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Structural Concrete Design - The Legacy of Dr. W. Gene Corley

ACI Fall 2013 Convention
October 20 - 24, Phoenix, AZ

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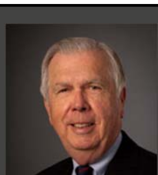
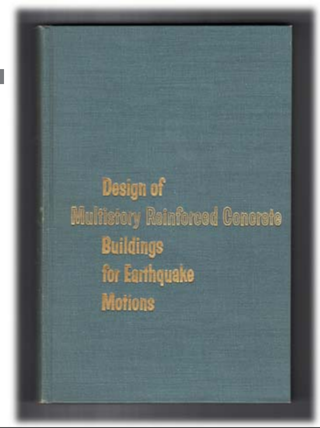


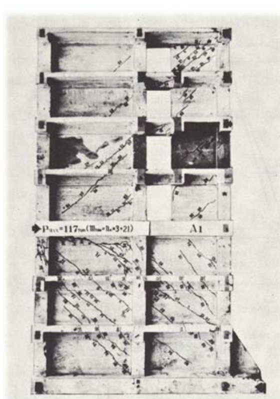
BEHAVIOR AND DESIGN OF EARTHQUAKE-RESISTANT STRUCTURAL WALLS

Jack Moehle, University of California, Berkeley
Sharon L. Wood, University of Texas at Austin

The 1960s



The 1960s



Muto Laboratory, U. Tokyo

The 1960s

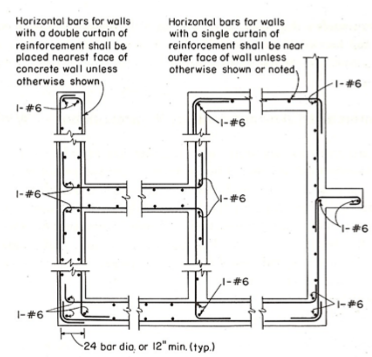


Fig. 6-9. Plan view showing typical wall reinforcement details.

Blume, Newmark, and Corning, 1961

Key Papers on Structural Walls

Barda, F., J.M. Hanson, and W.G. Corley (1977). “Shear Strength of Low-Rise Walls with Boundary Elements,” Special Publication 53.

Barney, G.B., K.N. Shiu, B.G. Rabbat, A.E. Fiorato, H.G. Russell, W.G. Corley (1978). “Earthquake-Resistant Structural Walls – Tests of Coupling Beams,” Report to the National Science Foundation.

Oesterle, R.G., A.E. Fiorato, J.D. Aristizabal-Ochoa, and W.G. Corley (1980). “Hysteretic Response of Reinforced Concrete Structural Walls,” Special Publication 63.

Corley, W.G., A.E. Fiorato, and R.G. Oesterle (1981). "Structural Walls," Special Publication 72.

Oesterle. R.G., J.D. Aristizabal-Ochoa, K.N Shiu, and W.G. Corley (1984). “Web Crushing of Reinforced Concrete Structural Walls,” ACI Journal.

