Engineering Roadmap **For Helical Tiebacks**

The Leading Edge In Helical Foundations

MacLean Dixie HFS™

Building Solid Foundations

ISO 9001:2008
QSR-938

DEEP FOUNDATIONS INSTITUTE DFI

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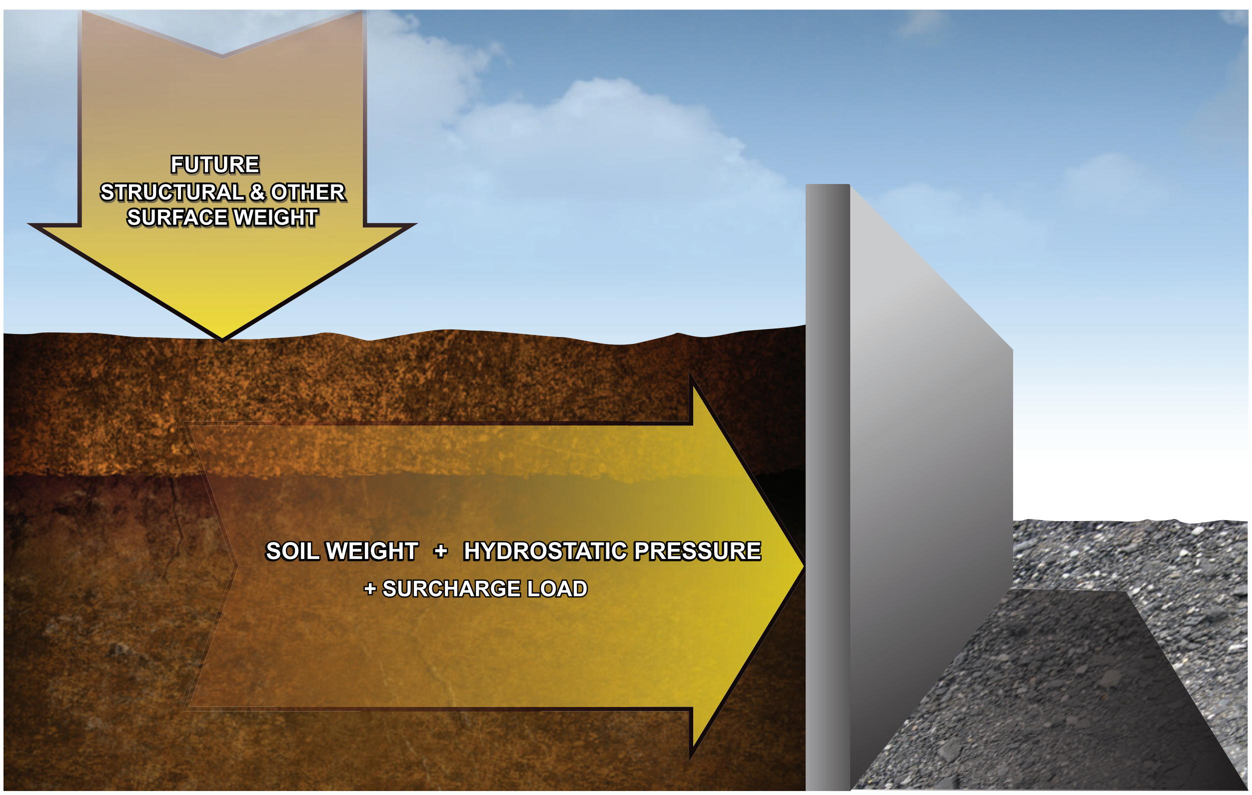
For the preliminary design of a helical tieback wall, the following information should be collected:

- The loading conditions, including:
    - o Boring Logs
    - o Soil pressure load
    - o Hydrostatic pressure load if adequate drainage is not provided
    - o Surcharge loads from buildings, roads, parking lots, heavy equipment, etc. present at the top of the wall
- The design plan for the wall
    - o Reinforced Cast-in-place Concrete?
    - o Soldier Pile with lagging?
    - o Shotcrete?
    - o Sheet pile?
- Has a global stability analysis been performed?



