

# **Retainer**

## **Retaining Wall Stability Analysis Software**

### **DOCUMENTATION**

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October 2025

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# Abstract

Retainer is a Python-based application developed to perform stability analysis of cantilever retaining walls. The software automates calculations for sliding, overturning, and bearing capacity checks using both Rankine's and Coulomb's earth pressure theories. It supports multiple soil layers, water table consideration, and various loading conditions. The tool provides engineers with a simple and accurate way to assess wall stability through an interactive graphical interface and detailed result visualization.

**Keywords:** Retaining Wall, Rankine's Theory, Coulomb's Theory, Earth Pressure, Stability Analysis

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# 1 Introduction

Retainer is a Python-based application for analyzing retaining wall stability. It automates calculations for sliding, overturning, and bearing capacity failures using Rankine's and Coulomb's earth pressure theories.

## Key Features:

- User-friendly graphical interface
- Multi-layer soil support (up to 4 layers)
- Water table consideration
- Automatic method selection
- Comprehensive stability checks
- Graphical output and detailed reporting

## 2 Theoretical Background

### 2.1 Earth Pressure Theories

**Rankine's Theory** (used for surcharge/water/multiple layers):

$$K_a = \frac{\cos \alpha \left( \cos \alpha - \sqrt{\cos^2 \alpha - \cos^2 \phi} \right)}{\cos \alpha + \sqrt{\cos^2 \alpha - \cos^2 \phi}}$$

**Coulomb's Theory** (used when shear zone doesn't intersect wall):

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

### 2.2 Safety Factors

- **Sliding:**  $FS_{sliding} = \frac{\tan \delta \cdot \sum V}{\sum H}$
- **Overturning:**  $FS_{overturning} = \frac{\sum M_r}{\sum M_o}$
- **Bearing:**  $FS_{bearing} = \frac{q_{na}}{p_{max}}$

## 3 Software Usage

### 3.1 Input Parameters

- **Wall Geometry:** a (stem height), b (embedment), c (toe), d (base thickness), e (top thickness), f (heel), g (additional heel), h (slope height)
- **Material Properties:**  $\gamma_c$  (concrete),  $\gamma_w$  (water),  $\delta$  (wall friction),  $q_{na}$  (bearing capacity)

- **Soil Layers:** Unit weight ( $\gamma$ ), friction angle ( $\phi$ ), cohesion ( $C$ ), thickness
- **Loading:** Surcharge ( $q$ ), backfill slope ( $\alpha$ ), wall batter ( $\beta$ )

### 3.2 Application Workflow

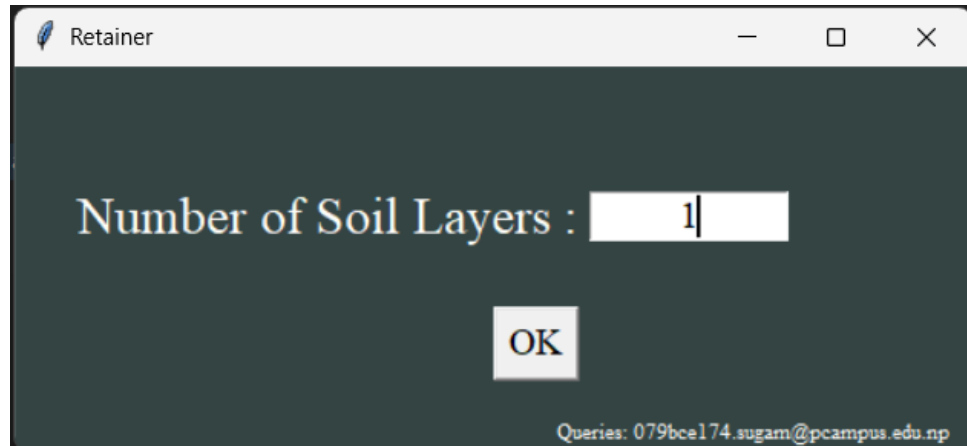


Figure 1: Configure number of soil layers (1–4)

