



AD FALCON API Manual

# Simulation of Saturated Soil Column Response unde Shaking from Its Base

Javad Ghorbani

March 26, 2026

## Contents

<b>1</b>	<b>Simulation of Saturated Soil Column Response unde Shaking from Its Base</b>	<b>3</b>
1.1	File Name . . . . .	3
1.2	Results . . . . .	4



# 1 Simulation of Saturated Soil Column Response unde Shaking from Its Base

In this section, we present the results of the simulation of the response of a saturated column of soil subjected to cyclic excitation at the base. The model uses the SaniSand plasticity framework for cyclic behaviour, and has the following key features.

## 1.1 File Name

fem\_cyclic\_1d.txt

### Column geometry

- Height: 10 m
- Width: 1 m

### Initial conditions

- Uniform initial void ratio: **0.8**
- Prescribed initial geostatic stresses:
  - Vertical Effective stress: **96 kPa**
  - Overburden pressure on top boundary: **1 kPa** (to avoid numerical instability near zero initial stress due to model sensitivity to pressure)
  - Initial pore-water pressure: varies linearly from **0 kPa** at the top to **98 kPa** at the bottom

### Cyclic excitation

- Base-motion amplitude: 0.2g
- Frequency: 5 Hz
- Duration: 2.0 s

```
% Prescribed Values
@PrescribedValue Acceleration 1
@@DOF: DisX
@@Amplitude: 2.0
@@LoadType: Sinusoidal
@@Frequency: 5
@@PhaseLag: 0
@@StartStep: 2
@@NodeIds: 1 2 3
@@Propagate: FinalStep 1
```

### Boundary conditions

- **Sides** nodes at same depth share horizontal displacements
  - **Bottom** (z = 0 m): fixed in vertical; prescribed horizontal shaking
  - **Top** (z = 10 m): permeable (drainage allowed)

### Material parameters

The model uses the SaniSand plasticity framework with the following material parameters:

- **Elastic parameters:**

- $G_0 = 125.0$  MPa
- $K_0 = 150.0$  MPa

- **Plasticity parameters:**

- $M_c = 1.25$
- $\Lambda = 0.37$
- $N_c = 18.7$
- $\alpha_c = 3370$
- $n_b = 1.25$
- $c_h = 0.968$
- $n_d = 2.3$
- $h_0 = 12.0$
- $A_0 = 0.4$
- $M_e = 0.89$
- $c_z = 600$
- $z_{max} = 4$
- $P_{atm} = 100.0$  kPa
- $P_{min} = 0.1$  kPa
- $p_{apex} = 0.01$  kPa

- **Tolerance parameters:**

- $STOL = 1.0 \times 10^{-5}$
- $LTOL = 1.0 \times 10^{-6}$

- **Permeability:**

- Saturated permeability:  $k_{sat} = 2.5 \times 10^{-12}$  m\*m

- **Phase properties:**

- Solid density:  $\rho_s = 2.7$  g/cm<sup>3</sup>
- Liquid density:  $\rho_w = 0.997$  g/cm<sup>3</sup>
- Liquid bulk modulus:  $K_l = 2.25 \times 10^6$  kPa
- Liquid viscosity:  $\mu = 1.0 \times 10^{-6}$  m<sup>2</sup>/s



## 1.2 Results

### Prescribed base displacement verification

The applied base excitation is defined as a sinusoidal acceleration. Double integration of

