APPENDIX FWII

Franklin, Wisconsin (2008-09)

Phase II - Quarry Blasting

Meissner & Dowding_2000

Figure FWII-1 – Photograph of the residential structure in Franklin, WI

Background

This report aims to assuage the concerns about blasting vibrations near a residential structure in suburban Wisconsin by comparing crack responses caused by weather fronts to those caused by ground motions. The test building is a one-story concrete masonry block structure shown in Figure FWII-1. The building is situated next to a limestone quarry. Blasting operations are conducted in an area 1500-2000 feet west from the house.

To account for weather and blast effects, ground vibrations, air overpressure and temperature and humidity levels outside of the house have been measured. The locations of all sensors are indicated in Figure FWII-2. Two cracks were selected for observation, one on a ceiling and one next to a doorway. Their respective locations can also be seen in Figure FWII-3. To monitor crack development, similar sensors were installed across each crack and on the wall next to the crack. A triaxial Geosonics geophone was installed in the ground on the north side of the house to monitor the propagation of shock waves from the quarry. This sensor registers movement in all three directions on separate channels and stores the results in the form of peak particle velocity (PPV) data.

Franklin, WI

The crack sensors and outdoors temperature and humidity sensors were read every hour, registering a total of 6503 data points during the observation period. The results can be seen in Figure FWII-4 where individual readings are plotted in blue, the 24-hour central moving average in red and the 30-day central moving average in black. The same data plotted for a shorter period demonstrate that temperature variations correlate well with crack displacement. Since the red line is the 24-hour moving average and the black that for 30-day, the distance between them is indicative of the magnitude of change; a large, continuous change in temperature causes a deviation in crack response.

Crack responses for a total of 64 dynamic events were recorded. For each event, the peak ground motion in three orthogonal directions was recorded along with the crack response in microinches. Table FWII-1 presents blast event data with zero to peak crack responses. Figure FWII-5 compares the time histories of ground motion and crack response for an event on July 16th, 2009. The ceiling crack exhibits a zero-to- peak response of 192 μ-in while the door only responds 39 μ-in.

Figure FWII-6 below compares the climatological response of the ceiling crack to its dynamic response. Response of the crack to weather fronts is 3x greater than the maximum response to blasting and 10x greater than response to ground motion at 0.1 ips.

Reference:
Meissner, Jeffrey E., and Charles H. Dowding. *Test House in Franklin, WI*. Rep. 2008-2009.