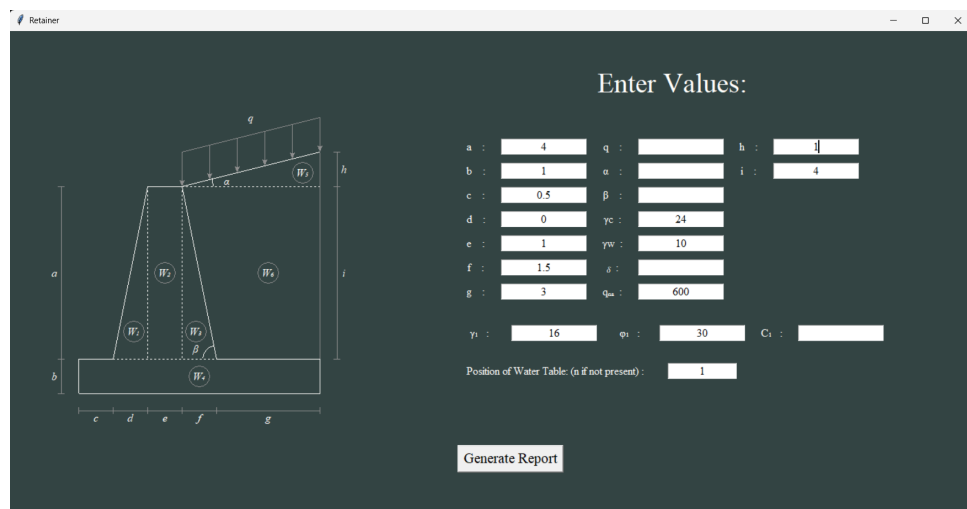


Figure 2: Input wall geometry and material properties

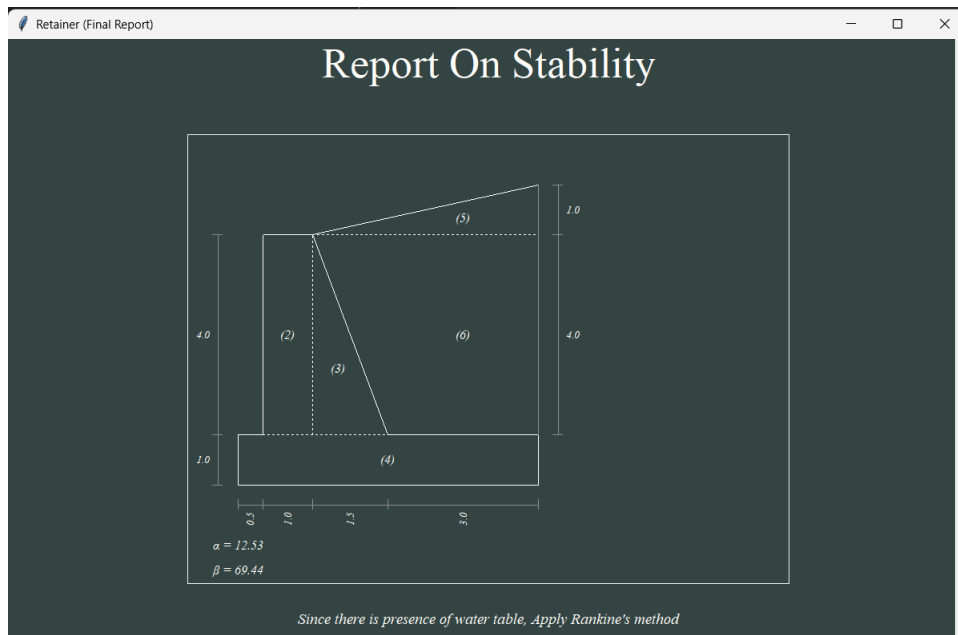


Figure 3: Diagram of Retaining Wall

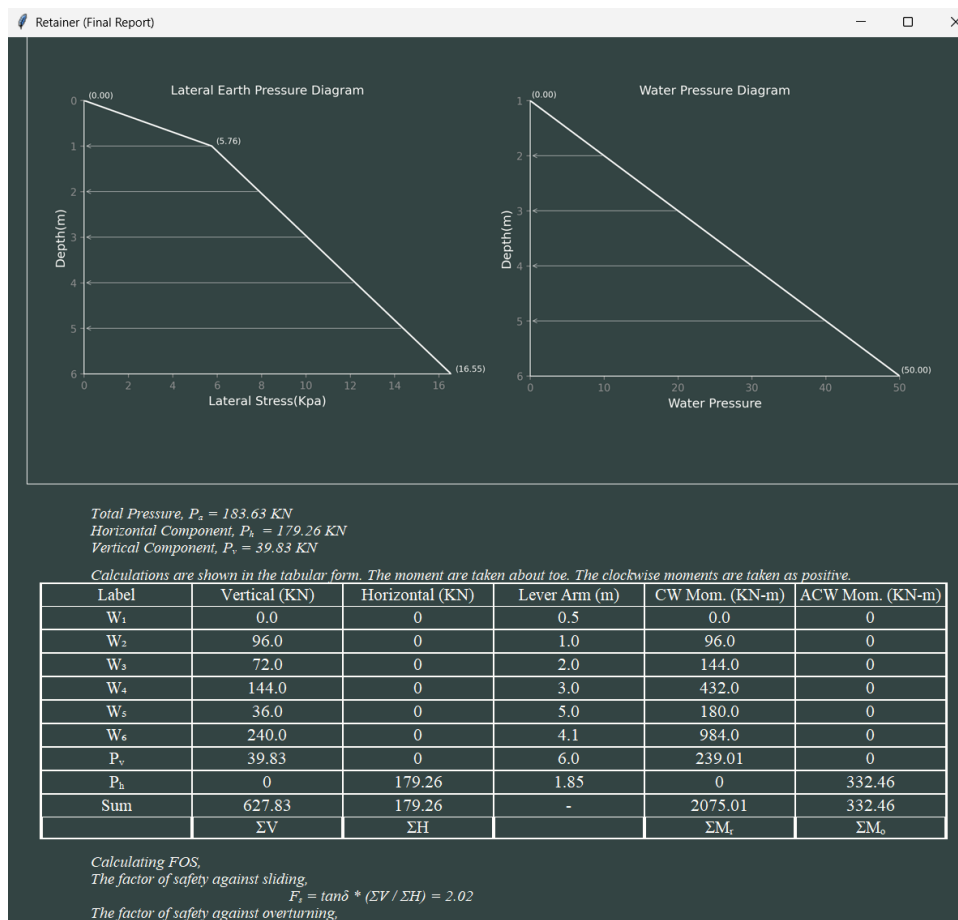


Figure 4: Pressure Diagrams

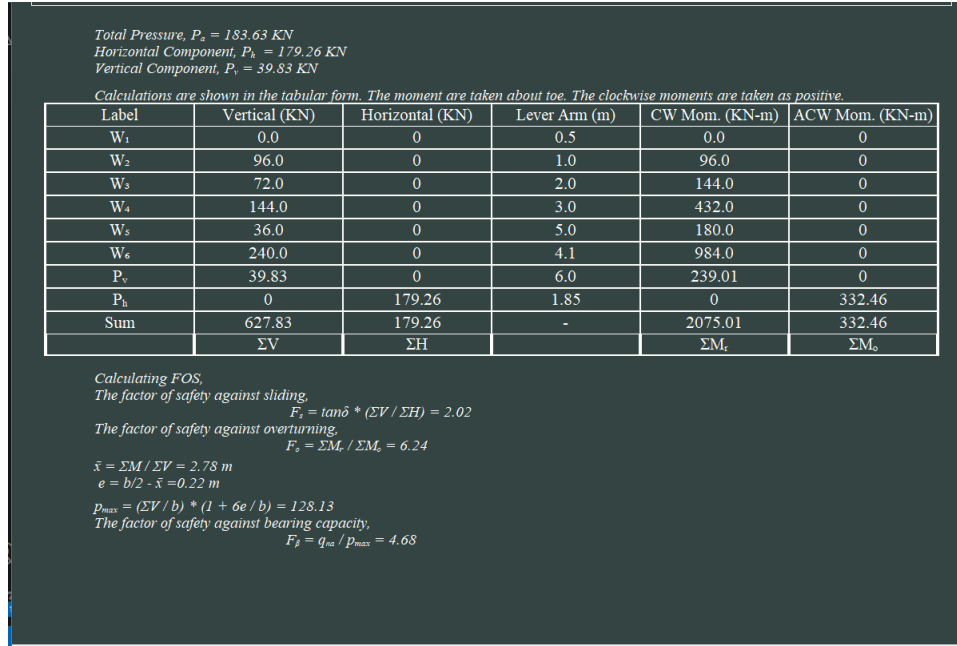


Figure 5: View analysis results and safety factors

## 4 Installation

### 4.1 Requirements

- Python 3.6+
- Required packages: matplotlib, numpy, Pillow, tkinter

### 4.2 Installation Steps

```
pip install matplotlib numpy pillow
python retainer.py
```

## 5 Technical Specifications

### 5.1 Software Architecture

- **Input Module:** GUI and data validation
- **Analysis Engine:** Geotechnical calculations
- **Graphics Module:** Pressure distribution plots
- **Reporting Module:** Comprehensive output generation

### 5.2 Method Selection Logic

The software automatically selects Rankine's method when:

- Surcharge load present ( $q > 0$ )

- Water table exists
- Multiple soil layers present
- Shear zone intersects wall stem

Otherwise, Coulomb's method is applied.

## 6 Output Interpretation

### 6.1 Safety Factor Guidelines

- **Sliding:**  $FS > 1.5$  (acceptable)
- **Overturning:**  $FS > 1.5$  (acceptable)
- **Bearing:**  $FS > 2.0$  (acceptable)

### 6.2 Results Include

- Pressure distribution diagrams
- Force and moment calculations
- Safety factor verification
- Eccentricity and maximum pressure

## 7 Support

- Developer: Sugam Paudel
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- Version: 1.0.0.0
- Institution: Pulchowk Campus, Tribhuvan University