Characterization of Confined Masonry Structures for Integration with HAZUS

EERI-WHE / PAGER Project Review Meeting

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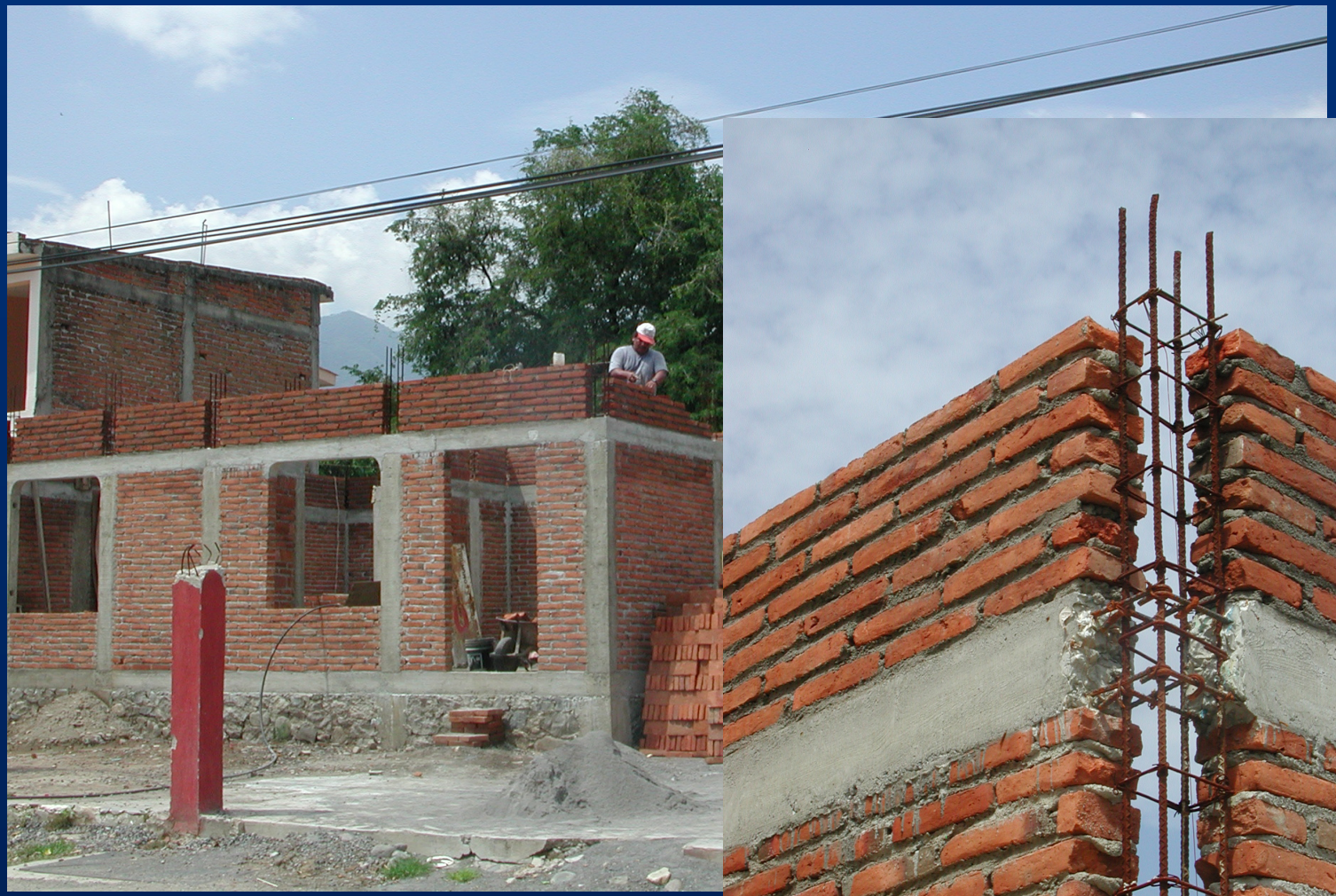
23 September 2009

