



276 Fourth Avenue
Chula Vista CA 91910

MASONRY RETAINING WALLS

FORM 4614

Department of Planning and Building
BUILDING DIVISION
Ph (619) 691-5272 Fax (619) 585-5681

Department of Public Works
ENGINEERING DIVISION
Ph (619) 691-5021 Fax (619) 691-5171

The City of Chula Vista requires a permit for the construction of retaining walls, **except** those less than three feet in height and not supporting surcharge. This publication outlines the city's requirements for retaining walls with level backfill, with sloping backfill and with vehicular surcharge.

If construction does **not** involve grading, contact the Building Division of the Planning & Building Department for information on how to obtain a permit for a retaining wall (619-691-5272). If construction **does** involve grading, contact the Engineering Division of the Public Works Department (619-691-5024).

I. **INSPECTIONS**

You must call the City for inspections after several specific phases of construction. To schedule an inspection for a retaining wall permit having a permit number starting with a "B", call the Building Division at (619) 409-5434. For permit numbers starting with "PG", call the Engineering Division at (619) 585-5737. Please call for these inspections at the following times, and do not proceed to the next phase of construction until the City inspector has given you written approval to proceed:

A. Call for a **footing inspection** after you have made the excavation for the footing, tied the steel securely in its final position, and made the site ready for concrete placement. Do not place concrete until the City inspector has given you written approval to proceed.

B. Call for a **masonry pre-grout inspection** after you have laid the block and have set the reinforcing steel in place, but before you place the grout. The grout space shall be clean so that all spaces to be filled with grout do not contain mortar projections greater than ½ inch, mortar droppings or other foreign material. Do not lay blocks higher than 6 feet without a pre-grout inspection.

1. If cleanout holes are required, lay the block to the full height of the grout pour before you call for the pre-grout inspection. Place grout in a continuous pour in grout lifts of not more than 4 feet in height.
2. If cleanout holes are not required, call for a masonry pre-grout inspection prior to each grout pour. Do not lay block higher than the grout pour. Note that cleanouts are required for all grout pours of over 5 feet in height.

C. Call for a **backfill/drainage inspection** after grouting is completed and rock or rubble wall drains are in place, but before earth backfill is placed.

D. Call for a **final inspection** after you have completed the construction and, if the City has required one, after a registered professional has prepared a compaction report. (See Section VII).

II. **DESIGN TABLES**

The design tables, found towards the end of this publication, address a variety of different loading conditions and footing configurations. If you have a loading condition that is not shown in this publication, you must have a registered professional engineer or a licensed architect design the wall specifically for conditions existing on the site. Examples of loading conditions not covered in this publication include walls supporting building foundations and walls subjected to truck traffic surcharge greater than 250 psf, unless those loads are applied away from the wall a distance at least equal to the height of the wall.

Retaining wall height is measured from the top of the footing to the top of the wall. You must not build higher than the design height of the wall.

III. **BLOCK**

All block must be Grade N, grouted solid. (Design $f'_m = 1,500$ psi minimum)

IV. **CONCRETE MIX REQUIREMENTS**

Note: Use of plastic cement is not permitted in retaining walls located in this Seismic Zone.

A. The concrete mix for **footings** must have a compressive strength of at least $f'_c = 2,500$ psi in 28 days. You may use a mix containing the following proportions by volume:

- 1 part Portland cement
- 2¹/₂ parts sand
- 3¹/₂ parts ³/₄-inch maximum-size gravel
- 7 gallons of water maximum per sack of cement

Note: Hand-mixed concrete and grout are not permitted on projects subject to the “Standard Specifications for Public Works Construction” (“Green Book”).

B. The **mortar** mix must have a compressive strength of at least 1,800 psi. You may use a mix containing the following proportions by volume:

- 1 part Portland cement
- 3¹/₂ parts sand
- ¹/₄ part hydrated lime or lime putty

C. **Grout** must have a compressive strength of at least 2,000 psi in 28 days. You may use a mix containing the following proportions by volume:

- 1 part Portland cement
- 3 parts sand
- 2 parts pea gravel (³/₈-inch aggregate)

Note: Hand-mixed concrete and grout are not permitted on projects subject to the “Standard Specifications for Public Works Construction” (“Green Book”).

Add water until you achieve pouring consistency without segregating the grout components. Rod or vibrate immediately. Re-rod or re-vibrate the grout about 10 minutes after pouring to ensure proper consolidation. When the grouting of a second lift is to be continued at later time, stop the grout placement 2 inches from the top of the masonry units.

Note: All cells must be filled solid with grout.

V. **MORTAR KEY**

To obtain proper bonding between the footing and the first course of block, form a mortar key by embedding a flat 2x4 flush with, and at the top of, the freshly placed footing concrete (See Drawing CVCS 33). Remove the 2x4 after the concrete has started to harden (about 1 hour). You may omit a mortar key if you set the first course of block into the freshly placed concrete footing.

VI. **WALL DRAINS**

Provide wall drains (4-inch-diameter) at 6-foot intervals along the length of the wall and located just above the level of the soil or paving on the front face of the wall (See Drawing CVCS 33). Alternatively, form the drains by placing a block on its side at 6-foot intervals, by leaving out the mortar in the vertical spaces between all the blocks in the first course above the soil, by paving (head joint) on the front face of the wall, or by some other equivalent method acceptable to the City. Backfill behind wall drains or open head joints must be 12 inches wide filled with gravel and must extend from the top of the footing to above the top of the drain or open joint.

VII. **SOIL**

Wall design, footing sizes and reinforcing steel are all based on an active earth pressure with an equivalent fluid pressure of 36 psf and a weight of 120 pounds per cubic foot (pcf). Extend all footings at least 12 inches into undisturbed natural soil or into fill that has been compacted to at least 90 percent relative compaction per ASTM: D 1557-91. Dampen soil prior to placing concrete in footings. Where the ground slopes away from the base of the wall, you must have a horizontal distance of at least 7 feet from the toe of the footing to “daylight.” (See Drawing CVCS 33) The City may require a soils report, prepared by a registered civil engineer specialized in soil mechanics or a licensed geotechnical engineer, depending on soil conditions at the site.

Footings sizes in the attached tables are based on a 1,000 psf maximum soil bearing value. If you wish to take advantage of a higher bearing value, you must have a licensed architect (a licensed architect may not design Public Works walls that are in the right-of-way) or a registered civil/structural engineer design the wall(s) specifically for the existing site conditions. Again, the City may require a soils report, prepared by a registered civil engineer specialized in soil mechanics or a registered geotechnical engineer, depending on soil conditions at the site.

VIII. REINFORCING STEEL

Use reinforcing steel bars which conform to ASTM specification A615-85, Grade 40 or 60. When you can't use one continuous bar, you must lap or splice bars a distance of at least 40-bar diameters (i.e. 15" for #3 bars, 20" for #4 bars, 25" for #5 bars, 30" for #6 bars). The required minimum lap splice for bars of different size must be based on the diameter of the larger size bar. Bends in the reinforcing steel must conform to the Manual of Standard Practice of the American Concrete Institute. Backing for hooks must be at least a distance equal to four bar diameters. All required bar embedment dimensions are clear distances to outside of bar. Spacing for parallel bars is center to center of bars.

