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Speaker: Conor Taaffe, Customer Services Manager

Building on soft ground
Building on soft ground – specific requirements

- Ground investigation
- Bearing capacity
- Foundation design
- Differential settlement
- Drainage and services
- Remedial works
Figure 1  Relationship of ground investigation to the design process
Shear Strength

Figure 1  Soft ground shear strength ($c_v$) profile
### Bearing Capacity

<table>
<thead>
<tr>
<th>GROUP</th>
<th>TYPES OF SUBSOIL</th>
<th>BEARING CAPACITY kN/m²</th>
<th>FIELD TEST</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) ROCK</td>
<td>Limestone Slate</td>
<td>4,000</td>
<td>Requires adequate or other mechanically operated pick for extraction.</td>
<td>Foundations must be carried down to unweathered rock and should get every bearing.</td>
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<td></td>
<td>Hard shales</td>
<td>6,000</td>
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<tr>
<td>(2) SAND &amp; GRAVEL (NON-COHESIVE SOILS)</td>
<td>Compact sand</td>
<td>Greater than 600</td>
<td>Requires pick for extraction. Wooden board 50 mm square in cross section hard to drive beyond 100 mm.</td>
<td>Based on foundation width = 1 m.</td>
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<tr>
<td></td>
<td>Compact gravel</td>
<td>Greater than 300</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Loose gravel</td>
<td>Less than 400</td>
<td>Can be excavated with spade.</td>
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<tr>
<td></td>
<td>Gravel</td>
<td>I see them</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Loose silty clay soil</td>
<td>Less than 100</td>
<td>Wooden peg 50 mm square in cross section can be easily pulled in</td>
<td></td>
</tr>
<tr>
<td>(3) CLAYS AND SILTY CLAYS (COHESIVE SOILS)</td>
<td>Very stiff silty clay</td>
<td>300 - 600</td>
<td>Cannot be moulded with the fingers and requires a pick or pneumatic spade for excavation.</td>
<td>All clays and silts are susceptible to long term settlement. To avoid this it may be necessary to use foundations at greater depth or use foundations other than ordinary strip piles, raft, slabs etc.</td>
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<tr>
<td></td>
<td>Very soft silty clay</td>
<td>150 - 900</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Stiff clay/sandy clay</td>
<td>70 - 100</td>
<td>Can be moulded by substantial pressure with the fingers and can be excavaed with spade.</td>
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<tr>
<td></td>
<td>Firm clay/sandy clay</td>
<td>20</td>
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<tr>
<td></td>
<td>Soft clay</td>
<td></td>
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<tr>
<td></td>
<td>Soft silt</td>
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<tr>
<td></td>
<td>Soft sandy clay</td>
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<tr>
<td></td>
<td>Very soft silt</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Very soft clay</td>
<td></td>
<td></td>
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<tr>
<td>(4) PEAT</td>
<td>Soft/Firm</td>
<td></td>
<td></td>
<td>Great care required in sheet piling applications</td>
</tr>
<tr>
<td></td>
<td>?</td>
<td></td>
<td></td>
<td>Great care required in design of foundations</td>
</tr>
<tr>
<td>(5) FILL OR MADE GROUND</td>
<td>Miscellaneous</td>
<td>Depends on type and amount of materials</td>
<td>Visual examination.</td>
<td>Requires specialist examination. Special foundation solutions are required.</td>
</tr>
</tbody>
</table>

Guideline bearing pressures.
Ground Stresses

Figure 2  Ground stresses beneath strip and raft foundations
FOUNDATION DESIGN

- Strip – reinforced/unreinforced
- Raft – simple/complex
- Piles & ground beams
- Ground improvement – lime stabilisation, stone columns
- Specialist Design
FOUNDATION DESIGN

Figure 3 Choosing a foundation for soft ground

[Diagram showing a process flow for foundation design, including steps such as treating ground, foundation solution, removing or replacing soft ground, and decision-making based on soil properties and materials.]

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Strip Foundation

1) Cavity should be filled to a level between 150 and 225 mm below doc.

2) Wall must be centred on foundation.

Ground level

150 mm min from ground level to dpc.

600 mm min to bottom of foundation

Floor level inside

See Appendix A for details where radon membrane is required in ground floor.

Foundation width to be min 5xT (T - wall thickness).
Remove Ground
Suspended Pre-cast Floor

Figure 7: Typical T beam floor.

- Screed thickness and reinforcement (where required) in accordance with manufacturer's recommendations
- 500 gauge polythene vapour control layer
- Rigid insulation batts between T beams
- Proprietary T beam
- Proprietary insulation covers to T beams to reduce likelihood of cold bridging
- Ventilated underfloor void
- dpc
- 150 mm min
Suspended in-situ floor

Typical reinforced concrete suspended ground floor slab.
Raft Construction

**Figure 4** Section through a typical plane raft

**Figure 5** Section through a typical edge-beam raft
Raft Construction (contd)

1. Excavate to suitable bearing, ensuring that all soft layers are removed.

2. Extend hardcore 1 metre beyond edge of raft.
   Fill and compact in 225 mm maximum layers and provide step at edge.
   Note: Filling and compaction to be carried out under structural engineer's supervision.
Raft Construction (contd)

3. Place reinforcement, shutter, pour, vibrate and cure.
   Note: Dimensions/grade of concrete/steel sizes, locations all to structural engineer’s specification.

4. Provide dpm, insulation and min. 65 mm thick screed.
   Ensure that dpm is 120 gauge. Do not use recycled material. See Appendix A for guidance on sites requiring radon membranes.
DRIVEN PILES
GROUND BEAMS
CFA BORED PILES

Diagramatic view of CFA pile.
CHD Bored Piles
DIFFERENTIAL SETTLEMENT

- Upper limit of 25kPa on bearing pressure
- Max. total settlement 50mm
- Max. differential settlement 25mm
- Max. tilt 1/500
DRAINAGE & SERVICES

- Flexible pipe joints
- Sliding couplers
- Hanging support
- Lightweight backfill material
- Areas of least loading
- Distance between manholes
REMEDIAL WORKS

- Local repairs
- Underpinning
- Ground floors
- Raft repairs
- Piles
- Services
Land Drains
Underpin 1
Underpin 3

Beam and Pile System
Underpin 4
Underpin 5
Raked Piles
Floor Settlement
Trial Hole
Mini-Piling

- Steel bar
- Grid 1 sq.m
- Grout
Cased Piles

- End bearing pile
- Infill concrete
- Pile Cap
Lateral Movement of Piles
Settlement of piles
Cracked Piles