Preliminary Load Calculations

1. What type of soil is present? (clay or sand) ________ (1)

2. What is the Standard Penetration Test N-value (bpf) of the soil? ________ (2)

3. What is the angle of internal friction (ϕ) for the soil?

   If line (A) was clay, enter 0, otherwise $\Phi = 27 + 0.31 \times$ Line2. ________ (3)

4. What is the cohesion (psf) of the soil? If Line 1 is sand, enter 0,

   otherwise c = (Line2)/8 ________ (4)

5. What is the bearing capacity factor (unitless) of the soil?

   If Line 1 is clay, enter 0, otherwise consult the table to the right: ________ (5)

6. What is the unit weight (pcf) of the soil? ________ (6)

7. What is the coefficient of active earth pressure (Ka) for the soil?

   $K_a = \tan^2\left(45 - \frac{\text{Line 3}}{2}\right)$ ________ (7)

8. What is the height (feet) of the proposed wall? ________ (8)

9. What is the maximum water level (feet) behind the wall (if no drainage is provided)? ________ (9)

10. Calculate the wall load (psf) due to soil pressure above the water table: $\frac{(\text{Line8} - \text{Line9})^2}{2} \times \text{Line6} \times \text{Line7} =$ ________ (10)

11. Calculate the wall load (psf) due to soil pressure below the water table:

    $\frac{(\text{Line9})^2 \times (\text{Line6} - 62.4) \times (\text{Line7})}{2} + (\text{Line6} \times \text{Line7} \times \text{Line9} \times (\text{Line8} - \text{Line9})) =$ ________ (11)

12. Calculate the wall load (psf) due to hydrostatic pressure:

    $\frac{(\text{Line9})^2 \times 62.4}{2} =$ ________ (12)

13. Is there an additional wall load (psf) due to surcharge pressures? ________ (13)

14. What is the anchor spacing (feet between horizontally adjacent anchor shafts)? ________ (14)

15. Calculate the required ultimate load (pounds) on the anchor:

    $(\text{Line10} \times \text{Line11} \times \text{Line12} \times \text{Line13}) \times \text{Line14} \times 2(\text{safety factor}) =$ ________ (15)

φ	Nq
28	10.68501
28.5	11.3158
29	11.98862
29.5	100
30	13.47353
30.5	14.29293
31	15.16906
31.5	16.10645
32	17.11006
32.5	18.18529
33	19.33806
33.5	20.57486
34	21.9028
34.5	23.32966
35	24.86401
35.5	26.51527
36	28.29382
36.5	30.21106
37	32.27962
37.5	34.51343
38	36.92789

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Anchor Selection

Based on the required ultimate load (Line 15) select an anchor shaft from the chart below based on the ultimate tension capacity column:

Description	Designation	Kt	Torsional Capacity (ft-lbs)	Max Design Tension (lbs)	Max Design Compression (lbs)	Ultimate Tension (lbs)	Ultimate Compression (lbs)
1.50" RCS	D6	10	5,500	30,000	27,500	60,000	55,000
1.50" RCS (High strength)	D7	10	7,000	35,000	35,000	70,000	35,000
1.75" RCS	D10	10	10,000	50,000	50,000	100,000	100,000
2.00" RCS	D15	10	15,000	75,000	75,000	150,000	150,000

Then select a helix configuration to support the required load in the available soils. The selection of a proper helix configuration for a given loading and soil profile condition is an iterative process. The 8”-10”-12” configuration is a good place to start. Then, a larger or smaller configuration can be attempted if either adequate capacity cannot achieved within a reasonable depth or if adequate capacity could be achieved with a smaller helix configuration.

Make sure that soil boring information utilized is taken from soil borings that are within the anticipated Tieback Termination Area. Do not utilize soil boring information that is taken from an area that is within the active soil pressure area.