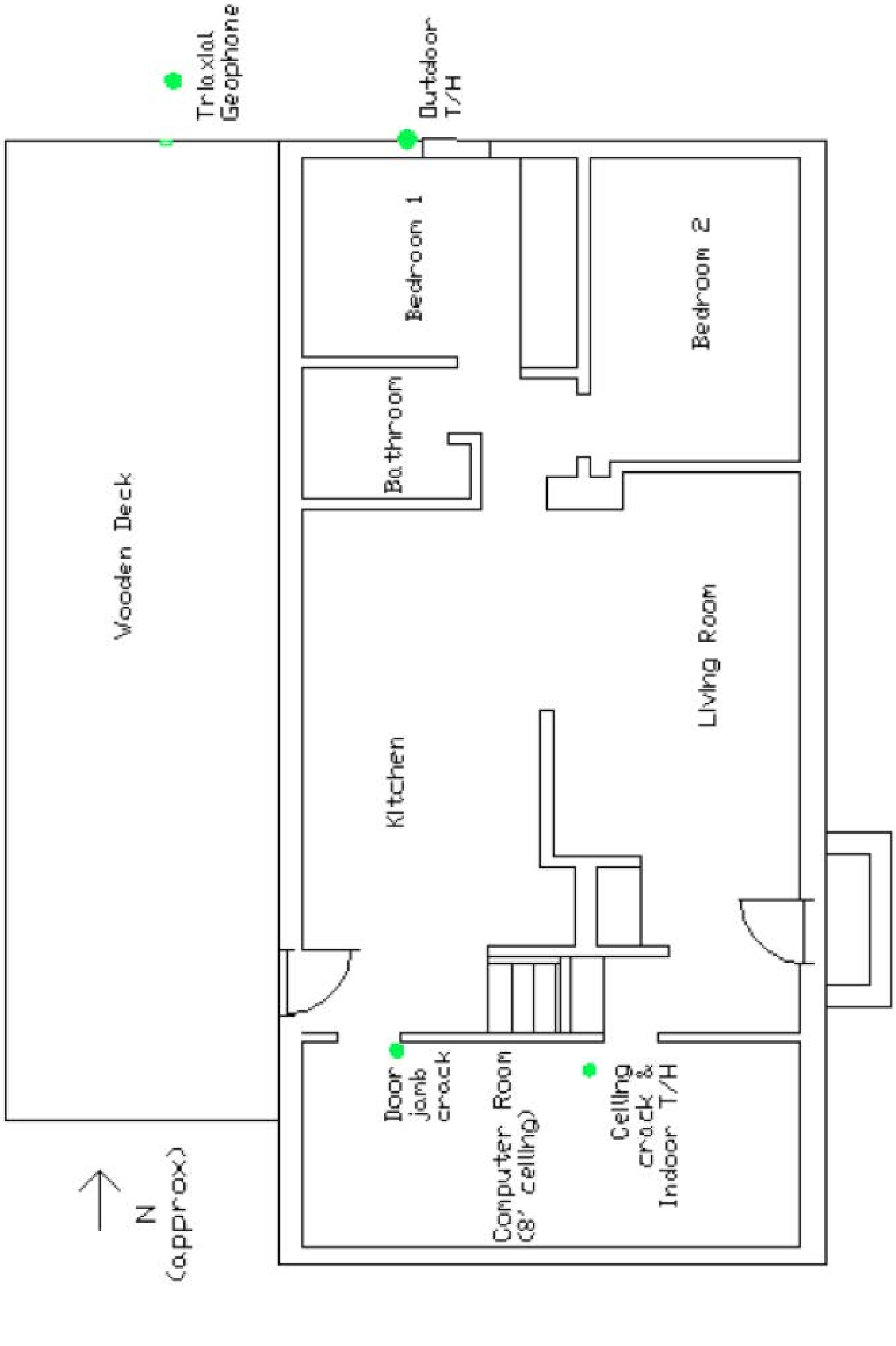

Figure FWII-2 - Exact sensor and equipment locations in the house.

Ceiling Crack

Door Crack

Figure FWII-3 - Location of cracks monitored including context (left) and closeup (right). The ceiling crack appears on the top while the door crack appears on the bottom.

