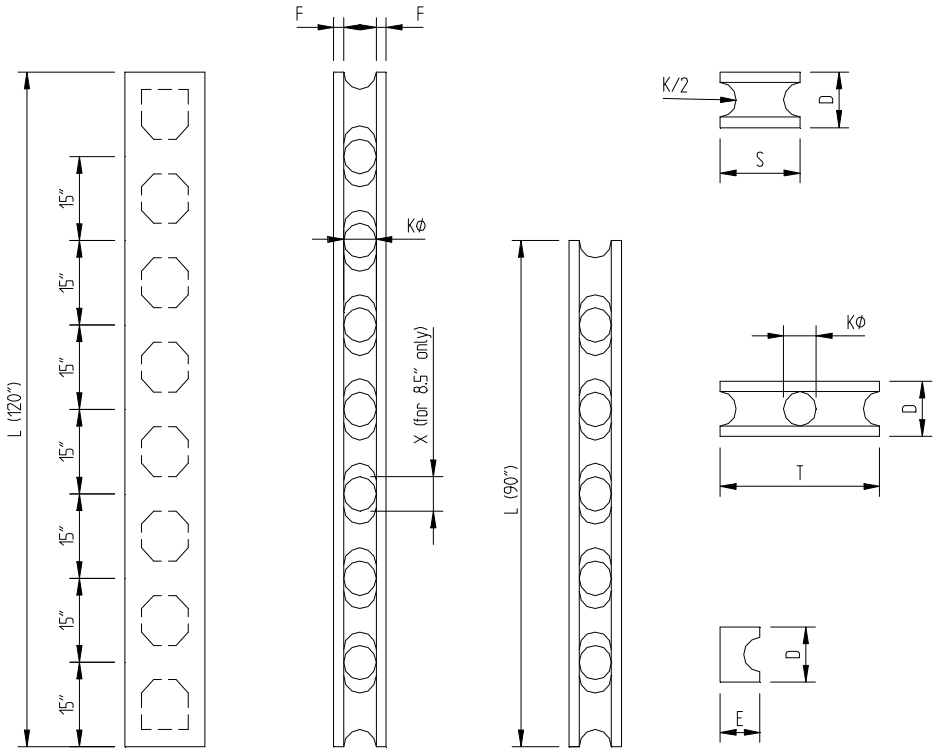
TECHNICAL DATA REFERENCE GUIDE

THIS GUIDE INCLUDES A SELECTION OF TECHNICAL DATA AND SUMMARIZES THESE REPORTS OF TESTING DONE IN EUROPE AND U.S. CONTINUOUS TESTING IS BEING DONE IN THE U.S. AND OTHER COUNTRIES. THIS GUIDE WILL BE UPDATED AS NEW TEST RESULTS BECOME AVAILABLE. REFERENCE IS MADE TO THE REPORT NUMBERS AND DATES ISSUED. COPIES OF THE FULL REPORTS ARE AVAILABLE UPON REQUEST.

THE OUTLINE OF TEST RESULTS IS FOR REFERENCE ONLY. FOR ANY APPLICATION OF THESE TESTS IN STRUCTURAL CALCULATIONS, REQUEST THE FULL TEXT OF THESE REPORTS OR ASK FOR ENGINEERING INFORMATION BASED ON SUCH TESTING.

Issued by RASTRA of The Americas, L.L.C.



DIMENSIONS

Thickness	Core Diameter	Flange	Length	Single Height	Double Height	End Panel Depth	Core Diameter
D	K	F	L	S	T	E	X
8.5"	5"	1.75"	90" or 120"	15"	30"	7.5"	5.25"
10"	6"	2"		15"	30"	7.5"	NA
12"	6"	3"		15"	30"	7.5"	NA
14"	6"	4"		15"	30"	7.5"	NA

VOLUMES & WEIGHTS

Thickness	Length	Standard Element (cubic feet)			End Element	Weight Single Element
		Outside	Cavity	Net	Net	
8.5"	120"	6.64	1.97	4.67	-	147 lbs
	90"	8.83	2.63	6.33	-	110 lbs
10"	120"	10.42	3.67	6.75	4.22	158 lbs
	90"	7.81	2.73	5.08	3.17	120 lbs
12"	120"	12.5	3.67	8,83	5.26	197 lbs
	90"	9.37	2.73	6.64	3.95	148 lbs
14"	120"	14.58	3.67	10.91	6.31	243 lbs
	90"	10.94	2.73	8.21	4.73	183 lbs

