APPENDIX UNII

Universal, Indiana (2009)

Surface Coal Mine Blasting

Dowding & Meissner_2011

Figure UNII-1 – Photograph of the residential structure in Blanford, Indiana

Background

This is Phase-II report of the response of a two story residential structure in Blanford, Indiana, shown in Figure UNII-1, that is located near a surface coal mine. A typical blast, 2000 feet (610 meters) from the house, involved 54, 100 ft (30 m) deep holes arranged in six rows (in a direction radial to the house). Each hole was loaded with 675 lbs (306 kg) of explosive with four decks and thus ~170 lbs of explosive per delay. Such a shot would produce ground motions with a peak particle velocity of 0.14 ips to 0.9 ips (3.5 mm/s to 23 mm/s) and a dominant frequency of 6 to 30 Hz. The house contains two, instrumented, uncracked drywall joints and a cracked drywall joint for comparison. The instrumentation and floor plan of the house are shown in Figure UNII-2.

Context (top) and details (bottom) of the instrument installations are shown in Figure UNII-3. The living room walls in the house contain the instrumented dry wall joints as shown in the drawing and center photograph. Horizontal and vertical un-cracked dry wall joints are C9 and C10. Uncracked locations near the centers of the drywall sheets are C2 and C6. Drywall joint crack, C7, shown in the bottom right most photograph, is at the doorway (adjacent to C6) between the living room and the kitchen. This crack is not fully extended, and did not extend during the observation period. Out-of plane, mid-wall motions were measured with velocity transducers as shown in the bottom left photograph.

Figure UNII-4 compares four months of responses of the 2 uncracked (C9, C10) and one cracked (C7) drywall joints, and 2 uncracked drywall sheets (C2, C6) to temperature and humidity- induced, climatological effects. Variation in temperature and humidity inside and out is presented on the bottom. Joint, crack and sheet responses are plotted to the same scale at the top for comparison.

These long-term measurements, spanning some four months, show that uncracked weaknesses in wall covering are less responsive to long term, climatological effects than other cracked locations. The same is true for vibratory response.

Vibratory response time histories of uncracked and cracked dry wall joints for these two houses are shown in Figure UNII-5. The relationship between vibratory and climatological response for uncracked wall weakness (dry wall joints) is the same as for cracks as shown by the bar chart comparisons in Figure UNII-6. Where climatological response is small, so is vibratory response for both cracked and uncracked joints. Cracking of a joint does not appear to diminish its dynamic response; at least not relative to other uncracked weaknesses such as the joints. Cracked joints are seen to respond more than uncracked joints to both vibratory and climatological drivers. Figure UNII-7 compares the vibration response of C7 and C10 to groundmotions and superstructure (H3, H4) as well as wall response (H3, H4).

Measurements made in this structure investigated several concerns regarding the usefulness of the observation that cracks respond more to climatological than vibratory effects. Concerns addressed are: 1) sensitivity of uncracked locations and 2) crack response in low excitation frequency - high particle velocity environments. Responses of the weakest of wall components, the paper-thin joints between drywall sheets were measured and shown to be less than that of cracked joints. Specifically, measurements presented herein show that a cracked joint does not respond less than other uncracked weaknesses in the wall covering to either climatological or vibratory effects. Even in high particle velocity and low excitation frequency environments cracks continue to respond more than do uncracked weaknesses.

Reference:
Dowding, Charles H., and Jeffrey E. Meissner. *Response of Un-Cracked Drywall Joints and Sheets to Blast Vibration and Weather*. Rep. 2011.

