

1610 - H = Soil Lateral Loads

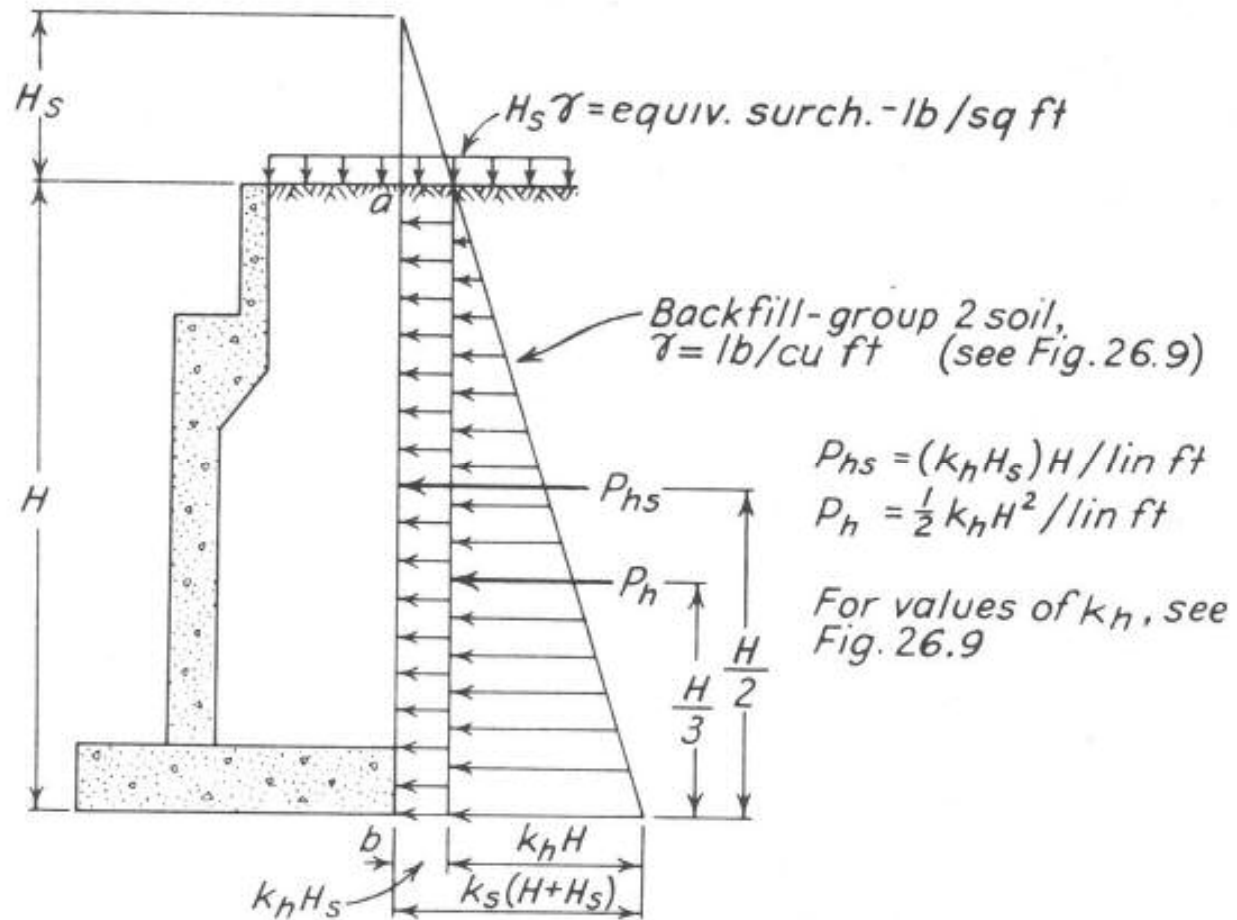
- Used for design of foundations, basement walls, retaining walls
- Lateral pressures given in Table 1610.1 or taken from site specific soil investigation report
- Active and at-rest pressures are given

