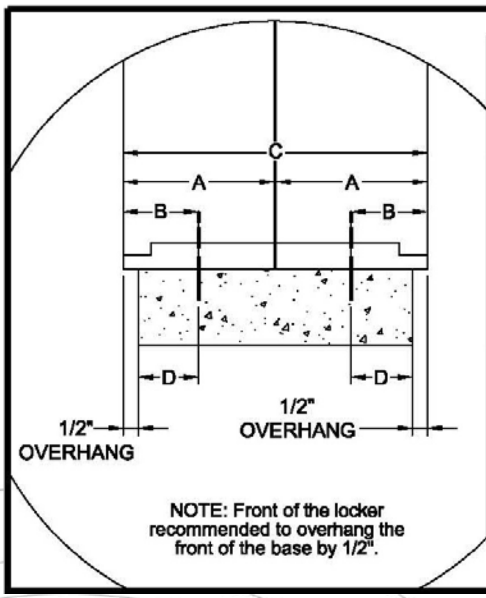
DeBourgh
ALL AMERICAN LOCKERS

SEISMIC DESIGN FACTORS

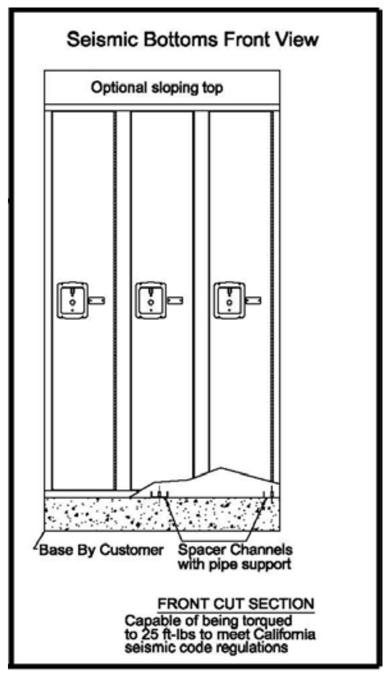
Designers and Architects choose high quality, long lasting products from DeBourgh for many reasons, including our products' ability to stand up against some of nature's most destructive conditions. Geographic regions that experience earthquake activity, such as California, require additional design considerations. DeBourgh's lockers are utilized throughout a countless number of schools, hospitals, police departments, fire stations, and corporate office locations. As such, we designed our product standards in consideration of California's Code of Regulations and the California Department of State Architect's guidelines for meeting seismic locker design requirements.

SEISMIC ANCHORING DETAIL



Single Hole Seismic Bottoms Side View
Depth Example Values

LOCKER INSTALL TYPE	LOCKER DEPTH	A	B	C	D
Wall Mount	12" Deep	12"	6"		5 1/2"
	15" Deep	15"	7 1/2"		7"
	18" Deep	18"	9"		8 1/2"
	22" Deep	22"	11"		10 1/2"
	24" Deep	24"	12"		11 1/2"
Back To Back	12" Deep	12"	6"	24"	5 1/2"
	15" Deep	15"	7 1/2"	30"	7"
	18" Deep	18"	9"	36"	8 1/2"
	22" Deep	22"	11"	44"	10 1/2"
	24" Deep	24"	12"	48"	11 1/2"