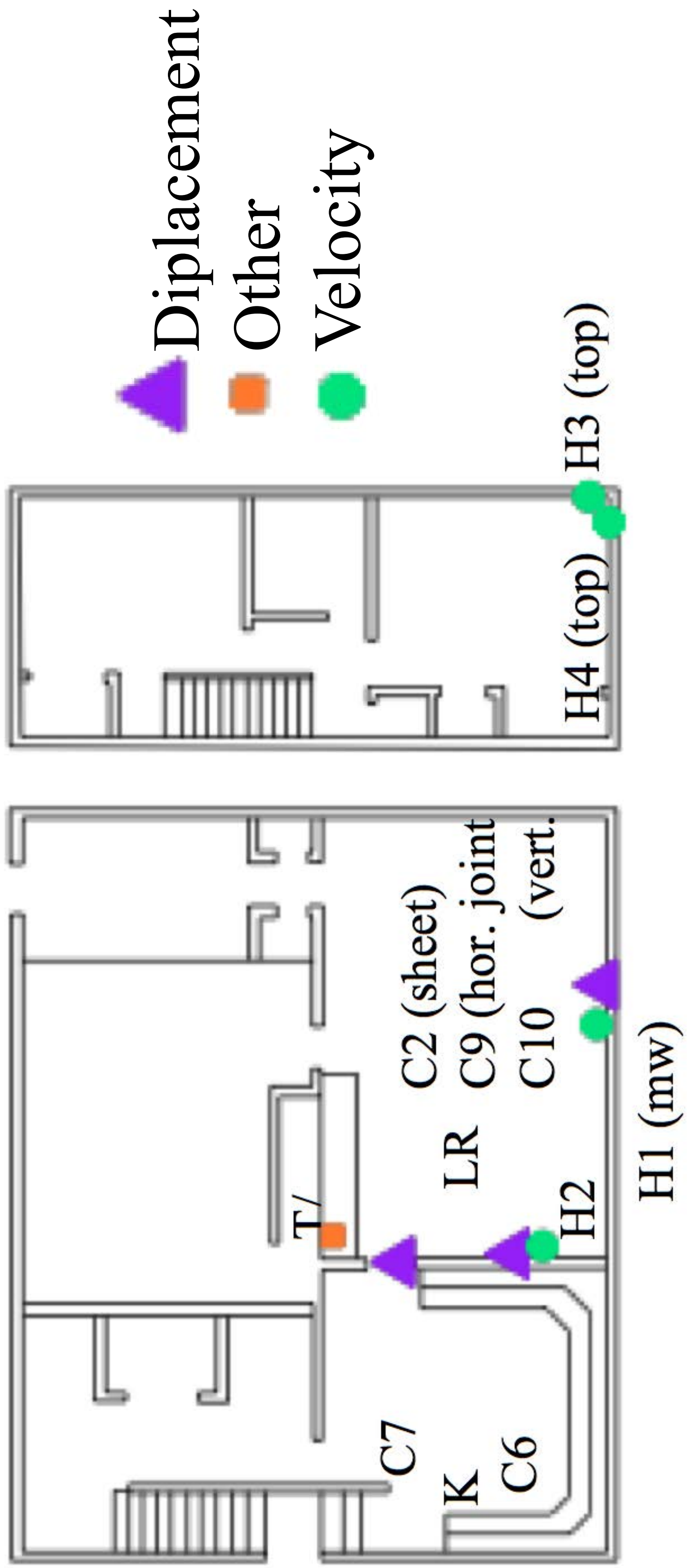

Figure UNII-2 - Instrument locations

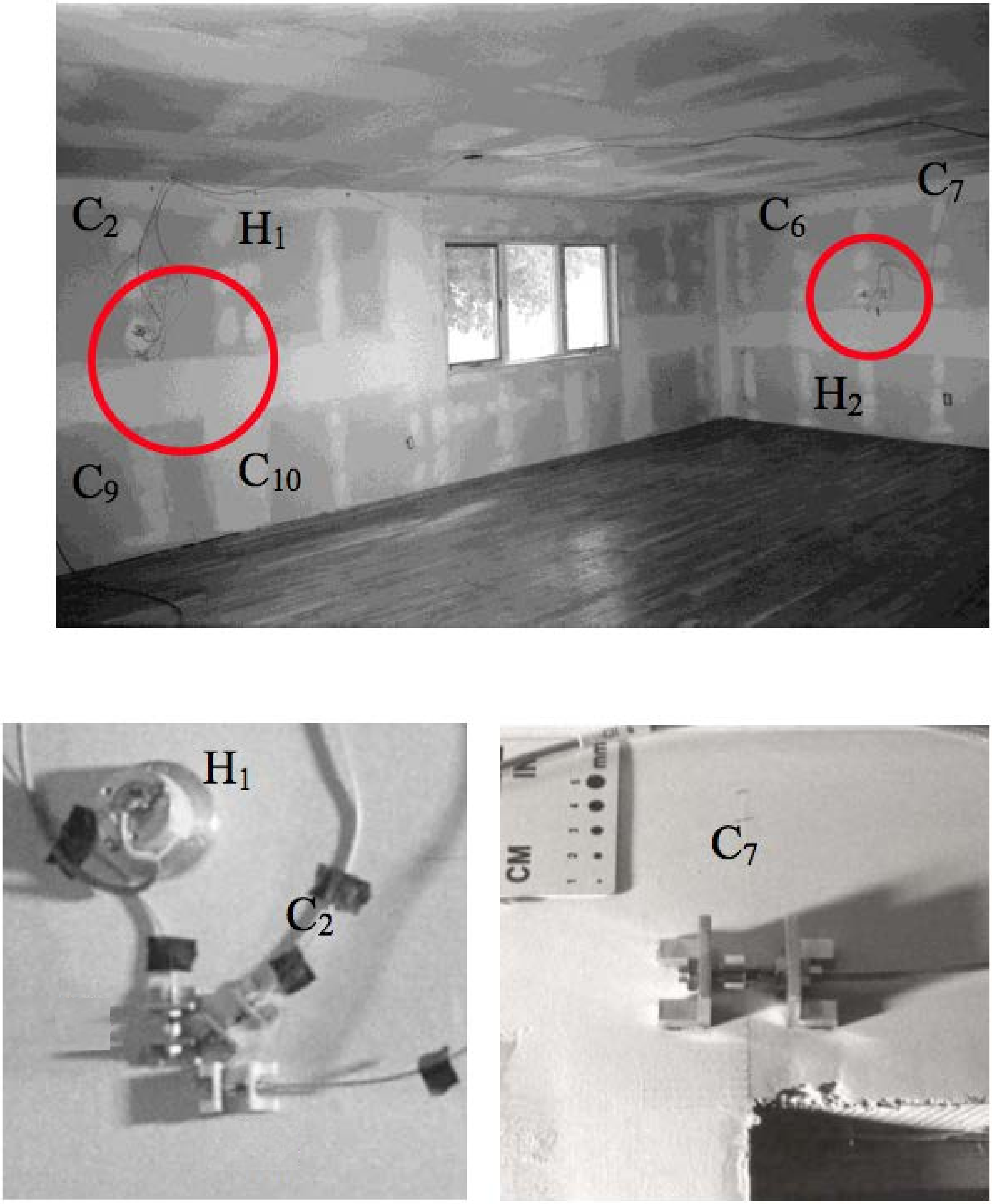

Figure UNII-3 - Installation details for the house. The photograph on top shows context of instrumentation and with detail on the bottom. C9&10 cross un-cracked drywall joints; C7 crosses a cracked drywall joint; and C2&6 are located on drywall sheets. H1&2 are on out of wall planes on the first story.

