Soil Nailing
Nail Bars (Steel reinforcing bars)
Nail Head (Consist of two main component)

1. Bearing plate
2. Hex nut and washers
Grout
Centralizers
Corrosion Protection Elements

Double Corrosion Protection.
1. Single Barrier Protection.
2. Epoxy Coating.
4. Sacrificial Corrosion Allowance.
5. Borehole Grout.
6. Temporary and permanent facing
Drainage system
Modes of failure

1. External failure mode (Failure surfaces not intersecting the nails)

2. Internal failure mode (Surfaces intersecting all nails)

3. Facing failure mode
   - Flexure Failure
   - Punching Shear Failure
   - Headed-Stud Tensile Failure
Manual calculations

Normalized allowable pull-out resistance $\mu$

$$\mu = \frac{q_u D_{DH}}{F_{SP} \gamma S_H S_V}$$

$q_u$ is the bond strength according to soil type and construction method the bond strength is selected for cohesionless soil, method of construction is Augured with silty fine sand. $q_u = 73$ KPa (10.6 Psi), $H = 24$ m (78.74 ft), $D_{DH} = 15$ cm (6 in), $F_{SP}$ typically $= 2$, $18$ KN/m2 (115.62pcf), $S_H = 1.5$ m (5 in), $V_H = 1.5$ m (5 in)

$$\mu = \frac{10.6 \times 144 \times 6 \times 1/12}{2 \times 115.62 \times 5 \times 5} = 0.132$$

$L/H = 1.05$
$L = H \times 1.05 = 78.74$ ft (24 m)
Using the correction factor from figure 4.7.17, from the interaction between the DDH and the curve $C1L = 0.83$
$L_{corrected} = 1.05 \times 0.83 \times 78.74 = 83.6$ ft (20.9 m)

In general
9 bars Ø 36, Wall thickness 30 cm, Grout hole = 15 cm, plate with 40°40°10 cm
Corrections of Normalized Maximum In-Service Nail Force

\[ t_{\text{max} - \text{c}} \] (corrected) = \( C_{1F} \times C_{2F} \times t_{\text{max} - \text{c}} \) (from charts for \( D_{\text{姚明}} = 100 \text{ mm, } c^* = 0.02 \))

- \( C_{1F} \): Correction for Drillhole Diameter
- \( C_{2F} \): Correction for Soil Cohesion

(a) Correction for Drillhole Diameter

(b) Correction for different values of normalized cohesion \((c^* = c/c_{s})\):

\[ C_{1L} = 4.0 \times c^* + 1.09 \geq 0.85 \]
\[ C_{2L} = 4.0 \times c^* + 1.09 \geq 0.85 \]

(c) Correction for different global factors of safety

\[ C_{1L} = 0.52 \times FS + 0.30 \geq 1.0 \]
L/H = 1.05
L = H×1.05 = 78.74 ft (24m)
Using the correction factor from figure 4.7.17, from the interaction between the DDH and the curve C1L = 0.83
L_corrected = 1.05×0.83×78.74 = 83.6 ft (20.9m)

In general
9 bars Ø 36, Wall thickness 30cm, Grout hole =15cm, plate with 40*40*10 cm
Simulation for the Western Side

- The area excavated for 10m depth.
- The 10m depth will be excavated in stages, in each stage an excavation of 1.5m depth will be performed and a nail with 10m length with 15 degree inclination installation.
- The horizontal spacing between the nails = the vertical spacing = 1.5m
Western Results from SNailPlus software

In general
8 bars Ø 36, Wall thickness 30cm,
Grout hole =15cm, plate with 40*40*10 cm
TOP-DOWN CONSTRUCTION
General Sequence of Top Down

1. Casting of columns
2. Installation of columns
3. Completion of Ground Floor
4. Excavation up to 2nd layer
5. Completion of 2nd layer and then excavation up to bottom as sequence
6. Construction of raft
7. Slab completion
8. Construction of retaining wall along all sides from raft to the Ground floor
Analysis and Design of Top Down Construction System
Analysis and Design of Top-Down Construction System
Structure Data

Table 5.7.1 - Material Properties - Summary

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>E (MPa)</th>
<th>Unit Weight (kN/m³)</th>
<th>Design Strengths</th>
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<tbody>
<tr>
<td>Steel</td>
<td>Rebar</td>
<td>199947.98</td>
<td>76.9729</td>
<td>$E_y=413.69$ MPa</td>
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<td></td>
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<td>$F_u=620.53$ MPa</td>
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<tr>
<td>Con-28</td>
<td>Concrete</td>
<td>24870</td>
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<td>$F_c=28$ MPa</td>
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Table 5.7.1(a) - Story Data

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<thead>
<tr>
<th>Name</th>
<th>Height</th>
<th>Elevation</th>
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<tr>
<td>Story2</td>
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<tr>
<td>Base</td>
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مقطع عرضي في العمود

Ø12.00

41Ø18
مقطع عرضي في العمود

Ø12.00

41Ø18
SHEET PILE SUPPORTED
Structure Data

Table 7.2.1 - Material Properties - Summary

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<tr>
<th>Name</th>
<th>Type</th>
<th>E (MPa)</th>
<th>Unit Weight (kN/m²)</th>
<th>Design Strength</th>
</tr>
</thead>
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<tr>
<td>Cen-20</td>
<td>Concrete</td>
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<td>25</td>
<td>Fc=20 MPa</td>
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Table 7.2.1 - Story Data

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<th>Name</th>
<th>Height (m)</th>
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<tr>
<td>Base</td>
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</tr>
<tr>
<td>Name</td>
<td>Type</td>
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<tr>
<td>Steel</td>
<td>Rebar</td>
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<td>Con-28</td>
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<tr>
<td>Name</td>
<td>Height (m)</td>
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<td>------------</td>
<td>------------</td>
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<tr>
<td>TOP LEVEL</td>
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<tr>
<td>Base</td>
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Construction of Sub Structure

Retaining Wall

Staging

Simultaneous construction of Super Structure

B4 Level Slab Construction
Construction of Super Structure
Prepared by:

• Aseel Khateeb
• Aya Jararaa