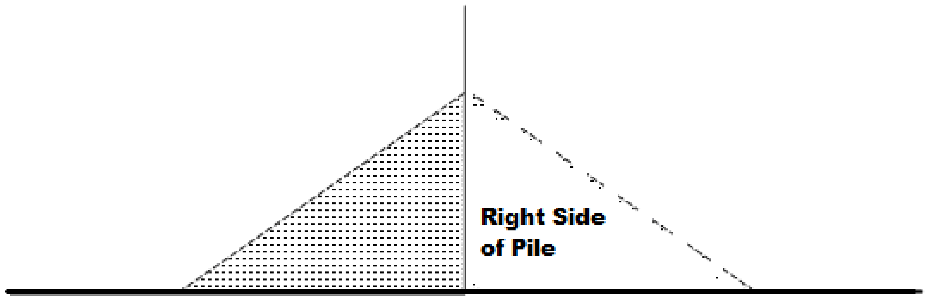
Drawing #1

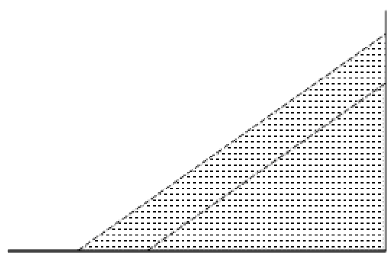
A pile of particulate, with gravity, stabilizes at a unique angle (angle of repose or drained friction angle). The friction between the particles makes this angle (Google: “Rankine -- 1857”). The dotted line is the upper surface. (To keep things simple, the drawings show only the “left” half of the pile.)



Drwg. #1

Drawing #2

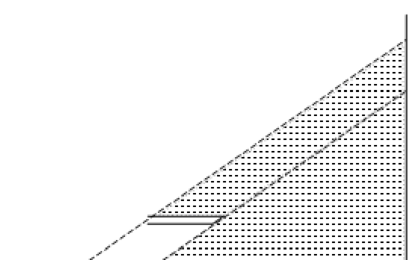
Adding more to the pile creates a new layer (the second dotted line). This makes the pile higher, and heavier -- but it still has the same friction between the particles, so it still has the same angle.



Drwg. #2

Drawing #3

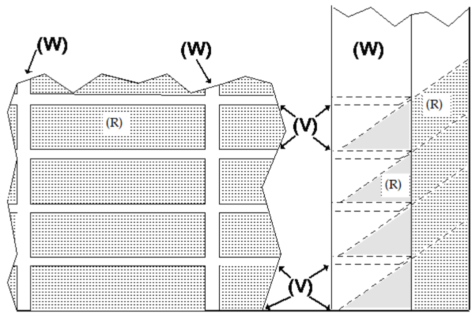
This shows a “step” put into the pile. This “step” does not affect the original pile, but it does stop the new layer. The “step” supports the particulate directly above it, and the Rankine active force(2) stops the “flow”.



Drwg. #3

Drawing # 4

Here are more "steps", each stopping the "flow" of each layer. These "steps" are the patented "Particular Valves" (stop-mode).



Drwg. #4

The "Particular Valves" (V) -- stacked vertically -- form the retaining wall (W). This "Particular Wall" stops the flow of the pile. The lower face of the "step" forces the particulate (R) to "stop" at its natural angle of repose onto the upper face of the lower "step". So:

- The only horizontal force against the **"Particular Wall"** is the Rankine active force(2). This develops along the right vertical edge of the particulate **within each valve**. This Rankine force transfers **within each valve** by inter-particle frictional forces to become a horizontal force vector on the "top" face of each "step" (see Drawing #5 -- Rh). The Rankine active force stabilizes **within each valve**, for each layer the valve stops. There is NO difference of the Rankine active force between the bottom valve, or the top valve -- **virtually eliminating any rotation.**
- In addition, there is a center of gravity vector force downward on each valve, equal to the weight of the particulate within each valve, and closer to the retained earth/slope.

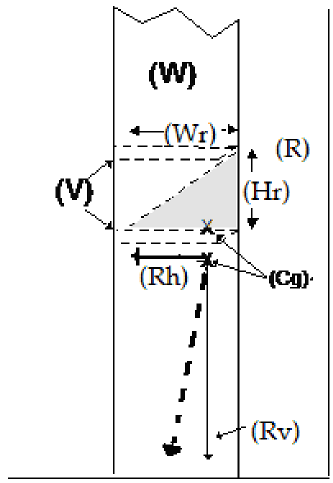
These two aspects make the "Particular Wall" fundamentally different from a conventional retaining wall.

- The horizontal forces on a "Particular Wall" stabilize at each valve level, **eliminating failure due to rotation**; and the "Particular Wall" is **independent of the weight or materials of construction** (ie concrete, steel, other, or combinations). In contrast, horizontal forces on a conventional wall are stabilized over the entire wall, subjecting it to rotation; and it is dependent on the weight or materials of construction.