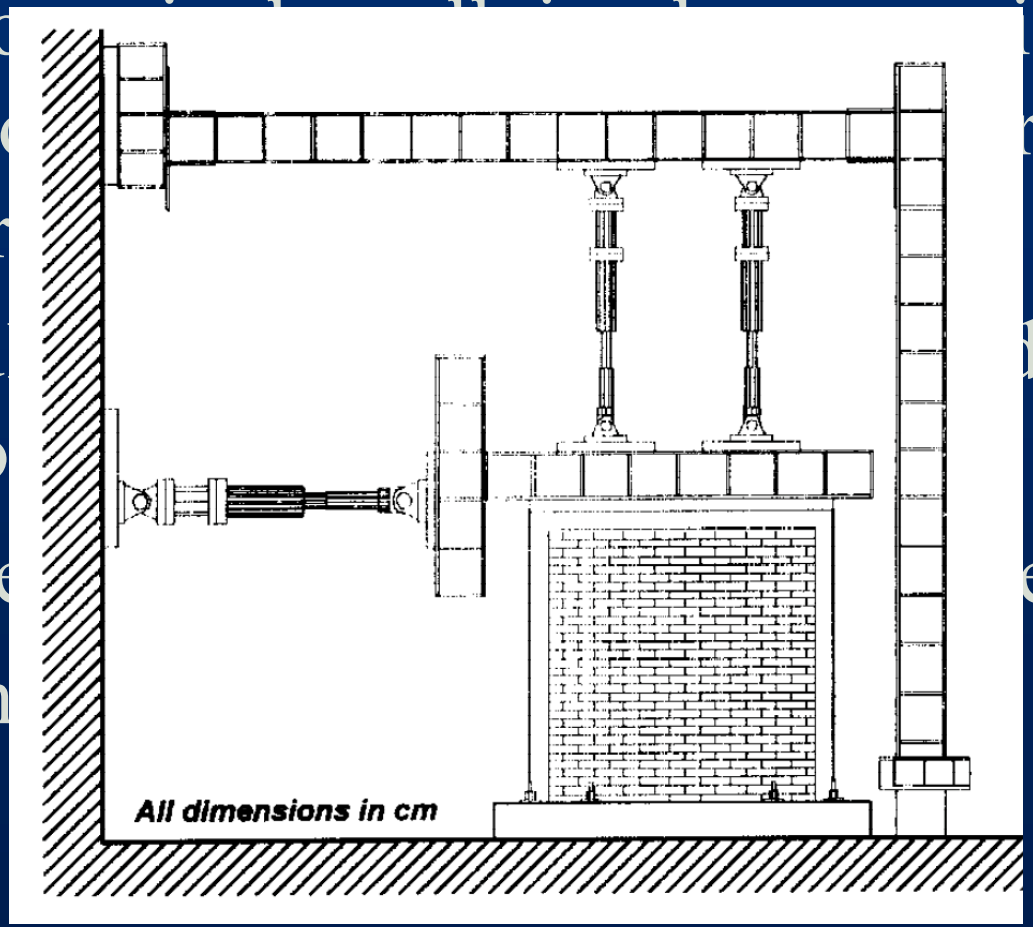
Presentation Overview

- Available Literature
- Project Scope
- Modeling Assumptions
- Conversion to Spectral Space
- S_d, S_a Plots
- HAZUS Parameter Selection
- Bonus Information



Available Data

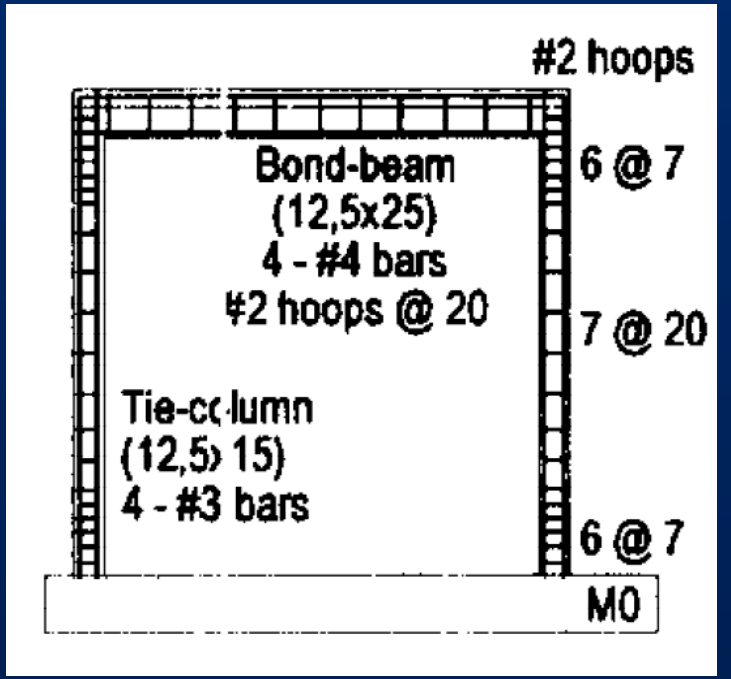
- Numero -static cyclic l rameters and retr
- Handfu ded uni-directio
- Few pse ests
- Predom



Project Scope

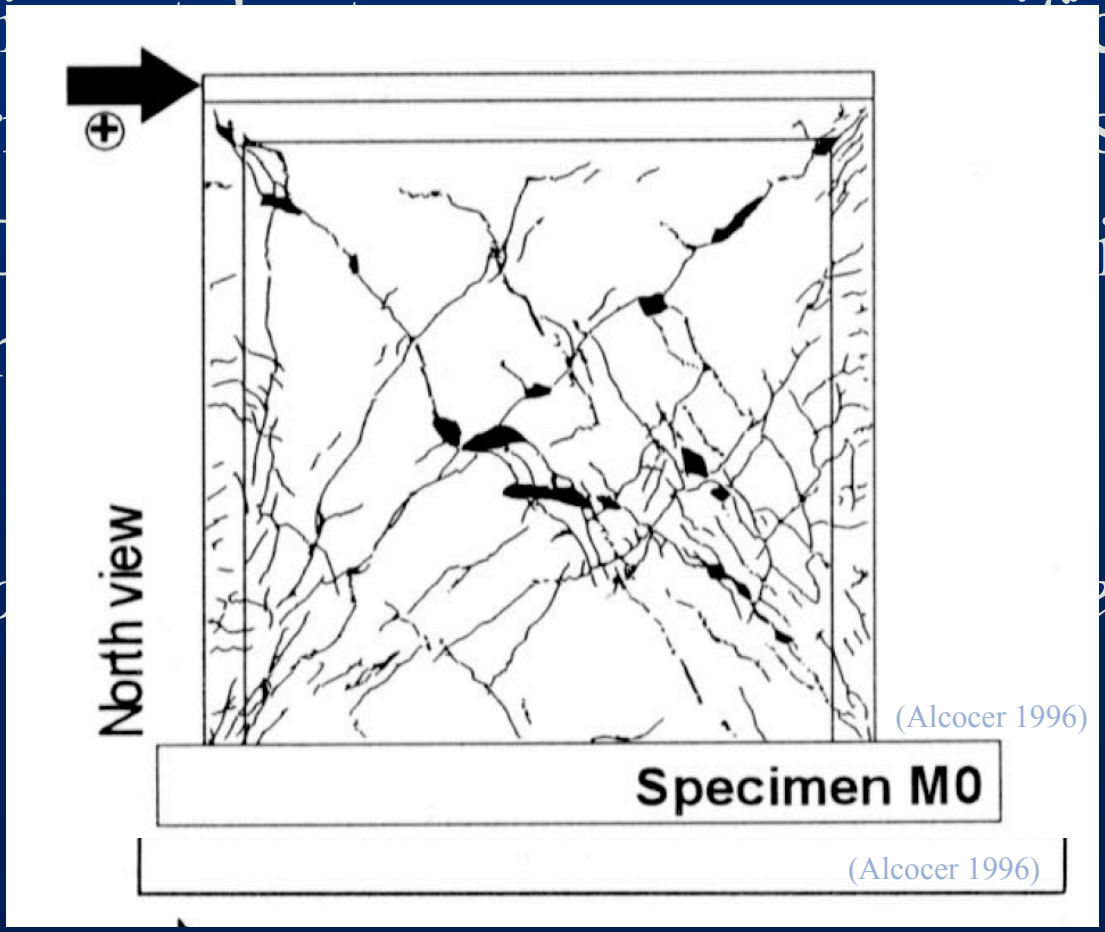
Focus on *typical* construction:

- Unreinforced wall panels
- Lightly reinforced confining elements w/ shear reinforcement
- Clay brick and concrete block
- No retrofit or improvement techniques
- 1-5 stories



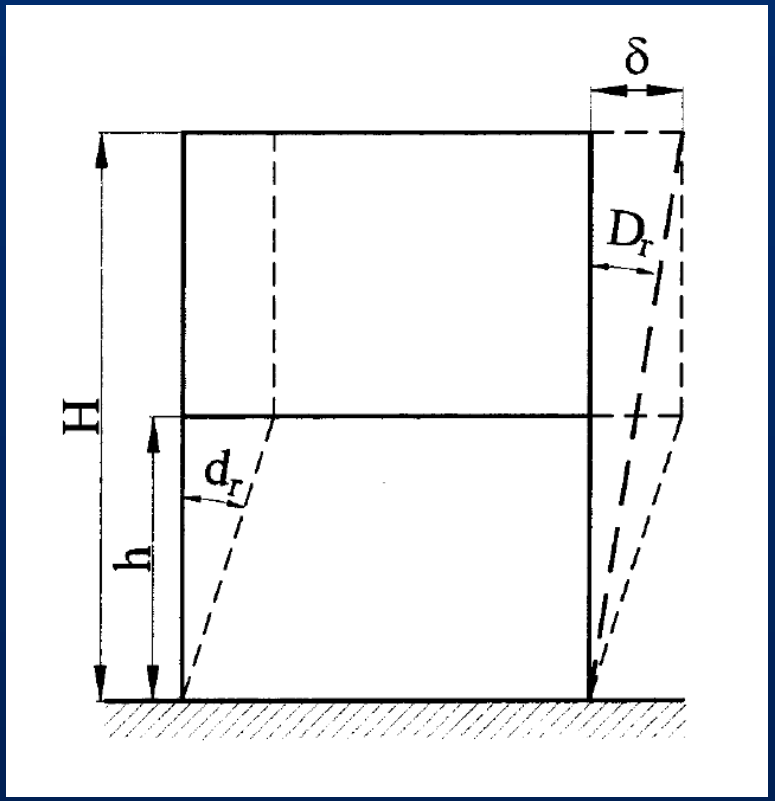
Scope: Limitations of Available Data

- Experi… c perfor… story
- For 3D… ion is in first-m…
- No of …
- *Lack o… es*

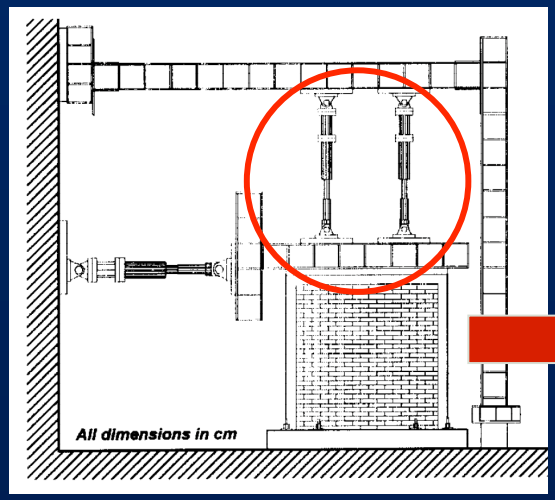


Modeling Assumptions

- Soft-story mechanism: building displacement occurs at first level
- Wall stiffness affected by vertical load → mass of the structure is assumed as-tested
- Thus, the performance of a single wall is suggestive of the building performance

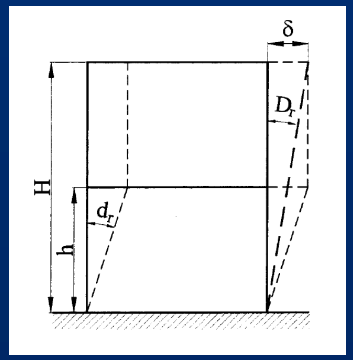


(Rodriguez 2005)

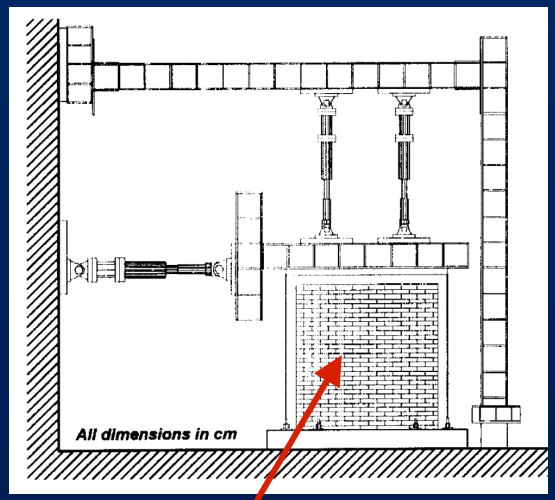

All dimensions in cm

Conversion to Spectral Space

- $S_d = \Delta \alpha_2$
  - Effective height factor based on 1-story
- $S_a = \omega^2 S_d$
  $= (K / M_{eff}) S_d$
- Effective mass: equivalent to the mass of a typical floor plan, or "cell" multiplied times effective mass parameter
  - e.g., if a wall tested with the equivalent of 4-stories above, then the mass of a 4 story "cell" is assumed here
- Stiffness based on the available data for a single wall: force and displacement at 1st level
- Effective height and mass parameters taken from SEAOC Blue Book

