An information series from National Concrete Masonry Association

Precast Lintels For Concrete Masonry Construction

INTRODUCTION

In residential and commercial buildings of concrete masonry, precast lintels are often used to span openings in the walls. These horizontal members function as beams in supporting the weight of the wall, as well as other dead and live loads over the openings, and transmitting these loads to the adjacent masonry. Flexural strength, shear strength, and deflection are critical to the design of lintels.

Because of their rigidity, strength, durability, fire resistance and aesthetics, the most common types of lintels for concrete masonry construction are those manufactured of precast reinforced concrete or reinforced concrete masonry units. The color and surface texture of these lintels can accent or duplicate the surrounding masonry.

Lintel Design

Precast lintel dimensions are illustrated in Figure1. Lintels are manufactured to an actual height of 7-5/8 inches to coincide with the typical course height of concrete masonry. A modular lintel length should be specified which equals the clear span plus at least two times the lintel height to provide for proper bearing at each end. The width of the lintel, or the width of the combination of side by side lintels, should equal the width of the supported masonry wythe.

Typical concrete compressive strengths for precast lintels range from 2500 to 3500 psi. Reinforcement is normally Grade 60 (60,000 psi specified yield strength). Values in Table 2 are based upon these material properties.

The area of reinforcement for lintels should exceed the minimum reinforcement ratio (pmin = $200/f_y$)[2] to insure ductile behavior. In addition, the reinforcement ratio should not exceed 75% of the balanced reinforcement ratio[2] ($P_{max} = 0.75p_b$).
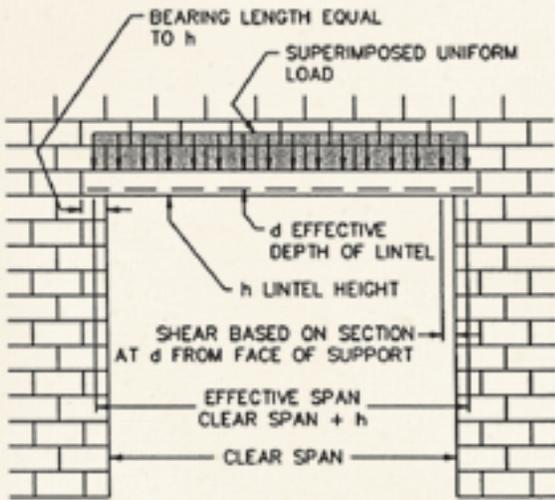
Precast lintels are designed based on flexural strength, shear strength, or limiting deflection criteria. Design values listed in Table 2 are in accordance with the following criteria:

Flexural Strength Criteria[2]

$$\phi M_n = \phi[A_s f_y(d-a/2)]$$

Shear Strength Criteria[2]

$$\phi V_n = \phi(2) \sqrt{f'_c}\, bd$$

Deflection Criteria (2)

$$\Delta_{max} = L/600$$
$$\Delta = 5wL^4/384E_c I_e$$

Flexural strength is determined in accordance with ACI 318-89[2] Section 9.1. Shear strength is determined in accordance with ACI 318-89[2] Section 11.3. Deflection criteria, which governs most of the values in Table 2, is based on controlling cracking in masonry supported by precast lintels. Consequently, for lintels supporting non-reinforced masonry, lintel deflection should be limited to 0.00167 times the effective span of the lintel (L/600).[1] For lintels supporting reinforced masonry, lintel deflection should be limited to 0.00278 times the effective span (L/360). Lintel deflection is calculated based on the effective moment of inertia, I_e, given in Section 9.5.2.3 of ACI318.[2]

Provision for long term deflection resulting from creep and shrinkage was included by multiplying the initial deflection by the factor of 2.0 in accordance with the requirements of Section 9.5.2.5 of ACI 318-89.[2]

Values given in the design tables are maximum uniform superimposed loads.
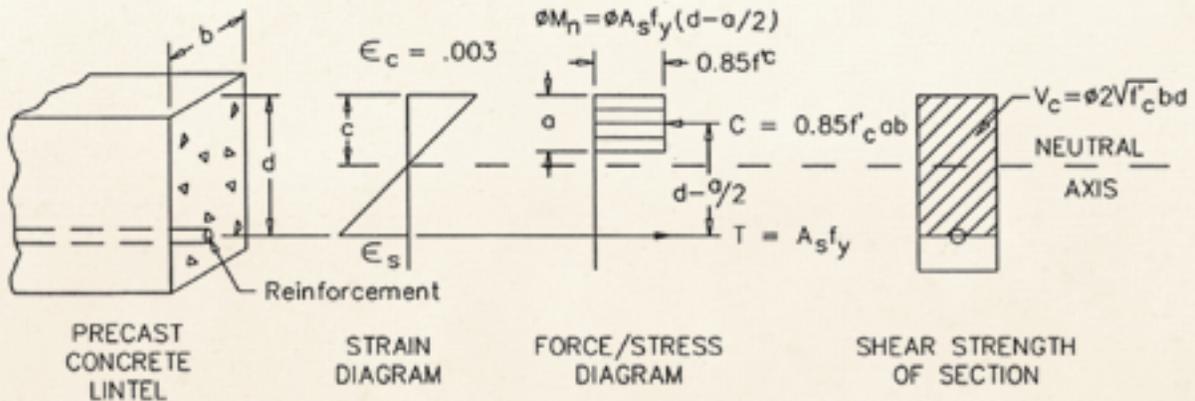

FIGURE 1. LINTEL DESIGN PARAMETERS.

FIGURE 2.

Lintels should be clearly marked on the top whenever possible to prevent the possibility of improper installation.

