

User's Guide

Footing Design

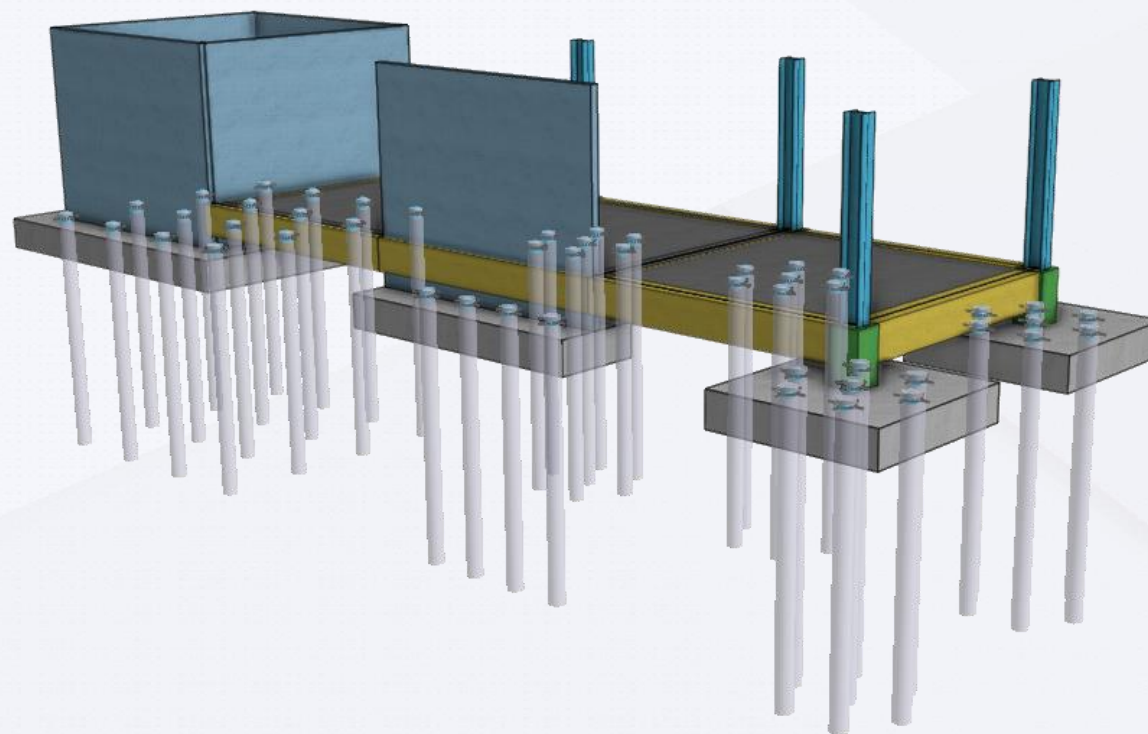
HOW TO ARRANG A PILE

Footing Design - 05

How to checking a stability

- Isolated footing 01
- Soil bearing 02
- Overturning 03
- Sliding 04

<i>midas nGen version</i>	<i>nGen 2021 (v1.1)</i>
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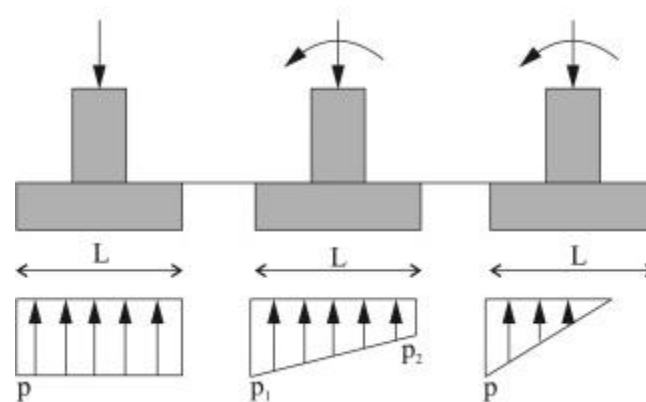


Introduction

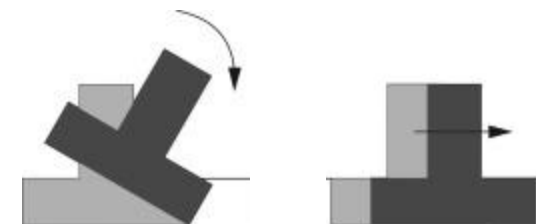
nGen reviews the following three things to confirm the stability of the foundation.