Low-rise walls

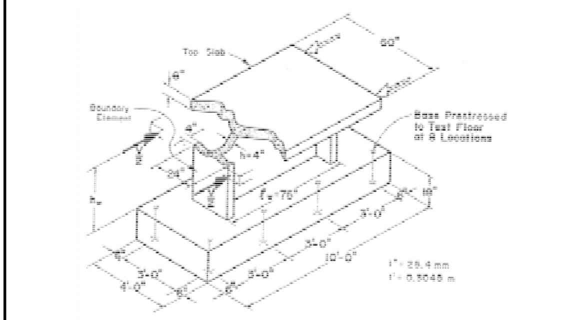


Fig. 1--Test specimen

Low-rise walls

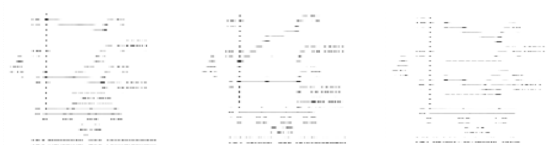


Fig. 5--Effect of principal variables

Low-rise walls

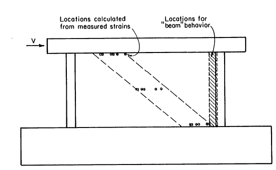


Fig. 21--Location of resultant compressive force in concrete

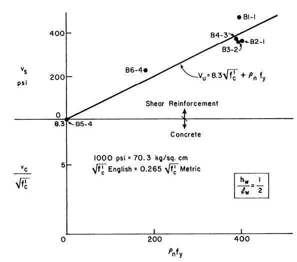
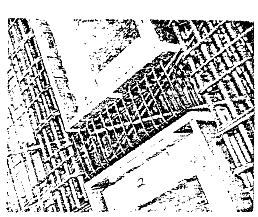
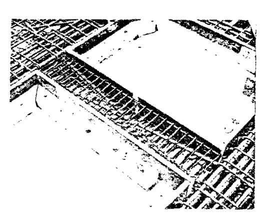