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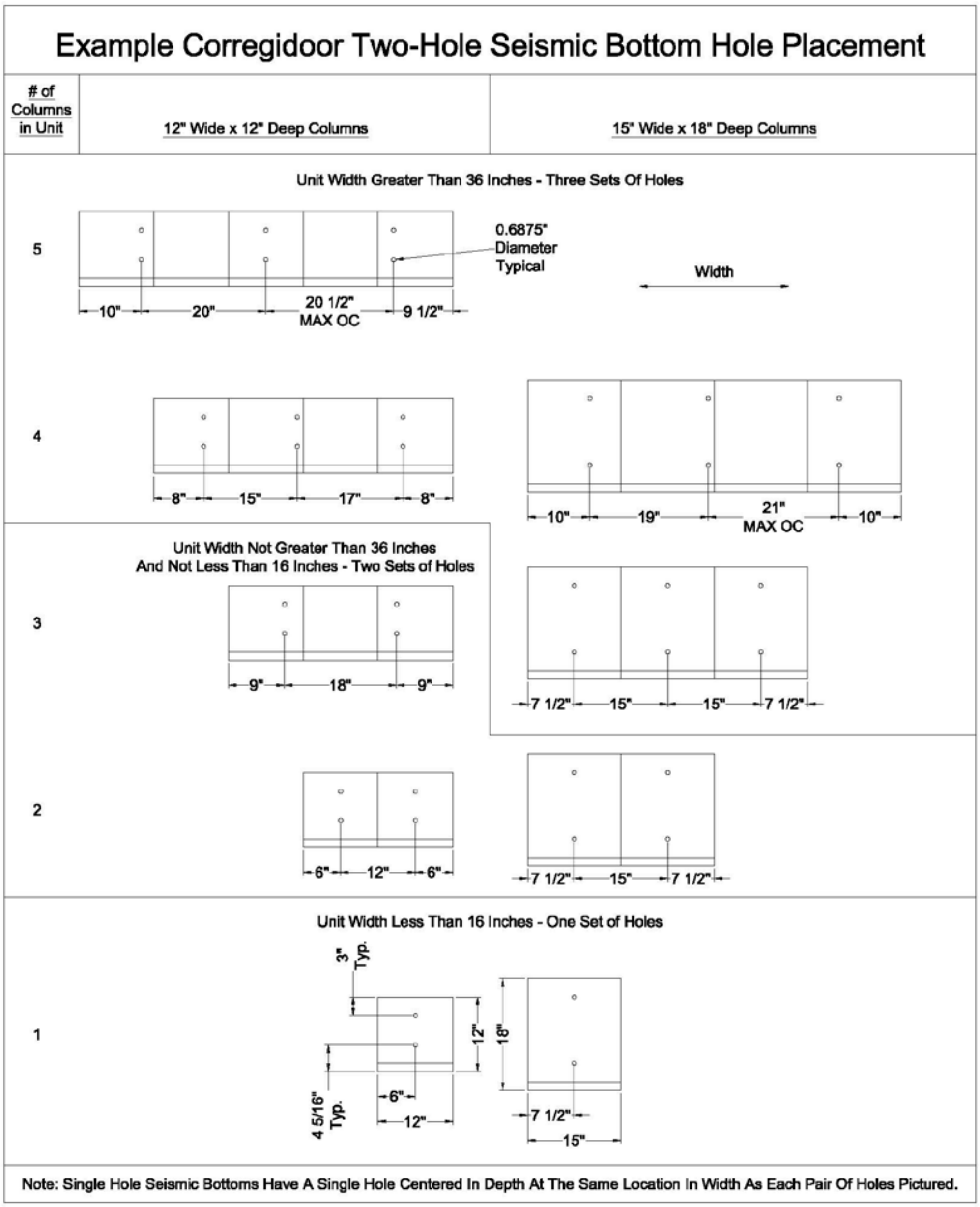