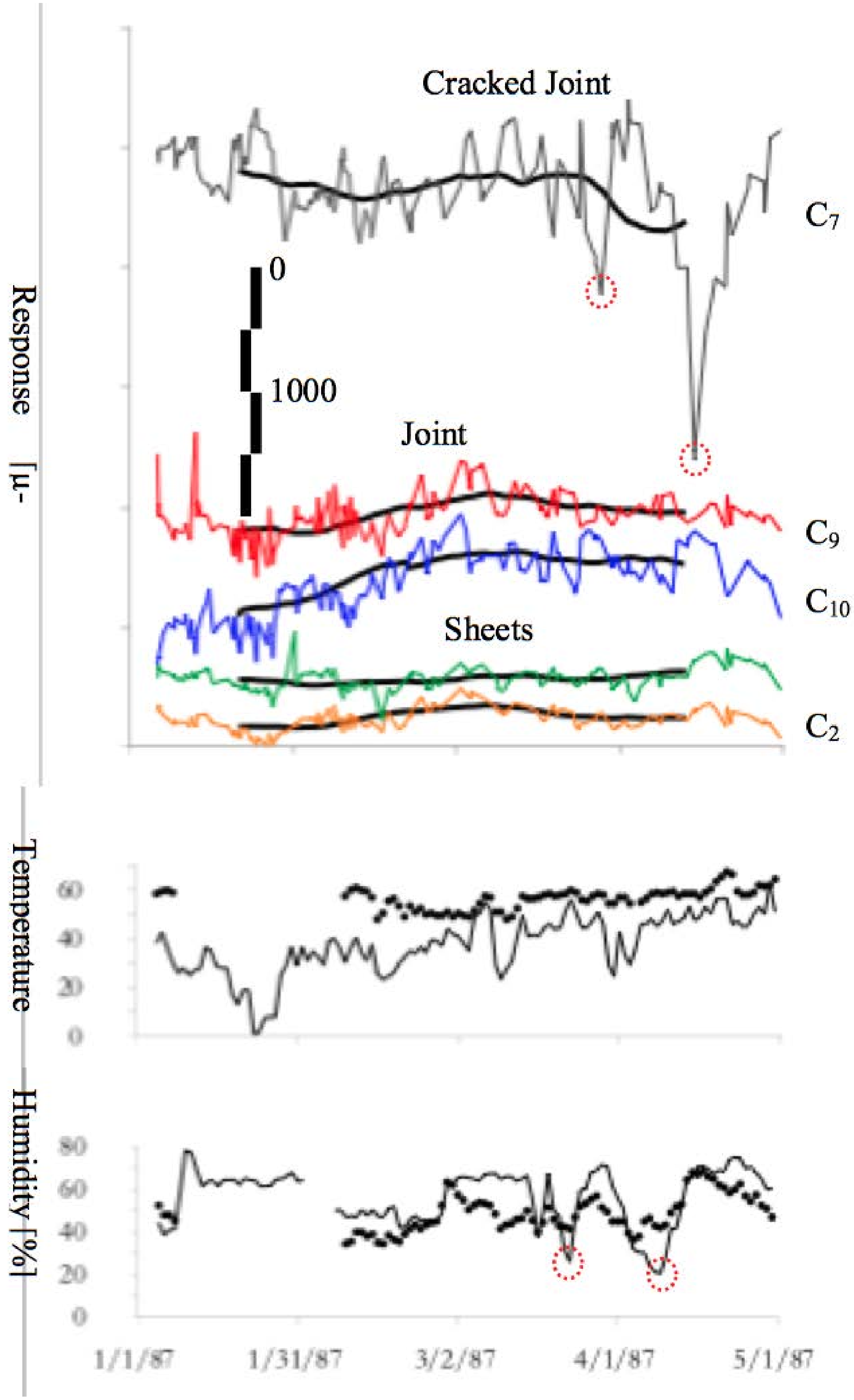

Figure UNII-4 - Comparison of four months of climatologically induced responses of joints. 30-day central moving average shown with the thick line. Temperature and Humidity are plotted on the bottom (dotted=inside, solid=outside), and joint responses are plotted on the top with common time and response scales for comparison.

