Monolithic Adobe (Cob) Test Walls

Art Ludwig/ art@OasisDesign.net—August 1st, 2018

Monolithic Adobe (Cob) building offers many advantages:

- High-quality, affordable, sustainable housing
- Climate friendly
- Sweat-equity friendly
- Firestorm and debris flow resistant
- Beautiful and soulful

With 10,000 homes lost to wildfire in California in 2017 alone, the need for fire and climate safe housing is greater than ever.

And, the barriers are lower than ever: California's Accessory Dwelling Unit law eliminated most of the zoning barriers to adding cob cottages in backyards. The main remaining barrier is the lack of engineering values needed for calculations to verify earthquake safety.

Quail Springs is collaborating with Art Ludwig of Oasis design to develop user-friendly reinforcement to enable cob to meet earthquake standards in all seismic zones. We are working with Oasis and Cal Poly San Luis Obispo's engineering department to test these walls, to get engineering values for the various reinforcing regimes.

The walls here will be subject to "in plane reverse-cyclc testing" that is, pushed and pulled from a top corner, in the plane of the wall, with a portable loading frame capable of exerting up to 100,000 lbs of force, until the wall fails. These tests will yeild a resistance per linear foot of wall for each different type of reinforcement. This value can be used to do the calcs necessary to permit a structure of any shape, including organic curves, like this pilot project Art Ludwig is proposing for downtown Santa Barbara (see oasisdesign.net/shelter/safetycottage).

We are looking for people who are interested in underwriting this groundbreaking work. The total goal for the project is $25,000. Please contact sasha@quailsprings.org or andrew@quailsprings.org if you or someone you know might be willing to support in this way.