1. Soil Bearing
2. Overturning
3. Sliding

In fact, in general architectural structures, the foundations do not independently overturn and slide because they are connected between the foundations or the foundation-horizontal material. Overturning and sliding should be reviewed for the entire structure. This section introduces a general method of calculating overturning and sliding.



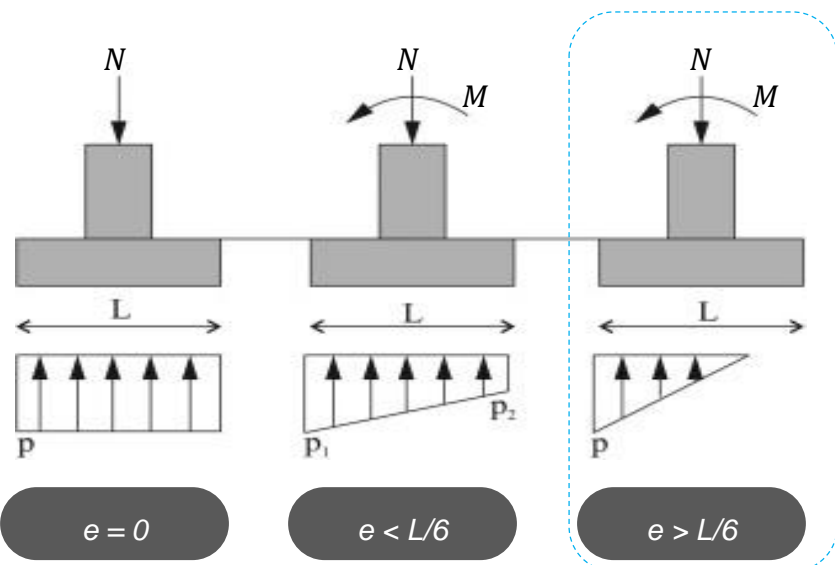
Soil Bearing



Overturning

Sliding

Soil Bearing for 1-way



$$P = \frac{N'}{BL}$$

$$P_1 = \frac{N'}{BL} + \frac{6M}{BL^2}$$

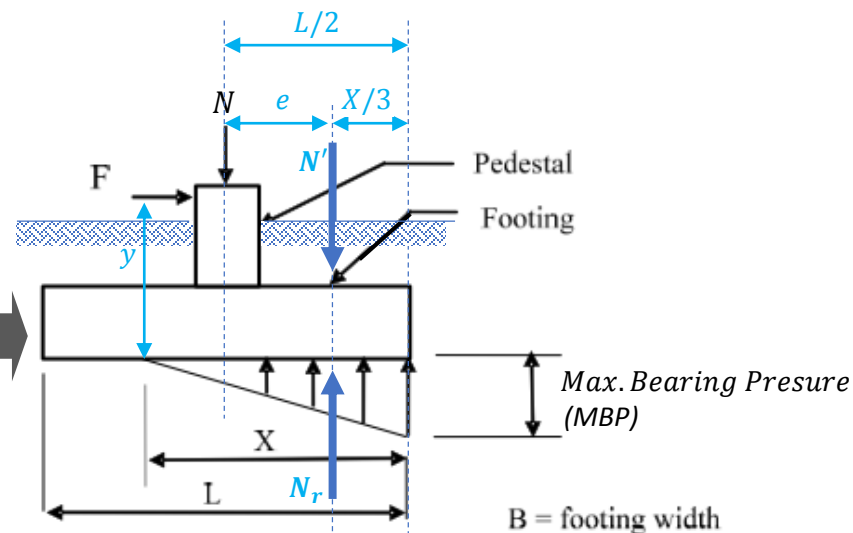
$$P_2 = \frac{N'}{BL} - \frac{6M}{BL^2}$$

$N' = N + \text{Weight of footing and pedestal} + \text{Soil Weight}$

Max. Bearing pressure = N/BL

Max. Bearing pressure

$$= \frac{N}{BL} + \frac{6M}{BL^2}$$



For vertical equilibrium : $N' = N_r$

* $N' = N + \text{Weight of footing and pedestal} + \text{Soil Weight}$

From triangular soil pressure distribution : $N' = (MBP) * B * X/2$

→ Re-arrange for (MBP) : $(MBP) = 2N'/(B*X)$

Centroid of triangular soil pressure distribution is $X/3$ from (MBP), So : $e = L/2 -$