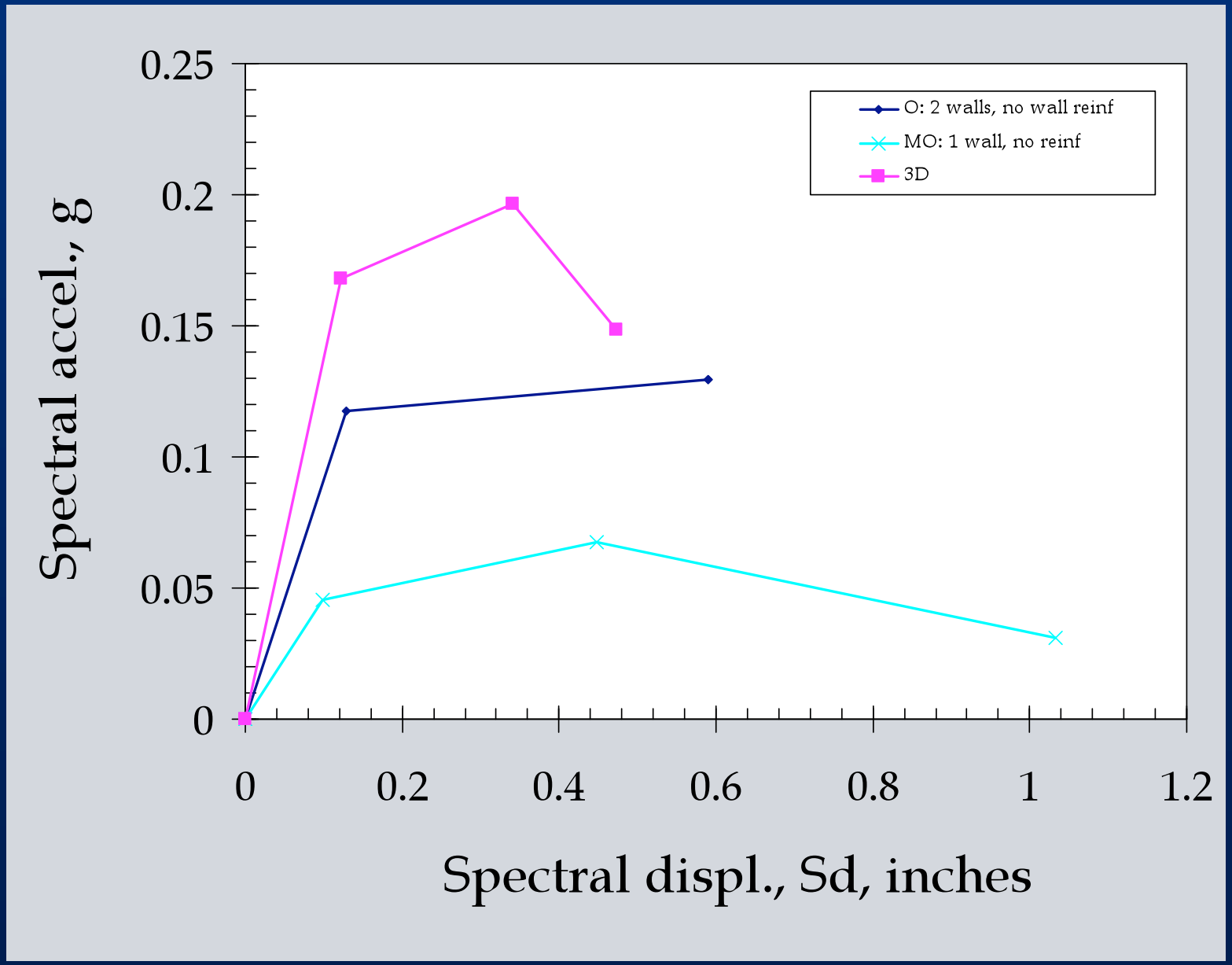


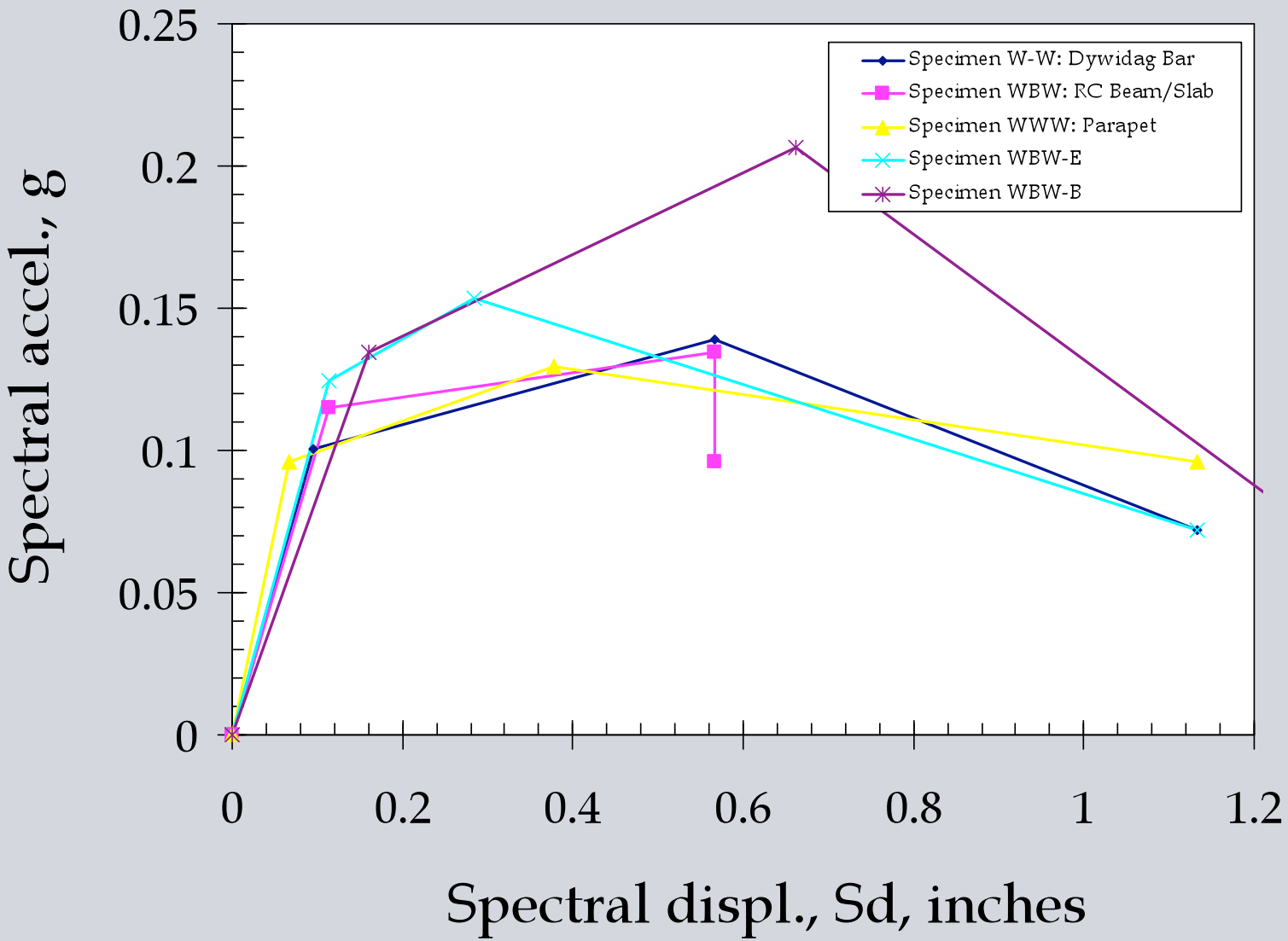
(Rodriguez 2005)

