A Real Root Pile (Pali Radici)

Support of Vancouver's Hollow Tree

Parallels to Wind Turbine Foundations

By Horst Aschenbroich Dipl. Ing.
President / CEO

History

One of Vancouver's famous landmarks, the over 1000 year old Hollow Tree in Stanley Park was and still is a unique gathering place where, for generations, people from all over the world have been photographed.

Con-Tech Systems Ltd.

LOCATION PLAN

The North Western part of the park was devastated by a severe hurricane force wind which fell over 3000 trees and dangerously tilted the tree.

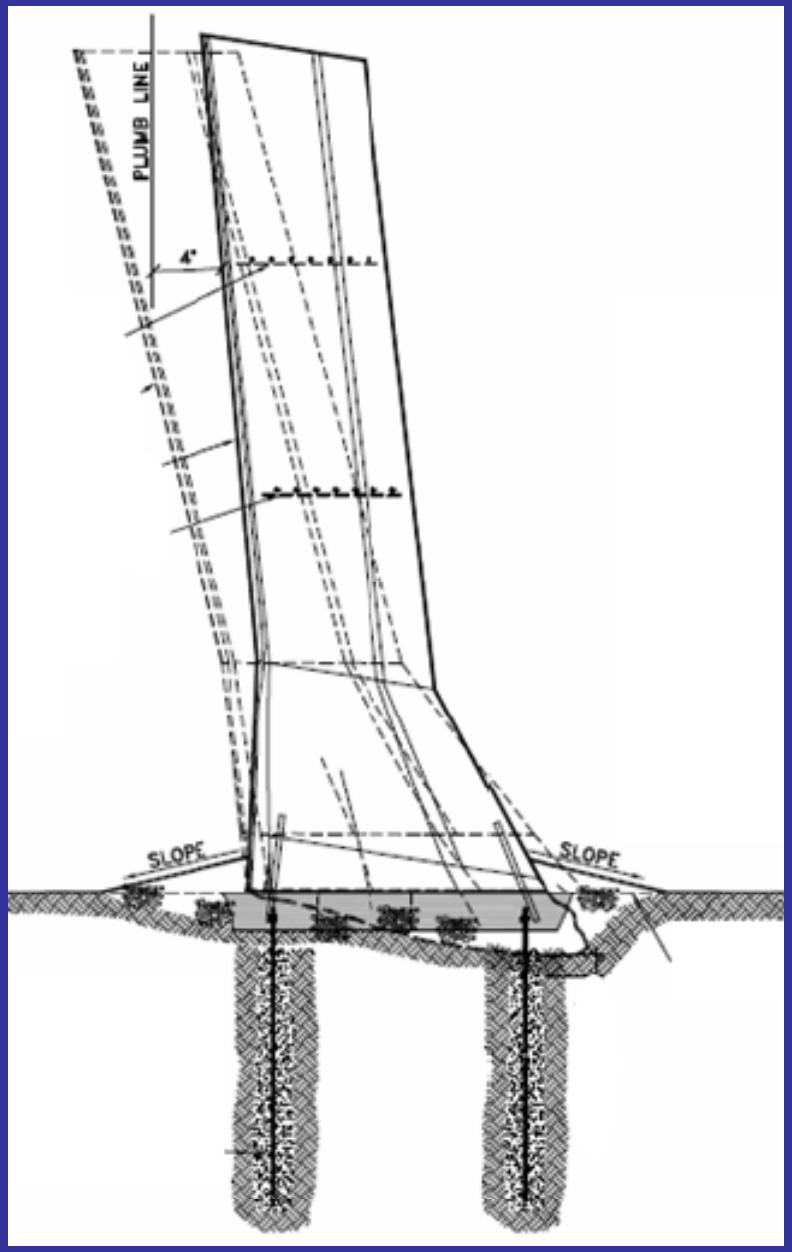
The tree was condemned to be taken down after it was tilting into a dangerous position of tipping over.

Two proposals were considered by the Vancouver Parks Board

- 1. Keep the tree standing with external braces.
- 2. Take the tree down and replace it with a replicate out of plastic.

Both proposals were criticized by the public.

Our proposal to keep the tree standing with a new (artificial) root system using Micro Piles as Root Piles, (as a donation to the city of Vancouver), was eventually accepted by the Parks Board.