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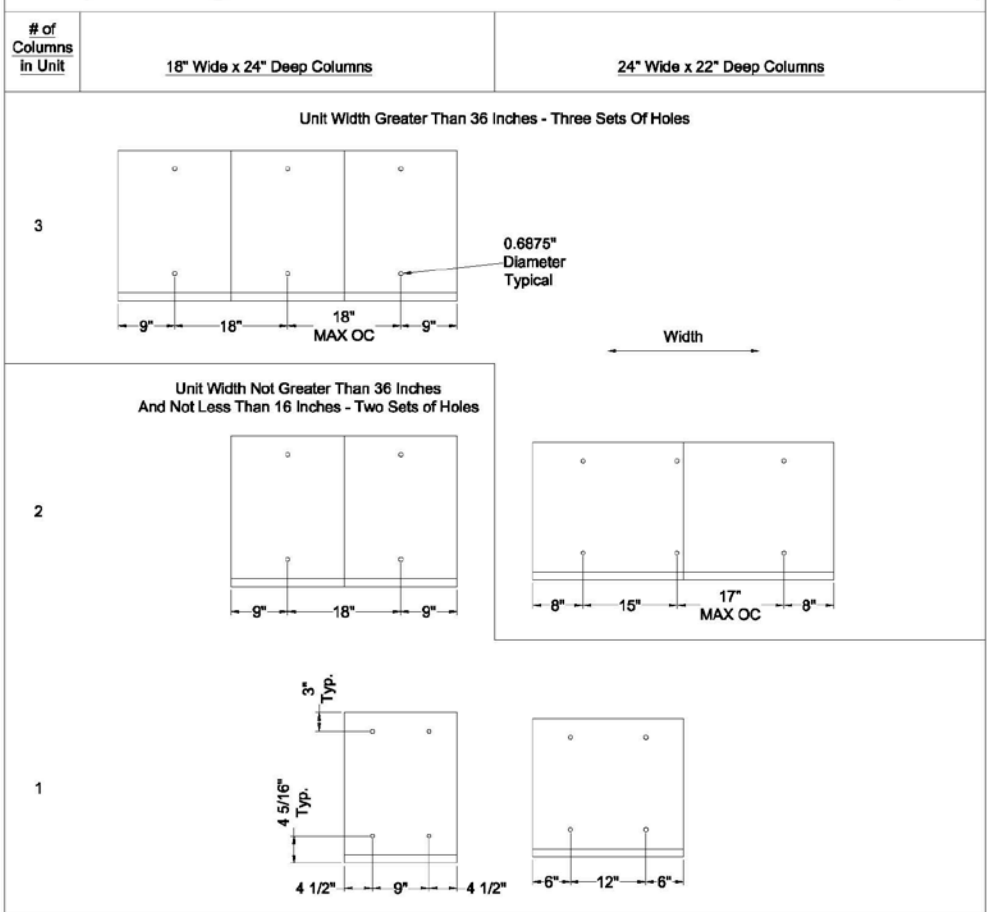
Example Corregidoor Two-Hole Seismic Bottom Hole Placement (Cont.)



Note: Single Hole Seismic Bottoms Have A Single Hole Centered In Depth At The Same Location In Width As Each Pair Of Holes Pictured.

Product	Product Specification	Max Dead Load	Reasonable Live Load
Angle Iron Athletic Lockers (60 in. max width)	PDF	600 lb	100 lb
Corregidoor Lockers (60 in. max width)	PDF	400 lb	100 lb
Rebel Lockers (60 in. max width)	PDF	400 lb	100 lb
Collegiate Lockers (36 in. max width)	PDF	250	50 lb

Table 1: Seismic Design Force Calculation Data

In order to apply the earthquake load as part of the load combinations from ASCE 7 Chapter 2, designers and architects will need to apply the calculated earthquake load distributed across the mass of the lockers. Designers and architects can estimate distributed seismic loads as weighted planar loads across the top, bottom, sides, intermediate partitions, and shelves. Designers and architects should double the load for units joined side to side or back to back. Use the following gauge thickness and perforation sheet percentage tables to adjust the weights of the planar loads.

Gauge of Steel	Thickness (Inches)
18	0.048
16	0.0598
14	0.075
12	0.105

Table 2: Gauge Thickness for Weighting Planar Loads

Perforation Pattern	Sheet Percentage (Approximate)
Solid	100%
Secur-N-Vent	100%
Louvered	100%
Diamond Perforated	75%
Expanded Mesh	25%

Table 3: Perforation Pattern Sheet Percentage for Weighting Planar Loads

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How DeBourgh's Design Complies – Methodology and References

As mentioned previously, we designed our product standards in consideration of California's Code of Regulations and the California Department of State Architect's guidelines for meeting seismic locker design requirements.

Applicable California legislation includes the Alquist Act and the Field Act. The Alquist Act is baked into the California Code of Regulations and pertains to hospitals. According to the FEMA Design Guide for Improving Schools [1], the 2009 IBC categorizes school buildings with occupant load greater than 250 as Type III structures. This document also states in §4.4.2 that "As previously mentioned, California K-12 schools are regulated by the Field Act, which singles out the design and construction of schools to resist earthquakes and is an important model for other States to consider. The Field Act is not a code; rather, it requires that schools be designed by a licensed architect or structural engineer, that plans and specifications be checked by the Department of the State Architects (DSA), and that independent testing and inspection be conducted during construction."

