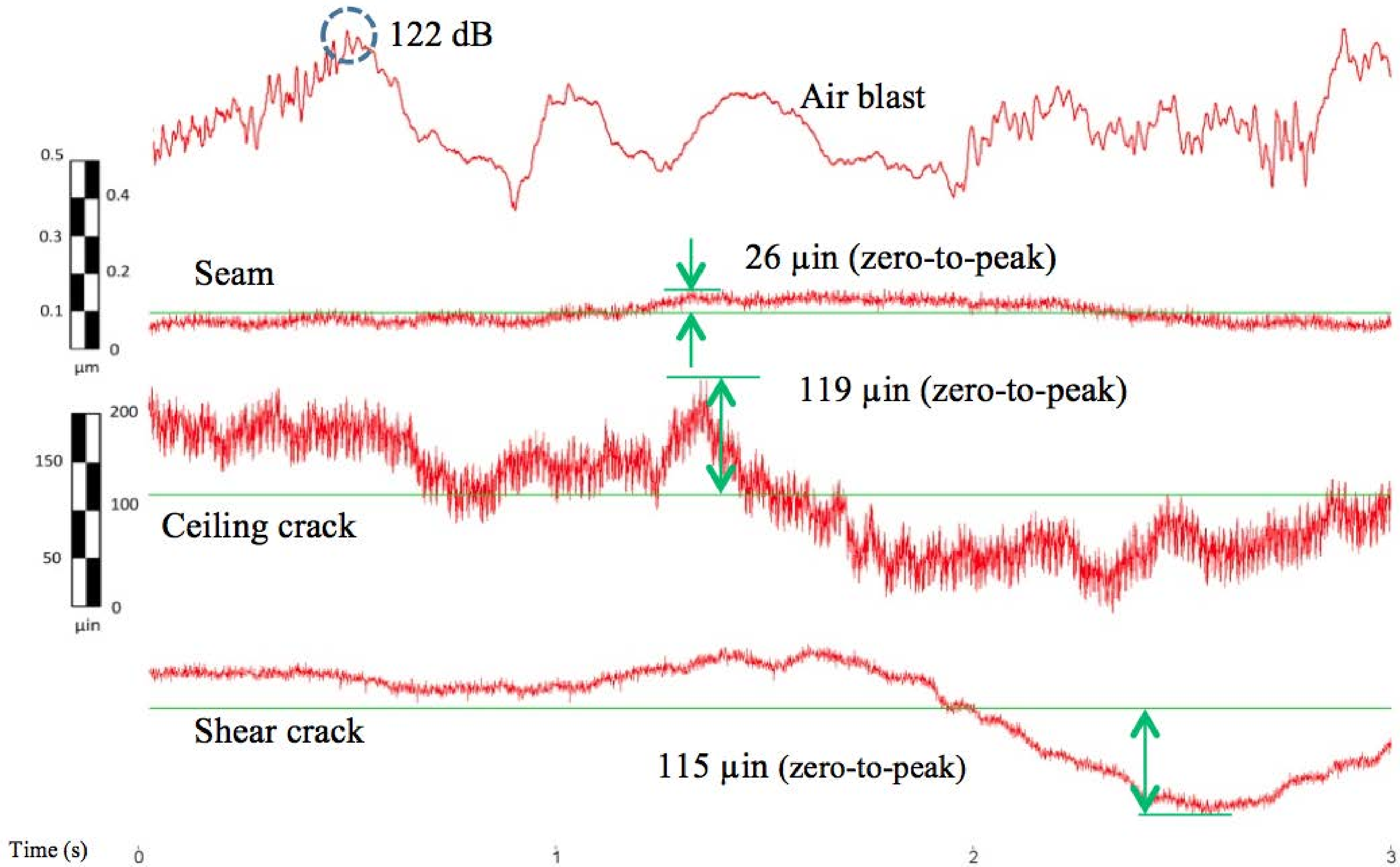


Figure SY-8 - Example wind event on May 15, 2011 showing Air Overpressure and Crack Responses (1µin = 0.0254µm). Measurements are zero-to-peak

