

City of Riverside

Underground Construction Standards

UGS-016

GENERAL SPECIFICATIONS FOR PRECAST REINFORCED CONCRETE VAULTS AND MANHOLES

These General Specifications are intended as a guide to minimum requirements for precast reinforced concrete substructures used by the City of Riverside. Applicable city and state ordinances must also be complied with. All structures must meet or exceed these specifications and have received written approval from the Department before being acceptable for use on the City of Riverside system.

DESIGN CRITERIA

1. Loads

Design loads shall consist of dead load, live load, impact, and in addition, loads due to water table, and any other loads which may be imposed upon the structure.

Live loads shall be for H-20 and/or H-20-S16 per AASHTO Standard Specifications for Highway Bridges and late tentative revisions. Design wheel load shall be 16 kips. The live load shall be that loading which produces the maximum shears and bending moment in the structure.

2. Impact

Impact factor shall be calculated by the equation $I = (50/L + 125)100$ where "I" is the percentage increase of the live load due to impact and "L" is the design span length of the roadway floor except that 30 percent shall be the maximum increase in live load due to impact.

For shear due to truck loads, use the length of the loaded portion of the span from the point under consideration to the far reaction, except for cantilever arms, then use 30 percent.

For Vaults With Cover 0' to 1'-0" Inc., I=30%

For Vaults With Cover 1'-1" to 2'-0" Inc., I=20%

For Vaults With Cover 2'-1" to 2'-11" Inc., I=10%

3. Distribution of Wheel Loads

A minimum one foot of earth cover shall be presumed in the dead load calculations for all vault covers. When the depth of fill is two feet or more, concentrated loads shall be considered as uniformly distributed over a square, the sides of which are equal to 1-3/4 times the depth of fill. When such areas from several concentrations overlap, the total load shall be considered as uniformly distributed over the area defined by the outside limits of the individual areas; but the total width of distribution shall not exceed the total width of the supporting slab.

For single spans, the effect of live load may be neglected when the depth of cover is more than eight feet and exceeds the span length; for multiple spans, it may be neglected when the depth of cover exceeds the distance between faces of end supports or abutments. When the depth of cover is less than two feet, the wheel load shall be distributed as in slabs with concentrated loads.

4. Bending Moment

a. For main reinforcement perpendicular to traffic:

For simple spans, the live load moment shall be calculated by $M=(S+2/32)P$. For cantilever spans, $M=(PR/E)X$ and $E=0.8X+3.75$ where:

M = live load moment in foot-pounds per foot width of slab (impact not included)

S = effective span length, in feet

P = 16,000 pounds

PR = load on one rear wheel of truck

X = distance in feet from load to point of support

E = width of slab in feet over which a wheel is distributed

b. For main reinforcement parallel to traffic:

For simple spans, the live load moment shall be calculated by $M=900S$ and $E=4+.06S$, maximum 7.0 feet. For cantilever spans, $M=(P/E)X$ and $E=.35X+3.2$, maximum 7.0 feet.

c. If traffic can approach the vault from any direction, then the maximum bending moment obtained by either method shall govern in the steel design.

d. When the slab is continuous over three or more supports, 80 percent of the simple span bending moment may be used.

e. In case of slabs supported on four edges and reinforced in both directions, the proportion of the load carried by the short span of the slab shall be

assumed as given by the following equations:

For load uniformly distributed- $P=B^4/A^4+B^4$

For load concentrated at center- $P=B^3/A^3+B^3$

Where "P" is proportion of load carried by short span:

"a" is length of short span of slab

"b" is length of long span of slab

Where the length of slab exceeds 1.5 times its width, the entire load shall be assumed to be carried by the transverse reinforcement.

The distribution width "E" for the load taken by either span shall be determined as provided for other slabs. Moment obtained shall be used in designing the center half of the short and long slabs. The reinforcement steel in the outer quarters of both short and long spans may then be reduced 50 percent. In the design of the supporting beams, consideration shall be given to the fact that the loads delivered to the beams are not uniformly distributed.