Description	Configuration Length In.	Configuration Length Ft.	Approximate Bearing Plate Area Ft.^2
8” - 10”	24	2.0	0.751
10” - 12”	30	2.5	1.184
12” - 14”	36	3.0	1.704
14” - 14”	42	3.5	1.986
8” - 10” - 12”	54	4.5	1.462
10” - 12” - 14”	66	5.5	2.177
12” - 14” - 14”	78	6.5	2.697

16. Enter the approximate bearing plate area ($ft.^2$): ______________________ (16)

17. If the soil type (Line 1) is clay, you can compute the geotechnical capacity at this point, otherwise skip to Line 18: *Line16 X Line4 X 9 =* ______________________ (17)

18. Enter the installation angle (degrees from horizontal).
Depending upon the wall and slope geometry any value from 10 to 30 degrees can be used.
We recommend starting at 20 degrees. ______________________ (18)

19. What is the distance (feet) between the bottom of the wall and the anchor shaft? ______________________ (19)

20. Determine the required depth (feet) to achieve the required ultimate capacity:

$$\frac{\dfrac{Line15}{Line16 \times Line5} - 62.4 \times (Line8 - Line9)}{Line6 - 62.4} = \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_} \quad (20)$$

21. Determine the required anchor length (feet) to achieve the required depth:

$$\frac{Line20 - (Line8 - Line9)}{\sin(Line18)} = \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_} \quad (21)$$

22. What is the horizontal distance (feet) between the connection point and the failure plane?

$$\theta = 45 + \frac{Line3}{2} = \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_} \quad (22)$$

Check against the Minimum Embedment Depth
Determine the minimum embedment depth by, first:
Finding the distance between the tieback to wall connection point and the failure surface:

23. What is the angle (degrees) of the failure plane?

$$Line19 / (\tan(Line22) + \tan(Line18)) = \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_} \quad (23)$$

24. What is the vertical distance (feet) between the connection point and the failure plane?

$$Line\ 19 - \left[Line19 \times \tan(Line22) / (\tan(Line22) + \tan(Line\ 18)) \right] = \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_} \quad (24)$$

25. What is the straight line distance (feet) between the connection point and the failure plane?

$$\sqrt{(Line23)^2 + (Line24)^2} = \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_} \quad (25)$$

26. Then, enter the length (feet) of the selected helix configuration: ______________________ (26)

27. Then determine the required length (feet) of embedment beyond the failure plane due to helix size:

Enter the largest helix diameter (inches): ______________________ (27)

28. 4 X Line27/12 = ______________________ (28)

29. Finally, enter any additional length required to reach competent soil: ______________________ (29)

30. The minimum required length of the anchor is:
Line26 + Line28 + Line29 = ______________________

31. Finally, choose the greater of the minimum required anchor length (Line 30) and the length required for geotechnical capacity (Line21):

Disclaimer: *These calculations address only the required embedment depth and the required pull-out capacity of the anchor and should be used for preliminary or feasibility analyses only. The internal wall stresses, the global stability of the wall/soil system, the local stresses at the anchor connection points, among other considerations, MUST be evaluated by a licensed structural engineer.*

Pile Spacing Design Possibilities

Tieback Spacing is determined by two factors:

1. The load requirements of the project
2. The designed load capacity of the tieback. Helical tieback anchors can only be spaced as close as 3 times the diameter of the largest helix utilized (measured from edge-of-helix to edge-of-helix).

