

Continuous Slab Calculations

DL	LL	fc'	fy
82.5	80	4,000	60,000

Slab Thickness

Both ends continuous	ln=	10
Minimum h=	ln/28=11(12)/28	4.29 inches
One end continuous	ln/24=11(12)/24	5 inches
Minimum h=		
Try 4.5" slab. Design a 12" wide segment	b=	12 inches

Load

Slab weight (dead load) =	82.5 psf		
wu= 1.2wDL+1.6wLL =	326 psf =	0.326 ksf	
By designing a slab segment 12" wide, the loading is	326 lb/ft.	566.3717	

Moments and Shears

Moments:

End Span		
Exterior Support (spandrel beam)	Mu=Wu ln^2/24	1.36 kip-ft
Mid-span (end integral with support): (+)	Mu=Wu ln^2/14	2.33 kip-ft
Interior Support:	Mu=Wu Ln^2/10	3.26 kip-ft
Interior Spans		
Interior Supports:	Mu=Wu ln^2/11	2.96 kip-ft
Mid-span (end integral with support):	Mu=Wu ln^2/16	2.04 kip-ft

Shears:

End Span		
Face of first interior support:	Vu=1.15 Wu ln/2 =	1.87 kips
All other supports:	Vu= Wu ln/2 =	1.63 kips

Slab Design

Determine an approximate effective depth d.			
d = h - 0.75 (cover) - 0.625 / 2 (assume # 5 bars)	h=	5.5	
	cover=	0.75	
d =	4.4375 "	Bar # dia	0.625

Steel Reinforcing

Minimum reinforcement for slabs of constant thickness is that required for shrinkage and temperature:

Minimum required As= 0.0018 bh	b=	12 h=	5.5
0.1188 in^2 per ft			
Maximum spacing for shrinkage and temperature steel =	5h or	18 "	

smax = 5(h)=	27.5 "
Thus, smax =	18

Shrinkage and temperature steel: use #3 at 11" c/c	As =	0.12 in^2
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Assume a tension-controlled section (the steel reaches its yield stress, et > 0.005, and Φ = 0.9)

The maximum moment (end span, interior support) is Mu = 3.26 kip-ft

$$Mu = \Phi Mn = \Phi bd^2 k$$

$$k = Mu / \Phi bd^2 = 0.1839 \text{ ksi}$$

Table A-8

p=	0.0067		
As = pbd =	0.3568 in^2	>	0.12 in^2 OK

The steel required at other points is found in a similar manner (all values in the formula for k are the same except for Mu):

$$\text{Required } k = Mu / \Phi bd^2 = \text{Mu} /$$

The results are summarized in the following table.

LOCATION	MOMENT	k (ksi)	REQUIRED p	As (in^2 per 12")
End Span				
Exterior Support (spandrel beam) (-)	1.36 kip-ft	0.0766	0.0027	0.14
Mid-span (end integral with support): (+)	2.33 kip-ft	0.1314	0.0047	0.25
Interior Support: (-)	3.26 kip-ft	0.1839	0.0067	0.36
Interior Spans				
Interior Supports: (-)	2.96 kip-ft	0.1672	0.0061	0.32
Mid-span (end integral with support): (+)	2.04 kip-ft	0.1150	0.0041	0.22

Shear Strength

$$\Phi = 0.75 \lambda = 1$$

$$\Phi V_n = \Phi V_c = \Phi 2 \lambda \sqrt{f_c'} b w d = 4374.93 \text{ lb} = 4.37 \text{ kips} > 1.87 \text{ kips OK}$$

No shear reinforcement is required

Main Steel

Maximum spacing for main reinforcement = 3h or
 smax = 16.5 or 18" 18"
 Use smax = 18" in positive moment areas (to allow bar cutoffs).

The following table was developed to summarize the possible selections for the

LOCATION	As REQ	reinforcing steel.	As provided per 12"
End Span		POSSIBLE SELECTIONS	
Exterior Support (spandrel beam) (-)	0.14	#3 @ 9"	0.15
		#4 @ 15" (multiple of 5") (USE)	0.16
Mid-span (end integral with support): (+)	0.25	#3 @ 5"	0.26
		#4 @ 9"	0.27
		#4 @ 8" (USE)	0.30
Interior Support: (-)	0.36	#3 @ 3.5"	0.38
Interior Spans		#4 @ 6.5"	0.37
Interior Supports: (-)		#5 @ 10" (multiple of 5") (Use)	0.37
	0.32	#3 @ 4"	0.33
		#4 @ 7.5"	0.32
		#5 @ 10" (multiple of 5") (Use)	0.37
Mid-span (end integral with support): (+)	0.22	#3 @ 6"	0.22
		#4 @ 11"	0.22
		#4 @ 8" (matches end span)	0.30

Development length in the spandrel beam

Determine the development length of the #4 bars @ 15" c/c.

$$l_d = (K_d / \lambda) \{ \psi_t \psi_e \psi_s / (c_b + K_{tr} / d_b) \} K_{er} d_b$$

A. Determine Kd from table 5-1 (pg 167)

$$K_d = 82.2$$

B. Establish values for the factors ψ_t , ψ_e , ψ_s , and λ

- $\psi_t = 1.3$ (the bars are top bars)
- $\psi_e = 1$ (bars are not coated)
- $\psi_s = 0.8$ (bars are #4)
- $\lambda = 1$ (normal-weight concrete is used)

C. Check the product $\psi_t \times \psi_e =$

$$1.3 < 1.7 \text{ OK}$$

D. Determine c_b .

Based on cover (center of bar to nearest concrete surface),

$$c_b = .75 + .5/2 = 1"$$

Based on bar spacing (one-half the center to center distance),

$$c_b = .5(15) = 7.5"$$

$$\text{Use } c_b = 1"$$

E. check $K_{tr} = 40A_{tr} / (s_n)$

$$K_{tr} = 0 \text{ There is no transverse steel crossing the plane of splitting.}$$

F. Check $(c_b + K_{tr}) / d_b =$

$$(1.0 + 0) / .5 = 2 < 2.5 \text{ OK}$$

G. Calculate Ker if applicable

$$K_{er} = As \text{ REQ} / As \text{ provided} = 0.14 / .016 = 0.8986$$

H. Calculate l_d ($l_d > 12"$)

$$l_d = (K_d / \lambda) \{ \psi_t \psi_e \psi_s / (c_b + K_{tr} / d_b) \} K_{er} d_b$$

$$l_d = 19.2047 > 12"$$

$$\text{Use } l_d = 20 \text{ (rounded up)}$$

$$\text{Available } l_d = 12" \text{ (beam width) - } 2.9" \text{ (cover) } = 10" < 19"$$

Determine if a 180 degree standard hook is adequate

Because the 20" development length cannot be furnished, a hook must be provided

A. Calculate l_{dh}

$$l_{dh} = (.02 \psi_e f_y / \lambda \sqrt{f_c'}) d$$

B.

$$\psi_e = 1 \text{ (the bars are uncoated)}$$

$$\lambda = 1 \text{ (normal weight concrete is used)}$$

C. Modification factors are as follows:

1) Assume a side cover of 2.5" (normal to the plane of the hook);

2) For excess steel, use

$$As \text{ required} / As \text{ provided} = 0.8986$$

D. The required development length is

$$l_{dh} = (.02 \psi_e f_y / \lambda \sqrt{f_c'}) d$$

$$l_{dh} = 336782.5708$$

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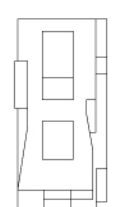
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Key Plan



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