Limited access and stringent environmental restrictions prohibited large equipment brought into the park, this opened the opportunity to suggest the use of Titan-IBO Micro Piles.

The project was done in four stages.

First Stage

Straightening of the tree.

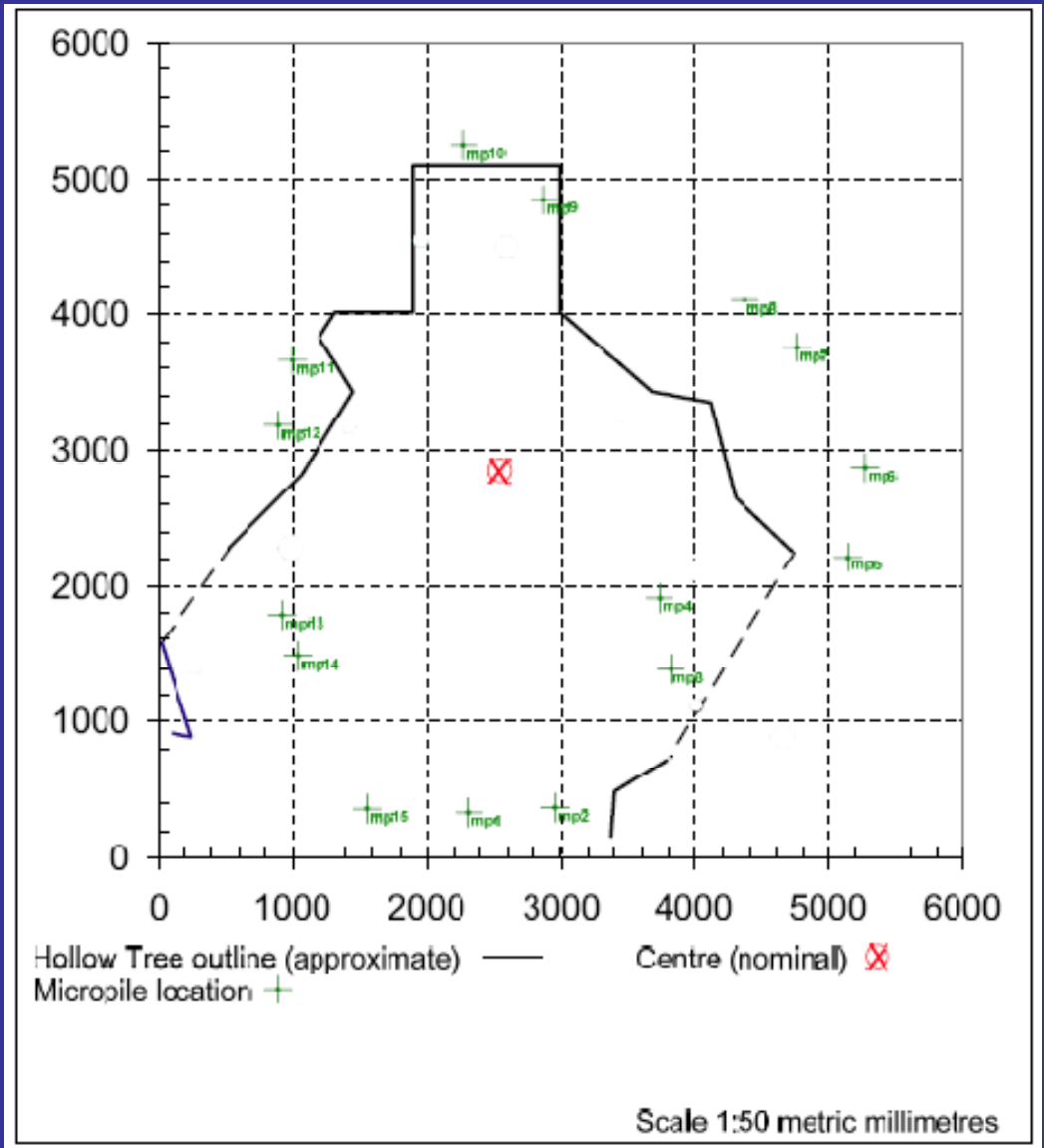
Braces with a hydraulic jacking system were used to push the tree to its original vertical position.

