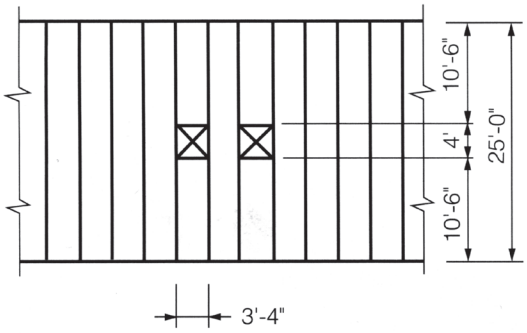
SPANCRETE MANUFACTURERS ASSOCIATION

RESEARCH NOTES

LOAD DISTRIBUTION AROUND MULTIPLE CENTRAL OPENINGS

Tests were conducted to study the lateral distribution of loads in a Spancrete® hollowcore system containing two full plank openings closely spaced at midspan. In the first test, the openings were saw cut after the planks were grouted to evaluate the influence of overcut. For the second test, the openings were created with short slabs supported by angle headers in order to evaluate the distribution of slab weight prior to grouting.



Test Assembly

CONCLUSIONS:

1. The Spancrete planks exhibited sufficient flexural ductility to develop the capacity of the entire system.

2. Overcut adjacent to sawn openings has no adverse affect on performance or ultimate strength.

3. Self weight may be distributed as superimposed load even if headers are used prior to grouting.

4. The previously recommended flexural distribution width of 0.55L is valid for both working load and ultimate conditions. (Distribution factors are listed in the Research Note entitled **"Load Distribution"**)

5. Based on the excellent ductility shown by these tests, the same conclusions may be applied and the results extrapolated for 48" and 60" and 96" Spancrete widths.

A design example is given on the reverse side.

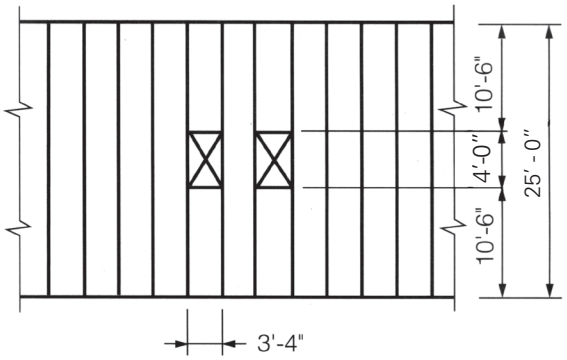
SPANCRETE MANUFACTURERS ASSOCIATION

DESIGN EXAMPLE

LOAD DISTRIBUTION AROUND MULTIPLE CENTRAL OPENINGS

GIVEN:

8" Spancrete® hollowcore system shown; plank dead load = 64 psf
Superimposed dead load = 15 psf and live load = 50 psf



PROBLEM:

Select a Spancrete section to support the given loads;
Check working and ultimate conditions based on flexure

SOLUTION:

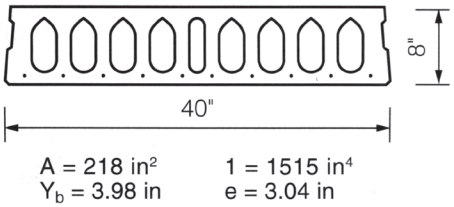
Effective distribution width of midspan =
0.55 (25) + 3.33 = 17.08 ft

Effective self weight $W_D = 64 + \frac{2(3.33)\ 64}{17.08} = 89$ psf

Effective superimposed $W_D = 15 + \frac{2(3.33)\ 15}{17.08} = 21$ psf

Effective live load $W_L = 50 + \frac{2(3.33)\ 50}{17.08} = 70$ psf

Try: 8608 (3/4" clear cover, 8-3/8" 250 ksi strands,
65% initial tension, 20% losses, $f_{PU}\ A_{PS} = 20K$)



A = 218 in² I = 1515 in⁴
Y_b = 3.98 in e = 3.04 in

$M_w = \frac{25^2}{8}$ (.089 + .021 + .070) 3.33 = 46.9 ft-k/slab

Check tension: $f_t = 8 \times 20 \times .65 \times .8\left(\frac{1}{218} + \frac{3.98 \times 3.04}{1515}\right)$

