ACME BRICK

#088

TECHNICAL SERVICES DIGEST **JUNE 1990 (REV AUG 2006)**

MORTAR PROPERTIES COMPARISONS FOR MASONRY CEMENT, PORTLAND CEMENT / LIME, AND HILL COUNTRY MORTAR MIX

This digest was prepared to inform interested parties of recently completed test of brick panels constructed with masonry cement mortar, and portland cement / lime mortars. Dr. Matthys has conducted extensive mortar research to compare masonry cement mortar performance with Portland cement lime mortars. An additional research project was conducted to compare the Hill Country Mortar to the previously tested masonry cement and Portland cement and lime mortars.

TABLE I
PRISM COMPRESSION STRENGTH

MORTAR MATERIAL	MIX #	MORTAR TYPE	COMPRESSION STRENGTH (psi)
Masonry Cement	1	N	2096
Masonry Cement	2	N	2041
Masonry Cement	3	N	2087
Masonry Cement	4	N	2086
Masonry Cement	5	S	2728
Masonry Cement	6	S	3110
Masonry Cement	7	S	3587
Masonry Cement	8	S	2640
Portland Lime	1	S	2809
Portland Lime	2	N	2279
Portland Lime	3	O	1737
Hill Country	1	N	2270
Hill Country	2	S	3427

TABLE I

Table 1 includes prism compressive strength values for Types N and S masonry cement, Type N, and S Portland cement and lime, and Type N and S Hill Country Mortars. The compressive prism strengths for both Type N and S mortars are approximately the same for masonry cement, Portland cement and Hill Country Mortars. These values would be of use in structural design of load bearing masonry in compression. Note compressive strength is not the only, or even the most important property that should be considered! Compressive strength is a relatively unimportant property for veneer construction.

TABLE II PANEL SHEAR STRENGTH			
MORTAR MATERIAL	MIX #	MORTAR TYPE	SHEAR STRENGTH (psi)
Masonry Cement	1	N	113.9
Masonry Cement	2	N	95.3
Masonry Cement	3	N	87.7
Masonry Cement	4	N	125.2
Masonry Cement	5	S	121.8
Masonry Cement	6	S	151.2
Masonry Cement	7	S	139.2
Masonry Cement	8	S	134.6
Portland Lime	1	S	138.3
Portland Lime	2	N	225.7
Portland Lime	3	O	91.7
Hill Country	1	N	179.9
Hill Country	2	S	252.6

TABLE II

Table II includes panel shear strength values for the same mortar types and materials. The ultimate shear (diagonal tension) capacity of Portland cement lime Type N mortar assemblages was higher than any of the Type N masonry cement panels tested. On the average the Portland cement lime mortars were 30% stronger. The Type N Hill Country Mortar panels were stronger than the masonry cement panels and stronger than the Portland cement lime panels. The ultimate shear (diagonal tension) capacity of Portland cement lime Type S mortar assemblages was higher than any of the Type S masonry cement panels tested. On the average the Portland cement lime Type S mortar panels were 64% stronger. The Hill Country Type S panels were stronger than the masonry cement panels and stronger than the Portland cement lime panels. These values would be of use in structural consideration of masonry under shear type loading which often occurs under lateral (wind, seismic) loading.

TABLE III FLEXURAL BOND STRENGTH			
MORTAR MATERIAL	MIX #	MORTAR TYPE	FLEXURAL BOND STRENGTH (psi)
Masonry Cement	1	N	46.8
Masonry Cement	2	N	53.7
Masonry Cement	3	N	61.6
Masonry Cement	4	N	46.8
Masonry Cement	5	S	59.1
Masonry Cement	6	S	54.1
Masonry Cement	7	S	32.9
Masonry Cement	8	S	30.6
Portland Lime	1	S	85.4
Portland Lime	2	N	103.6
Portland Lime	3	O	87.3
Hill Country	1	N	87.0
Hill Country	2	S	93.1

TABLE III

Table III depicts flexural bond strength comparisons. The flexural bond strength regardless of mortar type was significantly higher for Portland cement / lime and Hill Country Mortar as compared to masonry cement mortar. For Type N mortar specimens the average bond strength of Portland cement lime mortar was 64% higher than the average bond strength of masonry cement. The Type N Hill Country Mortar was higher than the average bond strength for masonry cement mortar. For Type S mortar specimens the average bond strengths of Portland cement / lime mortars were 134% higher than the average bond strengths of masonry cement mortars. Type S Hill Country Mortar specimens' bond strengths were 111% higher than the average bond strengths of masonry cement mortars.

TABLE IV WATER FLOW THROUGH WALL (LITERS/HR)			
MORTAR MATERIAL	MIX #	MORTAR TYPE	WATER FLOW (LITERS/HOUR)
Masonry Cement	1	N	6.2
Masonry Cement	2	N	8.4
Masonry Cement	3	N	1.7
Masonry Cement	4	N	1.1
Masonry Cement	5	S	4.1
Masonry Cement	6	S	4.2
Masonry Cement	7	S	4.2
Masonry Cement	8	S	1.3
Portland Lime	1	S	0.3
Portland Lime	2	N	0.1
Portland Lime	3	O	0.1
Hill Country	1	N	0.0
Hill Country	2	S	0.25

TABLE IV

Table IV contains water penetration test results. Since one of the primary functions of brick veneer is to be the first line of defense against weather, including wind-driven rain, water penetration resistance is the most important property tested in Dr. Matthys' research. Panels built with masonry cement mortar leaked significantly more than the portland cement / lime or Hill Country Mortar panels. On the average, the masonry cement mortar panels would be classified as poor with regard to water penetration. The Portland cement lime and Hill Country Mortar walls would be classified as good with regard to water penetration.

For perspective on the wall leakage numbers, 1 gallon of water equals 3.78 liters. One of the masonry cement mortar panels had water flowing through the panel at the rate of 6.2 liters(6.6 quarts) of water per hour. That is enough to flush a modern toilet. The highest rate was 8.4 liters (9 quarts) per hour.

SUMMARY

1. Compressive strengths for masonry cement, portland cement and lime and Hill Country Mortars are roughly equal.
2. Shear strength test indicate Portland cement and lime Types N and S are 30% and 64% stronger than the masonry cement Type N and S mortars. The Type N Hill Country panels were 70% stronger than masonry cement and 30% stronger than Portland cement and lime. The Type S Hill Country Mortar was 85% stronger than masonry cement and 12% stronger than Portland cement and lime.
3. When flexural bond strength was tested, the Type N Hill Country Mortar was 67% higher than masonry cement. The Type S Hill Country Mortar was 111% higher than masonry cement.
4. Water flow rates for Hill Country mortar panels did not have any measurable amount of water flow through the wall in 24 hours for Type N mortar. The Type S Hill Country panels had .25 liters or .07 gallons of water flow through the panel in 24 hours for a very sever test. One of the masonry cement mortar panels had almost 9 quarts of water pass through the wall for Type N mortar and about a gallon of water for Type S mortar.
5. Dr. Matthys has tested Capital Masonry Cement out of San Antonio. That masonry cement was comparable to Portland cement and lime mortars. The data presented in this digest reflects the performance of the masonry cements tested in Dr. Matthys' research.

REFERENCES

1. John H. Matthys, Ph. D. , P.E., 28 Day Test Report APG Type N and Type S Mortar, April 1990.
2. John H. Matthys, Ph. D. , P.E., Masonry Mortar Investigation, August 1988.