Second Stage

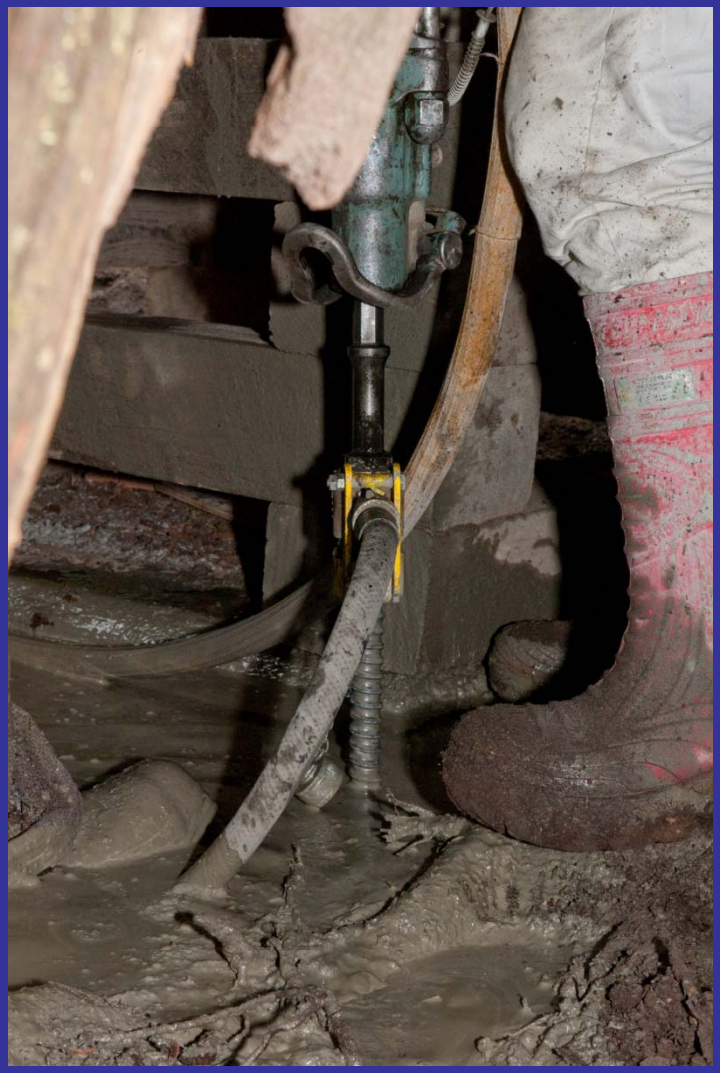
Installation of Micro Piles

15 Titan Hollow Bar Micro Piles (Root Piles)

8 inside and 7 outside the tree



Con-Tech Systems Ltd.