FLAT PANEL

Thickness	Width	Length	Weight
2"	30"	60"	50 lbs

FABRICATION TOLERANCES

RASTRA elements are produced to very small tolerances. This makes it possible to obtain straight and smooth walls. Below there is an excerpt of the Quality Control Sheet for the production of RASTRA elements, showing permissible tolerances at the time of production:

Tolerance*	D	F	F	L - long	L - short	E	S	T	J****
8.5”	± 1/8”	-1/2” ***	± 3/8”	+1/2” -3/8”	+1/2” -3/8”	+1/2” -5/8”	±3/32”	±3/32”	1/2”
10”	± 1/8”		+1/2”, -3/8”						
12”	± 1/8”		± 1/2”						
14”	± 3/16”		± 5/8”						

Straightness: Maximum camber out of plane over L =< 1/2"

Maximum camber in plane over L =< 1/8"

* Due to the nature of the product [1/8"] has to be considered the minimum reliably measurable dimension, thus a generally allowable tolerance.

** Openings may be oblong instead of round, created by reducing the thickness of 10" elements in the center. Tolerance is valid in longitudinal direction of element. In perpendicular direction tolerance results from flange thickness.

*** Cavity openings may be produced oblong to meet structural requirements. An upper (+) tolerance is not specified, it will result from the flange thickness (F).

**** J represents the offset of centers of the openings of the two element halves in either direction.

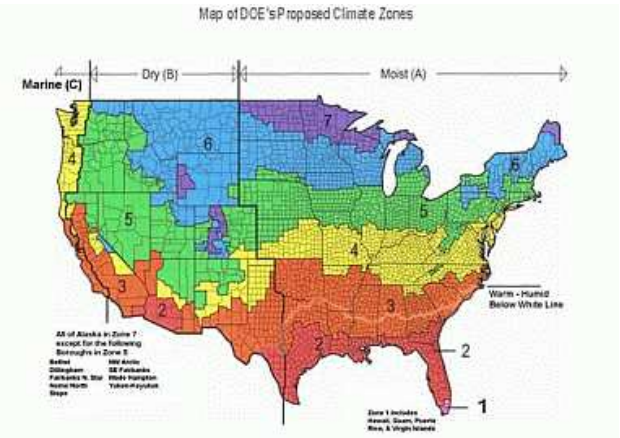
GENERAL DATA

RASTRA Panel	Concrete Consumption
10”, 12” & 14” wide	0.30 cubic feet per square foot of wall surface
Approximate Weight of Grouted Unfinished Wall	
10”	57 lbs per square foot
12”	60 lbs per square foot
14”	64 lbs per square foot
Reinforcement Consumption	
15” Centers	1.17 lineal feet per square foot of wall surface
30” Centers	0.85 lineal feet per square foot of wall surface

THERMAL PERFORMANCE

U.S. Department of Energy Oak Ridge National Laboratory – RASTRA specific tests				**RASTRA R-values** Panel Thickness and Climate Zone[3]				Minimum required R-value by DOE
DOE Climate Zone	Representative Cities	Thermal Mass Multiplier[1](TMM)	R –Value per Inch[2] 1.73* TMM	8.5" Panel[4] 5.5" Thastyron	10" Panel 6.5" Thastyron	12" Panel 8.5" Thastyron	14" Panel 10.5" Thastyron	Prescriptive Table[7]
1	Miami	1.79	N/A	15.6	19.7	27.7	37.8	13/6
2	Phoenix	2.17	N/A	18.9	23.8	33.6	45.9	13/6
3	Atlanta	1.98	N/A	17.2	21.7	30.7	41.8	13/6
4 except Marine	Washington DC	2.02	N/A	17.6	22.2	31.3	42.7	13/8
5 and Marine 4	Denver	2.10	N/A	18.2	23.1	32.6	44.4	19/13
6	Minneapolis	2.05	N/A	17.8	22.6	31.8	43.4	19/15
7 + 8	Alaska	1[5]	1.73[6]	8.7	11.0[6]	16.0[6]	22.5[6]	21/21

