How to use the spreadsheet for calculating earth pressures and forces, and the sliding and tipping values of retaining wall profiles

Inputs are into orange cells only. The other cells are not protected: take care not to overwrite them. Primary outputs are in bold red type. There is no provision for writing data files. In order to save a certain configuration, simply save the whole spreadsheet under a new name, or export as PDF.

Earth pressure coefficients

The coefficient for active earth pressure K_a and its horizontal component K_{ah} are calculated using Coulomb's method:

$$K_a = \frac{K_{ah}}{\cos(\delta-\alpha)} \qquad K_{ah} = \frac{\cos^2(\phi+\alpha)}{\cos^2(\alpha)\cdot\left[1+\sqrt{\frac{\sin(\phi+\delta)\cdot\sin(\phi-\beta)}{\cos(\delta-\alpha)\cdot\cos(\alpha+\beta)}}\right]^2}$$

You need the φ of the soil and the β of the slope (can be zero). If α is different to zero, choose profile type 1 (rectangle) and adjust the batter in order to get the desired α. The value of δ is set according to φ and the factor δ / φ. Other input values are not relevant.

Earth pressure forces

Two methods are included for calculating the active earth pressure forces and/or their components. The light magenta cells signify method Schmidt, which uses the relationship

$$E_a = K_a \cdot \gamma \frac{h^2}{2}$$

This is the total earth pressure force due to gravity (i.e. the soil's weight) per unit length of the retaining wall and labeled Eag. Inputs for γ soil and h of the wall are required. Depending on the profile shape set, the actually used retaining height is not the same as the visible height used as input. For profile 1 (rectangle) they are the same.

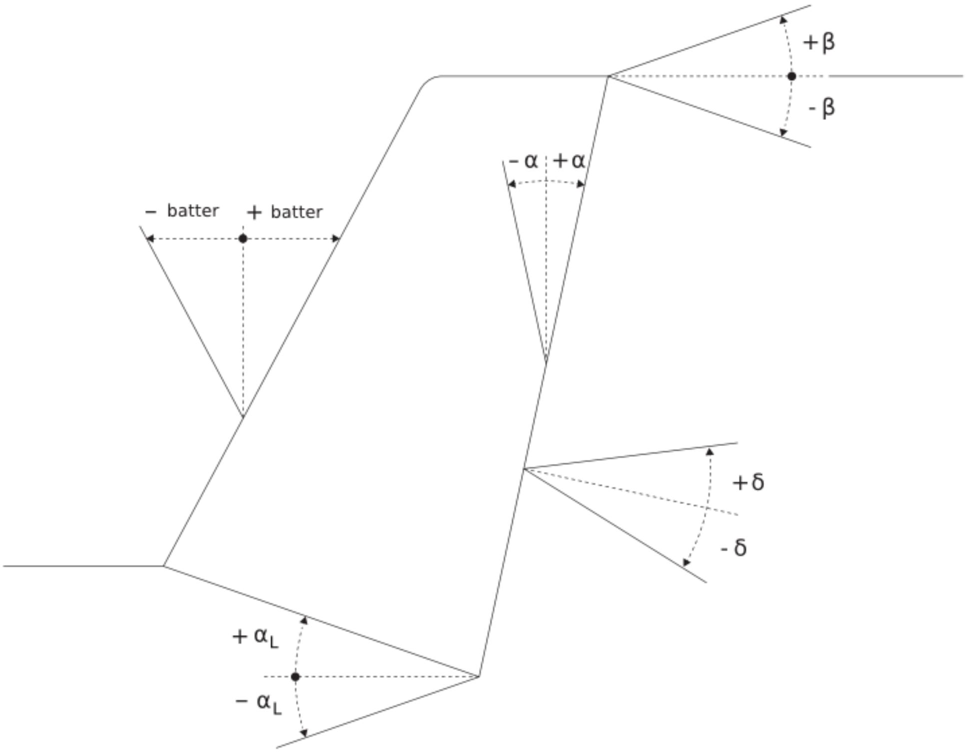
If input p is not zero, this will also provide an non-zero Eap, the earth pressure force due to additional uniform loading of the terrace.

The light cyan cells signify a method used in the FLL drystone retaining wall tables, modified by Schmidt. They first work out horizontal and vertical pressure components and then the horizontal and vertical forces.

Both methods calculate tipping moments and their corresponding lever arms. The cells for the moments in cases g and g+p should be the same for both methods; all other values will differ.

Wall parameters

Given inputs for the profile type, height, width, batter, γ and porosity of the wall, the spreadsheet will produce the wall's cross section area and weight per unit length and also a few secondary values.



Angle definitions

Tipping and sliding

With the inputs described above, the spreadsheet also gives the tipping stability (yellow cell). It is determined by working out the wall's stabilising moment and and balancing this against the tipping moments. Method Schmidt gives the safety factor for tipping and the directly related distance of the total force resultant from the shape's toe point. A SF tipping of 1 means that the force resultant passes through the toe (dist. toe zero) and the shape is on the verge of tipping. A SF tipping less than 1 and a negative dist. toe means the shape is unstable and tipping. A SF tipping over 1 and a postive dist. toe means the shape is stable. Generally a SF tipping of over 1.5 or 2 is desired.

Method FLL gives the eccentricity of the force resultant. This is the distance of the total resultant measured from the middle of the base rather than from the toe. The maximum values allowable by Swiss (SIA) and German (DIN) building specifications are also provided. The specifications are fulfilled when the conditions for cases g and g+p are *both* met.

The two methods given are not strictly comparable, but with usual profiles, a safety factor of 1.5 may correspond approximately to an eccentricity of one third of the width. However with sloping foundations, it is not always clear how the width to use is defined.

In order to work out the sliding stability (second yellow cell), the coefficient of friction between foundation to soil must be given. The actual input is the corresponding angle of friction. 45° corresponds to a coefficient of 1, about the highest achievable in practice. 30° is a more conservative value. In a drystone wall where the stone layers are inclined with the same angle as the foundation, i.e. with angle αL, the same applies. A safety factor over 1 shows that the wall will not slide in the given conditions, below 1 that it does. Generally a SF sliding of over 1.2 or 1.5 is desired.

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