$-\frac{46.9 \times 12 \times 3.98}{1515} = 0.432$ ksi

Check LL deflection: $\Delta = \left(\frac{5}{384}\right)\frac{3.33\ (.070)\ 25^4\ (1728)}{4300 \times 1515} = 0.31" = L/950$

Check ultimate $M_u = \frac{25^2}{8}$ [1.2 (.089 + .021) + 1.6 (.070)] 3.33 = 63.54 ft-k/slab

$\phi M_n \simeq \frac{.9}{12}$ (.98 x 8 x 20)$\left(7.06 - \frac{.98 \times 8 \times 20}{2 \times .85 \times 4 \times 40}\right)$ = 76.25 ft-k/slab (> M_u)

Check slab between openings for headered construction loads of 20 psf before grouting

Header reactions $R = \frac{10.5 \times 3.33}{4}$ (.064 + .02) = 0.74k

$M \simeq \frac{25^2}{8}$ (.064 + .020) 3.33 + 10.5 (2) .74 = 37.4 ft-k/slab (<M_w)

$M_u = (1.2)\ [(.064)\ (3.33)\ (\frac{25^2}{8}) + (10.5)\ (2)\ (.74)] + (1.6)\ (.020)\ (3.33)\ (\frac{25^2}{8}) = 46.96\ \frac{\text{ft-k}}{\text{ft}}$ (<63.54)

Note: Sample calculations are intended to illustrate the concept presented and do not represent all considerations necessary for the complete design. This research was done using 40" wide, 8" thick Standard Spancrete. However, this concept applies to all Spancrete cross sections.

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
Hanson Structural Precast Pacific, Inc.
Irwindale, California

KIE-CON
Division of Kiewit Pacific Co.
Anitoch, California

Owell Precast
Sandy, Utah

SOUTHWEST
Manco Structures, Ltd.
Schertz, Texas

SOUTH
Cement Industries, Inc.
Fort Myers, Florida

Florida Precast Industries, Inc.
Sebring, Florida

EAST
Mid-Atlantic Precast, LLC.
King George, Virginia

EGYPT
Samcrete Eqypt
Ahram, Giza

MEXICO
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Mexico City, Mexico

Spancrete Noreste
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CROATIA
Mucić & Co
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Barbados, West Indies

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Yapi-Merkezi
Camlica-Istanbul, Turkey

UAE
Hi-Tech Concrete Products LLC
Abu Dhabi, UAE

MACHINE MANUFACTURER
Spancrete Machinery Corporation
N16 W23415 Stoneridge Drive
Waukesha, WI 53188
Telephone: 414-290-9000
Fax: 414-290-9130
www.spancrete-machinery.com

SPANCRETE IS ALSO MANUFACTURED IN:

Armenia	*Ireland*
China	*Japan*
Denmark	*Russia*
Guatemala	*South Korea*
Hungary	*Switzerland*