1. Thermal Mass Multiplier (TMM) represents the influence of thermal mass upon the insulating capacity of a wall. (Steady-state R-values were developed for traditional wood-frame walls and do not include the Thermal Mass Benefit.) Variations according to climate zone reflect the influences of temperature and humidity.
2. The non-mass steady-state R-value for THASTYRON™ is 1.73/in. When the Thermal Mass Benefit is included, the resulting R-value is shown. No TMM is applied to flat panels with a thickness under 4".
3. The equivalent thickness of THASTYRON (the RASTRA insulating material) per RASTRA panel assumes a layer of concrete between two layers of THASTYRON™. The combined thickness of the THASTYRON layer can be approximated as follows:
{Wall thickness – 3.5" (3") concrete = number of inches THASTYRON}. This simplified calculation matches the testing and computer simulation that was conducted. The R-value of the assembly, however, increases slightly exponentially with increasing thickness. The TMM decreases with more insulation around the concrete (mass). These tendencies have been considered in the values for 12" and 14" walls.
4. 8.5" thick RASTRA panels have not been tested separately. Values shown are calculated values, based on other tests.
5. Per DOE Prescriptive Table (402.1), Thermal Mass Benefit is not considered in climate zones 7 + 8. The minimum required steady-state R-value is 21.
6. Steady-state R-values per testing.
7. These are prescriptive values, which are general in nature. The first number is the steady-state R-value that is prescribed for non-mass walls (frame); the second is the steady-state value that is required for mass walls unless there is an established, specific TMM higher than the prescriptive multiplier.



Computer simulation has been based on a steady-state R-value of 7.6 and a 10" thick wall made of 25lbs/ft³ EPS concrete. Slight variations in DBMS values for other thicknesses and basic R-values may result.

For all building systems, the "clear" wall R-value (as measured in hot box or hot plate tests) is higher than it is for the total house. Some building details (corner designs, studs) are designed in a way that they interfere with the insulating envelope. That design accounts for a reduction in the total-house R-value of up to 35%. According to research of RASTRA details by ORNL, the total-house R-value will not differ more than 3.2%. For wood frame this value is usually >9%. Other benefits, such as the tightness of the building or wall-surface temperature, also have an influence. These and other factors contribute to the real performance, as utility-use data supplied by residents of RASTRA houses show savings in excess of 50% in some instances.

SPECIFICATION – Section 03135

Uses: RASTRA panels are used as permanent form work for structural concrete walls in buildings of any type of construction including residential, commercial and multi-family.

Description: RASTRA panels are hollow core forms comprised of a mixture of polystyrene beads, Portland Cement, admixtures and water; containing approximately 85% by volume of recycled expanded polystyrene beads with a density of between 20 and 24 pcf. A RASTRA panel has a compressive strength of ≥ 56 psi and a tensile strength of ≥ 43 psi. The expansion of a RASTRA panel is the same as standard concrete (.0018 inch/ft.)

Concrete Fill: Normal weight concrete with 3/8" maximum aggregate size, 7½" to 8" slump, and a minimum compressive strength of 2500 psi at 28 days.

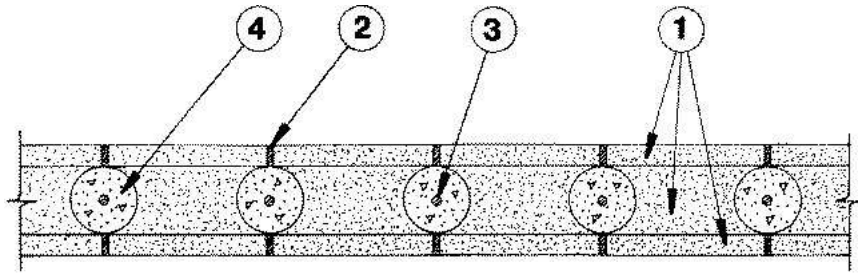
Reinforcement: Steel reinforcement bars with a minimum yield stress of 40 ksi complying with ASTM A 615.

Structural Design: Structural analysis and design of the concrete fill, steel reinforcement, and waterproofing is prepared in accordance with Building Codes.