Additionally, if lintels are over 36" in length and may be subjected to stress during storage, transportation, handling, or placement, then steel reinforcement should be provided in the top and bottom to prevent cracking. Minimum cover over the top steel should be 1-1/2".

Notations

a = depth of equivalent rectangular stress block

A_s = area of tension reinforcement, sq. in.

b = actual width of lintel, in.

c = distance from extreme compression fiber to neutral axis, in.

C = resultant compressive force in concrete, lbs.

d = distance from extreme compression fiber to centroid of tension reinforcement, in.

E_c = modulus of elasticity of concrete, psi

f_c = specified compressive strength of concrete, psi

f_y = specified yield strength of reinforcement, psi (60,000 psi)

h = actual height of lintel, in.

I_e = effective moment of inertia, in.⁴

L = effective length, in.

M_n = nominal moment strength, in.-lb. per ft.

T = resultant tensile force in steel reinforcement, lbs.

V_n = nominal shear strength

w = uniform load, lbs./in.

Δ = deflection, in.

ε_c = strain in concrete, in./in

ε_s = strain in steel reinforcements in./in.

φ = strength reduction factor

P_b = reinforcement ratio producing balanced strain conditions

References:

[1] Building Code Requirements for Masonry Structures (ACI 530-88/ASCE 5-88)

[2] Building Code Requirements for Reinforced Concrete (ACI 318-89)

Note: 3/8" Rod centered at top of each size lintel for shipping purposes only
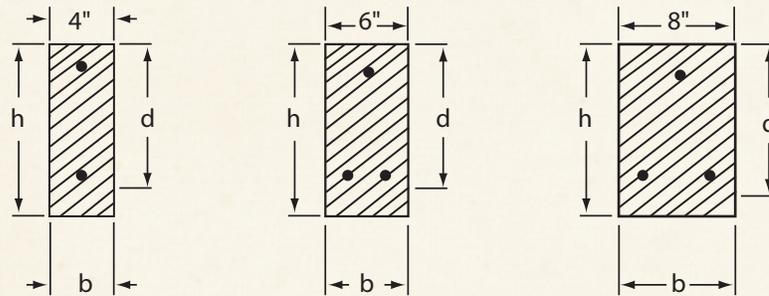
CROSS SECTIONS (uniform)

FIGURE 3.

MINIMUM COMPRESSIVE STRENGTH OF CONCRETE IN LINTELS: 3000 PSI

DIMENSIONS			
NOMINAL b x h – INCHES	4 x 8	6 x 8	8 x 8
WEIGHT – LB. PER LINEAL FT.	23.5	35	48
EFFECTIVE 'd' – INCHES	6.0	6.0	6.0
EFFECTIVE 'b' – INCHES	3.625	5.625	7.625
EFFECTIVE 'h' – INCHES	7.625	7.625	7.625

TABLE 1.

PRECAST CONCRETE LINTEL INFORMATION AND SPEC. SHEET
FOR NORMALLY STOCKED SIZES
Fc=3000 P.S.I.

Lintel Properties
Width=$3\frac{5}{8}$" Height=$7\frac{5}{8}$"
Weight=23.5 lbs. Per Linear Foot
REINFORCEMENT

Maximum Design Load-Pounds Per Linear Foot
Clear Span-Opening

	3'4"	4'	4'8"	5'4"	6'	6'8"	7'4"	8'	8'8"	9'4”	10'	10'8"
1-#3	850	625	445									
1-#4				350	260	200	160	125	100	80	65	50

Lintel Properties
Width=$5\frac{5}{8}$" Height=$7\frac{5}{8}$"
Weight=35.0 lbs. Per Linear Foot
REINFORCEMENT

Maximum Design Load-Pounds Per Linear Foot
Clear Span-Opening

	3'4"	4'	4'8"	5'4"	6'	6'8"	7'4"	8'	8'8"	9'4"	10'	10'8"
2-#3	1500	1005	710									
2-#4				560	420	320	250	200	160	125	100	80

Lintel Properties
Width=$7\frac{5}{8}$" Height=$7\frac{5}{8}$"
Weight=48.0 lbs. Per Linear Foot
REINFORCEMENT

Maximum Design Load-Pounds Per Linear Foot
Clear Span-Opening

	3'4"	4'	4'8"	5'4"	6'	6'8"	7'4"	8'	8'8"	9'4"	10'	10'8"
2-#3	1930	1310	930									
2-#4				730	550	425	330	260	210	170	135	110

TABLE 2.

NOTE: for additional information see N.C.M.A. TEK. NOTE 17-2

CUBE SIZE AND WEIGHT CHART

		2'8"	3'4"	4'	4'8"	5'4"	6'	6'8"	7'4"	8'	8'8"	9'4"	10'	10'8"	11'4"	12'
4X8	AMT.	30	30	30	30	30	30	20	20	10	10	10	10	10	10	10
4X8	WGT.	1885	2355	2820	3295	3765	4230	3135	3450	1880	2040	2195	2350	2510	2665	2820
6X8	AMT.	21	21	21	21	21	21	14	14	7	7	7	7	7	7	7
6X8	WGT.	1965	2455	2940	3435	3225	4110	3268	3600	1960	2125	2290	2450	2615	2780	2940
8X8	AMT.	15	15	15	15	15	15	10	10	5	5	5	5	5	5	5
8X8	WGT.	1925	2405	2880	3365	3845	4320	3205	3525	1920	2080	2245	2400	2560	2725	2880

TABLE 3.

FENDt

BLOCKS, PAVERS & WALL STONES