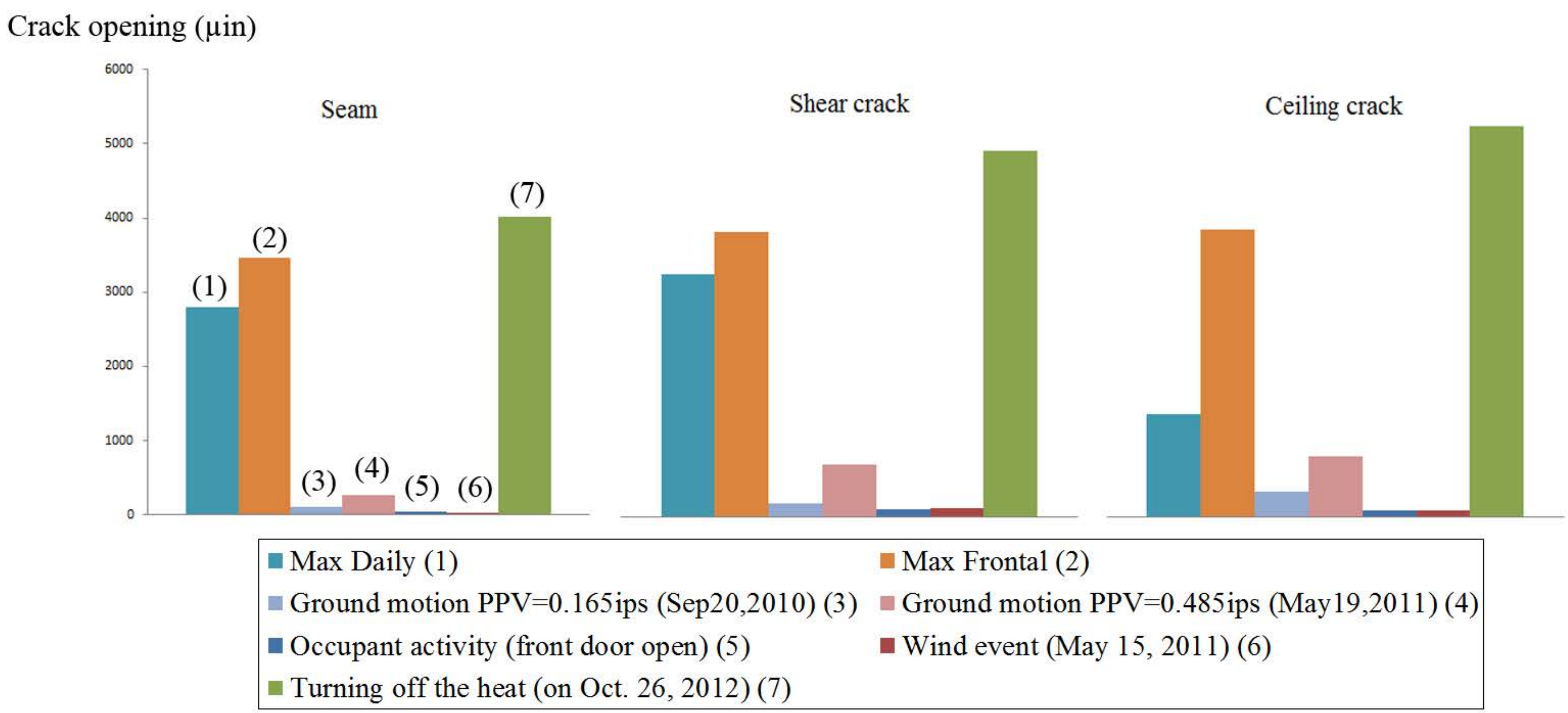


Figure SY-9 - Comparison of crack response magnitudes