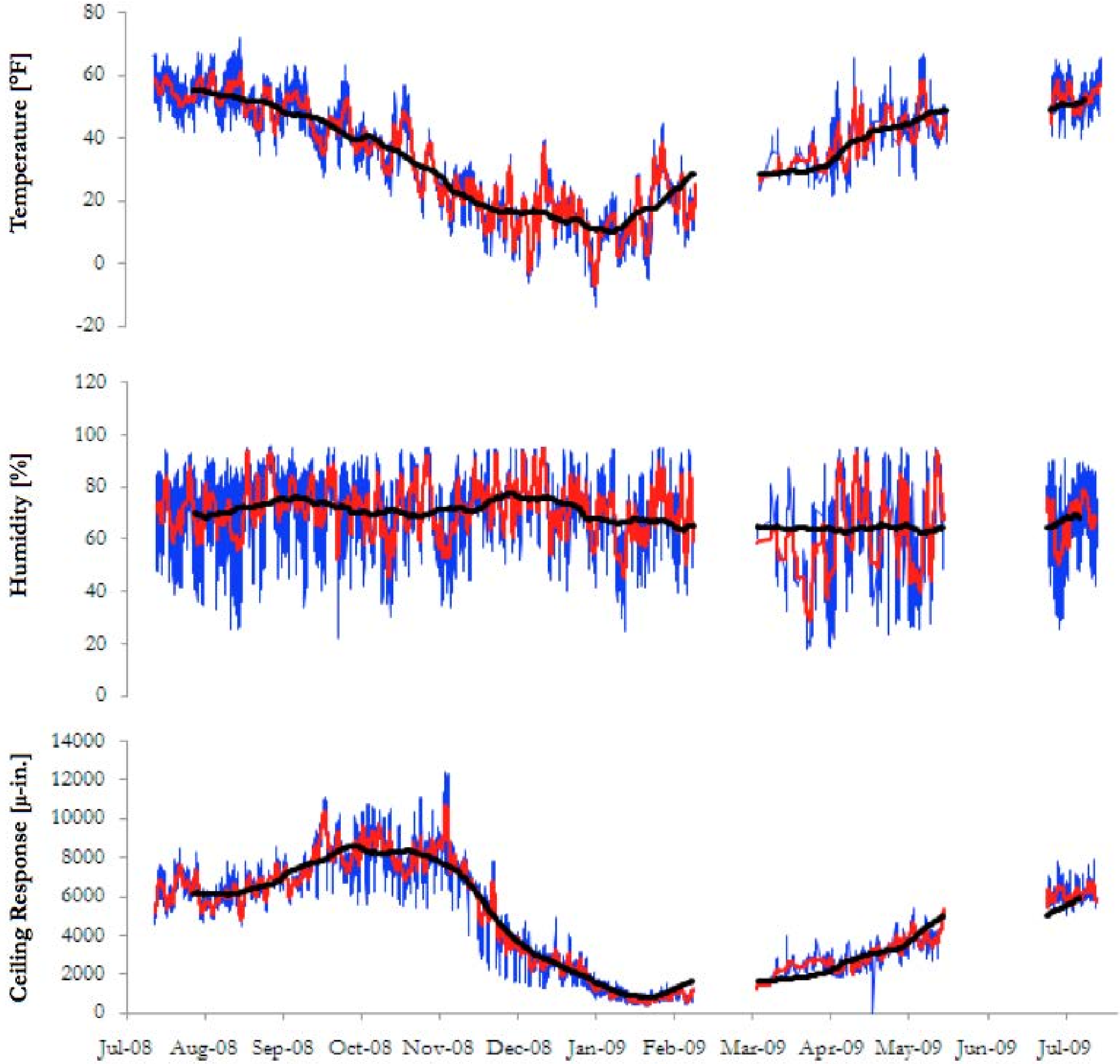

Figure FWII-4 - Correlation of outdoor temperature and humidity with ceiling crack response over a 1-year period.

Date	Geophone PPV [in/s]			Crack Response [μ-in.]		Air Overpressure [dB]
10/16/08 12:04 PM	0.103	0.087	0.084	124	-	
10/16/08 12:09 PM	0.093	0.143	0.115	289	-	
10/23/08 12:53 PM	0.095	0.074	0.053	216	-	
10/23/08 12:55 PM	0.098	0.057	0.070	167	-	
10/30/08 11:09 AM	0.235	0.343	0.227	308	-	
10/30/08 11:13 AM	0.142	0.195	0.128	189	-	
11/4/08 10:51 AM	0.157	0.181	0.087	736	-	
11/4/08 12:24 PM	0.103	0.097	0.105	176	-	
11/6/08 11:36 AM	0.110	0.079	0.073	198	-	
11/6/08 11:47 AM	0.152	0.198	0.225	334	-	
11/6/08 11:53 AM	0.146	0.204	0.101	275	-	
11/13/08 9:55 AM	0.213	0.238	0.203	305	-	
11/13/08 12:22 PM	0.143	0.159	0.160	167	-	
3/24/09 1:22 PM	0.201	0.105	0.143	89	66	
3/31/09 10:06 AM	0.140	0.086	0.081	88	80	117
3/31/09 11:45 AM	0.202	0.224	0.197	118	84	118
4/8/09 2:36 PM	0.086	0.093	0.062	108	83	-
4/21/09 12:35 PM	0.207	0.211	0.208	93	91	123
4/29/09 1:09 PM	0.095	0.086	0.062	73	86	-
7/16/09 10:45 AM	0.261	0.223	0.142	192	39	121
7/22/09 10:52 AM	0.123	0.108	0.066	354	45	124
7/27/09 11:44 AM	0.083	0.108	0.086	98	47	113

