Newsletter #8

Concrete, brick, and concrete masonry unit (CMU) portions of structures are stronger than plaster and gypsum drywall.

All other things being equal, regulations that prevent cracking of weaker plaster and lathe will prevent cracking in stronger concrete, brick, and concrete masonry unit (CMU) portions of structures.

TABLE 12-2 Cracking Observed from Blasting

Shot	Ground Vibration Level V	H_1 (East–West)	H_2 (North–South)	Crack Observation
45	0.38	1.03	0.54	Crack in cement block mortar joint[a]
82	2.21	1.41	1.75	Crack in joint compound over nailhead
83	3.05	2.75	1.64	Corner crack extension
84	2.17	2.01	1.44	Crack in joint compound over nailhead
86	0.85	1.34	1.15	Two-corner crack extensions
89	0.40	0.88	0.78	Corner crack extension
97	1.17	1.11	1.81	Crack in joint compound over nailhead
101	3.12	3.52	2.19	Corner crack extension
102	4.77	3.21	4.25	Plywood subfloor crack[b]
114	3.33	3.43	NA[c]	Brick veneer mortar joint crack
115	6.19	6.22	3.52	Basement block mortar joint cracks
126	6.19	6.94	5.27	Chimney mortar crack, all sides; basement block mortar joint separation (minor damage at RI 8507)

[a] Same position as crack after shot 115; up to shot 115, crack was difficult to distinguish from shrinkage crack. Block wall was unreinforced.
[b] Subfloor only; test house not completed with underlayment or finish floor.
[c] NA, not available.
Source: Stagg et al. (1984).

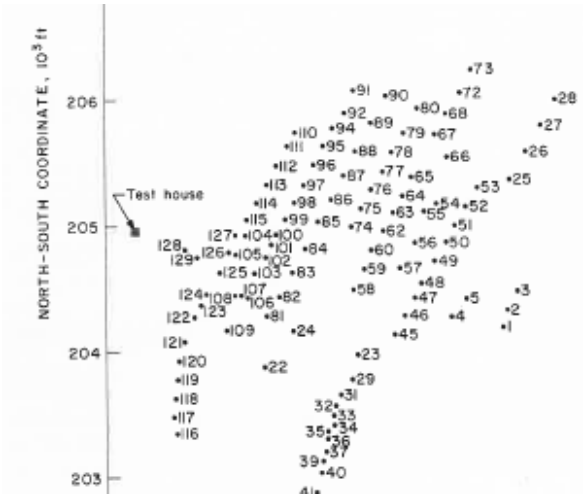


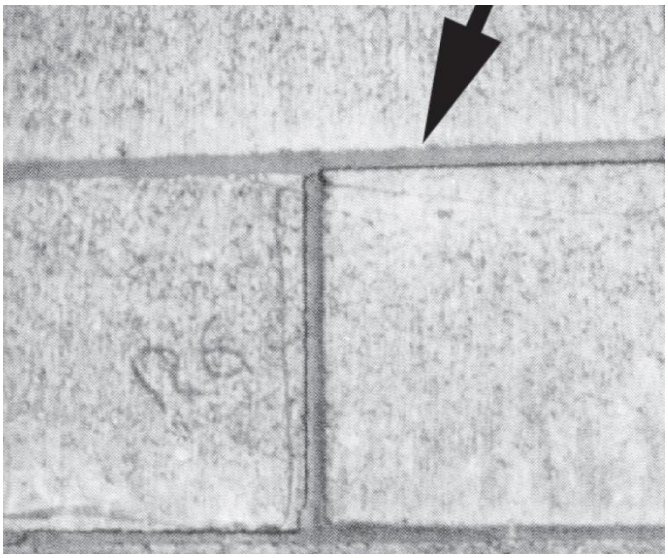
Figure 1 left is a table from RI 8896 of PPV's at which various components of USBM test house cracked, which demonstrates that brick and concrete masonry units (CMU) are stronger than plaster and lathe and gypsum drywall. Green box encapsulates the PPVs associated with cosmetic cracking of the weaker plaster materials and the red box the higher PPVs associated with cosmetic cracking of joints between bricks and CMUs. Right shows the locations of the blasts enumerated in thee left table. Blasting ceased when the bucket of the large excavator could no longer swing without striking the rest house (Stagg, et al, 1984)

Cracking observed in the test house demonstrates the ability of stronger wall and wall covering materials to resist vibratoraly induced cracking. Cracking in the test house was observed for both single events and continuous events. Results of 10's of thousands of cycles of continuous cyclic vibration will be discussed in future newsletters. Cracking from single, surface coal mine blasts at increasing peak particle velocity is shown in Table 11 from RI 8896 (Stagg et al, 1984). Locations of the nearest 100 events are shown in the graph on the right (Figure 5 From 8896). Given that inspections were made for 128 events, it is possible to interpret crack observations in Table 11 itself to be the result of a repetitive vibratory environment.

Cracking at the lowest PPVs occurs in weak materials in precarious locations. Consider that a "crack in the joint compound over a nail head" is a crack in just the thin (~ ½ mm) coat plaster-like compound itself. The corner crack occurs in the thin joint compound as well. In many homes the sheets of drywall that abut at the corners are joined with paper tape coated with a thin coating of the plaster like compound. Accordingly cosmetic cracks occurred at PPV's that were 30% lower than those for the brick and CMU walls It is not known at this time if the corners were paper taped or covered with only plaster.

Cracking in the brick and concrete masonry units occurs in the sand-cement joint mortar. These mortar joints are not thin coats on the masonry surface, but are 10 mm (0.4 in) thick adhesive surfaces between the bricks or CMUs. Table 11 shows PPV's of 89 to 157 mm/s (3.5 to 6.2 ips) are required to produce cosmetic cracks in the mortar joints.

While the test house was not constructed with concrete walls, other experiments can be employed to determine the concrete walls relative to CMU walls. Consider walls of a 2.4x2.4x1.8 m (8x8x6ft) tank filled with sand in which blasts were conducted by Crawford and Ward (1964). Two of the 4 walls were constructed of 9 and 10 in wide CMUs and the other two of 7 and 9 in thick unreinforced concrete. CMU walls failed at PPV's (measured at the center of the walls, perpendicular to the walls) of 75 mm/s (3 in/s) while the concrete walls did not crack until the PPV reached 254 mm/s (10 ips).



Mortar joint cosmetic crack produced by a surface coal mine blast with a PPV of 173 mm/s (6.8 ips). (Stagg et al, 1984). See Newsletter #6 for photograph of crack in joint compound above nail head.

References

Stagg, M.S. Siskind, D.E., Stevens, M. G., and Dowding, C.H. (1984), Effects of Repeated Blasting on a Wood Frame House, U.S. Bureau of Mines Report of Investigations RI 8896, available from International Society of Explosive Engineers.

Crawford, R. and Ward, H.S. (1965), "Dynamic Strains in Concrete and Masonry Walls" Building Research Note 54, National Research Council of Canada, Ottawa, Canada.