Additionally, the California Department of the State Architect has released a guide [2] for evaluating and retrofitting nonstructural earthquake hazards in schools.

Below is a roadmap through the California Code of Regulations. The destination provides the guidelines and technical details utilized by DeBourgh in designing our products. In addition to this roadmap, the California Building Standards Commission has released a guide[3] to provide additional support in navigating the CCR.

[1] Design Guide for Improving School Safety in Earthquakes, Floods, and High Winds. Chapter 4: Making Schools Safe from Earthquakes. Risk Management Series Publication. https://www.fema.gov/media-library-data/20130726-1530-20490-7321/424_ch4_web.pdf. Accessed 8:00 AM 8/8/16.

[2] Safer Schools: Guide and Checklist for Nonstructural Earthquake Hazards in California Schools. January 2003. Department of General Services – Division of the State Architect. http://www.seismic.ca.gov/pub/SB1122.pdf. Accessed 8:00 AM 8/8/16

[3]Guidebooks and Educational Documents. California Building Standards Commission. http://www.bsc.ca.gov/pubs/guides/tabid/3472/Agg11458_SelectTab/1/Default.aspx. Accessed 8:00 AM 8/8/16

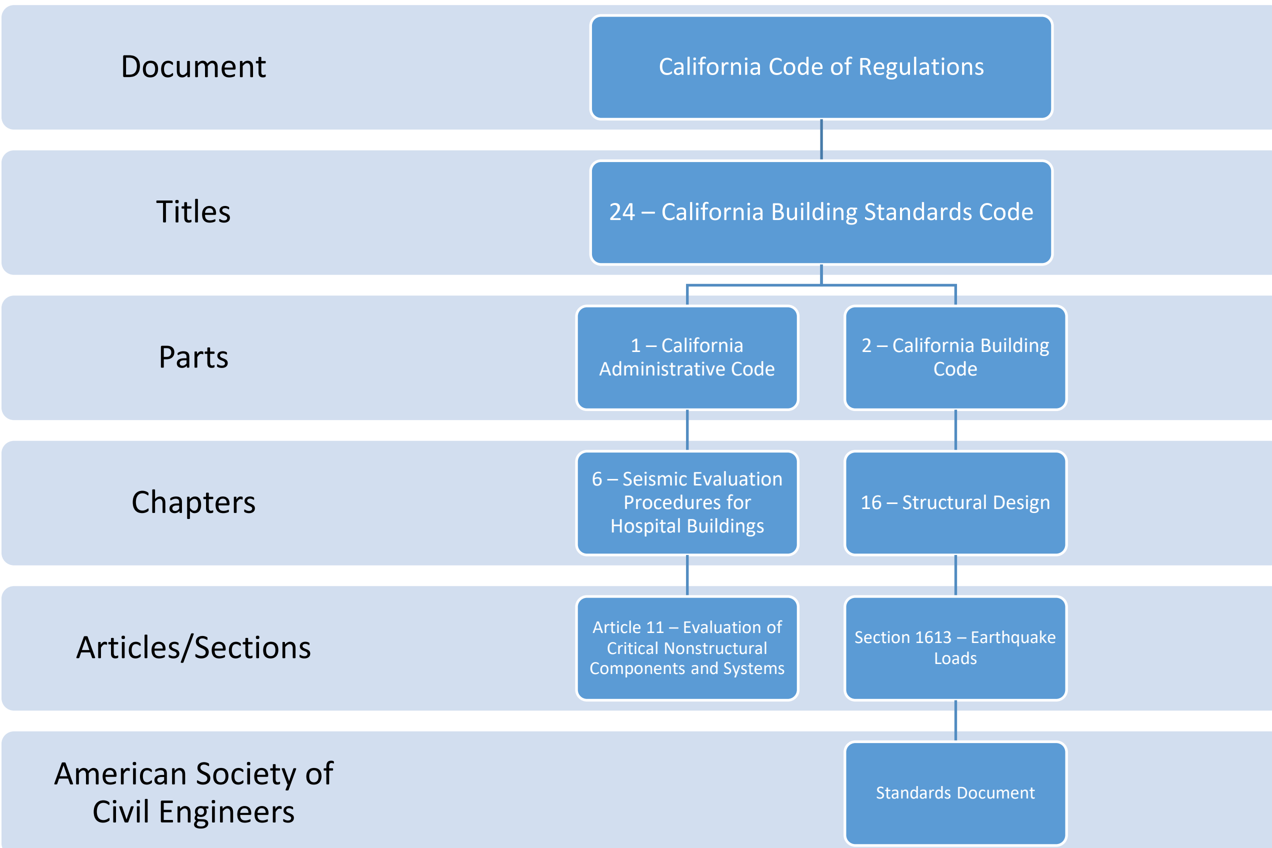

Figure 1 – Roadmap of California Code of Regulations

California Code of Regulations References

CCR Title 24 Part 1 Chapter 6 Article 1 Section 3 (Seismic evaluation)

- "All general acute care hospital owners shall perform a seismic evaluation on each hospital building in accordance with the Seismic Evaluation Procedures as specified in Articles 2 through 11 of these regulations. By January 1, 2001, hospital owners shall submit the results of the seismic evaluation to the Office for review and approval. By completing this seismic evaluation, a hospital facility can determine its respective seismic performance categories for both the Structural Performance Category (SPC) and the Nonstructural Performance Category (NPC) in accordance with Articles 2 and 11 of these regulations."

CCR Title 24 Part 1 Chapter 6 Article 11 Table 11.1 (Nonstructural Performance Categories) footnotes