Table FWII-1 - October 2008 to July 2009 Events comparing ground motions, crack response (zero to peak) and air overpressure

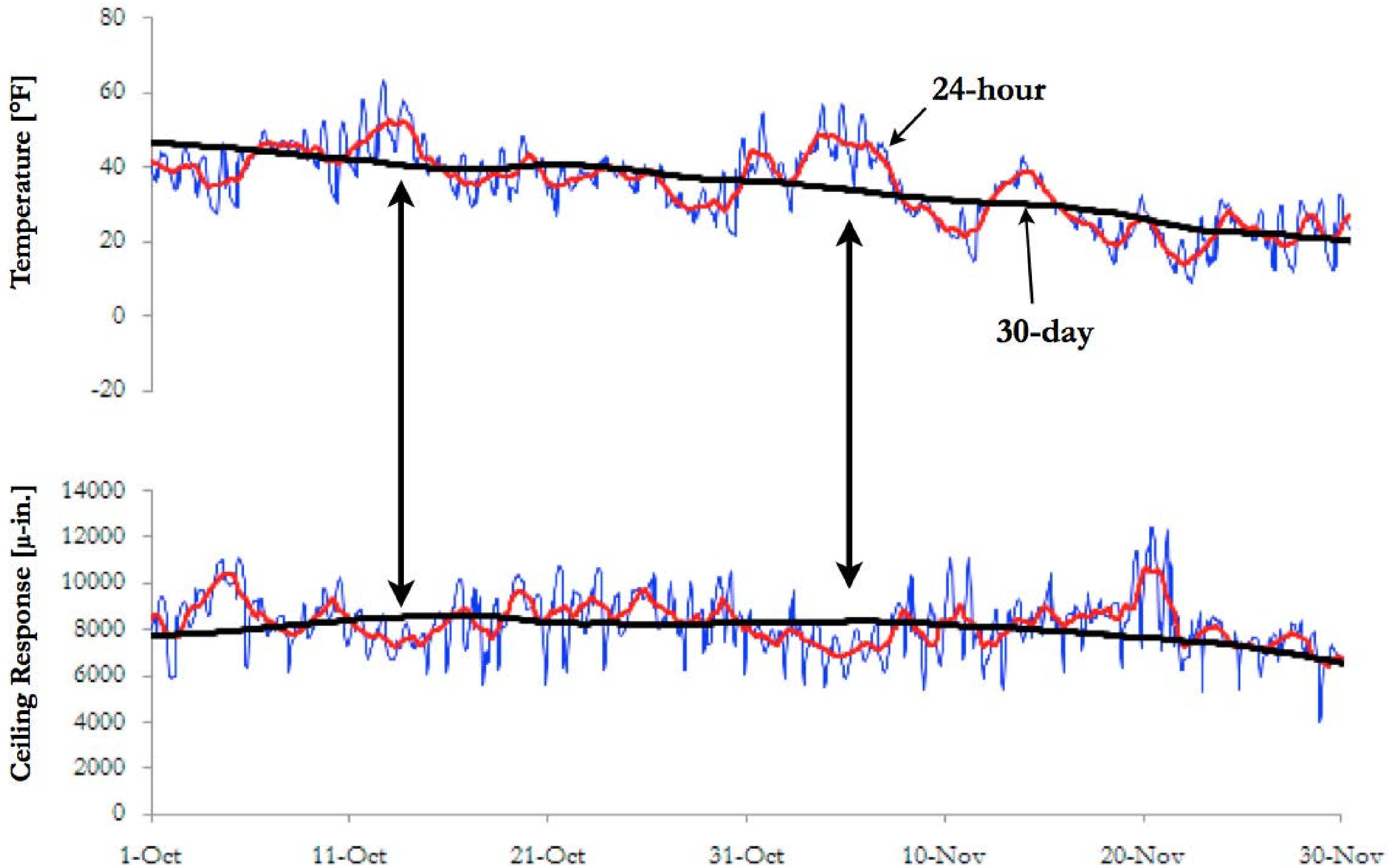

Figure FWII-5 - Correlation of Temperature and Ceiling Crack Response over a two-month period