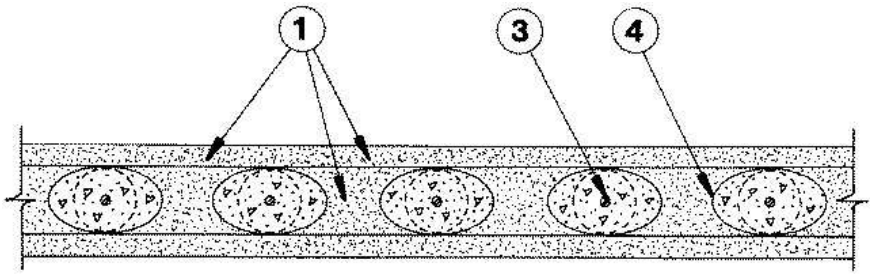
FIRE RESISTENCE RATINGS

ANSI/UL 263 - Design No. U915

Bearing Wall Fire Rating - 4 Hour



HORIZONTAL SECTION



VERTICAL SECTION

1. **Precast Concrete Units —** Min 10" thick by 7-1/2", 15" or 30" high concrete units.
2. **Caulking and Sealants* —** Units bonded together with polyurethane foam. Foam applied along the entire length of the joint at the interface of the two panels to a thickness of ½".
3. **Steel Reinforcement —** Horizontal cavities reinforced with minimum one No. 4 (1/2") steel rebar. Vertical cavities reinforced with min one No. 3 (3/8") rebar. Rebar located in the center of the cavity and held together with steel wire.
4. **Normal Weight Concrete —** Cavities of the wall filled with normal weight concrete using either carbonate or siliceous aggregate.

September 13, 2002

PHYSICAL PROPERTIES

Parameter (report numbers)	**Rating/Value**	**Remarks**
Recycled Content	± 85% by volume	Mainly post-consumer expanded polystyrene (EPS).
Bulk Density	22 lbs/ft^3 ± 10%	Elements for specific applications may be produced with higher density.
Compressive Strength of THASTYRON	56 psi	Depending on density.
Tensile Strength of THASTYRON	43 psi	Depending on density.
Water Vapor Transmission PI-4582/ws, 5/80	7.3	This is a (dimensionless) factor to measure possibility of condensation in the wall, particularly in cooler periods or with high air conditioning; the low value of Thastyron is a guarantee that no condensation will occur.
Fire Endurance UL – R14366, 9/91, 2/99	4 hour rating (ASTM E119)	A 10" un-plastered RASTRA wall has been tested for 5 hours under a load of 10,000 lbs/lin.ft.; two tests have been performed with an additional positive and negative load perpendicular to the wall, simulating a 35 mph wind pressure; with a temperature in excess of 2000°F on the exposed side the surface temperature on the unexposed side of the wall did not increase for more than 7°F; a high pressure water stream directed towards the wall immediately after burning did not penetrate the wall.
Thermal Barrier (Room Fire Test) OPL – 15715-1808, 9/97	no flame spread no smoke development wall meets UBC 26-3	A wood crib is burned in a corner built with un-plastered RASTRA walls exposing it to 1700°F +/-; flame spread, smoke and any damage of the wall is monitored.
Surface Burning Characteristic SGS – 113924. 9/98	Flame Spread Index 0 Smoke Development Index 5 NFPA Class A UBC Class 1 ASTM E 84 (NFPA 255, UBC 8-1)	4" thick Thastyron panels were exposed to flame and spreading of the flame front and smoke density, compared to red oak was measured. The flame front was proceeding less than 6", which is within the flame spread of the burner. For smoke development light absorption is measured. The test showed some very low absorption, for the test result values are always rounded to the next figure divisible by 5.
Frost Resistance TIB – KR/SI, 10/84	Highly Frost Resistant	Thastyron soaked in boiling water and frozen at -4°F; after 50 cycles no reduction of compressive strength could be found.
Toxicity	Low Toxic	Testing conducted using Leaching Procedure by EPA SW-846 method 1311,