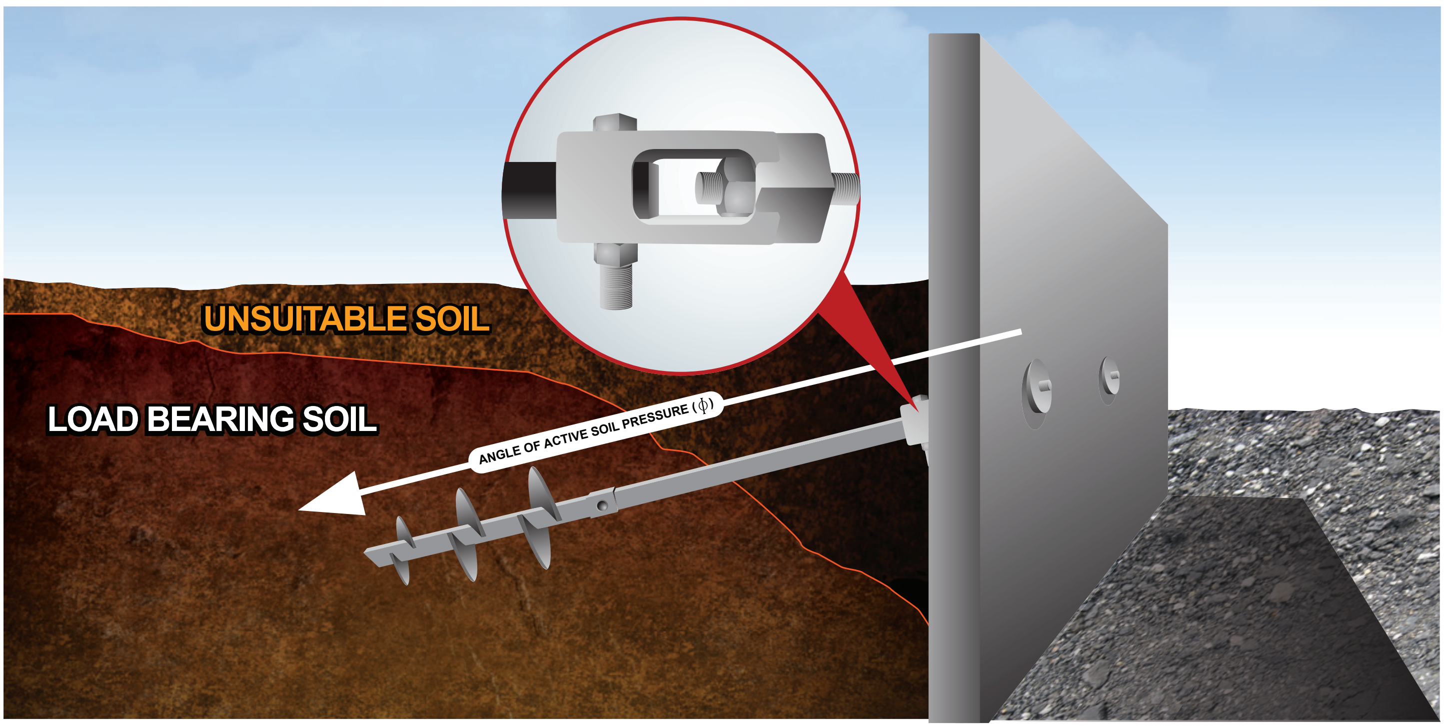
In the event that the design load requirement exceeds the designed load of the helical tieback the designer has two options:

1. Reduce the spacing of the helical tieback anchor within the spacing helical pile spacing limitations.
2. Select a tieback anchor that meets the load capacity requirements.

In the event that the load requirements exceed the spacing capacity of the helical tieback, a second row of helical tie-backs must be added to accommodate the load requirement of the wall and the spacing limitations of the helical tie-backs.

Helical Tieback Connections can be developed in the following ways:

1. Tie the helical adapter and plate within the concrete reinforcement of the proposed poured wall.
2. Attach helical tieback adapter to the finished wall with a plate, washer and nut.
3. Attach the helical tieback adapter to a soldier pile systems with a whaler, washer and nut.
4. Attach the helical tieback adapter to a finished sheet pile wall with either method 2 or 3 listed above.