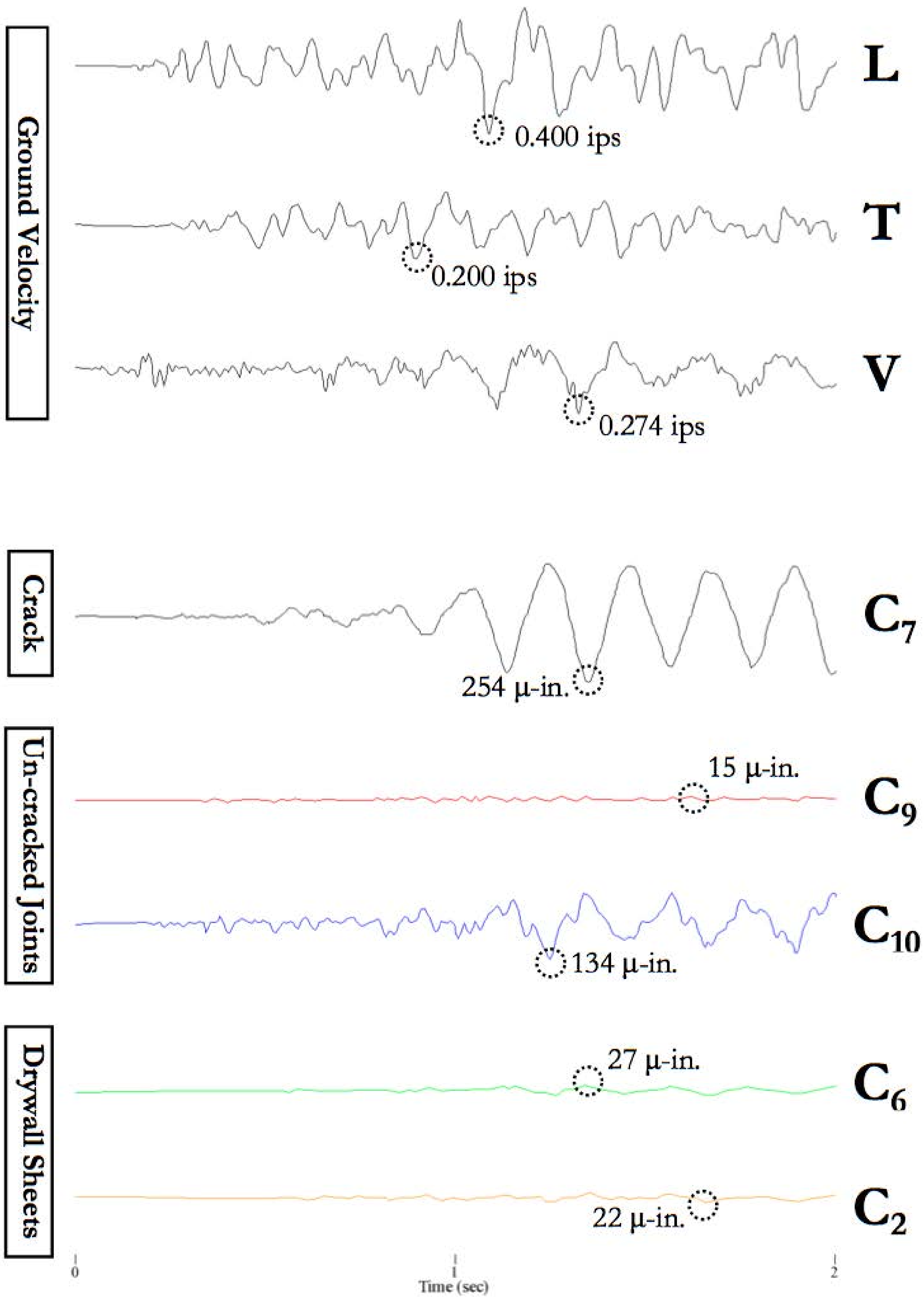

Figure UNII-5 - Comparison of ground motions (top) with joint responses (bottom) showing unusually low excitation frequency of the ground motions. (1 ips = 25.4 mm/s, 1 μ-in = 0.025 μm)