Soil Lateral Loads

TABLE 1610.1
SOIL LATERAL LOAD

DESCRIPTION OF BACKFILL MATERIAL ^c	UNIFIED SOIL CLASSIFICATION	DESIGN LATERAL SOIL LOAD ^a (pound per square foot per foot of depth)	
		Active pressure	At-rest pressure
Well-graded, clean gravels; gravel-sand mixes	GW	30	60
Poorly graded clean gravels; gravel-sand mixes	GP	30	60
Silty gravels, poorly graded gravel-sand mixes	GM	40	60
Clayey gravels, poorly graded gravel-and-clay mixes	GC	45	60
Well-graded, clean sands; gravelly sand mixes	SW	30	60
Poorly graded clean sands; sand-gravel mixes	SP	30	60
Silty sands, poorly graded sand-silt mixes	SM	45	60
Sand-silt clay mix with plastic fines	SM-SC	45	100
Clayey sands, poorly graded sand-clay mixes	SC	60	100
Inorganic silts and clayey silts	ML	45	100
Mixture of inorganic silt and clay	ML-CL	60	100
Inorganic clays of low to medium plasticity	CL	60	100
Organic silts and silt clays, low plasticity	OL	Note b	Note b
Inorganic clayey silts, elastic silts	MH	Note b	Note b
Inorganic clays of high plasticity	CH	Note b	Note b
Organic clays and silty clays	OH	Note b	Note b

Soil Lateral Loads



Additional Soil and Hydrostatic Pressure Loads

- Surcharge loads
- Upward load due to the hydrostatic upward pressure of water
- Lateral loads due to expansive soils not included in tables

IBC 2003 Rain Loads

- Design roofs for the weight of the accumulated rain assuming the primary drainage system is blocked.
- Accumulated rain includes the height of water above the secondary drain based on the rate of rainfall and rate of design flow through the drain.
- $R = 5.2(d_s + d_h)$ Eq. 16-37

IBC 2003 Rain Loads

- $R = 5.2(d_s + d_h)$ Eq. 16-37
- R : rain load in roof, psf
- d_s : height of water, inches, up to the secondary drain. Determined by design (set by plumber – usually 2" to 4" above the roof)
- d_h : height of water, inches, above the secondary drain, at the design flow of the drain. Determined by calculations.

IBC 2003 Rain Loads

- To determine d_h
 - find flow rate, Q , in gallons/min
 - Based on the drain's drainage area, A (sq.ft), and
 - Rainfall intensity, i (in/hour)
 - $Q = 0.0104 A i$
 - i : plumbing code : $i = 3.2$ in St. Louis
 - St. Louis County : $i = 4.6$
 - St. Louis City : $i = 6.0$
 - Plumber "never use less than 4.0"
 - Perhaps this is appropriate to size the drain, but is it appropriate for the rain load calculation?

IBC 2003 Rain Loads

- Having found Q , flow rate in gallons per minute, determine hydraulic head, dh , in inches, from table C8-1 (ASCE 7 Commentary). Interpolate as required.
- Need to know type of drain (pipe or scupper, closed or open) and size of drain.

IBC 2003 Rain Loads

TABLE C8-1
FLOW RATE, Q, IN GALLONS PER MINUTE OF VARIOUS DRAINAGE SYSTEMS AT VARIOUS HYDRAULIC HEADS, d_h , IN INCHES [C8-2]

Drainage System	Hydraulic Head d_h , Inches									
	1	2	2.5	3	3.5	4	4.5	5	7	8
4 in. diameter drain	80	170	180							
6 in. diameter drain	100	190	270	380	540					
8 in. diameter drain	125	230	340	560	850	1100	1170			
6 in. wide, channel scupper**	18	50	*	90	*	140	*	194	321	393
24 in. wide, channel scupper	72	200	*	360	*	560	*	776	1284	1572
6 in. wide, 4 in. high, closed scupper**	18	50	*	90	*	140	*	177	231	253
24 in. wide, 4 in. high, closed scupper	72	200	*	360	*	560	*	708	924	1012
6 in. wide, 6 in. high, closed scupper	18	50	*	90	*	140	*	194	303	343
24 in. wide, 6 in. high, closed scupper	72	200	*	360	*	560	*	776	1212	1372

*Interpolation is appropriate, including between widths of each scupper.