→ Re-arrange for X : $X = 3(L/2 - e)$

$$* e = M/N' = (F*y)/N'$$

Max. Bearing pressure = $2N' / (B*X) < \text{Allowable Soil Bearing Pressure (Compression)} / \text{Safety Factor}$
 Where $X = 2(L/2 - e)$ and $e = M/N'$

Member Design Parameters

Isolated Footing

RC: ACI 318M-14

Design Target Ratio

Result Average Distance

Allowable Soil Bearing Pressure

Allowable Soil Bearing Pressure (Compression) : 150.00 kN/m²

Allowable Soil Bearing Pressure (Uplift) : 0 kN/m²

Safety Factor

Compression : 1

Sliding : 1.5

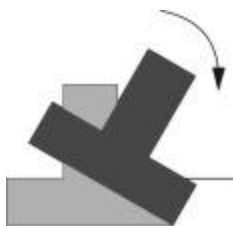
Uplift : 1.5

Overturning : 2

Sliding Parameter

Friction Factor : 0.5

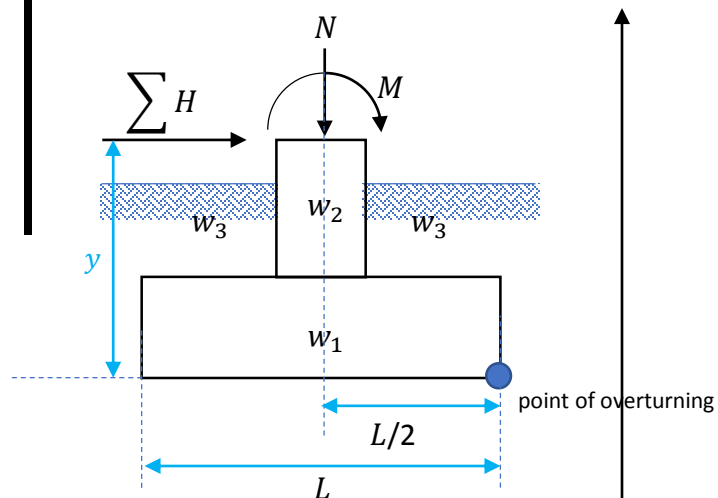
Overturning



Overturning Moment $M_u = M + M_h = M + \sum (H * y)$

Resistance Moment $M_r = N' * L/2$

$M_u < M_r / \text{Safety Factor}$

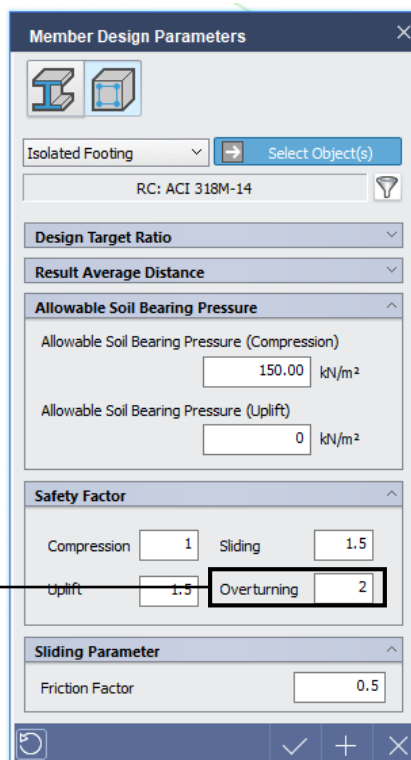


w_1 : Footing Weight

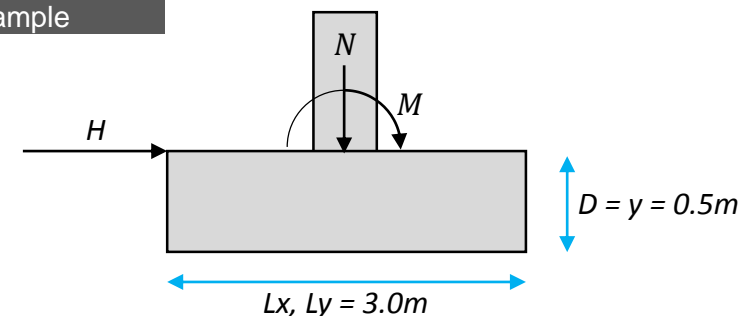
w_2 : Pedestal Weight

w_3 : Topping Soil Weight

$N' = N + w_1 + w_2 + w_3$



Example



1. Design Parameter

- Safety Factor = 2.000
- L_x, L_y (footing size) = 3,000mm
- $D = 500$ mm (footing depth)