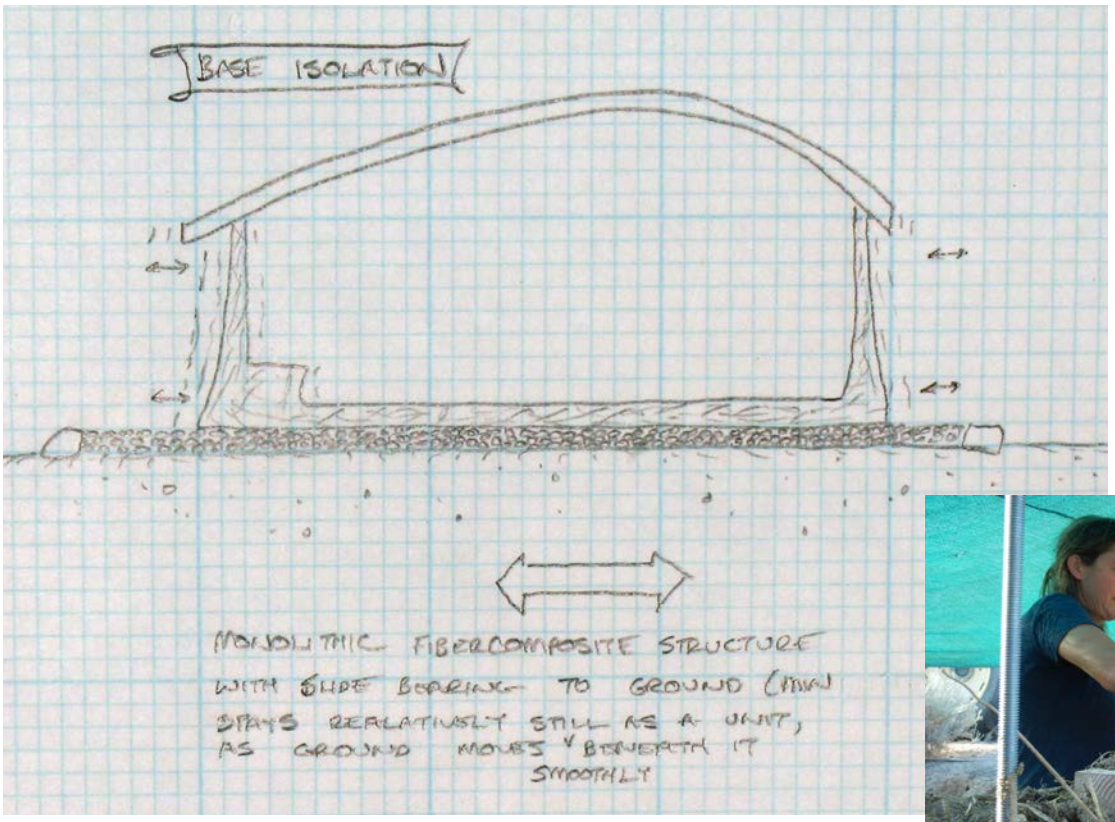
Cob Only Test Wall

Estimated resistance: 10,000 lbs. Target performance: Seismic zones B, C, D…and maybe even E, with really effective base isolation.

This is the "purest" wall; sand and clay, reinforced only with straw, and featuring good earthen building design practices:

- **Tied together at bottom** with a steel tension ring
- **Tied together at top** with a steel tension ring
- **Monolithic construction** straw well-knitted together so the whole thing is one brick
- **Round shape in plan reduces out of plane forces**
- **Tapered walls reduce even out stress**
- **Openings not too big, or too close, and reinforced** with buttresses or greater thickness

It is intended to be part of a 100% concrete free building system, with a steel band at the base and at the top of the walls to hold it together, and "base isolation" to reduce earthquake loads (the structure is not rigidly attached to the ground, so less force is transmitted to the structure when the ground moves. Many skyscrapers use base isolation).



The middle part is the part being tested; the base to attach to the machine is cob reinforced with a box of 6 guage, 6" square mesh, and the top to attach to the loading frame will have a thin bond beam of concrete, held on by all thread attached to wooden blocks in the wall (which is how roof beams are typically attached with this technique)

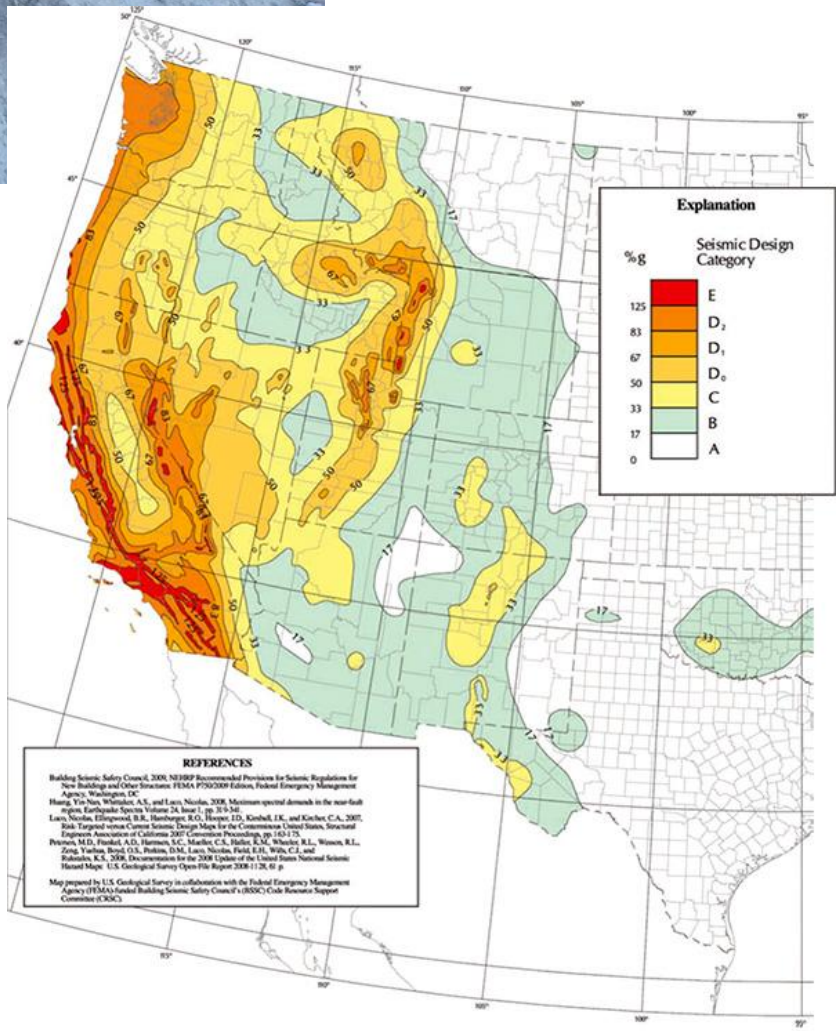
The elephant foot shape at the bottom reduces stress risers, increasing the strength of the wall by reducing the chance of failure at the bottom joint.

