This brochure was developed to describe the use of Hollow Core slabs for storm water detention vault lids. Detention vaults are usually subterranean structures located beneath parking lots or other open spaces. In this regard, the Hollow Core slab lid is typically designed to support vehicular loading in addition to soil cover.

Because of the high magnitude of the loads associated with typical design vehicles, 12½” thick Hollow Core slabs are used for detention vault lids. The following Span-Load charts present preliminary design information on this thickness. It is designed with a thick top flange to provide adequate durability and "punch-through" capacity.

The Hollow Core slab is manufactured in a standard 4'-0" width using a continuous concrete extrusion process. One continuous slab, approximately 600 feet long, is cast and allowed to cure for approximately 16 hours. When the concrete reaches sufficient strength to bond the pretensioned strands, slabs are cut from the continuous extrusion to customer specified lengths. Zero-slump, high strength concrete with a 28-day strength in excess of 8,000 psi and ½" diameter, 270 ksi, low relaxation steel strands are used in this process. The strands are pretensioned and fully bonded to the concrete to support the slab and design loads.

SPAN-LOAD CHART DESIGN CRITERIA

ATTENTION: The Span-Load Charts are derived from computer-calculated data, are intended as an aid to preliminary sizing, and must be interpreted using sound engineering judgment.

MODEL CODE - The 2012 edition of the International Building Code (2012 IBC) was used as the model code. The 2012 IBC references the most-current edition of ACI 318, which at the time this brochure was developed was ACI 318-11.

LOADING - With the exception of two contours clearly indicated on the Span-Load Charts, all values shown assume a superimposed soil dead load unit weight of 120 pcf. Each Span-Load Chart has been developed for a very specific Live Load. The reader will find charts for two standard AASHTO vehicles, HS20-44 & HS25-44. Also included are charts for 150 psf and 250 psf uniform Live Load, and finally, a chart for a 45 kip outrigger placed on an 18"x18" pad. Alternate load cases or unique vehicles (such as Vactor type vehicles) must be individually analyzed by CTC's engineering department.
ALLOWABLE STRESSES - The extreme fiber stress under full service load is limited to 0.45\(f'_c\) for compression and 7.5 \(\sqrt{f'_c}\) for tension in accordance with ACI 318-11, Sections 18.3.3 and 18.4.2. Although ACI 318 allows higher tensile stresses, CTC recommends maintaining the extreme fiber tensile stress to less than the modulus of rupture of concrete = 7.5 \(\sqrt{f'_c}\) due to the potentially corrosive environment associated with detention vaults.

FLEXURE - The nominal flexural strength, \(\phi M_n\), exceeds the required ultimate strength, \(M_u = 1.2M_{DL} + 1.6M_{LL}\) per Sections 9.2.1 & 18.2.1 of ACI 318-11. The strength reduction factor, \(\phi\), is calculated per Section 9.3.2.7. The stress in the pretensioned reinforcement at nominal flexural strength, \(f_{ps}\), is calculated per Sections 12.9 and 18.7.2.

SHEAR - The nominal shear strength, \(\phi V_n\), exceeds the required ultimate shear, \(V_u = 1.2M_{DL} + 1.6M_{LL}\) per Sections 9.2.1 & 11.1.1 of ACI 318-11. Web-shear strength, \(V_{cw}\), is calculated in accordance with CTA Technical Bulletin 85B1. This method calculates the applied shear which causes a principal tension of 4 \(\sqrt{f'_c}\) at the centroid of a prestressed member, as allowed in Section 11.3.3.2. Flexure-shear strength, \(V_{ci}\), is calculated as set forth in CTA Technical Bulletin 78B1. This method uses a modified version of Equation (11-10) based on full-scale testing of Hollow Core slabs.

Filling a predetermined number of voids with cast-in-place concrete will result in higher shear strength, particularly in the transfer zone near the ends of the slab. The Span-Load Charts in this brochure use 3,000 psi as the void-fill concrete strength. The capacity of the filled voids is discussed in CTA Technical Bulletin 85B1.

All values in the Span-Load Charts are based on Hollow Core slabs without shear reinforcement. It is not possible to provide shear reinforcement in extruded Hollow Core slabs.

DEFLECTIONS - Hollow Core slab design is usually controlled by allowable tensile stress or ultimate flexural & shear strength. Because detention vaults are typically subterranean structures, deflection is usually not a design concern. Should deflection be of concern for a particular application, deflections may be estimated according to the suggested method described in Section 4.8.4 of the PCI Design Handbook, 6th Edition.
ROUGH OPENINGS - The values in the Span-Load Charts apply to Hollow Core slabs without openings. Rough openings through the voided area of a Hollow Core slab no larger than six inches in diameter have little effect on the load carrying capacity. However, large openings which cut webs and strands have a significant impact on the load carrying capacity of the slab.

Typical features associated with the detention vault are manhole and vent openings. A detail of a 24" diameter manhole and a 12" diameter vent is shown on one of the sample drawings. If the reduced Hollow Core slab cross section is not structurally adequate to support the design loads, additional support from a knee wall is required. Refer to the knee wall detail shown on the sample drawing.

The Knee Wall envelope shown on each Span-Load Chart represents the maximum span under given uniform soil cover allowed without the use of a knee wall. Note that the high shear resulting from the 45 Kip Outrigger load is too great for the reduced section associated with the manhole notch. A knee wall is required at all manhole locations if the Outrigger load is specified.

CONNECTIONS - CTC designs and details the Hollow Core slabs for the gravity loads specified in the contract documents. Connection design for lateral or other loads is not included in the scope of CTC's design.

RELATED PUBLICATIONS AVAILABLE FROM CTC

- Guide Specifications for Precast, Prestressed Hollow Core Slabs
- Field Handling and Erection of Hollow Core Slabs
- Analysis of Wheel Loads on Hollow Core Slabs w/ Soil Cover
- CTA Technical Bulletins:
  - 73B6 Shear Diaphragm Capacity of Precast Floor Systems
  - 74B6 Composite Systems Without Roughness
  - 76B4 Composite Systems Without Ties
  - 78B1 Shear Strength of Hollow Core Members
  - 79B4 Shear Strength of Continuous Hollow Core Systems
  - 80B3 Shear Diaphragm Capacity of Untopped Hollow Core Floor Systems
  - 82B2 Grouting Precast Floor Systems
  - 85B1 Web Shear Strength of Prestressed Concrete Members