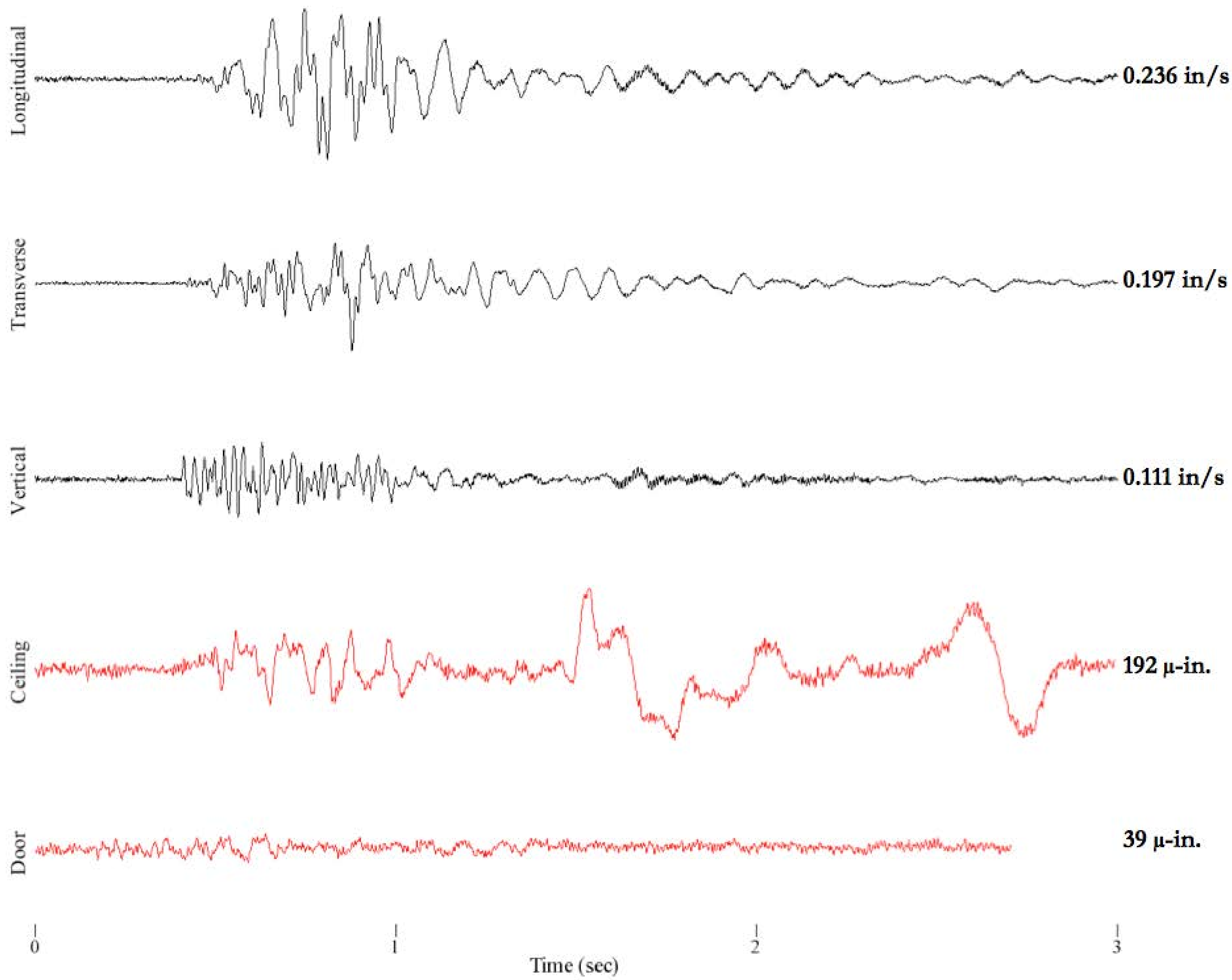

Figure FWII-6 - Comparison of ground motion and crack response time histories for a blast on July 16th, 2009 at 10:45 AM