Place two or more bars longitudinally in the footing. (See Tables for number of bars needed). For 6-inch or 8-inch blocks, place one #3 bar longitudinally in the center of the wall in a bond beam block every 16 inches of wall height as the blocks are laid up. For 12-inch blocks, place one #4 bar longitudinally in the center of the wall in a bond beam block every 16 inches of wall height as the blocks are laid up.

IX. JOINTS

Vertical control joints are needed at intervals of not more than 32 feet. Vertical expansion joints are needed at intervals of not more than 96 feet. (See Drawing CVCS 34.)

X. STEP FOOTINGS

Base the footing dimensions and the amount of reinforcing steel on the maximum height of the wall on either side of a step in the footing elevation. The construction of the step must follow the details on Drawing CVCS 34.

XI. BACKFILL

Do not place backfill material against a masonry retaining wall until the grout has either reached design strength or has cured for a minimum of 28 days. Compaction of backfill material by either jetting or ponding with water is not permitted. Each layer of backfill must be moistened and thoroughly tamped, rolled or otherwise compacted until the relative compaction is not less than 90%. If the wall is within the City right-of-way, subject to vehicular surcharge or subject to the "Standard Specifications for Public Works Construction" ("Green Book"), the City will require a compaction test and a certificate from a soils engineer showing that the entire fill has been compacted to at least 90 percent relative compaction per ASTM: D 1557-91.

XII. FENCING

If a pedestrian walkway is adjacent to the top of a retaining wall of more than 30-inches in height, you must install safety fencing at the top of wall. If a wall is greater than 30-inches in height and is adjacent to a street, driveway or parking area, you must install a vehicular guardrail at the top of the wall.

XIII. USE OF TABLES

First, determine the height of wall you need to construct. Then determine the slope of retained earth and if the wall supports vehicular surcharge. Based on what distance you choose from the footing toe to the face of wall, use the table with the necessary wall height and slope of retained earth or surcharge. From the appropriate table, copy the wall design information, including block width, reinforcing steel size and spacing, and footing and key dimensions, on to a copy of the City's typical wall section form (Drawings CVCS 31 or CVCS 32). Use a separate form for each different design of wall. (One wall design may be used for all walls of a certain height and lower. However, there may be savings in material costs if a different, more economical, design is used for walls of lower height.) Indicate on each form the locations on the property that the particular wall design will be used. See attached "HOW TO USE THE DESIGN TABLES" and "EXAMPLE."

XIV. PLAN SUBMITTAL

Prepare a **land development plan** (for Engineering Division permits) or **plot plan** (for Building Division permits) showing the location, type and height of each wall. Show all adjacent structures, driveways, parking areas and pedestrian walkways. Attach a completed form for each proposed wall design, as well as a copy of this procedure.

XV. DISCLAIMER

These design standards indicate a minimum acceptable design for retaining walls meeting very specific field conditions and construction procedures. City approval of retaining walls and any related improvements shall not constitute a representation of the adequacy of the design or engineering of such retaining walls or improvements, nor shall it constitute an implied representation as to its suitability or fitness for any particular purpose. The City assumes no liability or any responsibility for damage or failure. The owner should consult with an appropriate registered civil engineer or licensed architect.

HOW TO USE THE DESIGN TABLES

- Based on the site conditions and retaining wall location, determine if the wall will have a variable heel size (no limitation on the size of the heel), a 6-in or 2-in heel size, then
- Determine if the wall is retaining a level or sloping backfill, or level backfill with vehicular surcharge, then
- Based on the conditions noted above, select the appropriate design table (for ex. Variable heel (Minimum toe), 1.5 to 1 slope), then
- Move across the table and find the applicable retaining wall height (for ex. 6'-8".) Retaining wall height is measured from the top of the footing to the top of the wall. The design data found under that column (for ex. column titled CVV15-68) is what applies to the wall. Then,
- From the design data under the applicable column, determine if the wall is TYPE I or II, in case of the example TYPE II, then
- Transfer the design data to the appropriate drawing, CVCS 31 for TYPE I wall and CVCS 32 for TYPE II wall, as shown on the attached example, then
- Indicate on the plot plan the location and extent of where each wall type (for ex. CVV15-68) is to be built.
- Repeat the above steps for each wall with different height and/or conditions (for ex. heel size, backfill slope or vehicular surcharge.)

EXAMPLE

ENGINEERING WO# _____

BUILDING PERMIT # _____

PROJECT: Example

LOCATION: See your plan

WALL HEIGHT 6' 8"