BI – 08-95-0338, 5/95		metals by method 6010 & 7470, volatiles by method 8240; metals are less than 1/20 of regulatory limit, only traces of 4 volatiles out of 40 tested found.
Formation of Mildew API – 17137, 4/83	No mildew & fungus growth including black mold	Test cubes were kept under moist conditions for 40 days after inoculation of test germs (aspergillus niger, rhizopus nigricans). No growth of cultures could be observed; formation of mycel or konidien culture did not take place.
Water Transmission ATI – 03-30070.01, 12/98 ATI – 03-30305.01, 12/98	Meets requirements ASTM E331, ASTM E514, meets UBC 14-1 (grade "C" craft paper)	10" thick RASTRA wall with skim coat has been exposed to a water spray with a flow rate of 5.0 US gal/ft^2/hr at a differential pressure to simulate a 125mph wind. (extended testing done by US Navy and met standards).
Average Wall Humidity MA-39 – f711/83, 10/83	Average 2.5% by volume	Samples taken from a home more than 5 years in use from areas where most humidity is expected.
Expansion TUG – 52.620/83, 7/83	0.0018inch/ft (as standard concrete)	Even as RASTRA elements without concrete grout show shrinking and swelling in changing humidity, shrinkage is neglectible once the concrete is poured.
Thermal Performance MPA – 970344-Hu, 1/98	Effective R-values 20 to 49 h.°Fs.f./Btu	European testing on a 1.5m x 1.5m, and US testing of 8'x8' walls revealed heat conductivities of 0.084 to 0.053 Btu/h°F/ft of dry, grouted 10",12" and 14" walls. DBMS values between 1.79 and 2.17 have been established for 6 U.S. climate zones. Energy usage shows even better efficiency.
Sound Insulation BVFS – U3/19A/87, 2/87 MA-39 – F956/85, 6/85	>50dB(a)	Measurements have been taken in laboratories and in real buildings; dB is a value measured on a logarithmic scale, therefore, f.i. the difference between 27dB (good for a 2x4 framed wall) and a 50dB RASTRA wall result in 199% lower sound intensity. The value indicated in test results is an average. measure on a band width of 100 to 3150 Hz. Another aspect is sound absorption, which a RASTRA wall provides.

STRUCTURAL PARAMETERS

Pillar Strength TUG – 53.725/84, 3/84	> 70 kips/linear foot (failure load)	Test pillars consisted of 1 standard RASTRA element capped with 2 end elements; concrete strength 3000 psi, no reinforcement.
Cyclic Shear UCI – RAL 20177-IP, 9/96	10' x 10': ±68 kips 5' x 10' high: ±20 kips	Walls have been constructed with reinforcement on 15" centers not centered in the cavity. In order to simulate high wind or earthquake loads cyclic loading in plane and a constant axial load of 10,000 plf has been applied. The wall showed extreme good ductility and a deflection of 1.14" re. 1.24". Failure occurred near the base connection to the foundation.
Narrow Wall Cyclic Shear UCI – RAL-25683-NSW, 11/98	30" x 10' high load at 60": 11kips load at 75": 10kips load at 90": 9kips	To investigate shear resistance on very short elements of a wall, specimens consisting of only 1 standard and 2 end elements have been tested. Boundary reinforcement has been increased to avoid premature failure due to flexural forces. A constant axial load of 10,000plf has been used. Shear load has been applied in 3 heights to gain information about pillars with different aspect ratios.
Slender Wall UCI – RAL-23940-SW, 10/97	Axial load 1000plf, 7.5" out of center, width 45" (4 col.) Flexural load at failure: Wall 16' high: 2800 lbs Wall 20' high: 2200 lbs	The specimens were loaded with a constant out of center load to simulate roof loads introduced by ledgers. The out-of-plane load was applied on 1/3 points on the side to increase the eccentricity of all loads. The walls were able to sustain the applied axial and out-of-plane loads through the deflection limits given in the codes and beyond.
Out-of-Plane Load UCI – RAL-20177-OP, 9/96	9' span: 9kips	Load was applied in 1/3 points on a 10" RASTRA element laying flat. No brittle failure occurred even as the test was continued beyond 80% peak load. Deflections at peak load were 2.44".
Lintels & Beams UCI – RAL-20177-L, 9/96	Height:1 element (2 pillars) 10' span: 21kips 5' span: 26kips	One RASTRA element was used capped on the lower side with an end element to simulate a lintel design as it may be used in the field. Support was free at 10' distance, loaded at 1/3 points.