SPANCRETE MANUFACTURERS ASSOCIATION

RESEARCH NOTES

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 approah from the PCI Design Handbook, and a second order, or P-delta, analysis.

CONCLUSIONS:

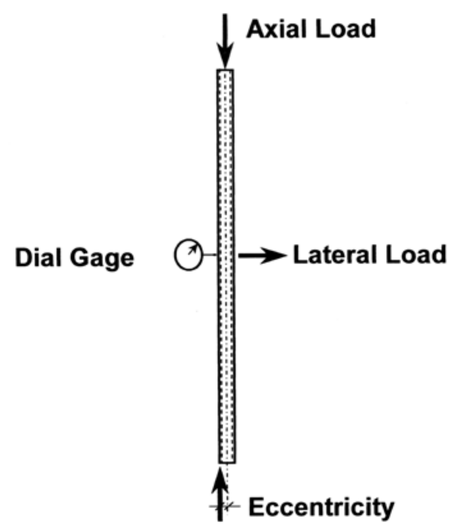
1. Test capacities exceeded those predicted by the ACI moment magnifer approach, even though the ACI slenderness limit of 100 was exceeded.

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 prediciton 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, ∅, must be applied.

5. A second order analysis should be used to evaluate slenderness effects when designing Load-Bearing Spancrete wall panels.



Wall Panel Test Set-up

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 dramaticaally after cracking.

A design example is given on the reverse side.

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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 in^4.

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:

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

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

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

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

Thus the first order deflection Δ_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 that is deflected. The instantaneous and sustained deflections are separated. With dead load and bowing considered sustained.

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

Δ_1 sustained = 0.83 (0.09) +1 = 1.07" Δ_1 instantaneous = 0.17 (0.09) + .53 = .55"

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

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

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

Final M_u = 38.9 + (23.2)(1.07/12) / {1 - [23.2(30x12)^2 / (ϖ^2)(5.97)(10^6)]}
+ (23.2)(.55/12) / {1 - [23.2(30x12)^2 / (ϖ^2)(10.92)(10^6)]} = 42.2 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.