BACKFILL SLOPE 1.5 : 1

SURCHARGE # _____

FOR CITY USE ONLY

By _____ Date _____

Inspection _____

Footings _____

Pregout _____

Backfill/Drain _____

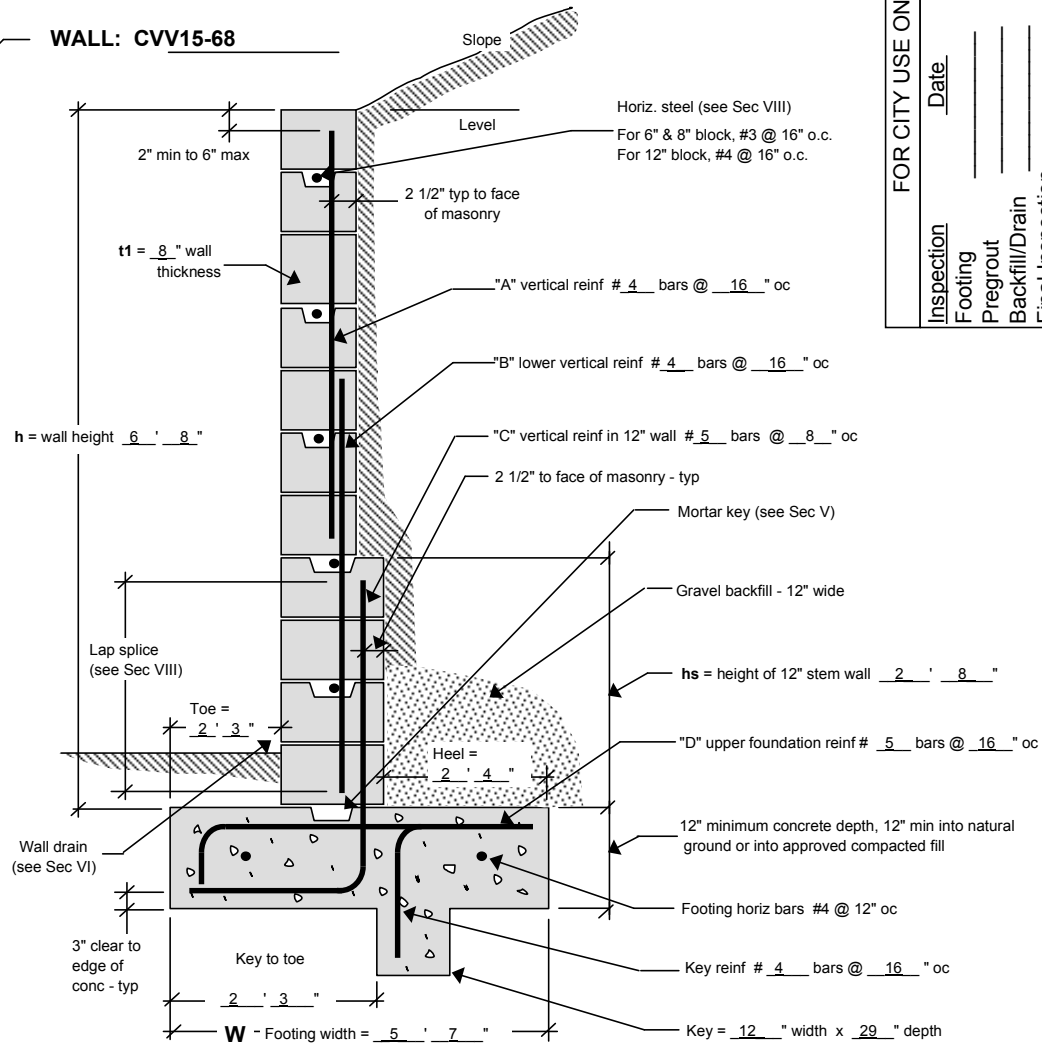
Final Inspection _____

Variable heel (Minimum toe), 1.50 to 1 Slope

6-5-01

CV Wall	CV1	CV2	CV3	CV4	CV5	CV6	CV7	CV8	CV9	CV10	CVV15-68	CV11	CV12
TYPE	I	I	I	I	I	I	II	II			II	II	II
Height - h	1'-4"	2'-0"	2'-8"	3'-4"	4'-0"	4'-8"	5'-4"	6'-0"			6'-8"	7'-4"	8'-0"
Slope	1.5:	1.5:	1.5:	1.5:	1.5:	1.5:	1.5:	1.5:			1.5:1	1.5:	1.5:
Block - t1	6"	6"	6"	8"	8"	8"	8"	8"			8"	8"	8"
Stem Block							12"	12"			12"	12"	12"
Heel	0'-8"	0'-9"	1'-11"	1'-0"	1'-3"	2'-1"	1'-9"	2'-0"			2'-4"	1'-7"	2'-1"
Toe	0'-4"	0'-8"	1'-10"	1'-11"	1'-2"	1'-2"	1'-8"	1'-11"			2'-3"	2'-7"	1'-11"
Vert Bar -A													
40 dia Lap													
Horiz Bars													
Lower Bar -B													
Min. Height of 12" Stem Wall													
Stem Bar - C													
Stem Horiz Bars													
Top Bar - D													
Footing Width-W													
Footing Horiz Bars													
Key to Toe													
Key (w by d)													
Key Reinf													

WALL: CVV15-68



Revised:	Original approval date:	CITY OF CHULA VISTA	
	Redrawn by: _____	date: _____	RETAINING WALL TYPE II

ENGINEERING WO# _____

BUILDING PERMIT # _____

PROJECT:

LOCATION:

WALL HEIGHT _____' _____"

BACKFILL SLOPE _____

SURCHARGE _____ #

FOR CITY USE ONLY

By _____

Date _____

Inspection _____

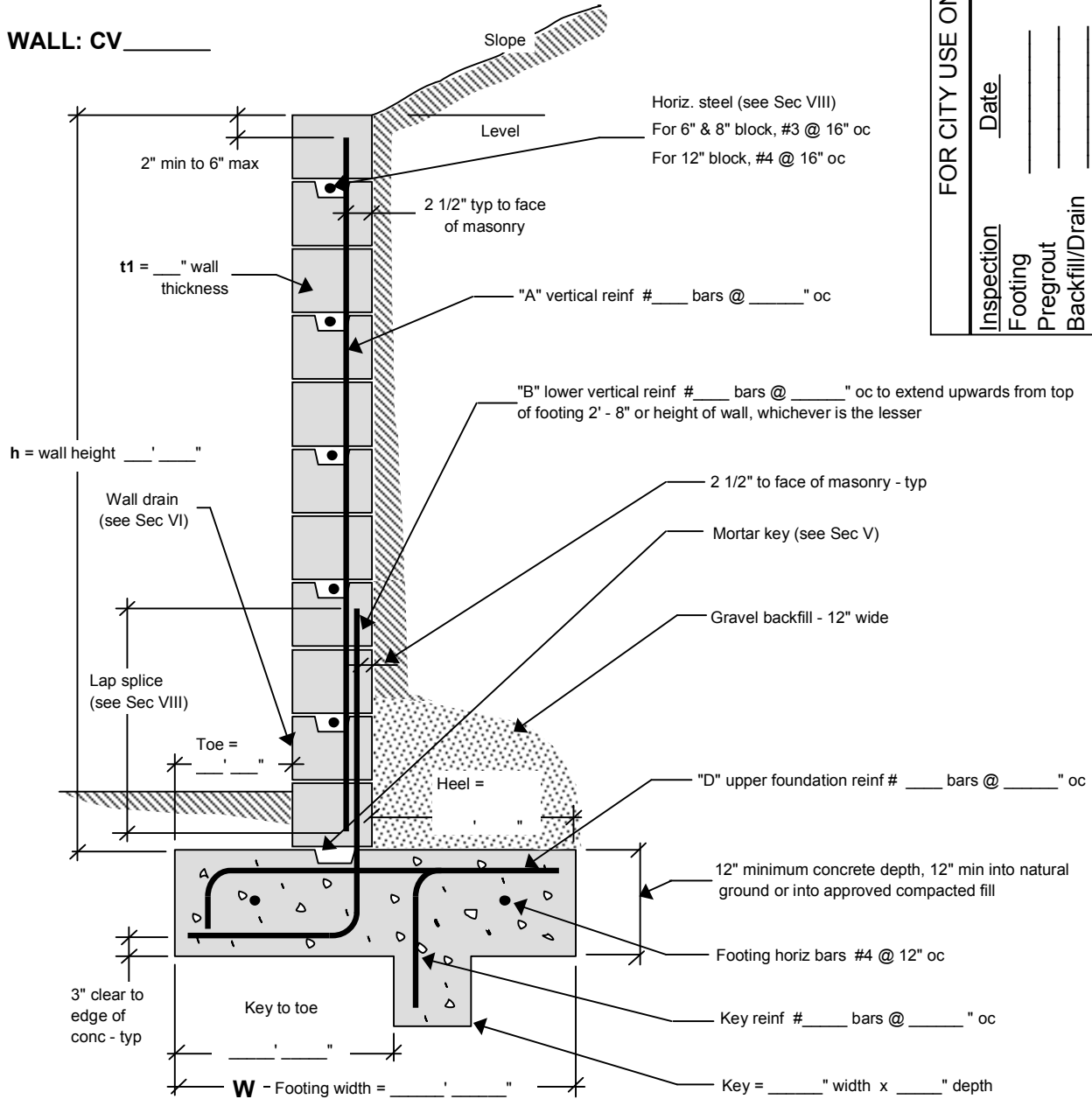
Footings _____

Pregout _____

Backfill/Drain _____

Final Inspection _____

WALL: CV _____



Revised: _____

Original approval date: 08/17/2001

Redrawn by: _____ **date:** _____

CITY OF CHULA VISTA

**RETAINING WALL
 TYPE I**

**CVCS
 31**

ENGINEERING WO# _____

BUILDING PERMIT # _____

PROJECT:

LOCATION:

WALL HEIGHT _____' _____"

BACKFILL SLOPE _____

SURCHARGE _____ #

FOR CITY USE ONLY

By _____

Date _____

Inspection _____

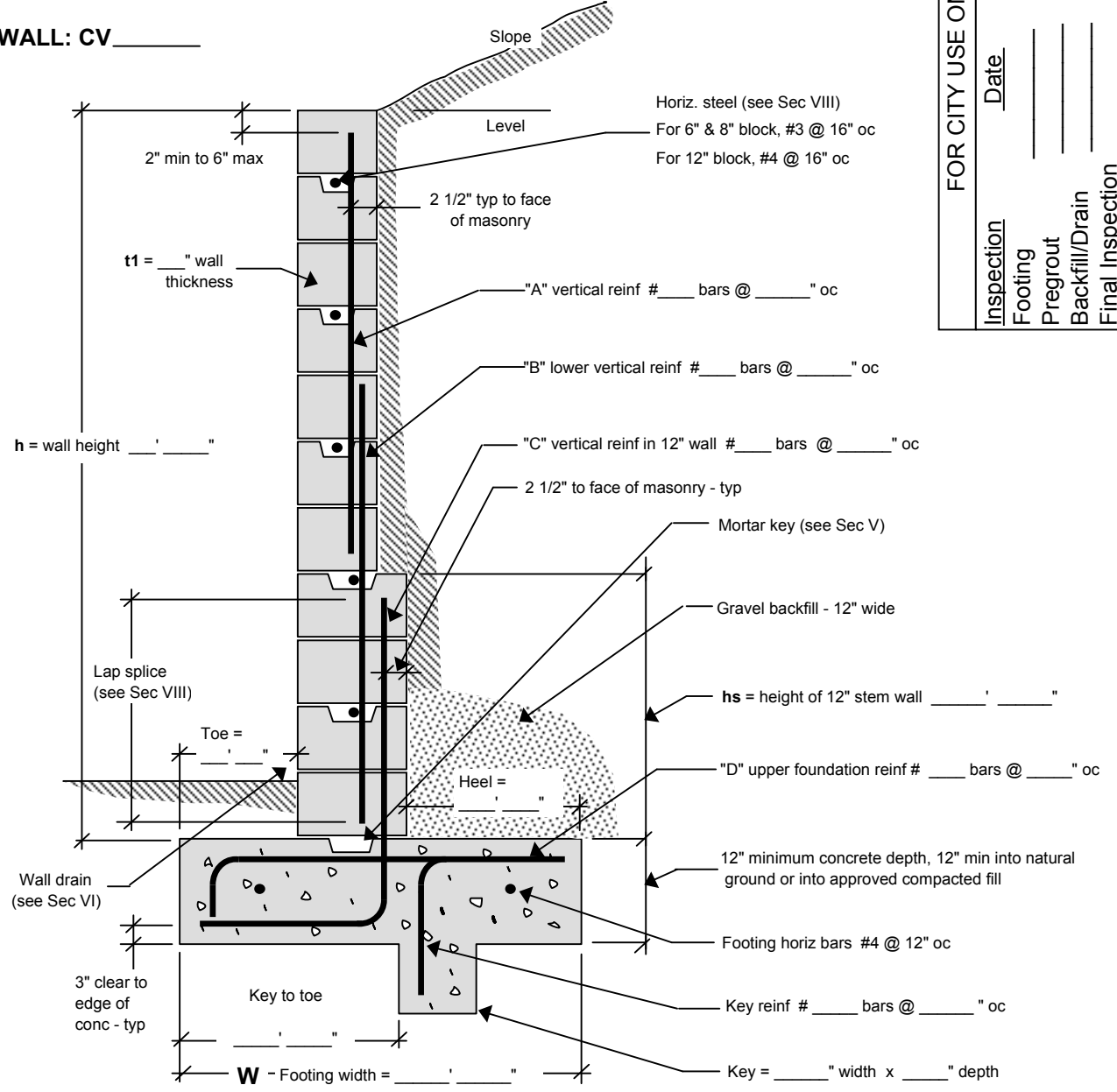
Footing _____

PregROUT _____

Backfill/Drain _____

Final Inspection _____

WALL: CV _____



Revised: _____

Original approval date: 08/17/2001

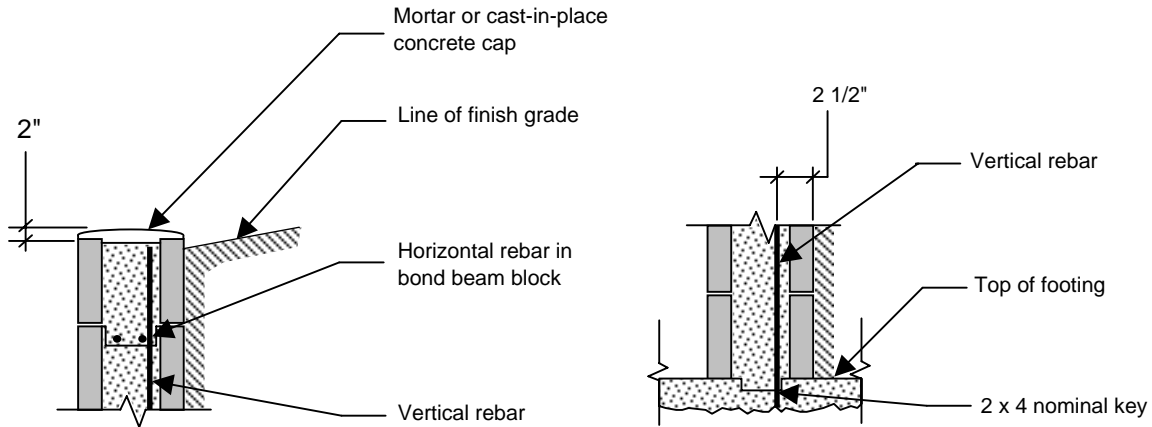
Redrawn by: _____ **date:** _____

CITY OF CHULA VISTA

RETAINING WALL TYPE II

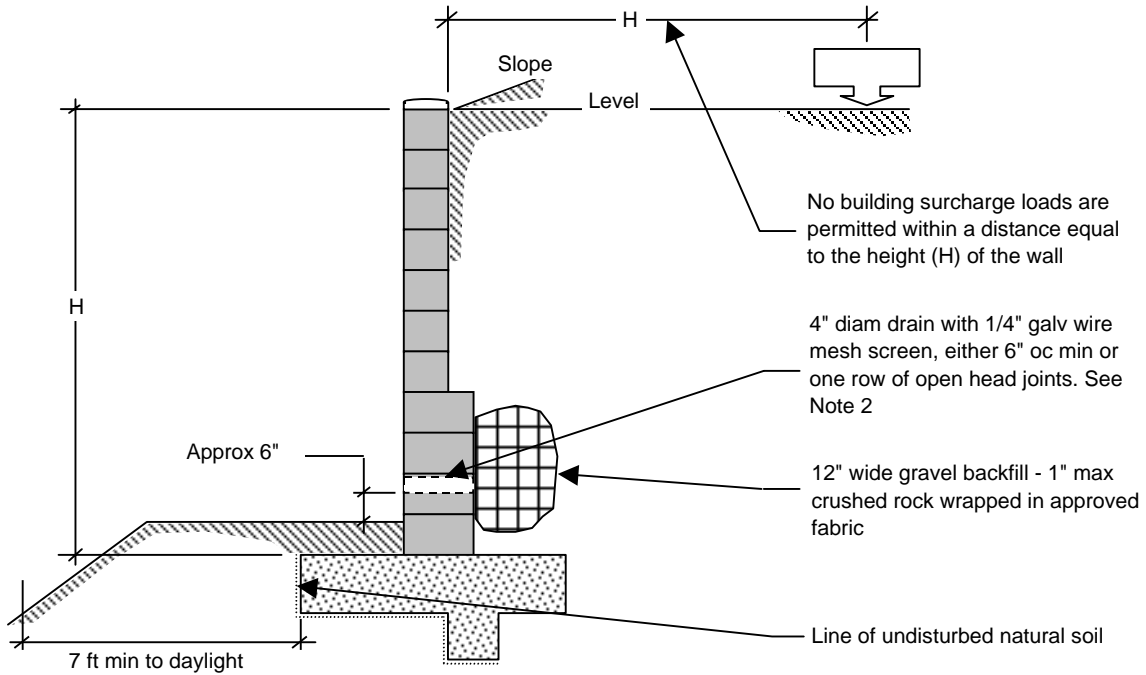
CVCS 32

RETAINING WALLS CAP, KEY AND DRAINAGE DETAILS



CAP DETAIL
See Note 1

KEY DETAIL
See Note 1



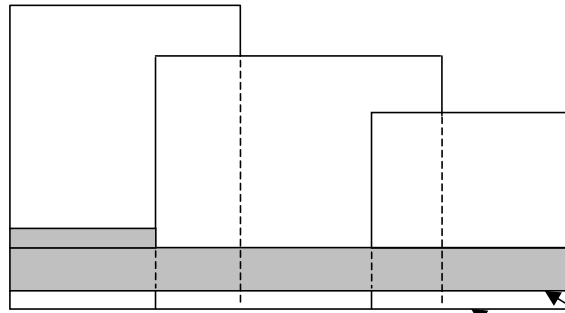
DRAINAGE - TYPICAL SECTION

- Notes: 1. All masonry walls must be built with cap, key and drainage details as shown above
 2. A 4-inch diameter drain may be formed by placing a block on its side

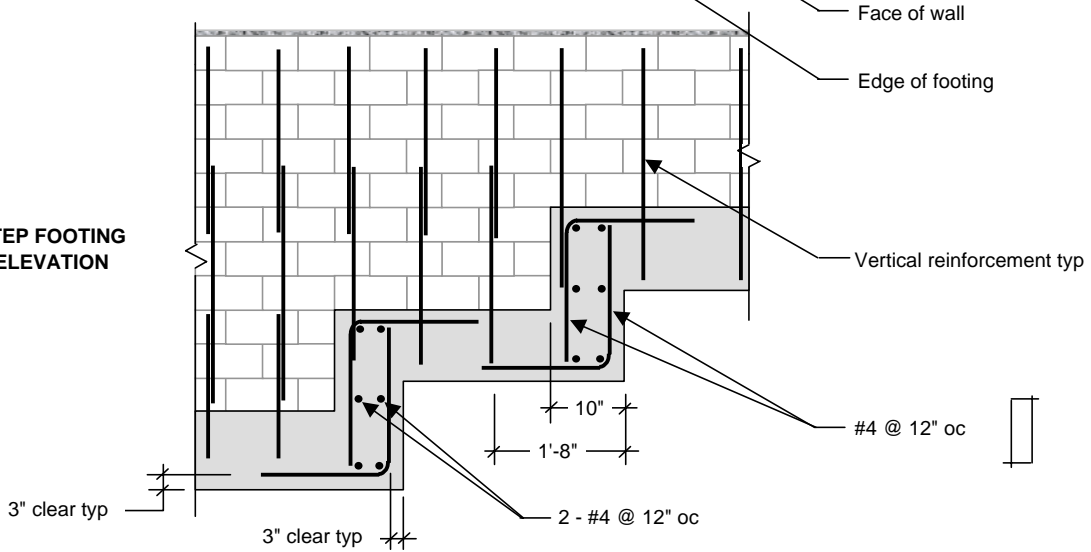