Fig. 22--Increase in strength with vertical wall reinforcement

Diagonally reinforced coupling beams



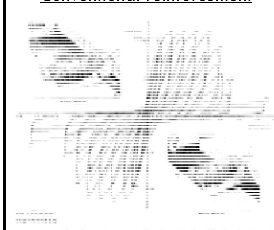
e) Specimen C6



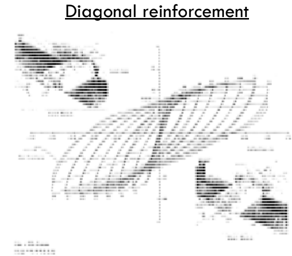
f) Specimen C8

Diagonally reinforced coupling beams

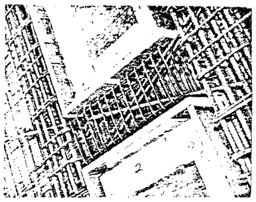
Conventional reinforcement



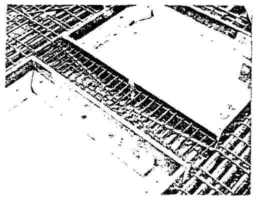
Diagonal reinforcement



Diagonally reinforced coupling beams



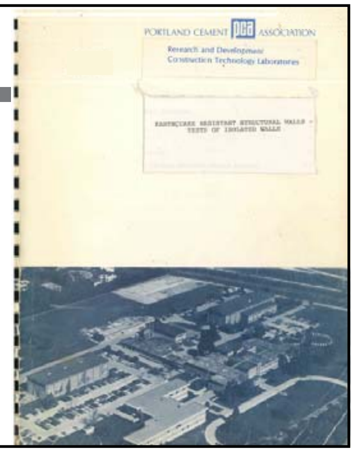
e) Specimen C6

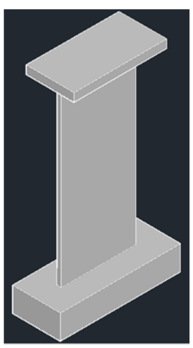


f) Specimen C8

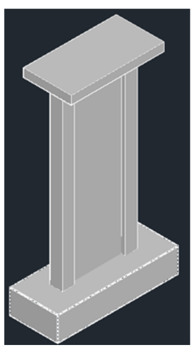
Slender walls

Earthquake Resistant
Structural Walls –
Tests of Isolated Walls

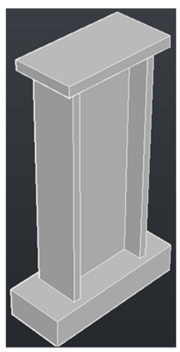




Rectangular

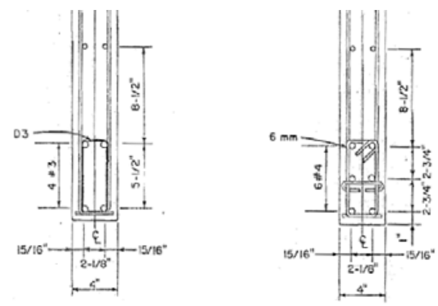


Barbell

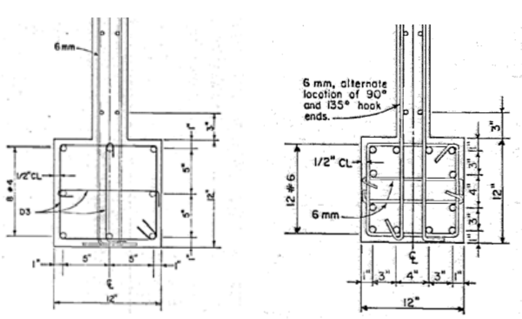


Flanged

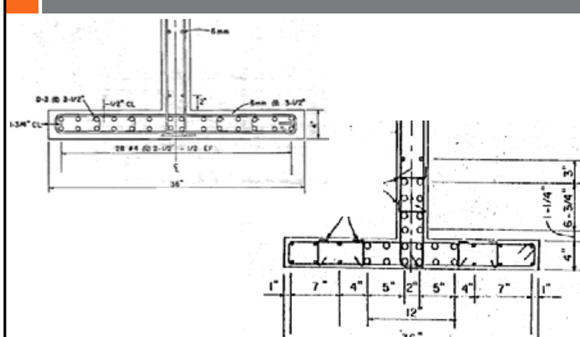
Boundary Elements – Rectangular Walls



Boundary Elements – Barbell Walls



Boundary Elements – Flanged Walls



Flexure and shear deformations

Flexure

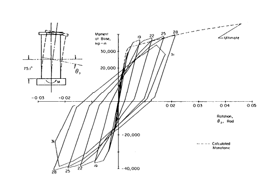


Fig. 9--Measured moment versus rotation relationship for Specimen B7

Shear

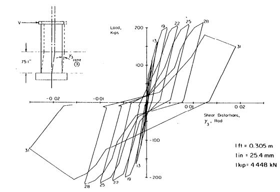
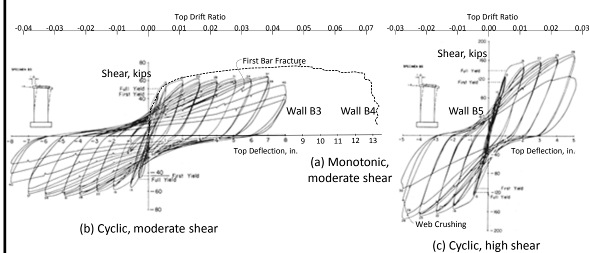
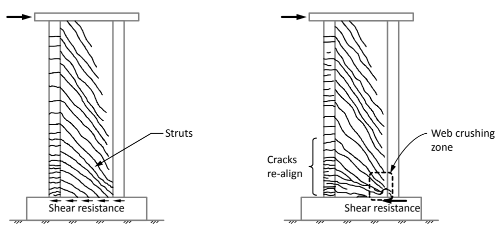


Fig. 10--Measured shear versus distortion relationship for Specimen B7

Effect of cyclic loading and shear



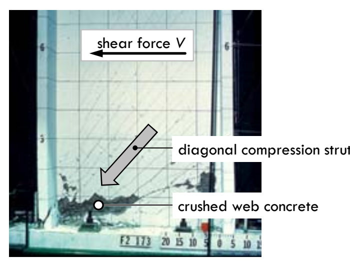
Web crushing of slender walls



(a) Initial crack pattern
(for one direction of loading)

(b) Cracking pattern after
several large reversals
(for one direction of loading)