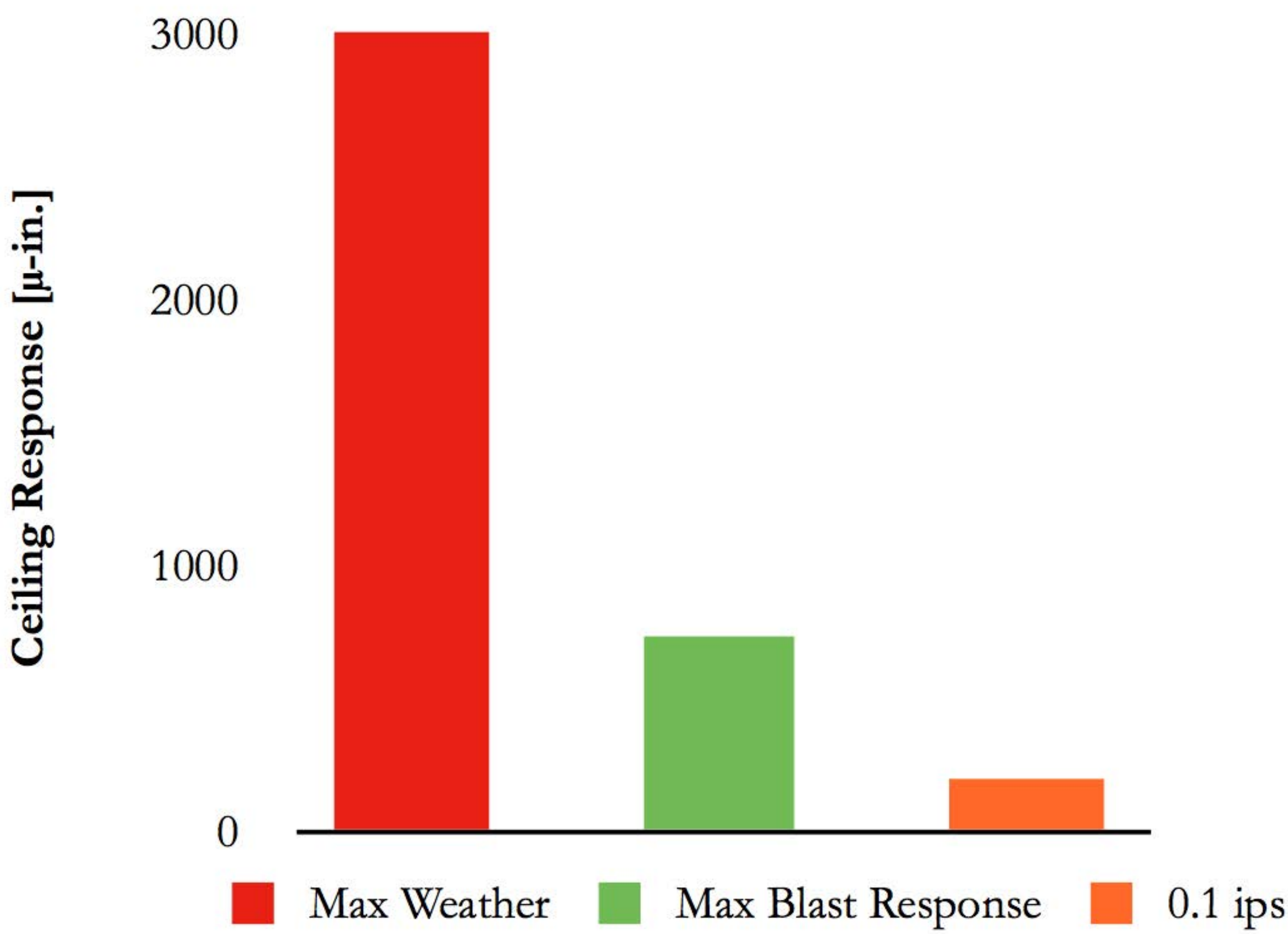

Figure FWII-7 - Bar chart comparison of ceiling responses to weather fronts and blasting