**Channel scuppers are open-topped (i.e., 3 sided). Closed scuppers are 4 sided.

IBC 2003 Rain Loads

- $R = 5.2(d_s + d_h)$ Eq. 16-37
- Knowing d_s and d_h , calculate R (psf)
- Apply R, maximum load per sq. ft., as an area triangular load, to the roof area around the drain, based upon the roof slopes.
- Total load as an inverted cone,
 $W = R (Area_{water}) / 3$

IBC 2003 Rain Loads

- Controlled drainage roofs use the roof as a retention system, and are often designed to hold a maximum $5\frac{3}{4}$ " of water (30 psf), including d_s and d_h , at the roof low points. Water above that elevation will drain from a secondary system like scuppers.

IBC 2003 Rain Loads

- Flat roofs must be designed to prevent ponding instability.
- Roofs with a slope steeper than or equal to $\frac{1}{4}$ " / ft. (1.193 degrees) do not need to be investigated for ponding instabilities.

IBC 2003 Rain Loads

- Ponding instabilities:
- See AISC Manual of Steel Construction, ASD, 9th Edition, Chapter K, Section K2
- See AISC Manual of Steel Construction, LRFD, 3rd Edition, Chapter K, Section K2
- See SJI Technical Digest #3, "Structural design of steel joist roofs to resist ponding loads", by Heinzerling, J.E, May 1971, \$20, www.steeljoist.org

IBC 2003 Rain Loads

- Ponding instabilities: the easy way
- Provide a minimum of $\frac{1}{4}$ " per foot of slope, and ignore ponding.

IBC 2003 Rain Loads

- Ponding instabilities: not-so-hard way
- Calculate C_p and C_s .
- If $C_p + 0.9 C_s \leq 0.25$, and $I_d \geq 25(S^4)10^{-6}$, then
- ponding is ok
 - $C_p = 32L_s(L_p)^4 / (10^7 I_p)$
 - $C_s = 32S(L_s)^4 / (10^7 I_s)$
 - I_d = moment of inertia of the deck (in⁴/ft)

IBC 2003 Rain Loads

- Ponding instabilities: still not-so-hard way – look in AISC Appendix
- Calculate C_p C_s U_p and U_s
- Look at nomograph charts to find a maximum C_p and C_s .
- If calculated values of C_p and C_s are less than the maximum C_p and C_s from the chart, ponding is ok.

IBC 2003 Rain Loads

- If ponding is not ok, increase the stiffnesses of the beams and/or joists and/or deck and recalculate.

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- Questions ??
- **Answers ??**

1612 - F_a = Flood Loads

ASCE 7-02 Sections 2.3.2 and 2.3.3

Load Combinations:

In V Zones or Coastal A Zones

Modified (4) $1.2D+1.6W+2.0F_a+L+0.5(L_r \text{ or } S \text{ or } R)$

Modified (6) $0.9D+1.6W+2.0F_a+1.6H$

In Non-Coastal A Zones

Modified (4) $1.2D+0.8W+1.0F_a+L+0.5(L_r \text{ or } S \text{ or } R)$

Modified (6) $0.9D+0.8W+1.0F_a+1.6H$

1612 - Flood Loads

- Structures located in Flood Hazard areas must be designed for flood loads
- Reference FEMA Flood Insurance Rate Maps
- Design in accordance with ASCE 24-98 Flood Resistant Design and Construction

1612 - Flood Loads

- Design must resist:
 - Flotation
 - Collapse
 - Permanent lateral displacement
- Design must consider:
 - Scour
 - Erosion
- Loads:
 - Hydrostatic loads
 - Hydrodynamic loads
 - Wave loads
 - Impact loads

Questions?