Revised:	Original approval date: 08/17/2001	CITY OF CHULA VISTA	
Redrawn by:	date:	RETAINING WALL DETAILS	CVCS 33

RETAINING WALL STEP FOOTING AND JOINT DETAILS

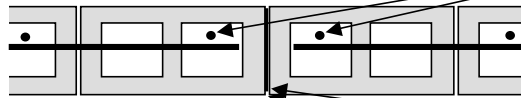
**STEP FOOTING
PLAN VIEW**



**STEP FOOTING
ELEVATION**

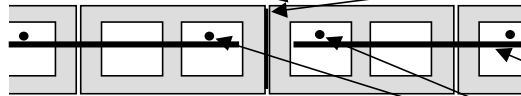


**CONTROL
JOINT**



Control joints must extend vertically every 32 ft oc along the wall. Solid grout may continue through the joint. Rack the mortar back at least 1".

**EXPANSION
JOINT**



Expansion joints must extend vertically every 96 ft oc along the wall. Joint must not contain any incompressible material (ex. Grout or mortar)

Additional vertical reinf bar on each side of control joint

Horizontal reinf

Baker rod

0.2" deep caulking

Baker rod

Horizontal reinf

Additional vertical reinf bar on each side of expansion joint

Revised:

Original approval date:

08/17/2001

CITY OF CHULA VISTA

Redrawn by:

date:

**RETAINING WALL
DETAILS**

**CVCS
34**

Variable heel (Minimum toe), 1.50 to 1 Slope

CV Wall	CVV15-14	CVV15-20	CVV15-28	CVV15-34	CVV15-40	CVV15-48	CVV15-54	CVV15-60	CVV15-68	CVV15-74
TYPE	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>II</i>	<i>II</i>	<i>II</i>	<i>II</i>
Height - h	1'-4"	2'-0"	2'-8"	3'-4"	4'-0"	4'-8"	5'-4"	6'-0"	6'-8"	7'-4"
Slope	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1
Block - t1	6"	6"	6"	8"	8"	8"	8"	8"	8"	8"
Stem Block							12"	12"	12"	12"
Heel	0'-8"	0'-9"	0'-11"	1'-0"	1'-3"	2'-1"	1'-9"	2'-0"	2'-4"	1'-7"
Toe	0'-4"	0'-8"	0'-10"	0'-11"	1'-2"	1'-2"	1'-8"	1'-11"	2'-3"	2'-7"
Vert Bar -A				#4@24"	#4@24"	#4@16"	#4@24"	#4@24"	#4@16"	#4@24"
40 dia Lap				20"	20"	20"	20"	20"	20"	20"
Horiz Bars	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"
Lower Bar -B	#3@24"	#3@24"	#3@24"	#4@24"	#4@24"	#5@16"	#4@24"	#4@24"	#4@16"	#4@24"
Min. Height of 12" Stem Wall							2'-0"	2'-8"	2'-8"	4'-0"
Stem Bar - C							#4@16"	#5@16"	#5@8"	#8@8"
Stem Horiz Bars							#4@16"	#4@16"	#4@16"	#4@16"
Top Bar - D							#4@16"	#5@16"	#5@16"	#6@16"
Footing Width-W	1'-6"	1'-11"	2'-3"	2'-7"	3'-1"	3'-11"	4'-5"	4'-11"	5'-7"	6'-3"
Footing Horiz Bars	3-#4	3-#4	3-#4	4-#4	4-#4	5-#4	5-#4	6-#4	7-#4	7-#4
Key to Toe		0'-8"	0'-10"	0'-11"	1'-2"	1'-2"	1'-8"	1'-11"	2'-3"	2'-7"
Key (w by d)	None	6" by 6"	12" by 8"	12" by 11"	12" by 15"	12" by 17"	12" by 21"	12" by 25"	12" by 29"	12" by 32"
Key Reinf							#4@16"	#4@16"	#4@16"	#4@16"

Variable heel (Minimum toe), Level, 250 psf Vehicular Surcharge

CV Wall	CVV250-14	CVV250-20	CVV250-28	CVV250-34	CVV250-40	CVV250-48	CVV250-54	CVV250-60	CVV250-68	CVV250-74
TYPE	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>II</i>	<i>II</i>	<i>II</i>	<i>II</i>
Height - h	1'-4"	2'-0"	2'-8"	3'-4"	4'-0"	4'-8"	5'-4"	6'-0"	6'-8"	7'-4"
Slope/Surcharge	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250
Block - t1	6"	6"	6"	8"	8"	8"	8"	8"	8"	8"
Stem Block							12"	12"	12"	12"
Heel	0'-9"	1'-0"	1'-0"	1'-0"	1'-9"	1'-6"	1'-9"	1'-6"	2'-3"	2'-0"
Toe	0'-3"	0'-6"	0'-9"	1'-0"	1'-0"	1'-6"	1'-6"	2'-0"	2'-0"	2'-6"
Vert Bar -A				#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"
40 dia Lap				20"	20"	20"	20"	20"	20"	25"
Horiz Bars	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"
Lower Bar -B	#3@24"	#3@24"	#4@16"	#4@24"	#5@16"	#5@8"	#4@24"	#4@16"	#4@24"	#5@16"
Min. Height of 12" Stem Wall							2'-0"	2'-8"	3'-4"	4'
Stem Bar - C							#4@16"	#5@16"	#6@8"	#8@8"
Stem Horiz Bars							#4@16"	#4@16"	#4@16"	#4@16"
Top Bar - D						#4@16"	#4@12"	#4@12"	#4@12"	#4@12"
Footing Width-W	1'-6"	2'-0"	2'-3"	2'-8"	3'-5"	3'-8"	4'-3"	4'-6"	5'-3"	5'-6"
Footing Horiz Bars	3-#4	3-#4	3-#4	4-#4	4-#4	5-#4	5-#4	6-#4	7-#4	7-#4
Key to Toe	0'-6"	0'-10"	1'-0"	1'-3"	1'-2"	1'-6"	1'-11"	2'-3"	2'-3"	2'-9"
Key (w by d)	6" by 3"	8" by 5"	8" by 8"	12" by 11"	12" by 11"	12" by 15"	12" by 17"	12" by 21"	12" by 21"	12" by 25"
Key Reinf							#4@16"	#4@16"	#4@16"	#4@16"

6-inch heel, Level Backfill

CV Wall	CV6L-14	CV6L-20	CV6L-28	CV6L-34	CV6L-40	CV6L-48	CV6L-54	CV6L-60	CV6L-68	CV6L-74	CV6L-80
TYPE	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>II</i>	<i>II</i>	<i>II</i>
Height - h	1'-4"	2'-0"	2'-8"	3'-4"	4'-0"	4'-8"	5'-4"	6'-0"	6'-8"	7'-4"	8'-0"
Slope	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level
Block - t1	6"	6"	6"	6"	8"	8"	8"	8"	8"	8"	8"
Stem Block									12"	12"	12"
Heel	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"
Toe	0'-3"	0'-5"	0'-7"	1'-0"	0'-11"	1'-5"	1'-8"	2'-1"	2'-1"	2'-6"	2'-11"
Vert Bar -A				#3@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"
40 dia Lap				15"	20"	20"	20"	20"	20"	20"	20"
Horiz Bars	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"
Lower Bar -B	#3@24"	#3@24"	#3@24"	#3@24"	#4@24"	#4@24"	#4@16"	#5@8"	#4@24"	#4@24"	#4@16"
Min. Height of 12" Stem Wall									2'-8"	2'-8"	2'-8"
Stem Bar - C									#4@16"	#5@16"	#5@8"
Stem Horiz Bars									#4@16"	#4@16"	#4@16"
Top Bar - D											
Footing Width-W	1'-3"	1'-5"	1'-7"	2'-0"	2'-1"	2'-7"	2'-10"	3'-3"	3'-7"	4'-0"	4'-5"
Footing Horiz Bars	2-#4	2-#4	3-#4	3-#4	3-#4	4-#4	4-#4	4-#4	5-#4	5-#4	5-#4
Key to Toe			0'-9"	1'-0"	1'-2"	1'-3"	1'-6"	1'-9"	2'-1"	2'-6"	2'-9"
Key (w by d)	None	None	6" by 1"	6" by 4"	8" by 7"	12" by 12"	12" by 13"	12" by 16"	12" by 18"	12" by 21"	12" by 24"
Key Reinf								#4@16"	#4@16"	#4@16"	#4@16"

6-inch heel, 2.00 to 1 Slope

CV Wall	CV620-14	CV620-20	CV620-28	CV620-34	CV620-40	CV620-48	CV620-54	CV620-60	CV620-68	CV620-74
TYPE	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>II</i>	<i>II</i>	<i>II</i>
Height - h	1'-4"	2'-0"	2'-8"	3'-4"	4'-0"	4'-8"	5'-4"	6'-0"	6'-8"	7'-4"
Slope	2.0:1	2.0:1	2.0:1	2.0:1	2.0:1	2.0:1	2.0:1	2.0:1	2.0:1	2.0:1
Block - t1	6"	6"	6"	6"	8"	8"	8"	8"	8"	8"
Stem Block								12"	12"	12"
Heel	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"
Toe	0'-4"	0'-6"	0'-9"	1'-2"	1'-4"	1'-10"	2'-2"	2'-3"	2'-10"	3'-3"
Vert Bar -A				#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"
40 dia Lap				20"	20"	20"	20"	20"	20"	20"
Horiz Bars	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"
Lower Bar -B	#3@24"	#3@24"	#3@24"	#4@24"	#4@24"	#4@16"	#5@8"	#4@24"	#4@24"	#4@24"
Min. Height of 12" Stem Wall									2'-8"	2'-8"
Stem Bar - C									#5@24"	#5@8"
Stem Horiz Bars									#4@16"	#4@16"
Top Bar - D										
Footing Width-W	1'-4"	1'-6"	1'-9"	2'-2"	2'-6"	3'-0"	3'-4"	3'-9"	4'-4"	4'-9"
Footing Horiz Bars	2-#4	3-#4	3-#4	3-#4	4-#4	4-#4	4-#4	5-#4	5-#4	6-#4
Key to Toe		0'-6"	0'-9"	0-11"	1'-3"	1'-7"	2'-0"	2'-3"	2-8"	3'-4"
Key (w by d)	None	6" by 4"	8" by 8"	12" by 11"	12" by 14"	12" by 18"	12" by 22"	12" by 25"	12" by 28"	12" by 32"
Key Reinf							#4@16"	#4@16"	#4@16"	#4@16"