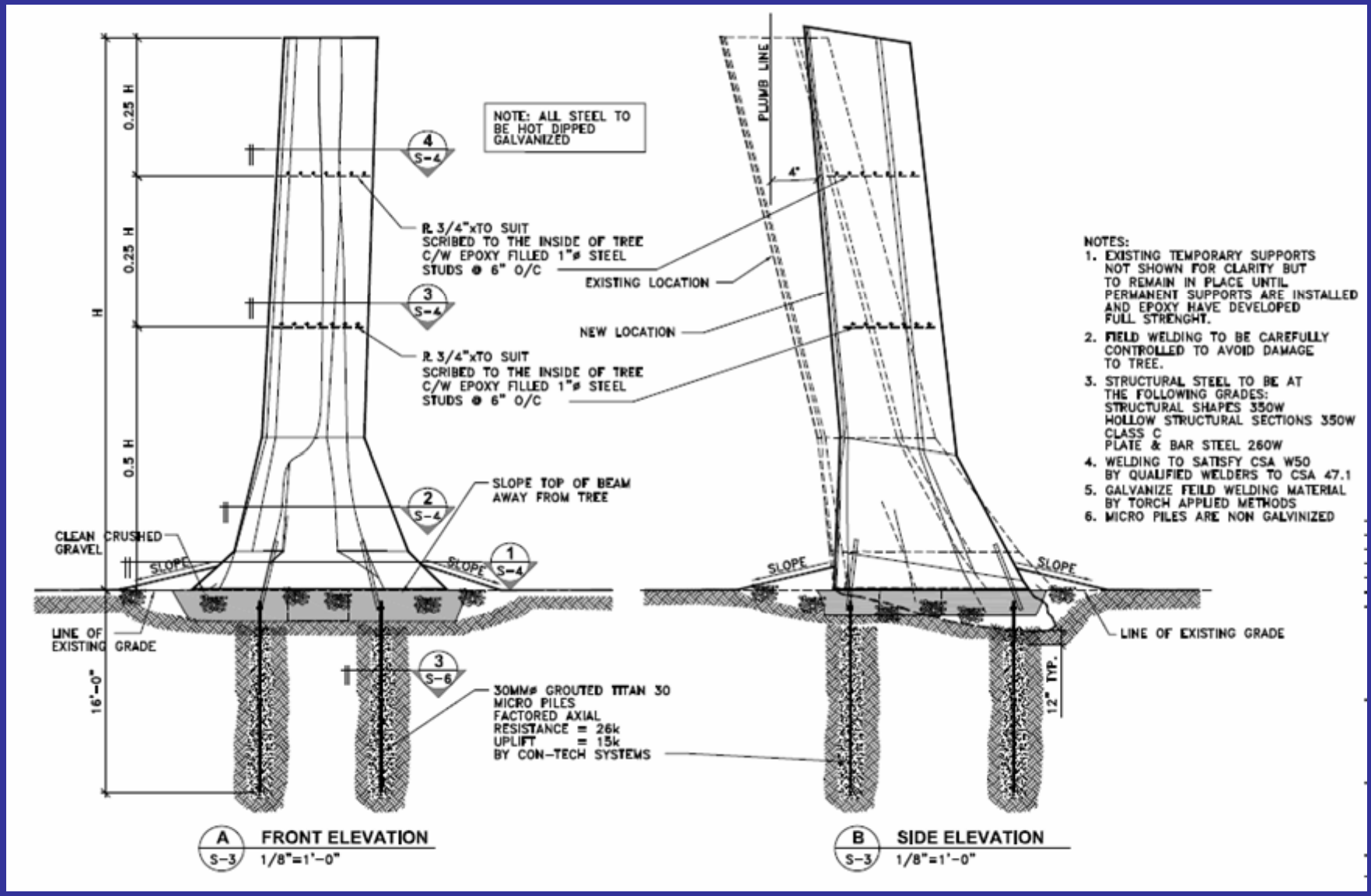
IBO (Injection Boring) Titan Micro Piles (Root Piles) installed with a hand held Drill inside the hollow tree