SPANCRETE MANUFACTURERS ASSOCIATION

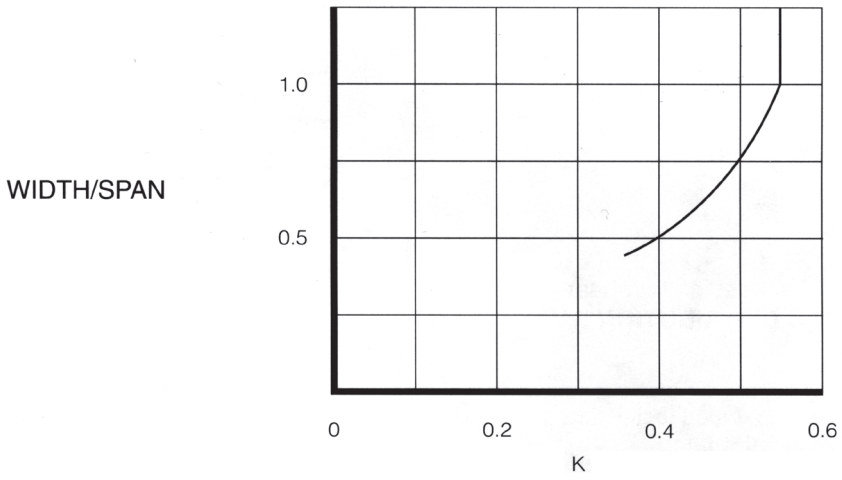
RESEARCH NOTES

WIDTH TO SPAN RATIO EFFECT ON LOAD DISTRIBUTION

In the study of distribution of non-uniform loads*, it was found that the midspan distribution width was a function of the width to span ratio. In most situations, this ratio will be much greater than 1.0.

However, for the special cases where this ratio is less than 1.0, the basic distribution widths* must be expressed as KL, where K is determined from the figure below.

For edge loads, the factor K must be halved. Where central openings are present, a net width should be used for determining the width to span ratio.



*For further information, refer to the Research Notes entitled **"LOAD DISTRIBUTION"**.

A design example is given on the reverse side.

SPANCRETE MANUFACTURERS ASSOCIATION

DESIGN EXAMPLE

WIDTH TO SPAN RATIO EFFECT ON LOAD DISTRIBUTION

GIVEN:

8" Spancrete® hollowcore floor shown
Superimposed live load = 40 psf
Superimposed dead load = 10 psf Plank dead load = 64 psf

PROBLEM:

Determine the equivalent effective design loadings to enable the floor slabs within the allowable distribution widths to carry the loads shown.

SOLUTION:

Width/Span = $\frac{16.67}{28}$ = 0.6

From chart, K = 0.44
Figure separately the distribution for the concentrated load, the wall load, and the uniform loads.

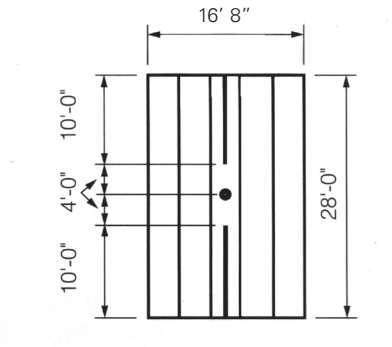
For flexural design:

$$P_u = \frac{1.2\ (2800) + 1.6\ (4400)}{0.44 \times 28} = 844 \text{ plf}$$

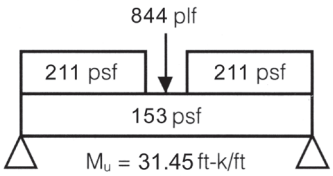
$$W_u = \frac{1.2\ (700) + 1.6\ (1100)}{0.44 \times 28} = 211 \text{ psf}$$

$$W_u = 1.2\ (64 + 10) + 1.6\ (40) = 153 \text{ psf}$$

For shear design:
Width to span ratio does not affect design for shear.
See RESEARCH NOTE "**LOAD DISTRIBUTION**."



WALL LOAD = 700 plf DL
WALL LOAD =1100 plf LL
CONCENTRATED LOAD = 2800lb. DL
CONCENTRATED LOAD = 4400lb. LL



FACTORED LOADS FOR FLEXURE

(Working stress conditions will also have to be checked.)

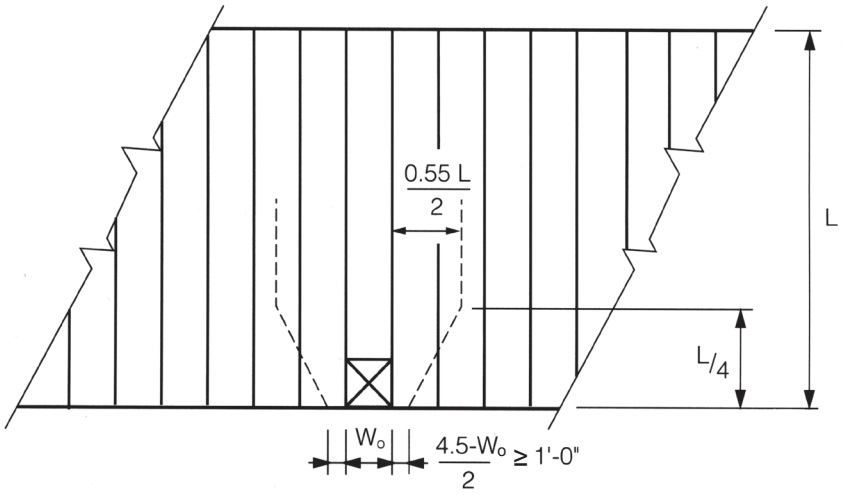
Note: Sample calculations are intended to illustrate the concept presented and do not represent all considerations necessary for the complete design. This research was done using 40" wide, 8" thick Standard Spancrete. However, this concept applies to all Spancrete cross sections.