Single Thick Mesh Reinforced Test Wall

Estimated resistance: 20,000 lbs. Target performance: Seismic zone B, C

This is the steel reinforcement that is departs the least from standard cob practice. A single sheet of 6 gauge steel reinforcing mesh with 6" squares is embedded in the foundation below, the full height of the wall, and the bond beam above.

For ease of construction, it could also be made with 10 guage (lighter) mesh.



Double Thick Mesh Reinforced Test Wall

Estimated resistance: 40,000 lbs. Target performance: Seismic zone C, D

Sheets of 6 gauge steel reinforcing mesh with 6" squares are embedded 1.5" below the surface all the way around, from the foundation below, the full height of the wall, and the bond beam above. There is also transverse 10 guage mesh. Encased like this, adobe is much more ductile; it can bend and crack really far without acutaully falling apart. For ease of construction, it could also be made with 10 guage (lighter) mesh.

		Double reinforced monolithic adobe w/ bolted posts	Double 6 ga mesh reinforced monolithic adobe	Single 6 ga mesh reinforced monolithic adobe	Oregon cob	Double reinforced monolithic adobe w/ bolted posts	Double reinforced monolithic adobe w/ post in epoxied friction fittings	Double 6 ga mesh reinforced monolithic adobe	Double 10 ga reinforced monolithi	Oregon cob
Tensile strenght of cob	psi		0	0	2	0	0	0	0	2
Tensile strenght of cob	psf	0	0	0	288	0	0	0	0	288
Cob resistance to uplift	**lbs**	**0**	**0**	**0**	**7,056**	**0**	**0**	**0**	**0**	**7,056**
%		0%	0%	0%	70%	0%	0%	0%	0%	57%
Total resistance on tension side		**63,526**	**40,935**	**22,090**	**10,089**	**61,585**	**57,134**	**48,268**	**35,500**	**12,479**
Relative to OR cob		630%	406%	219%	100%	610%	566%	478%	352%	124%
Compression side/tension side		0.93	1.44	2.66	5.83	1.00	1.00	1.00	1.00	1.00
Seismic zone		E	D	C	B	E	E	D	C	B
Strength	lbs/ ft	9,075	5,848	3,156	1,441	8,798	8,162	6,895	5,071	1,783
Target stregnth	lbs/ft	7,500	3,750	1,875	750	7,500	7,500	3,750	3,750	750
Target stregnth	lbs	52,500	26,250	13,125	5,250	52,500	52,500	26,250	26,250	5,250
Uplift / target		121%	156%	168%	192%	117%	109%	184%	135%	238%

Double Thick Mesh + 2in Drill Pipe Reinforced Test Wall

Estimated resistance: 60,000 lbs. Target performance: Seismic zone E

Sheets of 6 gauge steel reinforcing mesh with 6” squares are embedded 1.5” below the surface all the way around, from the foundation below, the full height of the wall, and the bond beam above. There are also twin posts of 2” recycled drill stem extending from ferrocement foundation to ferrocement roof.

This is the system proposed for the Adobe Safety Cottage Pilot Project on Ortega Street, which is in seismic zone E.