Exposed Piles

Notice good grout cover

Before placing Pile Cap Concrete

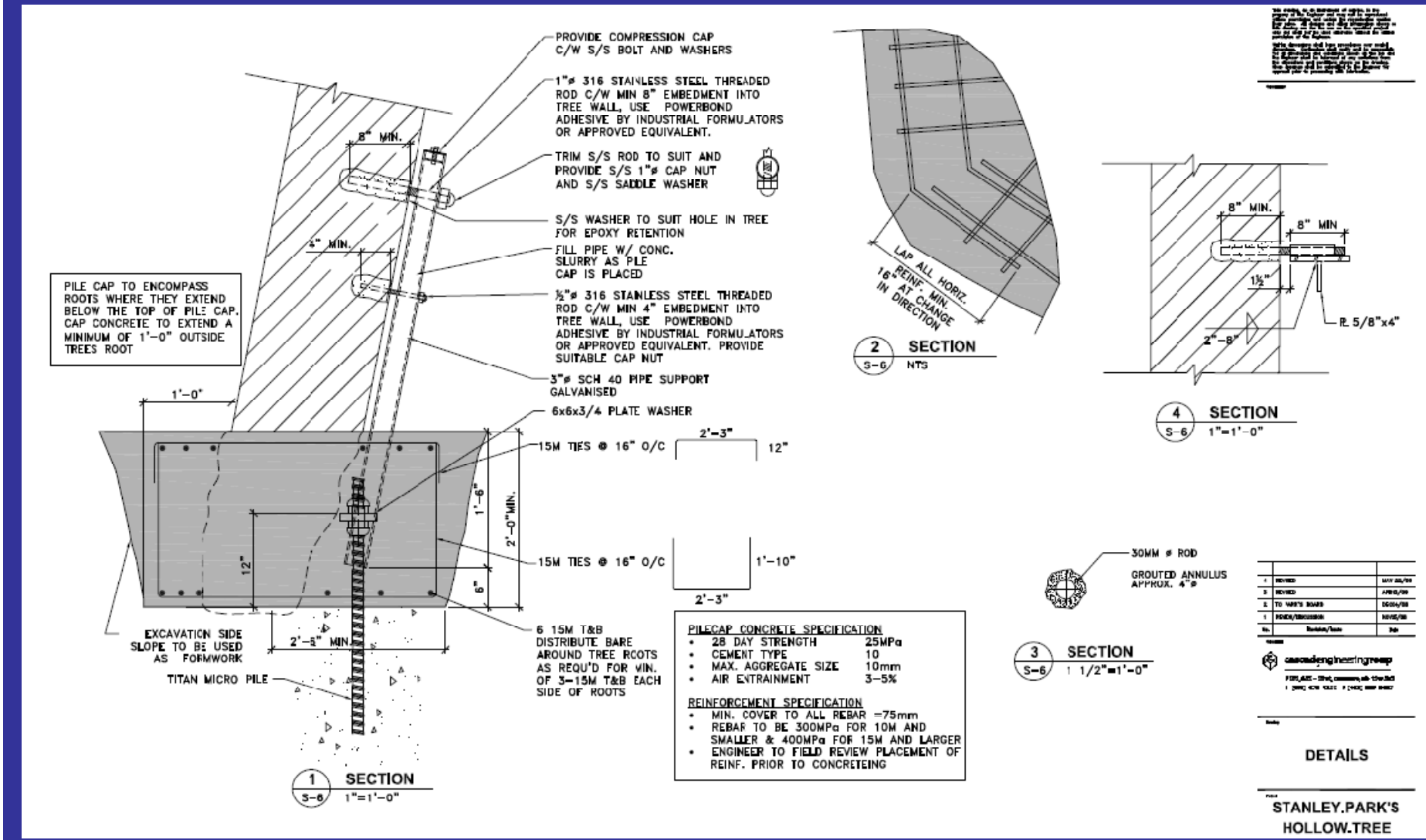
Reinforcing Pile Cap



Root Piles after straightening of the Tree

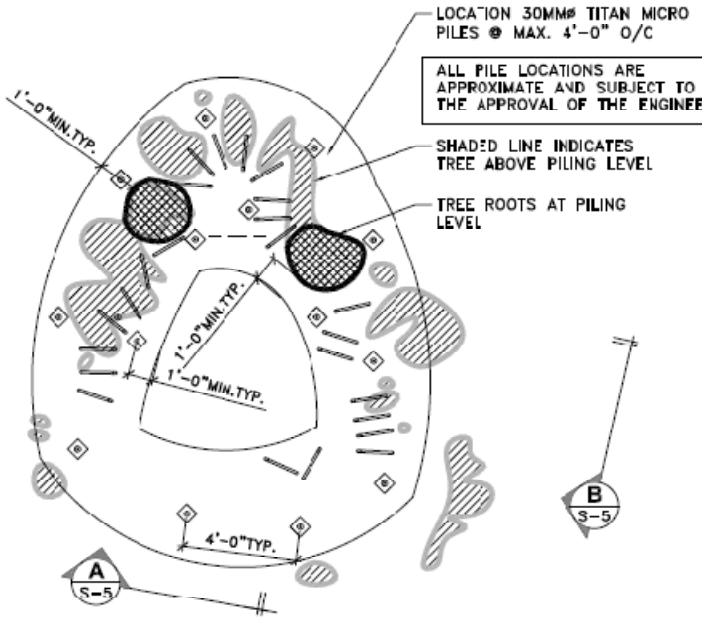
Con-Tech Systems Ltd.