6-inch heel, 1.5 to 1 Slope

CV Wall	CV615-14	CV615-20	CV615-28	CV615-34	CV615-40	CV615-48	CV615-54	CV615-60	CV615-68	CV615-74
TYPE	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>II</i>	<i>II</i>	<i>II</i>	<i>II</i>
Height - h	1'-4"	2'-0"	2'-8"	3'-4"	4'-0"	4'-8"	5'-4"	6'-0"	6'-8"	7'-4"
Slope	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1
Block - t1	6"	6"	6"	8"	8"	8"	8"	8"	8"	8"
Stem Block							12"	12"	12"	12"
Heel	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"
Toe	0'-6"	1'-0"	1'-8"	1'-4"	1'-8"	2'-1"	2'-4"	2'-9"	3'-3"	3'-9"
Vert Bar -A				#4@24"	#4@24"	#4@16"	#4@24"	#4@24"	#4@24"	#4@24"
40 dia Lap				20"	20"	20"	20"	20"	20"	20"
Horiz Bars	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"
Lower Bar -B	#3@24"	#3@24"	#3@24"	#4@24"	#4@24"	#5@16"	#4@24"	#4@24"	#4@24"	#4@24"
Min. Height of 12" Stem Wall							2'-0"	2'-8"	2'-8"	4'
Stem Bar - C							#4@16"	#5@16"	#5@8"	#8@8"
Stem Horiz Bars							#4@16"	#4@16"	#4@16"	#4@16"
Top Bar - D										
Footing Width-W	1'-6"	2'-0"	2'-8"	2'-6"	2'-10"	3'-3"	3'-10"	4'-3"	4'-9"	5'-3"
Footing Horiz Bars	3-#4	3-#4	4-#4	4-#4	4-#4	4-#4	5-#4	5-#4	6-#4	6-#4
Key to Toe		0'-6"	1'-0"	1'-0"	1'-6"	1'-11"	2'-4"	2'-9"	3'-3"	3'-9"
Key (w by d)	None	6" by 4"	8" by 10"	12" by 12"	12" by 17"	12" by 21"	12" by 25"	12" by 30"	12" by 34"	12" by 38"
Key Reinf						#4@16"	#4@16"	#4@16"	#4@16"	#4@16"

6-inch heel, Level Backfill, 250 psf Vehicular Surcharge

CV Wall	CV6S-14	CV6S-20	CV6S-28	CV6S-34	CV6S-40	CV6S-48	CV6S-54	CV6S-60	CV6S-68	CV6S-74
TYPE	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>II</i>	<i>II</i>	<i>II</i>	<i>II</i>
Height - h	1'-4"	2'-0"	2'-8"	3'-4"	4'-0"	4'-8"	5'-4"	6'-0"	6'-8"	7'-4"
Slope/Surcharge	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250
Block - t1	6"	6"	6"	8"	8"	8"	8"	8"	8"	8"
Stem Block							12"	12"	12"	12"
Heel	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"	0'-6"
Toe	0'-8"	1'-0"	1'-5"	1'-6"	1'-10"	2'-4"	2'-3"	2'-9"	3'-2"	3'-9"
Vert Bar -A				#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"
40 dia Lap				20"	20"	20"	20"	25"	20"	25"
Horiz Bars	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"
Lower Bar -B	#3@24"	#3@24"	#4@16"	#4@24"	#5@16"	#5@8"	#4@24"	#5@24"	#4@24"	#5@16"
Min. Height of 12" Stem Wall							2'-0"	2'-8"	3'-4"	4'
Stem Bar - C							#4@16"	#5@16"	#6@8"	#8@8"
Stem Horiz Bars							#4@16"	#4@16"	#4@16"	#4@16"
Top Bar - D										
Footing Width-W	1'-8"	2'-0"	2'-5"	2'-8"	3'-0"	3'-6"	3'-9"	4'-3"	4'-8"	5'-3"
Footing Horiz Bars	2-#4	3-#4	3-#4	3-#4	4-#4	4-#4	4-#4	5-#4	5-#4	6-#4
Key to Toe	0'-9"	2'-0"	2'-5"	2'-8"	3'-0"	3'-6"	3'-9"	4'-3"	4'-8"	5'-3"
Key (w by d)	6" by 4"	8" by 7"	8" by 10"	12" by 13"	12" by 16"	12" by 19"	12" by 22"	12" by 25"	12" by 28"	12" by 31"
Key Reinf						#4@16"	#4@16"	#4@16"	#4@16"	#4@16"

2-inch heel, Level Backfill

CV Wall	CV2L-14	CV2L-20	CV2L-28	CV2L-34	CV2L-40	CV2L-48	CV2L-54	CV2L-60	CV2L-68	CV2L-74	CV2L-80
Type	I	I	I	I	I	I	I	I	II	II	II
Height - h	1'-4"	2'-0"	2'-8"	3'-4"	4'-0"	4'-8"	5'-4"	6'-0"	6'-8"	7'-4"	8'-0"
Slope	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level
Block - t1	6"	6"	6"	6"	8"	8"	8"	8"	8"	8"	8"
Stem Block								12"	12"	12"	12"
Heel	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"
Toe	0'-4"	0'-8"	1'-1"	1'-3"	1'-5"	1'-8"	2'-2"	2'-4"	2'-4"	2'-8"	3'-4"
Vert Bar -A				#3@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"
40 dia Lap				15"	20"	20"	20"	20"	20"	20"	20"
Horiz Bars	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"
Lower Bar -B	#3@24"	#3@24"	#3@24"	#3@16"	#4@24"	#4@24"	#4@16"	#5@8"	#4@24"	#4@24"	#4@16"
Min. Height of 12" Stem Wall									2'-8"	2'-8"	2'-8"
Stem Bar - C									#5@24"	#5@16"	#6@8"
Stem Horiz Bars									#4@16"	#4@16"	#4@16"
Top Bar - D											
Footing Horiz Bars	2-#4	2-#4	3-#4	3-#4	4-#4	4-#4	4-#4	4-#4	5-#4	5-#4	6-#4
Footing Width-W	1'-0"	1'-4"	1'-9"	2'-0"	2'-3"	2'-6"	3'-0"	3'-4"	3'-6"	3'-11"	4'-6"
Key to Toe			1'-0"	1'-1"	1'-2"	1'-0"	1'-5"	1'-9"	2'-2"	2'-6"	2'-6"
Key (w by d)	None	None	6" by 2"	6" by 6"	8" by 8"	12" by 11"	12" by 14"	12" by 17"	12" by 19"	12" by 22"	12" by 26"
Key Reinf									#4@16"	#4@16"	#4@16"