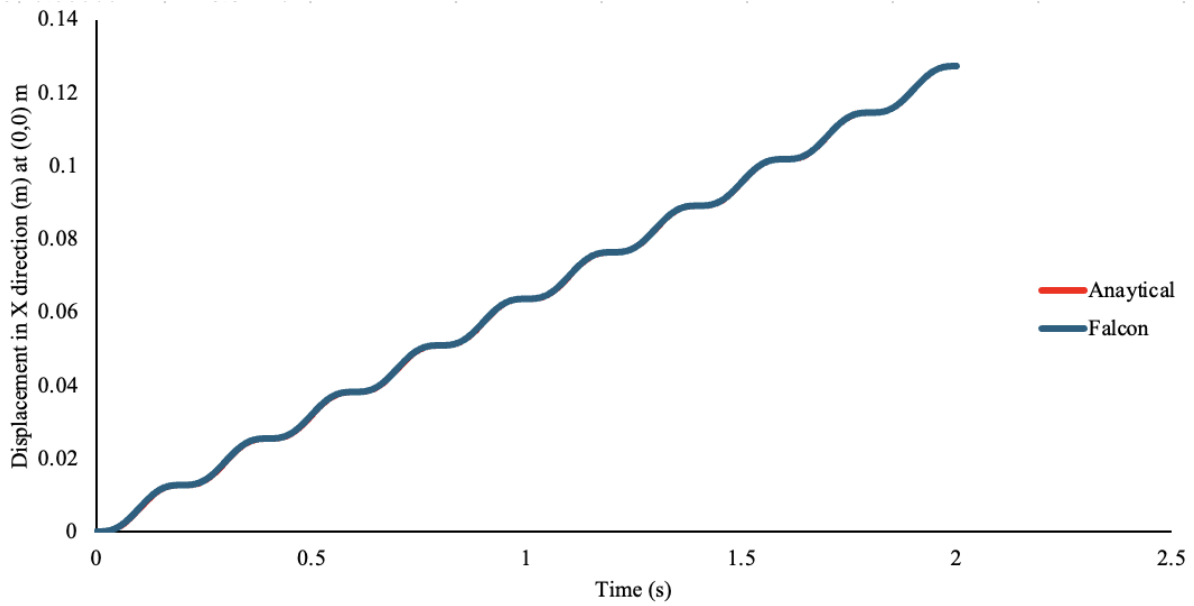


Figure 1: Prescribed displacement verification

$a(t) = A \sin(\omega t)$  with zero initial velocity and displacement gives:

$$u(t) = \frac{A}{\omega^2} (\omega t - \sin(\omega t))$$

which is a harmonic term superimposed on a linear drift term; the numerical displacement follows this closed-form trend.

#### **Stress path at (0.5, 5) m**

The  $p'-s_{xy}$  response at mid-depth shows cyclic degradation of mean effective stress under continued shaking.

#### **Pore-pressure build-up at (0.5, 5) m**

Pore water pressure increases progressively in response to the harmonic excitation.