- "For the purpose of NPC 2 and NPC 5, all enumerated items within Table 11.1 shall meet the requirements of Section 1632A of 2001 California Building Code (CBC) or equivalent provision in later version of the CBC by the specified timeframe as indicated by their respective NPC."
- "For the purposes of NPC 3 and NPC4 in SPC 2, SPC 3, SPC 4 or SPC 4D, buildings, all enumerated items within Table 11.1 shall meet the requirements of the 1998 CBC, Section 1630B or equivalent provision in later version of the CBC, by the specified timeframe. For the purposes of NPC 3R, all enumerated items within Table 11.1 shall meet the requirements of the 1995 CBC, Section 1630A, using I_p = 1.0 or equivalent provision in later version of the CBC, by the specified timeframe."

2016 CCR Title 24 Part 2 Chapter 16 Section 1613 (Earthquake Loads)

- "Every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance with ASCE 7, excluding Chapter 14 and Appendix 11A."

The American Society of Civil Engineers Standard 7 was also utilized in designing lockers to meet seismic design requirements. The following information was utilized in developing our product design specifications.

ASCE 7 Chapter 2 Section 2.2 – Symbols Reference

- A_k = load or load effect arising from extraordinary event A
- D = dead load
- D_i = weight of ice
- E = earthquake load
- F = load due to fluids with well-defined pressures and maximum heights
- F_a = flood load
- H = load due to lateral earth pressure, ground water pressure, or pressure of bulk materials
- L = live load
- L_r = roof live load
- R = rain load
- S = snow load
- T = self-straining load
- W = wind load
- W_i = wind-on-ice determined in accordance with Chapter 10

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ASCE 7 Chapter 2 Section 2.3 – Combining Factored Loads Using Strength Design

Basic Combinations – Structures, components, and foundations shall be designed so that their design strength equals or exceeds the effects of the factored loads in the following combinations, subject to several exceptions:

- 1.4D
- 1.2D + 1.6L + 0.5(L_r or S or R)
- 1.2D + 1.6(L_r or S or R) + (L or 0.5W)
- 1.2D + 1.0W + L + 0.5(L_r or S or R)
- 1.2D + 1.0E + L + 0.2S
- 0.9D + 1.0W
- 0.9D + 1.0E

