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 Figure 1. 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 \( p_{min} = 200/f_y \) to insure ductile behavior. In addition, the reinforcement ratio should not exceed 75% of the balanced reinforcement ratio \( p_{max} = 0.75 p_0 \).

Pre cast 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**
  \[ \phi M_n = \phi A_s f_y (d-a/2) \]

- **Shear Strength Criteria**
  \[ \phi V_n = \phi (2) \sqrt{f'_c bd} \]

- **Deflection Criteria**
  \[ \Delta_{max} = L/600 \]
  \[ \Delta = 5wL^4/384EI_e \]

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 \( L/600 \). 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.
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.
- \( V_s \) = nominal shear strength
- \( w \) = uniform load, lbs./in.
- \( \Delta \) = deflection, in.

- \( \varepsilon_c \) = strain in concrete, in./in
- \( \varepsilon_s \) = strain in steel reinforcements in./in.
- \( \phi \) = 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)

### Table 1

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<tr>
<th>NOMINAL b x h – INCHES</th>
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<th>6 x 8</th>
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<td>EFFECTIVE ‘b’ – INCHES</td>
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### CUBE SIZE AND WEIGHT CHART

<table>
<thead>
<tr>
<th>2'8''</th>
<th>3'4''</th>
<th>4'</th>
<th>4'8''</th>
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<th>6'</th>
<th>6'8''</th>
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<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
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<td>WGT.</td>
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<td>2820</td>
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<td>2040</td>
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<td>2350</td>
<td>2510</td>
<td>2665</td>
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</table>

**REINFORCEMENT**

1-#3

1-#4

<table>
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**NOTE:** for additional information see N.C.M.A. TEK. NOTE 17-2

### CUBE SIZE AND WEIGHT CHART

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**TABLE 3.**