- The "Particular Wall's **center of gravity is closer to the pile** it is retaining. It is more stable than a conventional wall, which has its center of gravity further from the pile.

Drawing #5

This is a force diagram showing the complete horizontal stability of a “Particular Wall”.



Drwg. #5

(R): This is the particulate the “Particular Wall” retains. The particulate can be the pile, or the “fill” between the “Particular Wall” and a pile of earth.

(V): This is both the upper and lower surfaces of a “Particular Valve” within the wall.

: The particulate “stopped” by the valve

(C_g) and “X”: These mark the location of the center of gravity on the lower valve surface.

(W): This indicates the “Particular Wall”

(Wr): This is the depth of the particulate within the valve.

(Hr): This is the height of the particulate within the valve

(R_h): This is the Rankine Active Force (horizontal) of the particulate:

(Rv): This is the vertical force of the weight of the particulate (R) in the valve (V)

The Rankine horizontal force (Rh) is transferred by friction to the upper surface of the valve (V):

$(sigma_h / sigma_v) = Tan^2 (45 - (\text{"dfa"}/2)$

"dfa" =	"drained friction angle" = "angle of repose"
$Sigma_h$ =	Rankine active force in terms of a horizontal pressure.
$Sigma_v$ =	The vertical pressure of the Rankine material at a depth "x", due to its density.
(R_h) =	The integral of $sigma_h$ from zero to a depth H_r.
(R_v) =	$(sigma_v \times (H_r) \times (W_r))/2$

Since (H_r) and (W_r) form a right triangle, the center of gravity is approximately 0.707 times the distance from the left end of the retained particulate (one divided by the square root of 2: $1 / \sqrt{2}$).

The resultant force vector operating on the retaining wall is the dot-dash line beginning at "X" in Drwg. #5. Doing the arithmetic of Rh / Rv, the density cancels out; therefore **the resultant angle is dependent on the angle-of-repose** of the Rankine material, **but it is independent of the density**.

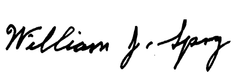
For example, if the assumed Rankine angle-of-repose (dfa) equals 30 degrees, the resultant force vector angle is approximately 10.9 degrees ($(sigma_h / sigma_v) = Tan^2 (45-(\text{"dfa"}/2))$.

As long as this vector clearly falls within the base of the retaining wall structure, the "Particular Wall" completely counters the horizontal forces from the external particulate pile. (For higher walls, the valves are staggered to accommodate the resultant force vector, keeping it within the base of the structure.). Traditional Force calculations must be done for the remaining "traditional" vertical faces. These have been greatly reduced by the introduction of the "Particular Valve".

In addition, a "Particular Wall" allows continuous:

- Water drainage,
- Freeze-hoving adjustment
- Relief of soil liquefaction, and
- Relief of uneven horizontal forces.

In conclusion -- properly designed, anchored, and maintained -- a "Particular Wall" will stand longer than any traditional retaining wall, under more circumstances.



"(V)": The valve shown is only one of a number patented "Particular Valve" shapes possible. These are chosen based on the overall design requirements.

"(R)": Designates a "Rankine" type material, defined as a material which:

- *develops a definite angle-of-repose, or drained friction angle; and*
- *can "flow" with semi-hydraulic properties, while still form a pile (which true fluids do not).*

"(W)": Designates the "wall" which must sustain the weight of the material contained within the "valves".

The valve shape and the design of the vertical structure shown are solely representative to illustrate the use of a "Rankine" particulate within a representative "Particular Valve" to improve the force diagram, and to stabilize the "Particular Wall" independent of construction method or weight of the wall. ***Other "Particular Valve" shapes and structures also fit the claims of the patent application.***

In the drawings, the valves are "open" on both side. They do not have to be (although this does aid in drainage).

However, as shown, if an event occurs where the angle of repose of the Rankine material lessens (becomes less than the approximately thirty degrees shown in these drawings) the Rankine particulate "spills" out without destroying the retaining wall structure. That is, ***a "stop" valve for one angle of repose -- by design -- can also be a "go" valve for a different angle of repose.***

In addition, if the material is subject to extreme horizontal forces -- ie. ***during earthquake or explosion -- the Rankine particulate will again "spill" out without destroying the retaining wall structure****. However, it is not a fully reliable fail-safe relief valve under these extreme conditions. Never the less, the "Particular Wall" will stand longer than a conventional retaining wall.*

The same results occur if Rankine material is interposed between the "Particular Wall" and "ordinary earth". If the "ordinary earth" becomes "fluid", or a strata of the "ordinary" earth becomes "fluid" -- such that added horizontal pressure beyond the designed Rankine active force is applied in a certain vertical zone --, the result would be to extrude the Rankine material within the wall through the associated open vertical structure (to the left in these drawings). The wall remains standing, while ***providing a visual warning of changing conditions****.*