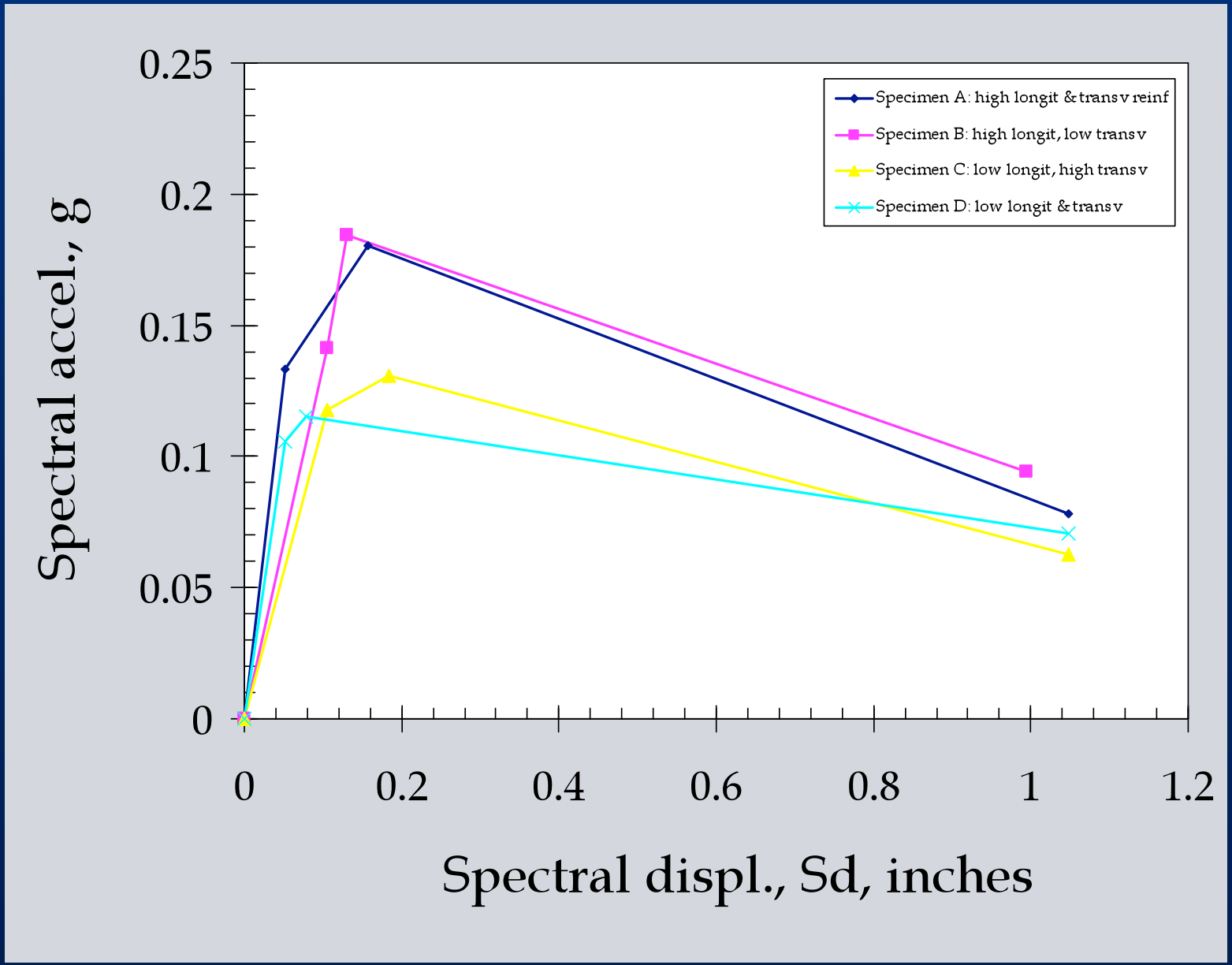


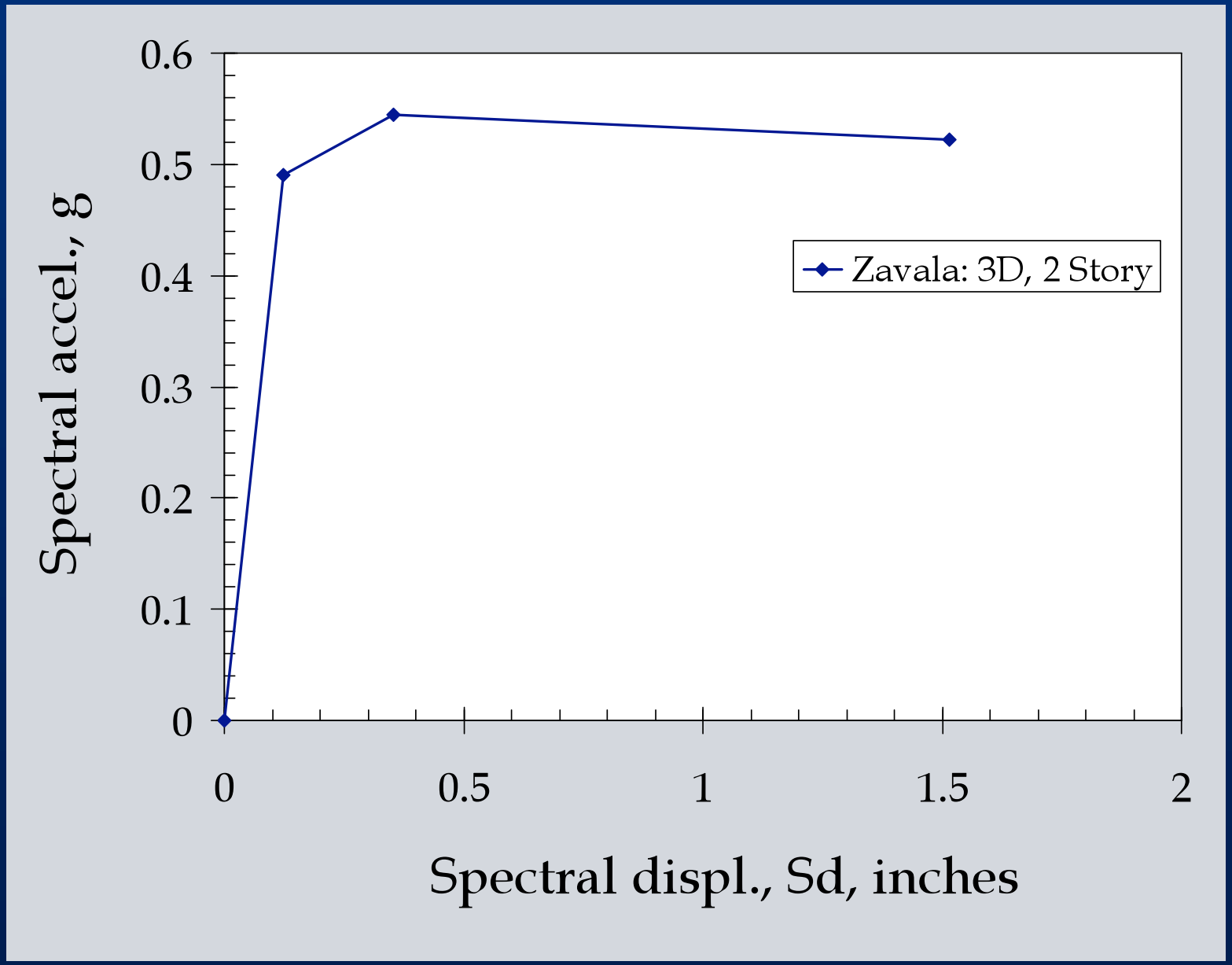
K = lateral force/displacement