Third Stage

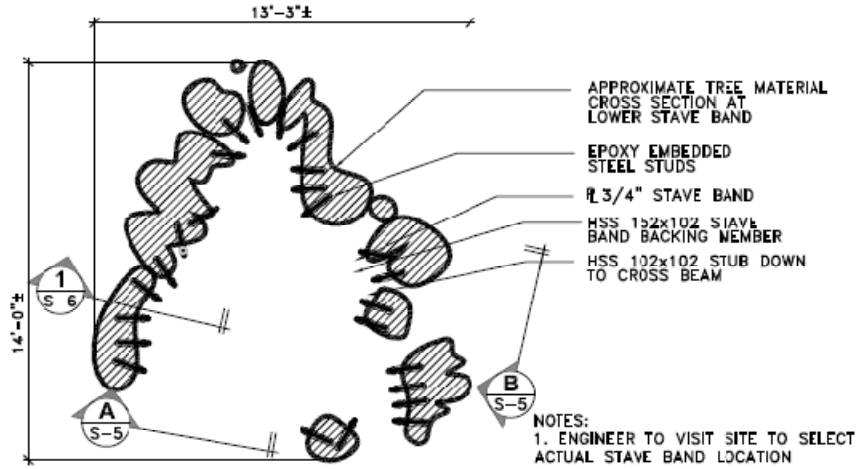


Connecting the tree to the Micro Piles

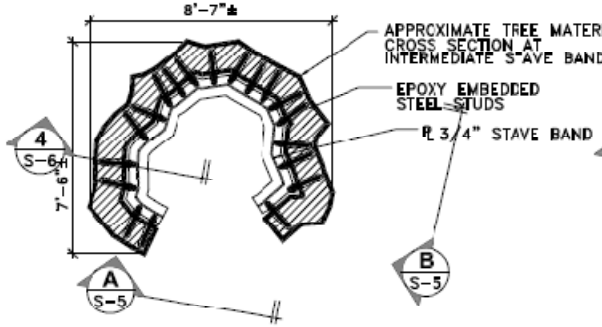
Con-Tech Systems Ltd.



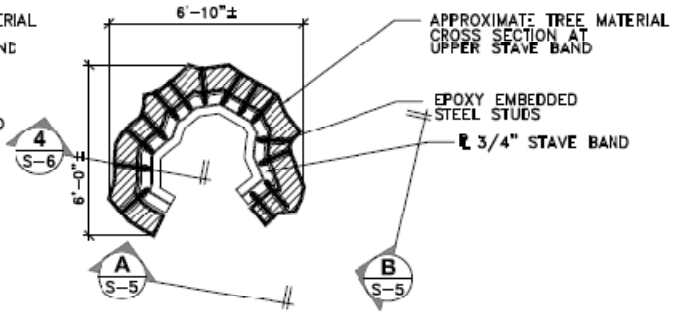
1 S-4 **TREE SECTION BELOW GRADE**
1/4"=1'-0"



2 S-4 **TREE SECTION @ PIPE CONNECTION TO TREE**
1/4"=1'-0"



3 S-4 **TREE SECTION @ INTERMEDIATE STAVE BAND**
1/4"=1'-0"



4 S-4 **TREE SECTION @ UPPER STAVE BAND**
1/4"=1'-0"

NOTES:
1. ENGINEER TO VISIT SITE TO SELECT ACTUAL STAVE BAND LOCATION

2. TREE INSIDE SURFACE TO BE SCRIBED AT SELECTED LOCATIONS AND TEMPLATE FITTED TO TREE

3. FINAL LOCATIONS OF EPOXY EMBEDED STUDS TO BE MARKED ON TEMPLATE AND PHOTOGRAPHIC EVIDENCE FORWARDED TO THE ENGINEER FOR REVIEW PRIOR TO STAVE BAND FABRICATION