SPANCRETE MANUFACTURERS ASSOCIATION

RESEARCH NOTES

SHEAR DESIGN AT END OPENINGS

Research on load distribution has been a major part of the continuing testing program conducted by the Spancrete Manufacturers Association.



EFFECTIVE RESISTING SLAB WIDTH AT END OPENINGS

CONCLUSIONS:

1. Openings at the end of a span will cause a concentration of shear stresses due to shear and torsion at the sides of an opening.

2. The midspan region will not be affected by an end opening as long as strand development occurs after the opening and before the area of maximum moment.

3. The effective resisting section shown is recommended for shear design around end openings. The design procedure is to superimpose on the uniform loads the distributed load concentrations.

A design example is given on the reverse side.

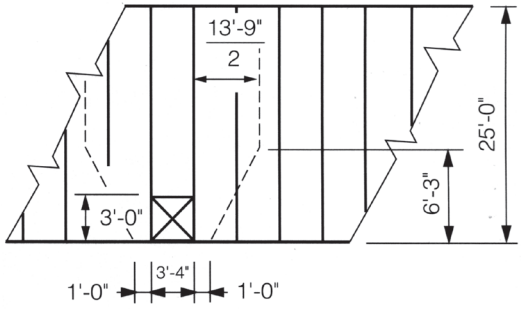
SPANCRETE MANUFACTURERS ASSOCIATION

DESIGN EXAMPLE

SHEAR DESIGN AT END OPENINGS

GIVEN:

An 8" x 40" Spancrete® hollowcore system as shown. Self-weight = 64 psf, uniform superimposed dead and live loads are 10 psf and 40 psf



PROBLEM:

Select the prestress, check strand development, and check shear.

SOLUTION:

1. From load tables, for a total superimposed load of 50 psf, select eight 5/16" dia. 250 ksi strands with 3/4" clear cover. Use 65% for initial tension and assume 20% losses, and concrete strength of 5000 psi

2. Check strand development from opening

   L_d required = $(f_{ps} - 2/3f_{se})\, d_b$ = (.98 x 250 - 2/3 x .65 x .8 x 250)5/16 = 50"

   L available = $\left(\frac{25}{2} - 3\right)12$ = 114"> 50" OK

3. Check shear caused by the additional concentration of load from the strip of slab containing the opening.

   Plank bearing = 4"

   At h/2, distribution width DW = $1 + \frac{.333}{6.25}\left(\frac{13.75}{2} - 1\right)$ = 1.31'

   W_u = 1.2 (10 + 64) + 1.6 (40) = 153 psf from uniform loads

   Distribute load from strip with opening and superimpose

   $W_u = 153 + \left(\frac{153 \times 3.33}{1.31 \times 2}\right)$ = 348 psf

   Checking shear at critical points, find:

   $\varnothing v_{cw}$ = 203 psi > v_u = 118 psi and $\varnothing v_{ci}$ = 106 psi > v_u = 78 psi. Shear check is OK.

4. If inclined shear had not checked at some point in the span, calculate a new effective width at that point, determine a new distributed load, and recheck shear.

Additional information for Shear Design is provided in Research Note title, **"SHEAR STRENGTH"**

Note: Sample calculations are intended to illustrate the concept presented and do not represent all considerations necessary for the complete design. This research was done using 40" wire, 8" thick Standard Spancrete. However, this concept applies to all Spancrete cross sections.