Retainer

Retaining Wall Stability Analysis Software

DOCUMENTATION

Sugam Paudel

Civil Engineering Student
Institute of Engineering, Pulchowk Campus, TU

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Abstract

Retainer is a Python-based application developed to perform stability analysis of 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**: γ_c (concrete), γ_w (water), δ (wall friction), q_{na} (bearing capacity)

- **Soil Layers**: Unit weight (γ), friction angle (ϕ), cohesion (C), thickness
- **Loading**: Surcharge (q), backfill slope (α), wall batter (β)

3.2 Application Workflow

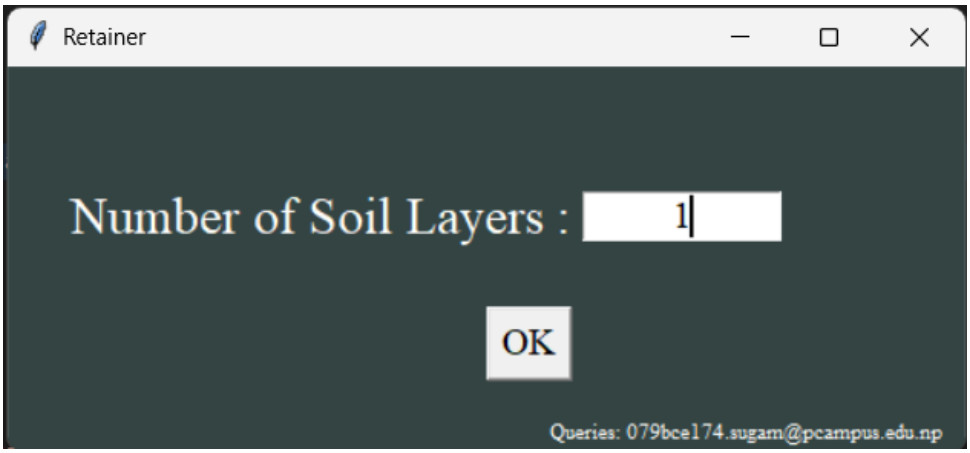


Figure 1: Configure number of soil layers (1–4)