5. Side Wall Design and Lateral Pressures

Structures which retain fills shall be proportioned to withstand pressures as given by Rankine's Formula, provided, however, that no structure shall be designed for less than an equivalent fluid pressure of 30 pounds per cubic foot with water, in the saturated condition.

When highway traffic can come within a horizontal distance from the top of the structure equal to one-half of its height, the lateral pressure shall have added to it a live load surcharge equal to not less than two feet of earth.

For rigid frames, a maximum of one-half of the moment caused by earth (lateral) pressure may be used to reduce the positive moment in the beams, in the top slab or in the top and bottom slab, as the case may be.

6. Bottom Slabs

The bottom slabs and beams must be proportioned to carry the full dead load of the vault together with superimposed live loads. No allowances shall be made for positioning of equipment loads on the floor of the vault. The pressures on the underside of the vault shall be assumed to be uniform.

7. Design Stress

a. Concrete:

$f_c = 2,500_2,900$ psi $n=12$

$f_c = 3,000_3,900$ psi $n=10$

$f_c = 4,000_4,900$ psi $n= 8$

$f_c = 5,000$ or more psi $n= 6$

extreme fiber in Compression $f_c = 0.40f_c$

Shear:

Beams without Web Reinforcement

Longitudinal bars not anchored $0.02f_c(75$ psi max.)

Longitudinal bars anchored $0.03f_c(90$ psi max.)

Beam With Web Reinforcement $V=0.075f_c bjd$

b. Reinforcing Steel:

Tension inflexural members and web reinforcement $f_s=20,000$ psi

Bond - deformed bars

Straight or hooked ends, exclusive of top bars

1) In beams, slabs and one-way footings $0.10f_c(350$ psi max.)

2) In two-way footings $0.08f_c(280$ psi max.)

Top bars - bars near top of beams and girders having more than 12 inches of concrete under bars $0.06f_c(210$ psi max.)

3) Structural Steel 18,000 psi

Concrete surfaces in contact with earth 1.5 inches

Beams and girders

Main reinforcing steel 1.5 inches

Stirrups and ties 1 inch

Interior walls and top slabs 1 inch

Interior bottom slab 1.5 inches

Where chairs or other steel supports used to maintain specified concrete cover are within 1/2 inch of surface, such supports shall be hot-dip galvanized.

GENERAL

1. Identification

All structures shall be identified with the manufacturer's name embedded, or otherwise permanently attached, to an interior wall. The nominal size or identifying number of the structure shall be also be included as a portion of the identification.

2. Finish

Concrete shall be free of rock pockets and "honeycomb" areas. Interior walls and ceilings and exterior surfaces exposed to view shall be smooth. Exterior surfaces below grade shall be dense and uniform, but a slight roughness is not objectionable. Floors shall have a 1/8 " per foot slope to a sump with a float or broom finish to provide a uniform but slightly rough surface.

3. Water Tightness

Structures shall be designed to provide a dry, water-tight installation. Installation instructions and recommendations should be forwarded to the installing contractor if the manufacturer does not erect the structure.

4. Components

Structure components shall be so designed to be interchangeable with units of the same design. Structure sizes, openings, recesses, inserts, and other accessories, shall conform to UGS-005 (for vaults and manholes).

APPROVALS

The criteria included herein shall govern all custom design or where field conditions are known.

For standard approval, all vaults and manholes shall be designed for the following conditions. Standard approval shall mean approval of a design for general use on the City of Riverside system.

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| a. Loads | H-20-S16 |
| b. Impact | I= 30% |
| c. Cover | One foot of earth. |
| d. Traffic | Traffic can approach the structure from any direction. |

e. Water table

The ground water table to be three feet below the finished surface. (75# per cubic foot)

f. Concrete

f's= 3,000# (minimum).