Web crushing

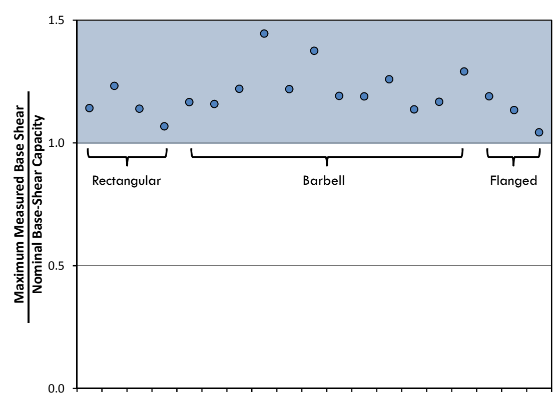


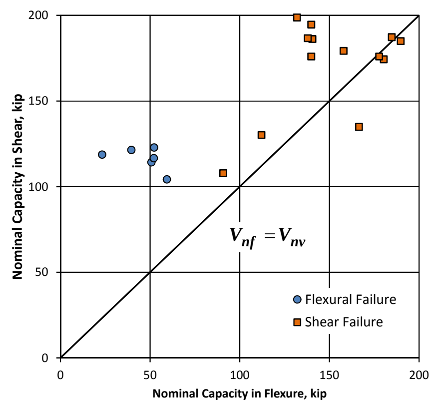
Nominal Capacity

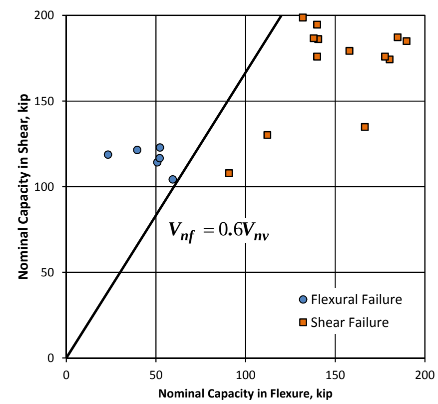
- Flexural Capacity, V_{nf}
- Shear Capacity, V_{nv}

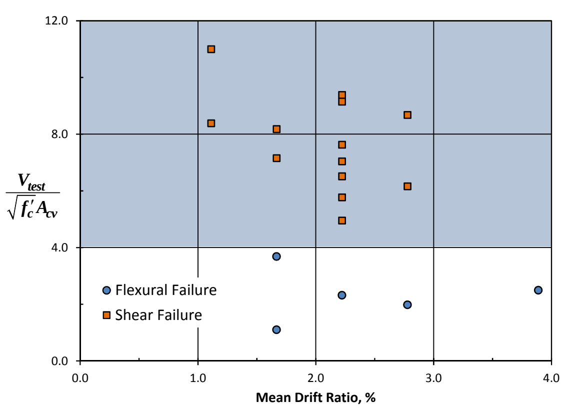
$$V_{nv} = \left(2\sqrt{f_c'} + \rho_n f_y\right) A_{cv}$$

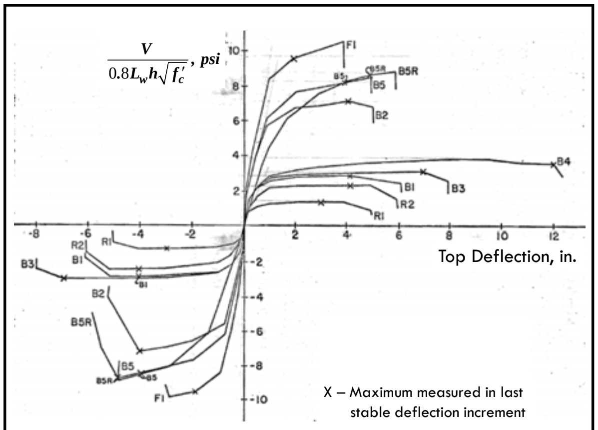
- Nominal Capacity, V_n = min (V_{nf}, V_{nv})











Slender Walls – Displacement Capacity

- All test specimens were able to sustain multiple cycles to drift ratios exceeding 1%.
- Walls with confined boundary elements were able to sustain larger inelastic deformations.
- Walls that experienced web crushing sustained slightly lower maximum inelastic deformations.
- Maximum inelastic displacement depends on loading history.

Slender Walls – Shear Capacity

- Average shear stress of $4\sqrt{f'_c}$ represented the boundary between flexural and shear failure mechanisms.
- If $V_{nf} > 0.6\ V_{nv}$, shear failure was observed under cyclic lateral loads.
- Walls with low web reinforcement ratios are susceptible to degradation of shear strength with cycling.

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