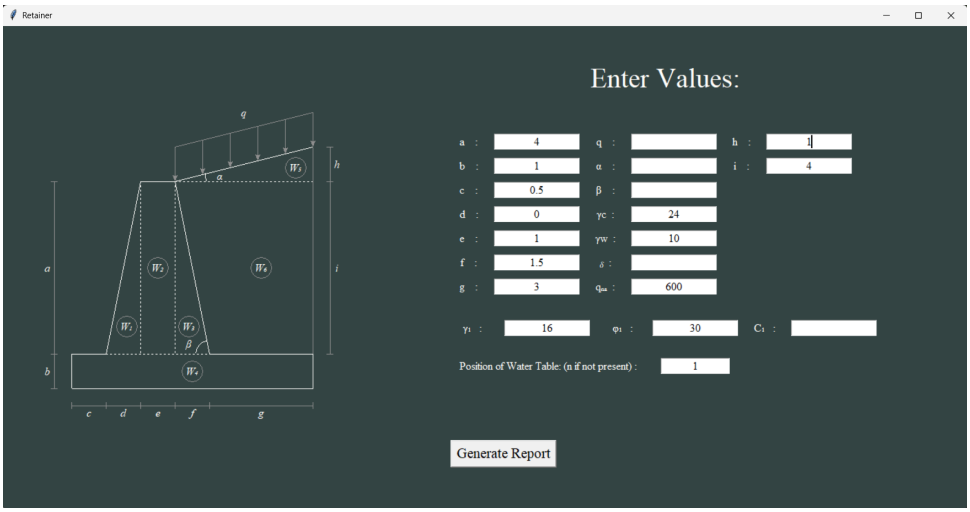


Figure 2: Input wall geometry and material properties

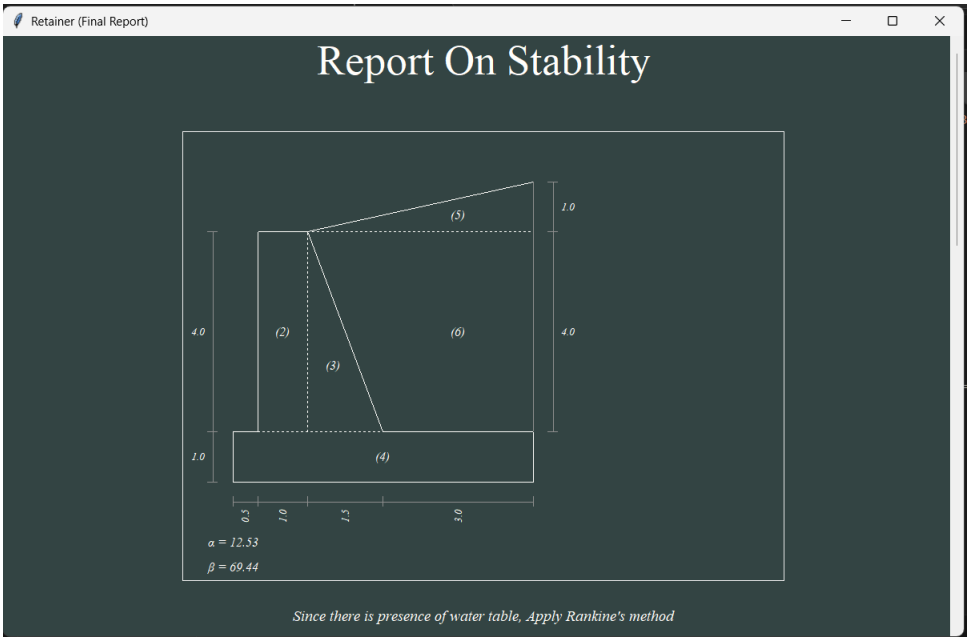


Figure 3: Diagram of Retaining Wall

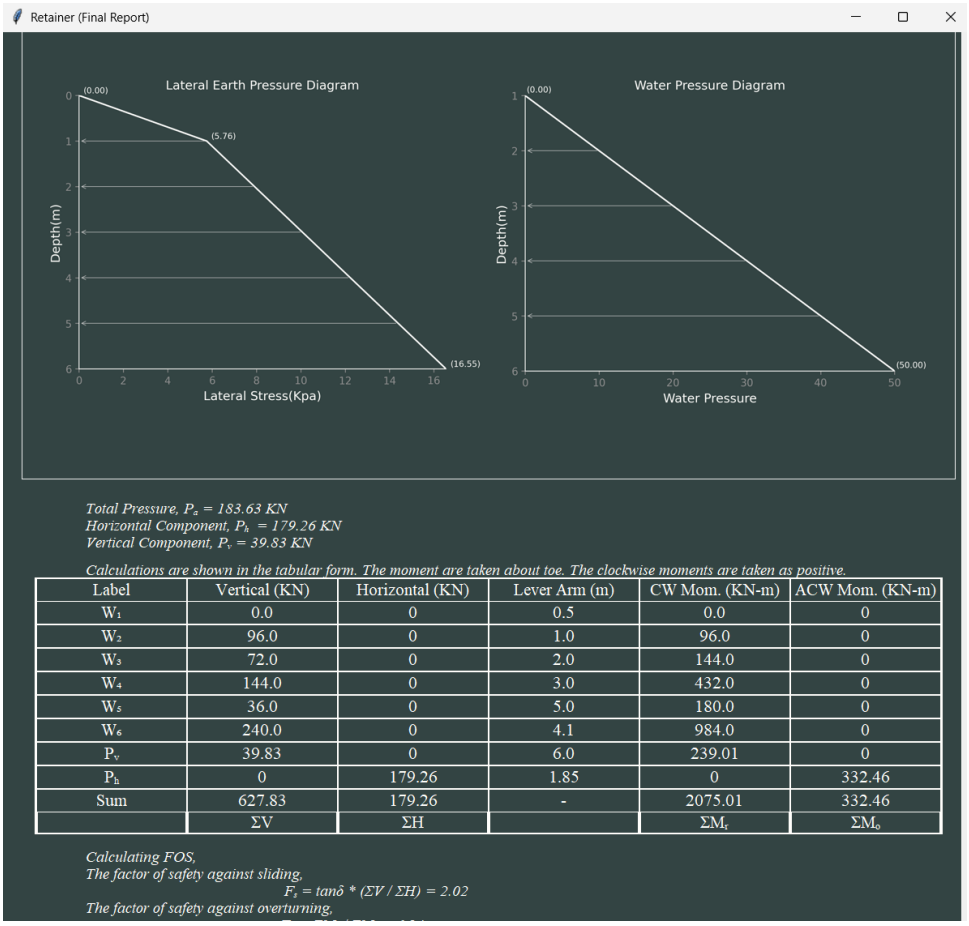
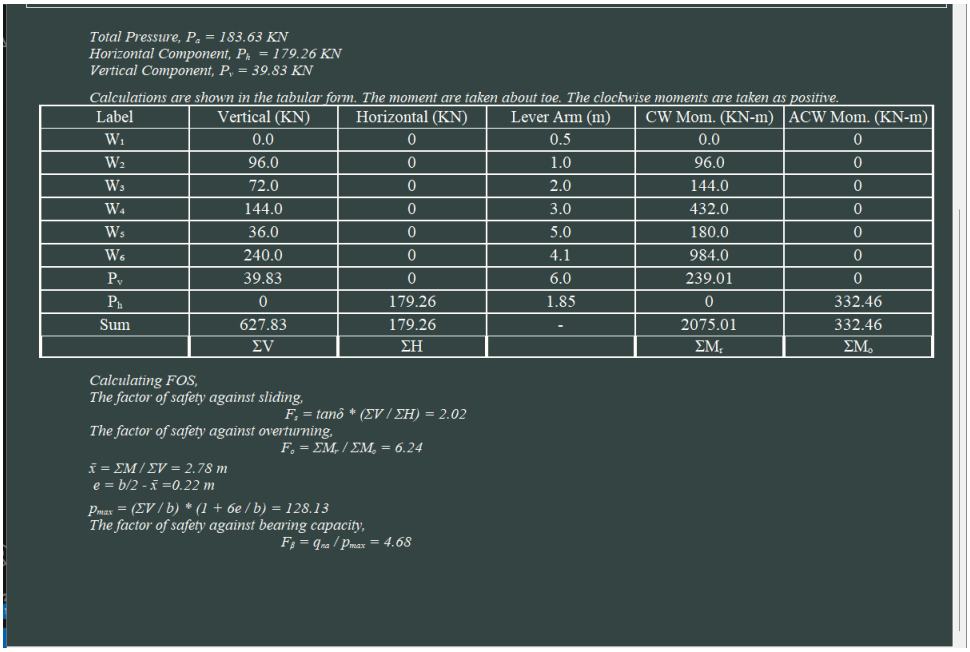


Figure 4: Pressure Diagrams



Total Pressure, P_a = 183.63 KN
Horizontal Component, P_h = 179.26 KN
Vertical Component, P_v = 39.83 KN

Calculations are shown in the tabular form. The moment are taken about toe. The clockwise moments are taken as positive.

Label	Vertical (KN)	Horizontal (KN)	Lever Arm (m)	CW Mom. (KN-m)	ACW Mom. (KN-m)
W_1	0.0	0	0.5	0.0	0
W_2	96.0	0	1.0	96.0	0
W_3	72.0	0	2.0	144.0	0
W_4	144.0	0	3.0	432.0	0
W_5	36.0	0	5.0	180.0	0
W_6	240.0	0	4.1	984.0	0
P_v	39.83	0	6.0	239.01	0
P_h	0	179.26	1.85	0	332.46
Sum	627.83	179.26	-	2075.01	332.46
	ΣV	ΣH		ΣM_r	ΣM_o

Calculating FOS,
The factor of safety against sliding,
$F_s = \tan\delta * (\Sigma V / \Sigma H) = 2.02$
The factor of safety against overturning,
$F_o = \Sigma M_r / \Sigma M_o = 6.24$
$\bar{x} = \Sigma M / \Sigma V = 2.78$ m
$e = b/2 - \bar{x} = 0.22$ m
$p_{max} = (\Sigma V / b) * (1 + 6e / b) = 128.13$
The factor of safety against bearing capacity,
$F_g = q_{na} / p_{max} = 4.68$

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
- Email: 079bce174.sugam@pcampus.edu.np
- Institution: Pulchowk Campus, Tribhuvan University