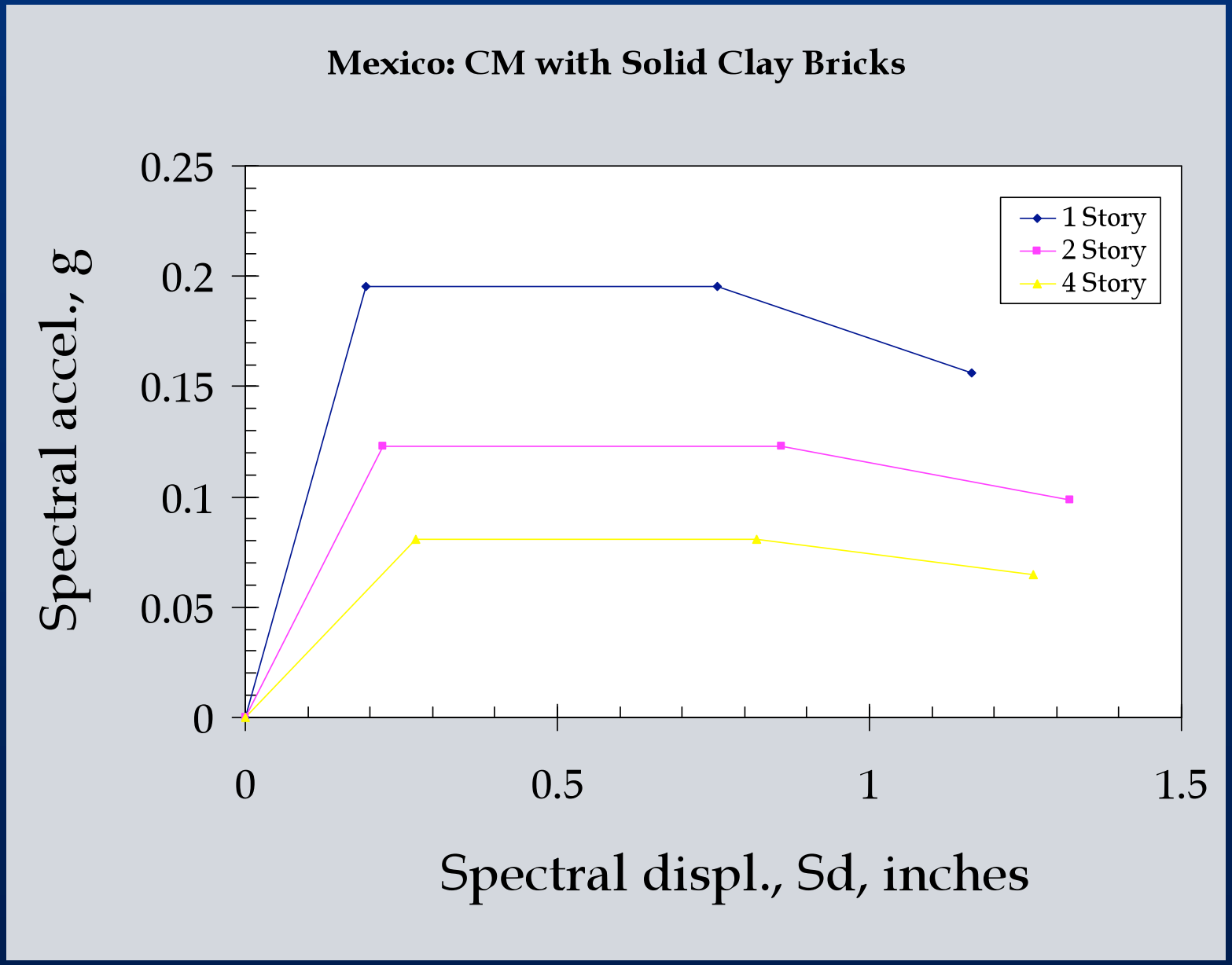
M_{eff} = 4-story cell x α_1

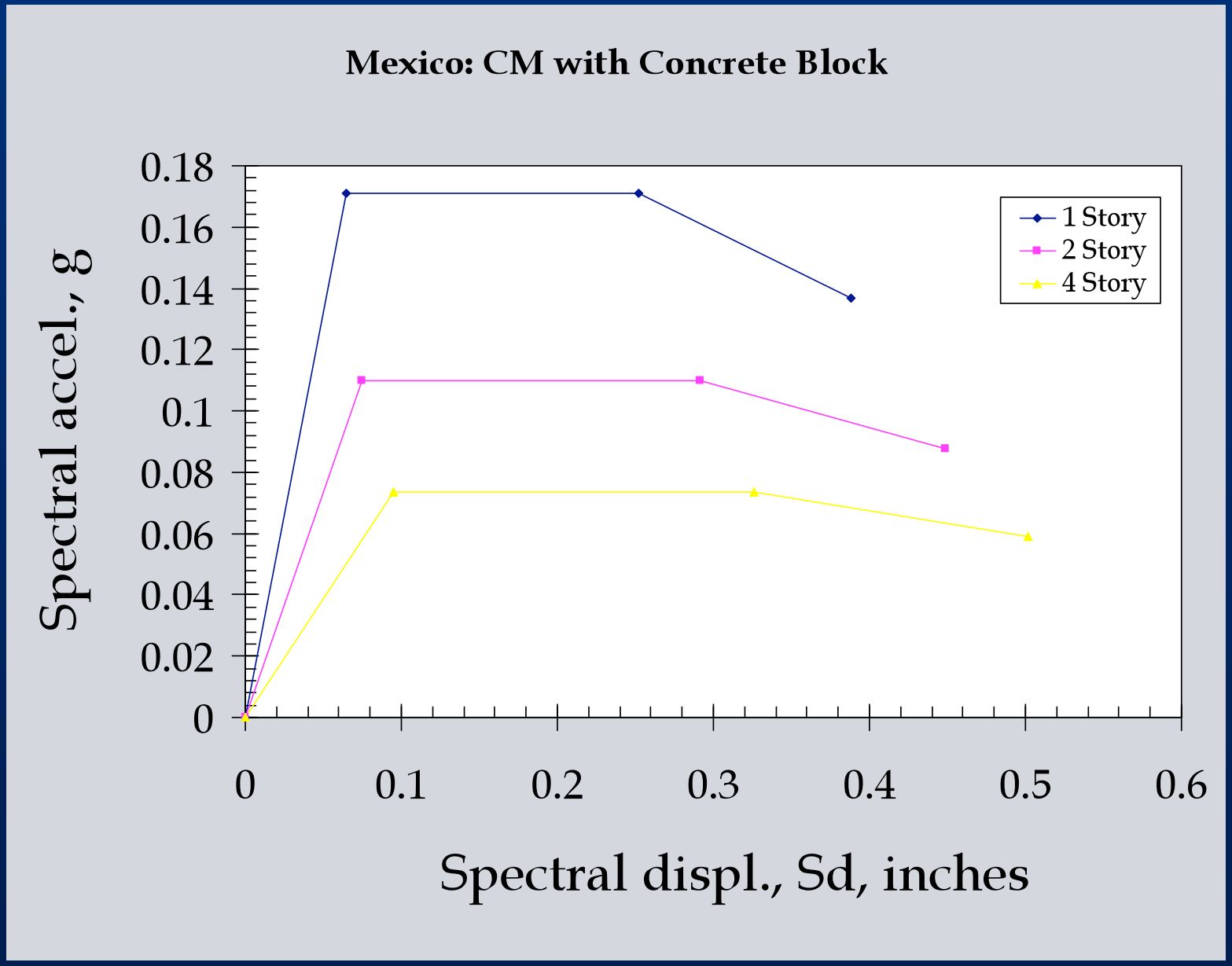

0.25
0.2
0.15
0.1
0.05
0
Spectral accel., g
0
0.2
0.4
0.6
0.8
1
1.2
Spectral displ., Sd, inches
O: 2 walls, no wall reinf
MO: 1 wall, no reinf
3D