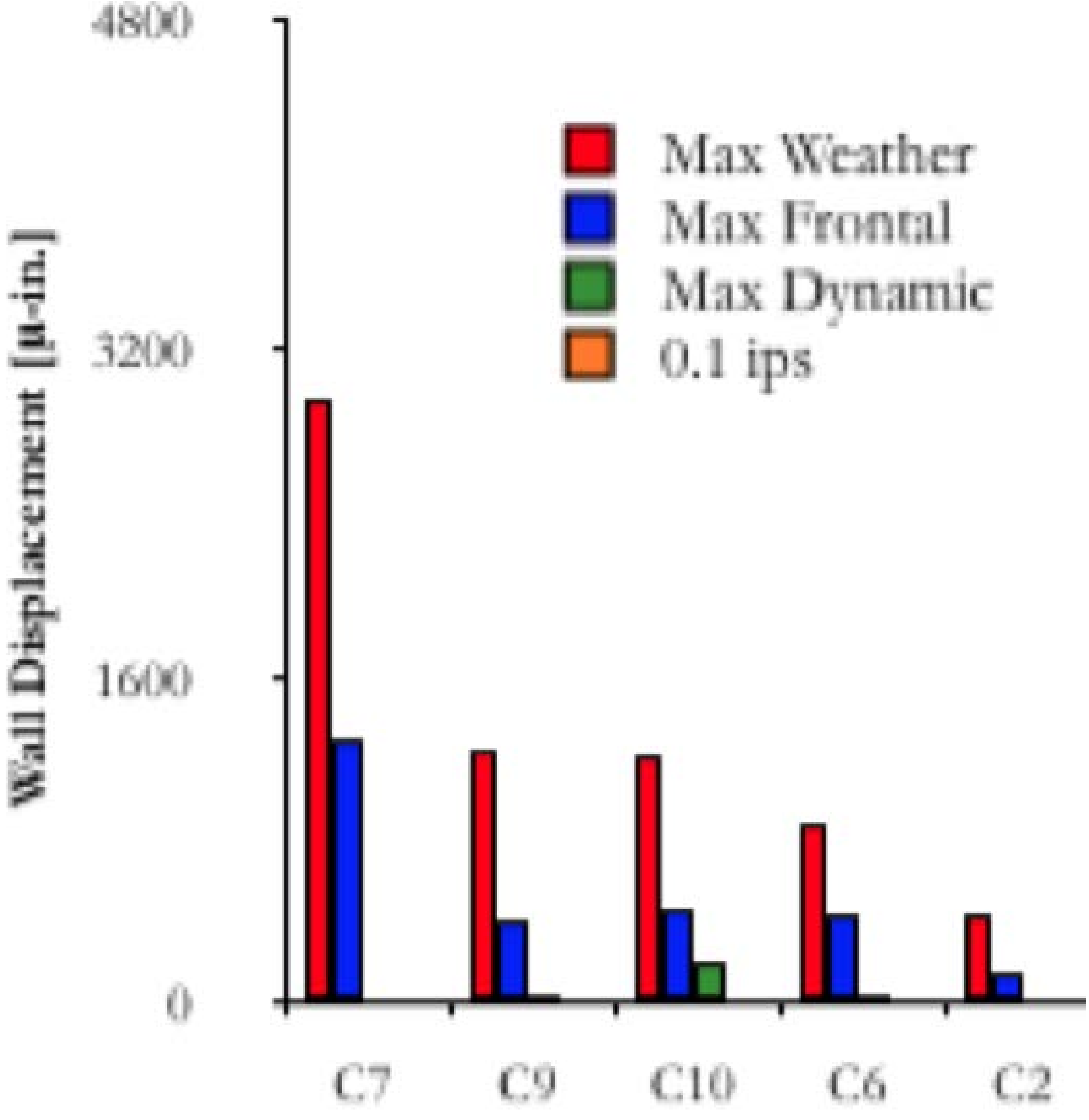

Figure UNII-6 - Bar chart comparison of crack/joint/sheet response induced by weather