2. Design Force

- $N = 128$ kN,
- $H = 27.56$ kN,
- $M = 55.47$ kN·m

3. Calculate Moment from Left Edge

- $M_r = N' * L_x/2$
 $= (128 + 3.0 * 3.0 * 0.5 * 25) * 3.0/2 = 360.75$ kN·m
 (Resistance Moment)
- $M_h = H * D = 27.56 * 0.5 = 13.78$ kN·m (Overturning Moment)
- $M = 55.47$ kN·m (Overturning Moment)

4. Calculate Overturning & Restoring Moment from Left Edge

- $M_u = M + M_h = 55.47 + 13.75 = 69.22$ kN·m
- $M_r / \text{Safety factor} = 360.75 / 2 = 180$ kN·m
- $M_u < M_r / \text{Safety factor} \dots \text{O.K.}$

Sliding



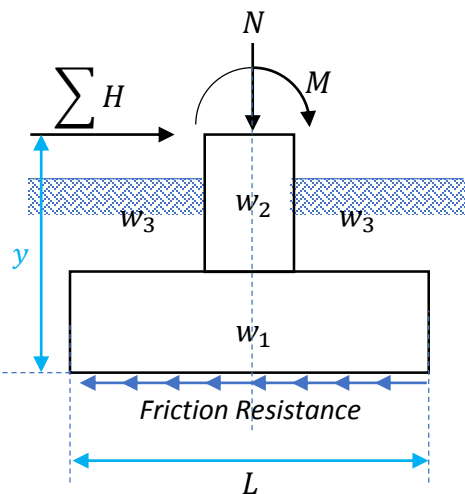
Horizontal force

$$H_u = \sum H$$

Friction Resistance

$$H_r = N' * \text{Friction Factor}$$

$$H_u < H_r / \text{Safety Factor}$$



w_1 : Footing Weight

w_2 : Pedestal Weight

w_3 : Topping Soil Weight

$$N' = N + w_1 + w_2 + w_3$$

Friction factor = 0.4~0.5

Member Design Parameters

Isolated Footing

RC: ACI 318M-14

Design Target Ratio

Result Average Distance

Allowable Soil Bearing Pressure

Allowable Soil Bearing Pressure (Compression) 150.00 kN/m²

Allowable Soil Bearing Pressure (Uplift) 0 kN/m²

Safety Factor

Compression 1.5

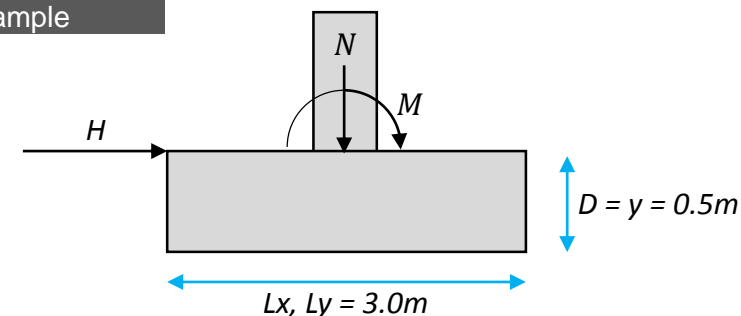
Uplift 1.5

Overturning 2

Sliding Parameter

Friction Factor 0.5

Example



1. Design Parameter

- Safety Factor = 1.500
- Friction Factor (μ) = 0.500
- L_x, L_y (footing size) = 3,000mm
- D = 500mm (footing depth)

2. Design Force

- N = 128kN,
- H = 27.56kN,
- M = 55.47kN·m

3. Calculate sliding capacity

- $H_u = H = 27.56$ kN (Horizontal Force)
- $H_r = (N + \text{Footing weight}) * \text{Friction Factor} (\mu)$
 $= (128 + 3.0*3.0*0.5*25) * 0.5 = 120.25$ kN
- $H_r / \text{Safety factor} = 80.17$ kN
- $H_u < H_r / \text{safety factor} \dots \text{O.K.}$

Thank you