Specimen W-W: Dywidag Bar
Specimen WBW: RC Beam/Slab
Specimen WWW: Parapet
Specimen WBW-E
Specimen WBW-B
Spectral accel., g
0.25
0.2
0.15
0.1
0.05
0
0
0.2
0.4
0.6
0.8
1
1.2
Spectral displ., Sd, inches


Specimen A: high longit & transv reinf
Specimen B: high longit, low transv
Specimen C: low longit, high transv
Specimen D: low longit & transv
Spectral accel., g
0.25
0.2
0.15
0.1
0.05
0
0
0.2
0.4
0.6
0.8
1
1.2
Spectral displ., Sd, inches


0.6
0.5
0.4
0.3
0.2
0.1
0
Spectral accel., g
0
0.5
1
1.5
2
Spectral displ., Sd, inches
Zavala: 3D, 2 Story


Mexico: CM with Solid Clay Bricks
Spectral accel., g
0.25
0.2
0.15
0.1
0.05
0
0
0.5
1
1.5
Spectral displ., Sd, inches
1 Story
2 Story
4 Story


Mexico: CM with Concrete Block
Spectral accel., g
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
0.1
0.2
0.3
0.4
0.5
0.6
Spectral displ., Sd, inches
1 Story
2 Story
4 Story

HAZUS Parameters

Dy	"Yield" was typically defined and chosen as first diagonal cracking
Ay	
Du	"Ultimate" or "Collapse" was typically defined by experimenters at 80% peak strength
Au	
Sdc	
BE	Some tests indicate 4%; more info sought
kshort	0.4
kmed	0.2
klong	0
θ 14	Approximately 1.0 in, but tests typically not brought to complete damage
β 14	Beta values available for yield & max
Natural Period	Chilean structures measured in field: median elastic T = 0.098s & 0.157s for 3 & 4 story
Ductility Factor	μ = 3-6 from experimental wall tests
Strength Reduction Factor	Published values reported by country; Tc not considered at this time

- Us

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IRAN	Not stated
Total Country	176177
Urban	125168
Rural	51009

CUADRO N°4.13

CUADRO N° 4.12

PERÚ: VIVIENDAS PARTICULARES CON OCUPANTES PRESENTES, SEGÚN ÁREA DE RESIDENCIA Y MATERIAL PREDOMINANTE EN LAS PAREDES EXTERIORES, 1993 Y 2007

Área de residencia / Material predominante en las paredes exteriores	1993		2007		Incremento intercensal		Incremento anual	Tasa de crecimiento promedio anual
	Absoluto	%	Absoluto	%	Absoluto	%		
Urbana	**3 017 681**	**100,0**	**4 789 588**	**100,0**	**1 771 907**	**58,7**	**126 565**	**3,3**
Ladrillo o bloque de cemento	1 540 324	51,0	2 926 762	61,1	1 386 438			
Adobe o tapia	958 151	31,8	1 126 917	23,5	168 766			
Madera	163 921	5,4	392 384	8,2	228 463	139,4	16 319	6,3
Quincha	102 506	3,4	106 918	2,2	4 412	4,3	315	0,3
Estera	135 955	4,5	119 340	2,5	- 16 615	-12,2	- 1 187	-0,9
Piedra con barro	25 464	0,8	20 808	0,4	- 4 656	-18,3	- 333	-1,4
Piedra, sillar con cal o cemento	46 999	1,6	31 589	0,7	- 15 410	-32,8	- 1 101	-2,7
Otro material	44 361	1,5	64 870	1,4	20 509	46,2	1 465	2,7
Rural	**1 409 836**	**100,0**	**1 610 543**	**100,0**	**200 707**	**14,2**	**14 336**	**0,9**
Ladrillo o bloque de cemento	41 031	2,9	64 865	4,0	23 834			
Adobe o tapia	959 734	68,1	1 102 798	68,5	143 064			
Madera	146 458	10,4	225 358	14,0	78 900	53,9	5 636	3,1
Quincha	105 037	7,5	76 944	4,8	- 28 093	-26,7	- 2 007	-2,2
Estera	12 074	0,9	25 171	1,6	13 097	108,5	936	5,3
Piedra con barro	111 500	7,9	86 015	5,3	- 25 485	-22,9	- 1 820	-1,8
Piedra, sillar con cal o cemento	7 248	0,5	2 350	0,1	- 4 898	-67,6	- 350	-7,6
Otro material	26 754	1,9	27 042	1,7	288	1,1	21	0,1

Fuente: INEI - Censos Nacionales de Población y Vivienda, 1993 y 2007.

vs. 5% reported

vs. 90% reported

Tumbes	48 638	20 336	4 621	2 618	18 199	325	267	129	2 143
Ucayali	94 299	16 911	697	73 134	454	1 221	68	121	1 693
Lima Metropolitana 1/	1 916 773	1 558 203	87 036	196 613	13 107	29 451	1 268	2 761	28 334
Lima Provincias 2/	203 858	83 762	91 495	3 402	4 917	15 697	2 221	244	2 120

1/ Comprende la provincia de Lima y la Provincia Constitucional del Callao.
2/ Comprende el departamento de Lima, excepto la provincia de Lima.
Fuente: INEI - Censos Nacionales 2007 : XI de Población y VI de Vivienda.