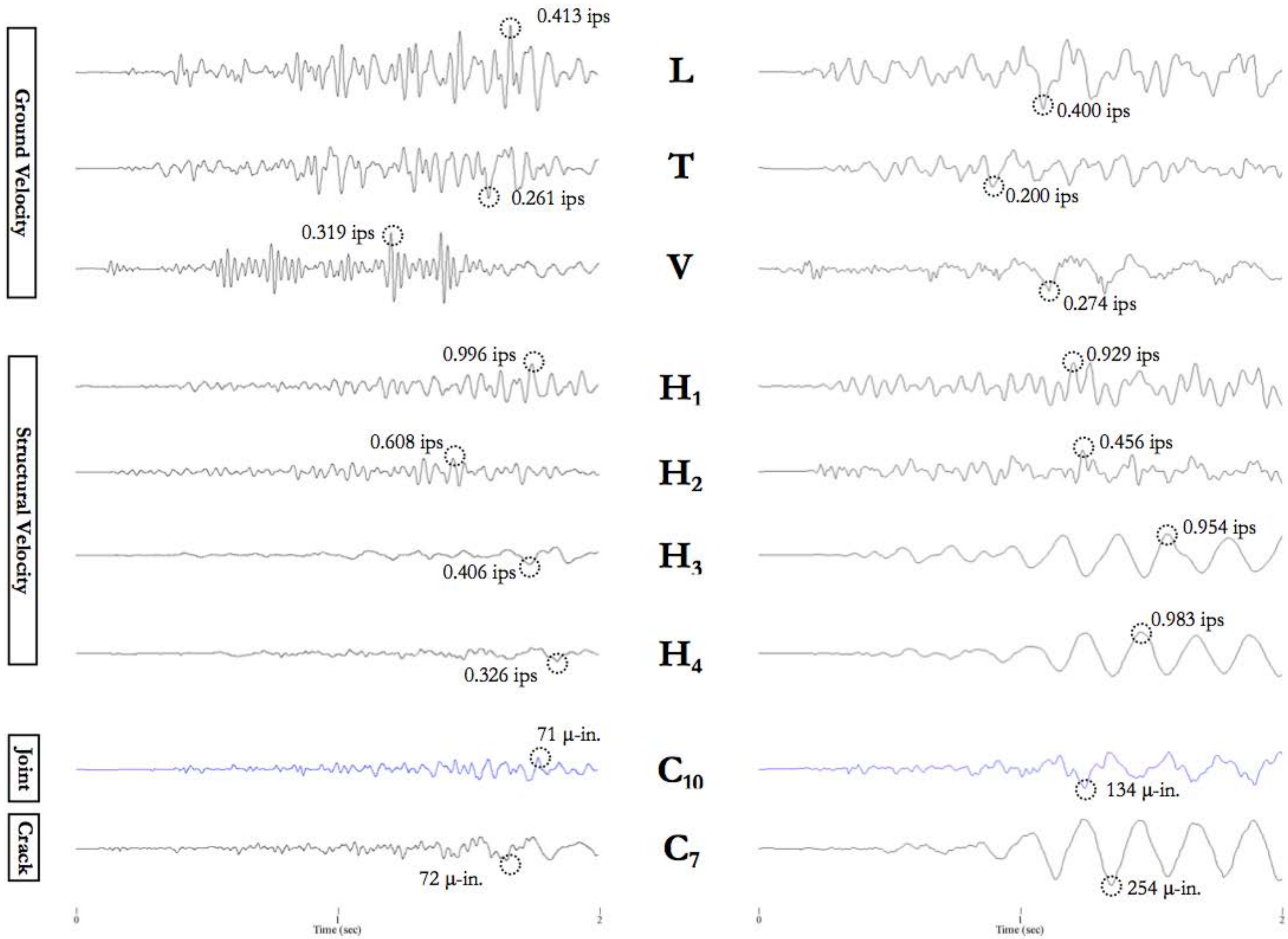

Figure UNII-7 - Time histories of ground motion, structural response, and cracked (C7) and un-cracked drywall joint response (C10). Low frequency excitation show joint response follows the motion of the upper story. 2/23/87 on the left and 4/2/87 on the right. (1 ips = 25.4 mm/s, 1 μ-in = 0.025 μm)