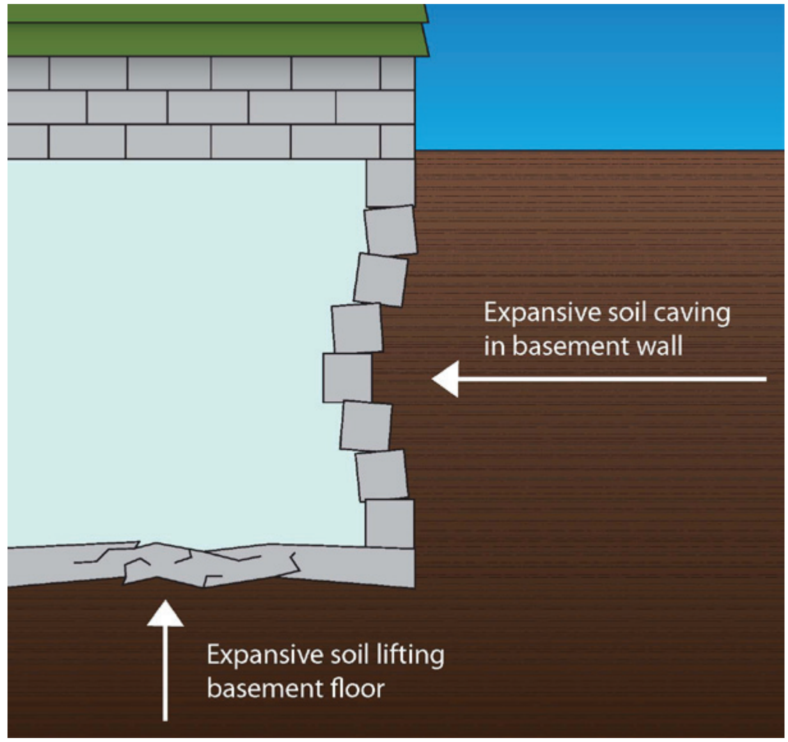


Corrosion Considerations

Please refer to Section 11 of the most recent MacLean Dixie Engineering Reference Manual regarding corrosion considerations of the project.

Repair Application

In addition to use for the construction of new retaining walls, helical tieback anchors can be used to repair existing foundation walls that have been damaged by expansive soils. The picture below illustrates a foundation surrounded by expansive clay soils. In periods of unusually wet weather, the soils can become saturated and expand against the foundation walls causing them to bow inwards.



The repair of foundation walls using helical tieback anchors consists of the following steps:

1. A small amount of soil behind the foundation wall is excavated to provide access to the exterior of the wall.

2. A small hole, just large enough to allow the couplings to pass through, is drilled in the wall.

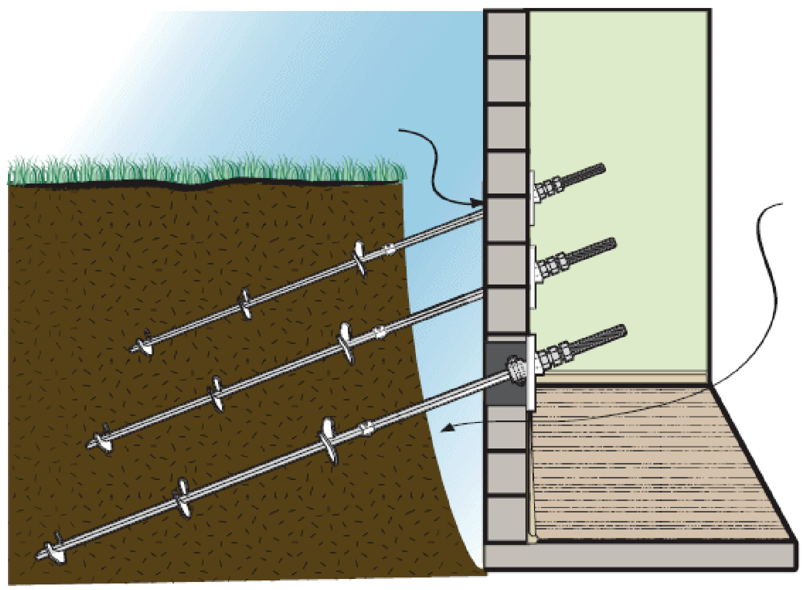
3. The helical anchor is inserted into the basement from the outside, coupling end first.

4. The helical anchor is advanced into the surrounding soil using light, hand-held equipment from the interior of the foundation.

5. When the helical anchor has been advanced to the required depth, a thread bar adapter and wall plate is installed around the anchor on the interior of the wall.

6. Thread bar is inserted into the adapter and the anchor is tensioned to bring the wall back to plumb and then set in place using nuts.

7. Excess thread bar is cut off, if necessary, and the repair is complete.



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