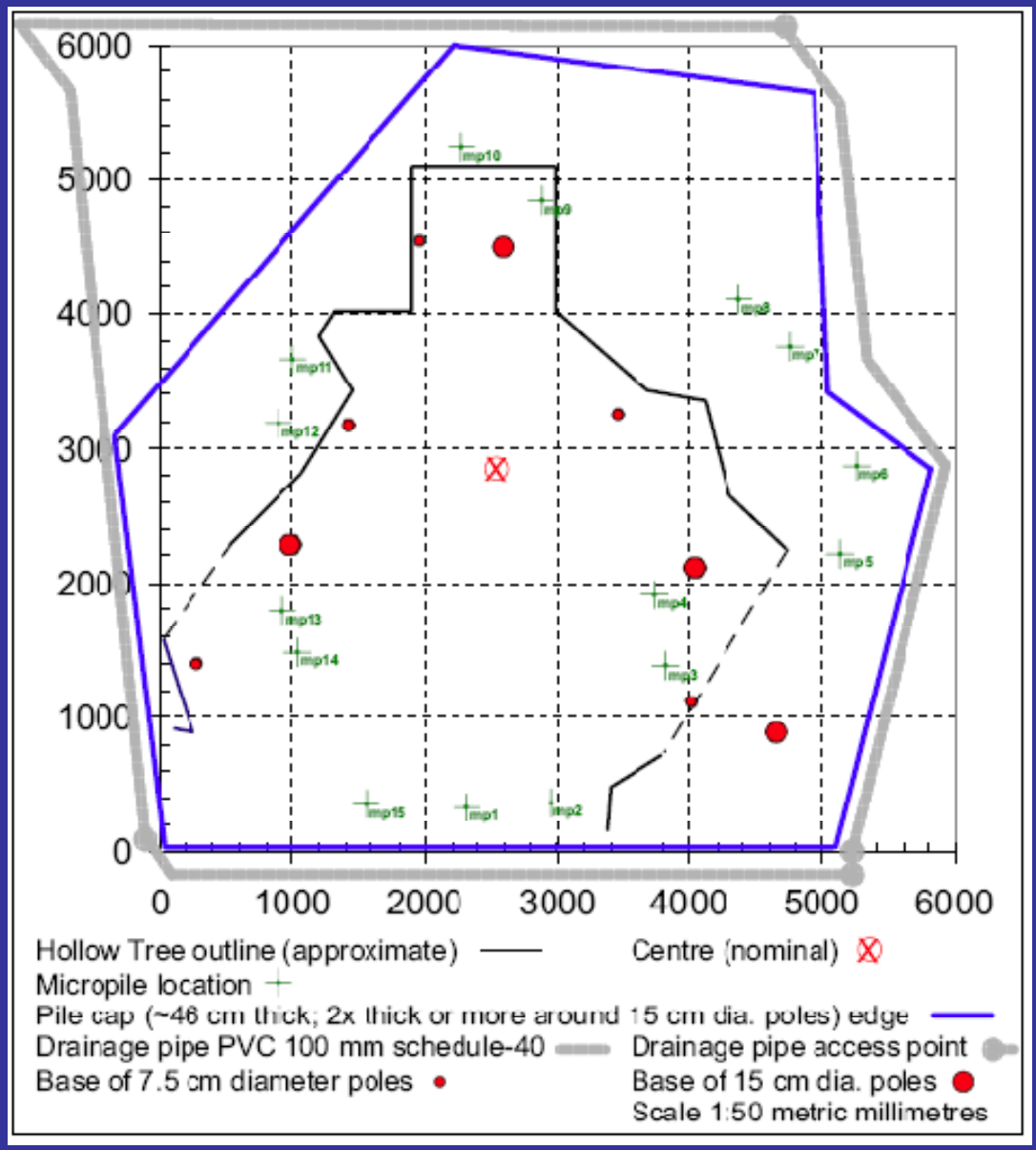
4. WHERE POSSIBLE EXISTING BRACING AND REINFORCEMENT TO REMAIN IN PLACE UNTIL STAVE BANDS ARE INSTALLED AND EPOXY IS SET

