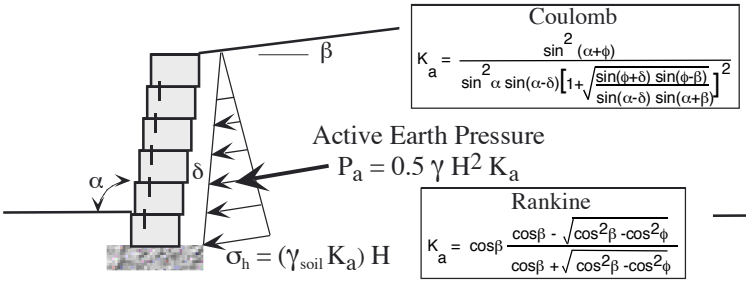
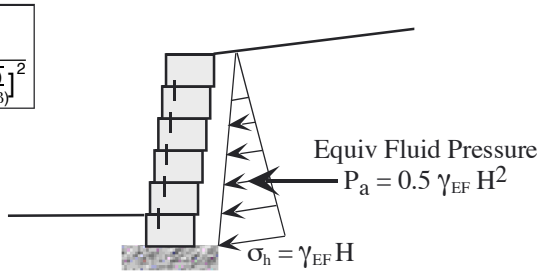
Equivalent Fluid Pressure

It is common for structural and geotechnical engineers to define the active earth pressure loading for simple retaining wall structures in terms of equivalent fluid pressure such as 40 pcf for ease of calculation. Many design codes define minimum equivalent fluid pressures as a means for establishing a simple retaining wall design criteria without site specific analysis. Since an active earth pressure calculation without considering surcharges or complex loadings yields a simple triangular earth pressure distribution, the similarity to a fluid pressure analysis at some equivalent weight is reasonable.



Active Earth Pressure



γ_{EF} is assumed fluid pressure weight

Equivalent Fluid Pressure

The limitation of an equivalent fluid pressure analysis is that it is independent of structure geometry such as wall batter and tiered wall configurations, does not permit the proper analysis of surcharge conditions such as broken back slopes and dead/live load combinations, and it avoids complicated stability analysis conditions such as compound failure planes and global stability.

The benefit of equivalent fluid pressure analysis is that it typically creates a easily understood minimum design loading regardless of structure geometry and assumed soil properties. For example, a heavily battered retaining wall design (10°+) utilizing high assumed soil strengths (ϕ = 36°) may result in very low calculated earth pressures (equiv. fluid pressure = 20 pcf) which may be unrealistic and depends upon very favorable conditions to perform adequately. Use of soil cohesion can also create unrealistically low calculated soil pressure.

Equivalent fluid pressure (pcf) and wall design criteria is compared below. Note the significant variance depending on soils strength, wall batter, backslope geometry, and design method.

		Rankine-Vertical				Coulomb-1:8 Batter			
Backslope >		Level	4:1	3:1	2:1	Level	4:1	3:1	2:1
ϕ angle	34°	34	37	39	49	25	29	32	39
	30°	40	44	48	65	30	36	40	52
	26°	47	53	59	90	36	45	50	90

Note: Equivalent fluid pressure based on soil weighing 120 pcf. Low ϕ angles and steep backslopes create high pressures and do not permit equation solution to earth pressure.