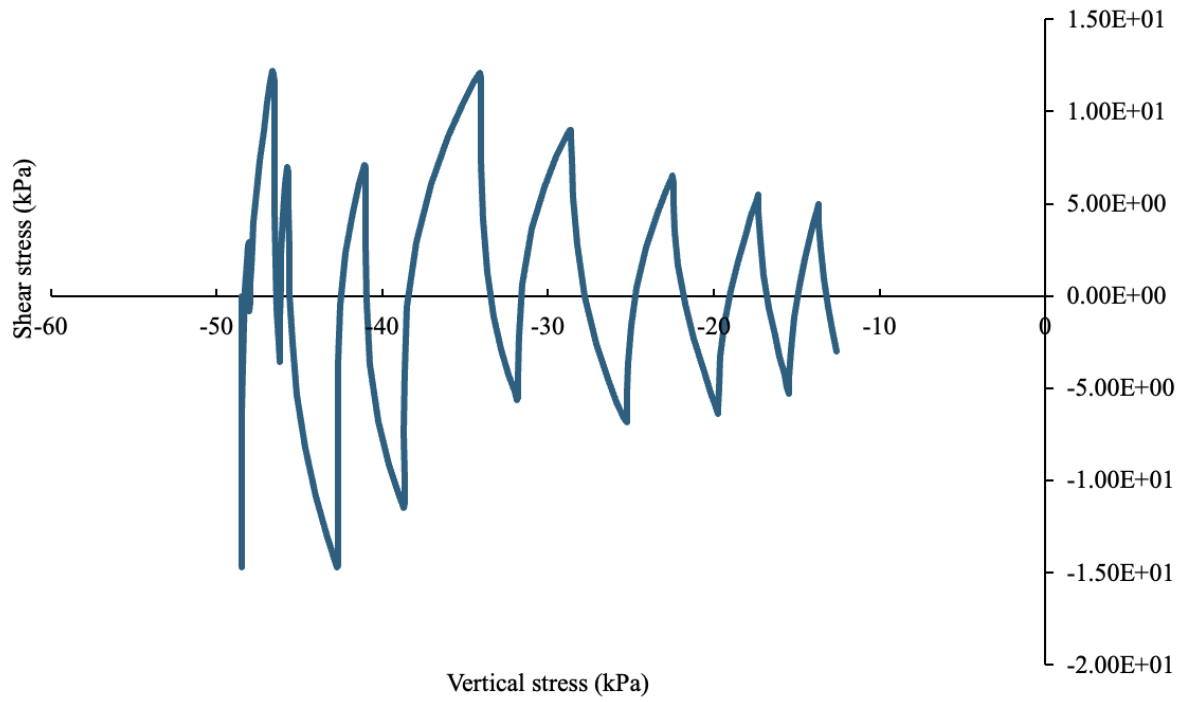


Figure 2:  $p'$  vs  $S_{xy}$  at (0.5, 5)m

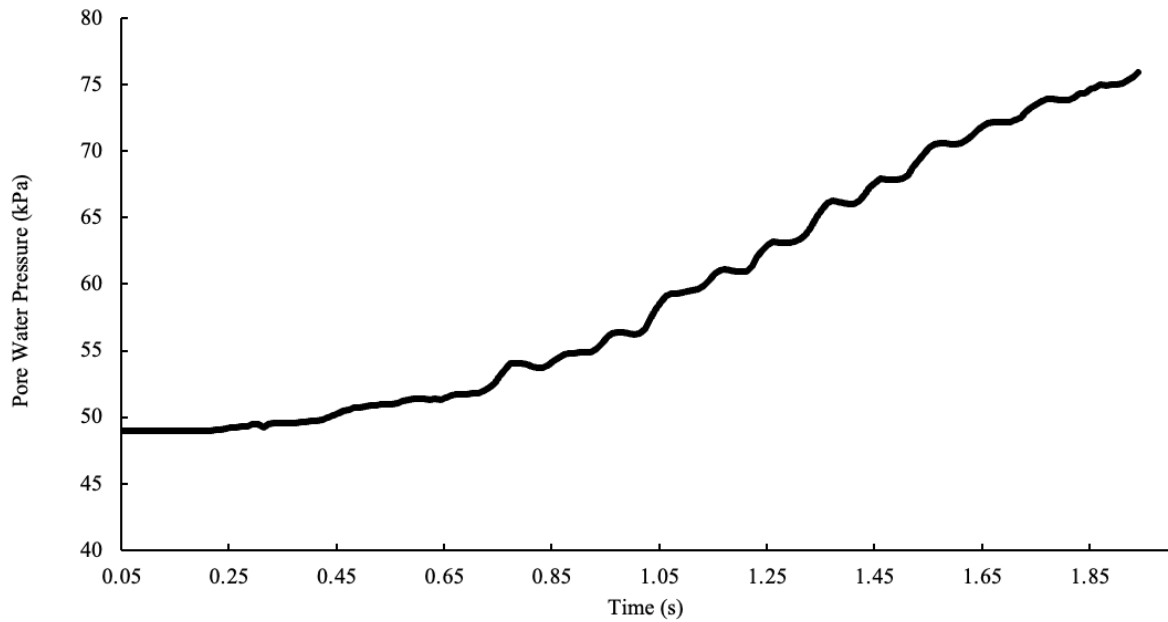


Figure 3: Pore pressure at (0.5, 5)m