2-inch heel, 2.00 to 1 Slope

CV Wall	CV220-14	CV220-20	CV220-28	CV220-34	CV220-40	CV220-48	CV220-54	CV220-60	CV220-68	CV220-74
Type	I	I	I	I	I	I	I	II	II	II
Height - h	1'-4"	2'-0"	2'-8"	3'-4"	4'-0"	4'-8"	5'-4"	6'-0"	6'-8"	7'-4"
Slope	2.0:1	2.0:1	2.0:1	2.0:1	2.0:1	2.0:1	2.0:1	2.0:1	2.0:1	2.0:1
Block - t1	6"	6"	6"	8"	8"	8"	8"	8"	8"	8"
Stem Block								12"	12"	12"
Heel	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"
Toe	0'-7"	0'-8"	1'-1"	1'-4"	1'-8"	2'-0"	2'-5"	2'-5"	2'-11"	3'-4"
Vert Bar -A				#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"
40 dia Lap				20"	20"	20"	20"	20"	20"	20"
Horiz Bars	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"
Lower Bar -B	#3@24"	#3@24"	#3@24"	#4@24"	#4@24"	#4@16"	#5@8"	#4@24"	#4@24"	#4@24"
Min. Height of 12" Stem Wall								2'-8"	2'-8"	3'-4"
Stem Bar - C								#5@24"	#6@16"	#6@8"
Stem Horiz Bars								#4@16"	#4@16"	#4@16"
Top Bar - D										
Footing Horiz Bars	2-#4	2-#4	3-#4	3-#4	3-#4	4-#4	4-#4	5-#4	5-#4	6-#4
Footing Width-W	1'-3"	1'-4"	1'-9"	2'-0"	2'-6"	2'-10"	3'-3"	3'-7"	4'-1"	4'-6"
Key to Toe		0'-7"	1'-0"	0'-11"	1'-3"	1'-7"	2'-0"	2'-5"	2'-11"	3'-4"
Key (w by d)	None	6" by 6"	8" by 8"	12" by 12"	12" by 14"	12" by 18"	12" by 22"	12" by 25"	12" by 28"	12" by 32"
Key Reinf							#4@16"	#4@16"	#4@16"	#4@16"

2-inch heel, 1.5 to 1 Slope

CV Wall	CV215-14	CV215-20	CV215-28	CV215-34	CV215-40	CV215-48	CV215-54	CV215-60	CV215-68	CV215-74
Type	I	I	I	I	I	I	II	II	II	II
Height - h	1'-4"	2'-0"	2'-8"	3'-4"	4'-0"	4'-8"	5'-4"	6'-0"	6'-8"	7'-4"
Slope	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1
Block - t1	6"	6"	6"	8"	8"	8"	8"	8"	8"	8"
Stem Block							12"	12"	12"	12"
Heel	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"
Toe	1'-2"	1'-4"	1'-6"	1'-9"	2'-4"	2'-9"	3'-0"	3'-3"	3'-10"	5'-0"
Vert Bar -A				#4@24"	#4@24"	#4@16"	#4@24"	#4@16"	#4@16"	#4@16"
40 dia Lap				20"	20"	20"	20"	20"	20"	20"
Horiz Bars	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"
Lower Bar -B	#3@24"	#3@24"	#3@24"	#4@24"	#4@24"	#5@8"	#4@24"	#4@16"	#4@16"	#4@16"
Min. Height of 12" Stem Wall							2'-8"	2'-8"	2'-8"	4'-0"
Stem Bar - C							#4@16"	#5@16"	#5@8"	#8@8"
Stem Horiz Bars							#4@16"	#4@16"	#4@16"	#4@16"
Top Bar - D										
Footing Horiz Bars	3-#4	3-#4	3-#4	4-#4	4-#4	4-#4	5-#4	5-#4	6-#4	7-#4
Footing Width-W	1'-10"	2'-0"	2'-2"	2'-7"	3'-2"	3'-7"	4'-0"	4'-5"	5'-0"	6'-2"
Key to Toe		1'-4"	1'-2"	1'-7"	2'-2"	2'-7"	3'-2"	3'-5"	3'-10"	5'-0"
Key (w by d)	None	4" by 6"	12" by 9"	12" by 13"	12" by 17"	12" by 22"	12" by 26"	12" by 30"	12" by 34"	12" by 38"
Key Reinf						#4@16"	#4@16"	#4@16"	#4@16"	#4@16"

2-inch heel, Level Backfill, 250 psf Vehicular Surcharge

CV Wall	CV2S-14	CV2S-20	CV2S-28	CV2S-34	CV2S-40	CV2S-48	CV2S-54	CV2S-60	CV2S-68	CV2S-74
Type	I	I	I	I	I	I	II	II	II	II
Height - h	1'-4"	2'-0"	2'-8"	3'-4"	4'-0"	4'-8"	5'-4"	6'-0"	6'-8"	7'-4"
Slope/Surcharge	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250	Level/250
Block - t1	6"	6"	8"	8"	8"	8"	8"	8"	8"	8"
Stem Block							12"	12"	12"	12"
Heel	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"	0'-2"
Toe	1'-4"	1'-9"	2'-2"	2'-3"	2'-10"	3'-2"	2'-8"	3'-1"	3'-8"	4'-0"
Vert Bar -A				#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"	#4@24"
40 dia Lap				20"	20"	20"	20"	25"	20"	25"
Horiz Bars	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"	#3@16"
Lower Bar -B	#3@24"	#3@24"	#4@24"	#4@24"	#5@16"	#6@8"	#4@24"	#5@16"	#4@24"	#5@16"
Min. Height of 12" Stem Wall							2'-0"	2'-8"	3'-4"	4'
Stem Bar - C							#4@16"	#6@16"	#6@8"	#8@8"
Stem Horiz Bars							#4@16"	#4@16"	#4@16"	#4@16"
Top Bar - D										
Footing Horiz Bars	3-#4	3-#4	4-#4	4-#4	4-#4	5-#4	5-#4	5-#4	6-#4	6-#4
Footing Width-W	2'-0"	2'-5"	2'-10"	3'-1"	3'-8"	4'-0"	3'-10"	4'-4"	4'-10"	5'-2"
Key to Toe	1'-0"	1'-4"	1'-3"	1'-6"	1'-11"	2'-3"	2'-8"	3'-0"	3'-8"	4'-0"
Key (w by d)	6" by 4"	8" by 8"	12" by 11"	12" by 14"	12" by 17"	12" by 20"	12" by 23"	12" by 26"	12" by 30"	12" by 34"
Key Reinf						#4@16"	#4@16"	#4@16"	#4@16"	#4@16"