ASCE 7 Chapter 2 Section 2.4 – Combining Nominal Loads Using Allowable Stress Design

Basic Combinations – Loads listed herein shall be considered to act in the following combinations; whichever produces the most unfavorable effect in the building, foundation, or structural member shall be considered. Effects of one or more loads not acting shall be considered. Subject to several exceptions:

- D
- D + L
- D + (L_r or S or R)
- D + 0.75L + 0.75(L_r or S or R)
- D + (0.6W or 0.7E)
- D + 0.75L + 0.75(0.6W) + 0.75(L_r or S or R)
- D + 0.75L + 0.75(0.7E) + 0.75S
- 0.6D + 0.6W
- 0.6D + 0.7E

ASCE 7 Chapter 11 – Seismic Design Criteria

- Every structure, and portion thereof, including nonstructural components, shall be designed and constructed to resist the effects of earthquake motions as prescribed by the seismic requirements of this standard.

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- Nonstructural components shall be designed and constructed in accordance with the requirement of Chapter 13.
- $S_{DS} = 2/3 * S_{MS}$ (For California, this works out to ≈ 10 – 100 when available on graph.)
- $S_{MS} = F_a S_S$
- $15 \leq S_S \leq 200+$ (When available on graphs in the ASCE standard)
- $F_a = 1$ (Presuming S_S is much greater than 1.25)
- Site Class is unknown, so use Site Class D.

ASCE 7 Chapter 13 - Seismic Design Requirements for Nonstructural Components

- Section 3 – Seismic Demands on Nonstructural Components
  - The horizontal seismic design force shall be applied at the component's center of gravity and distributed relative to the component's mass distribution and shall be determined in accordance with the following equation:
    - Seismic Design Force $F_P = (0.4 a_p S_{DS} W_p)(1+2z/h)/(R_p/I_p)$; $0.3 S_{DS} I_p W_p \leq F_p \leq 1.6 S_{DS} I_p W_p$
    - S_{DS} = spectral acceleration, short period, as determined from Section 11.4.4 ⍰ rough order of magnitude 10 or 100, higher for site class E/F.
    - a_p = component amplification factor that varies from 1 to 2.5 (select appropriate value from Table 13.5-1 or 13.6-1)
    - I_p = component importance factor that varies from 1 to 1.5 (see Section 13.1.3) Unless it contains something toxic, it's 1.
    - W_p = component operating weight [– see Table 1 in this document]
    - R_p = component response modification factor that varies from 1 to 12 (select appropriate value from Table 13.5-1 or 13.6-1)
    - z = height in structure of point of attachment of component with respect to the base. For items at or below the base, z shall be taken as 0. The value of z/h need not exceed 1.
    - h = average roof height of structure with respect to the base
    - The force shall be applied independently in at least two orthogonal horizontal directions in combination with service loads associated with the component, as appropriate. For vertically cantilevered systems, however [(such as back-to-back lockers)], the force shall be assumed to act in any horizontal direction. In addition, the component shall be designed for a concurrent vertical force ±0.2SDSWp. The redundancy factor, ρ, is permitted to be taken equal to 1 and the over strength factor, Ω_0, does not apply.
    - The spectral acceleration and weight should pretty much drive design in California. We should provide an estimate of unit and run weight as soon as possible.

- Section 4 – Nonstructural Component Anchorage
    - "A continuous load path of sufficient strength and stiffness between the component and the supporting structure shall be provided… The component forces shall be those determined in Section 13.3.1. The design documents shall include sufficient information relating to the attachments to verify compliance with the requirements of this section."
    - Lockers - architectural component – permanent floor-supported storage cabinets over 6 feet tall, including contents. (Table 13.5-1: $a_p^{a} = 1$, $R_p = 2\frac{1}{2}$, $\Omega_0^{c} = 2\frac{1}{2}$.)
    - Where flexible diaphragms provide lateral support for concrete or masonry walls and partitions, the design forces for anchorage to the diaphragm shall be as specified in Section 12.11.2.
    - Over strength is as required for anchorage to concrete. See Section 12.4.3 for inclusion of over strength factor in seismic load effect.

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