

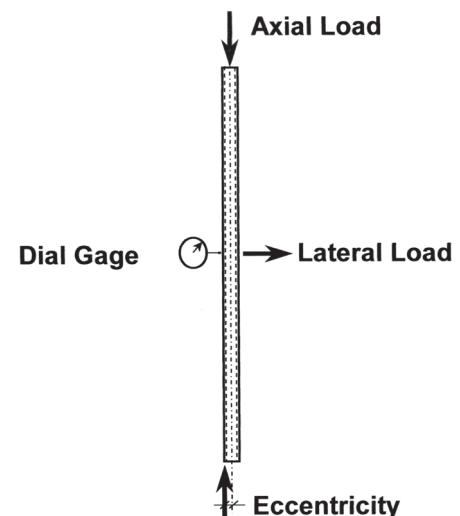
LOAD-BEARING SPANCRETE® HOLLOWCORE WALL PANEL DESIGN

A series of tests were conducted to evaluate the Load-Bearing capacity of vertical Spancrete hollowcore wall panels with particular attention to slenderness effects. Slenderness ratios of 93.5 and 151 were tested. The tests were set up to apply a variable axial load with eccentricity at one end. A constant lateral load was applied at midheight to simulate wind load on the panel and establish an initial panel deflection.

The results were evaluated using ACI moment magnifier provisions, a modified moment magnifier approach from the PCI Design Handbook, and a second order, or P-delta, analysis.

CONCLUSIONS:

1. Test capacities exceeded those predicted by the ACI moment magnifier approach, even though the ACI slenderness limit of 100 was exceeded.
2. The modifications to EI in the PCI Handbook were found to result in very erratic strength predictions and are not recommended for use.
3. A prediction of capacity based on a second order analysis was found to be in good agreement with the test results.
4. In comparison to a test condition, design applications must account for reduction in stiffness due to sustained loads. Also, a strength reduction factor, ϕ , must be applied.
5. A second order analysis should be used to evaluate slenderness effects when designing Load-Bearing Spancrete wall panels.
6. The ultimate tensile stress in the concrete should be maintained at a level below cracking for slender panels. While the effects of cracking can be evaluated, second order deflections tend to increase dramatically after cracking.



Wall Panel Test Set-up

A design example is given on the reverse side.

Research Notes are produced periodically by the SMA Technical Committee. SMA Research Notes are based on testing done for the Spancrete Manufacturers Association. The information contained in these Research Notes should be used by those experienced in structural design and should not replace sound engineering judgment.



DESIGN EXAMPLE

LOAD-BEARING SPANCRETE® HOLLOWCORE WALL PANEL DESIGN

GIVEN:

An 8" Spancrete hollowcore wall panel, 8' wide and 30' high, carrying axial loads of 16 k per panel dead load and 8 k per panel roof live load, both at an eccentricity of 3" from the panel centroid. The wind load is 25 psf. Assume the panel has an initial bow = 1". The panel moment of inertia = 3629 in⁴.

PROBLEM:

Design the panel for this Load-Bearing condition.

SOLUTION:

For the load combination 1.2D + 1.6W + .5Lr, the design forces are:

$P_u = 23.2$ k and $w_u = 0.320$ k/ft. Calculate first order deflections:

$$\text{Due to axial load: } \Delta_1 = \frac{Ml^2}{16EI} = \frac{23.2(3)(30 \times 12)^2}{16EI} \quad \text{Due to wind load: } \Delta_1 = \frac{5w^4}{384EI} = \frac{5(0.320)(30)^4 1728}{384EI}$$

Modify EI, per ACI for sustained loads and stiffness reduction:

$$\beta_d = \frac{1.2 \times 16}{(1.2 \times 16 + .5 \times 8)} = 0.83 \text{ for axial load and } B_d = 0 \text{ for wind load} \quad \text{Then } EI = \frac{0.7(4300)(3629)}{(1 + 0.83)} = 5.97 \times 10^6 \text{ for axial load}$$

$$\text{and } EI = \frac{0.7(4300)(3629)}{(1 + 0)} = 10.92 \times 10^6 \text{ for wind load, where } 0.7 = \text{ACI stiffness reduction for second order analysis.}$$

Thus the first order deflection $\Delta_1 = 0.09"$ axial + $0.53"$ wind + $1.0"$ bow = $1.62"$

The second order deflection is due to the axial load acting on a panel braced at the top and bottom only. The instantaneous and sustained deflections are separated. With dead load and bowing considered sustained.

$$\text{Dead load portion} = \frac{1.2(16)}{1.2(16) + .5(8)} = 0.83 \quad \text{Live Load portion} = 1 - 0.83 = 0.17$$

$$\Delta_1 \text{ sustained} = 0.83(0.09) + 1 = 1.07" \quad \Delta_1 \text{ instantaneous} = 0.17(0.09) + .53 = .55"$$

For the simple case of a panel braced at the top and bottom only:

$$\text{Final } M_u = M_{u1} + [P\Delta_1 / (1 - P^2 / \pi^2 EI)]$$

$$\text{First order } M_u = [23.2(3)/2(12)] + 0.32(30)^2/8 = 38.9 \text{ ft-k/panel}$$

$$\text{Final } M_u = 38.9 + (23.2)(1.07/12) / \{1 - [23.2(30 \times 12)^2 / (\pi^2)(5.97)(10^6)]\}$$

$$+ (23.2)(.55/12) / \{1 - [23.2(30 \times 12)^2 / (\pi^2)(10.92)(10^6)]\} = 42.2 \text{ ft-k/panel}$$

Since the gross moment of inertia was used to calculate deflections, the tension stress at factored and magnified moment must be checked. $M_u/S = 42.2(12)/(3.98)/3629 = 0.555$ ksi. The panel will be uncracked with a minimum prestress of 225 psi. Therefore the original assumption is validated. The panel design is completed by selecting a prestress pattern which provides the axial and flexural strength required.

Sample calculations are intended only to illustrate the concept presented and do not represent all considerations necessary for a complete design.

MIDWEST

Hanson Structural
Precast Midwest, Inc.
Maple Grove, Minnesota

Spancrete, Inc.
Green Bay, Wisconsin

Spancrete Industries, Inc.
Waukesha, Wisconsin

Spancrete of Illinois, Inc.
Arlington Heights, Illinois

Wells Concrete
Wells, Minnesota

WEST

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Irwindale, California

KIE-CON

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Sandy, Utah

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