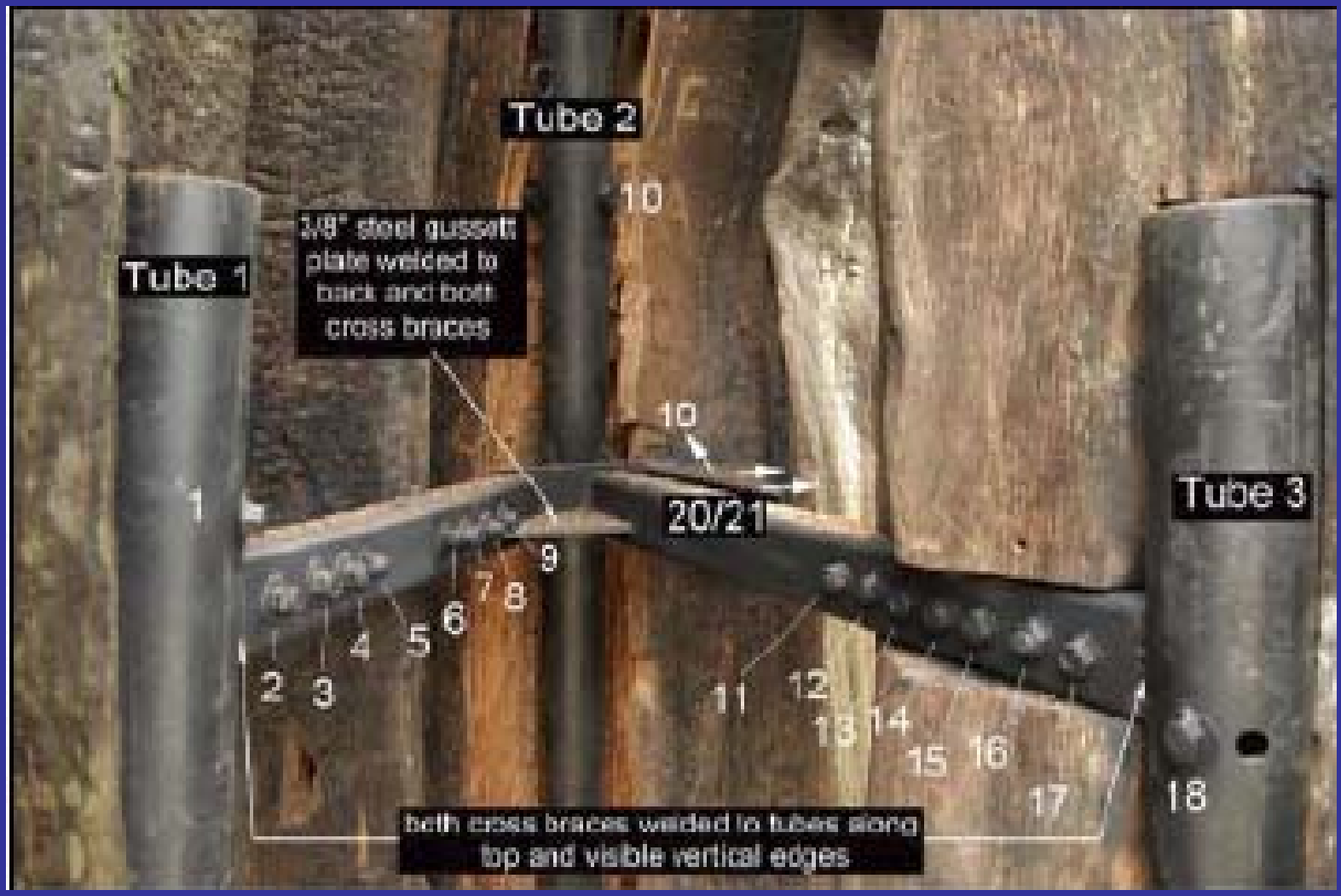
5. REMOVE TREE MATERIAL BELOW GRADE ONLY TO FACILITATE INSTALLATION MICRO PILES AND PILE CAP REBAR

6. EXCAVATE AND REPLACE EXISTING EARTH WITH CLEAN FREE DRAINING GRANULAR FILL AFTER STAVE BAND INSTALLATION IS COMPLETE

7. AS MUCH AS POSSIBLE MAINTAIN EXISTING TREE ROOTS DURING EXCAVATION.

Three internal tubes forming a tri-pod





Con-Tech Systems Ltd.

The tree now connected to the Root Piles before the landscaping

Fourth Stage

Placing a Cap on the Hollow Tree to extend its life time

Con-Tech Systems Ltd.

The Vision

Became the Reality

Con-Tech Systems Ltd.®

The group which made it happen

Con-Tech Systems Ltd.

He approves

Con-Tech Systems Ltd.

The Root Pile Support Paralleling to Wind Turbine Foundations ?

Example:

Catastrophic failure of several wind turbine foundations near Vechta / Lower Saxony, Germany

Here it was too late.

With a post-tensioned ground anchor system (or Root Piles),

this type of failure could be avoided.

Conventional Spread Footing with Mass Concrete

Similar to the ones which failed in Germany

500 to 600 cubic yards of concrete are required

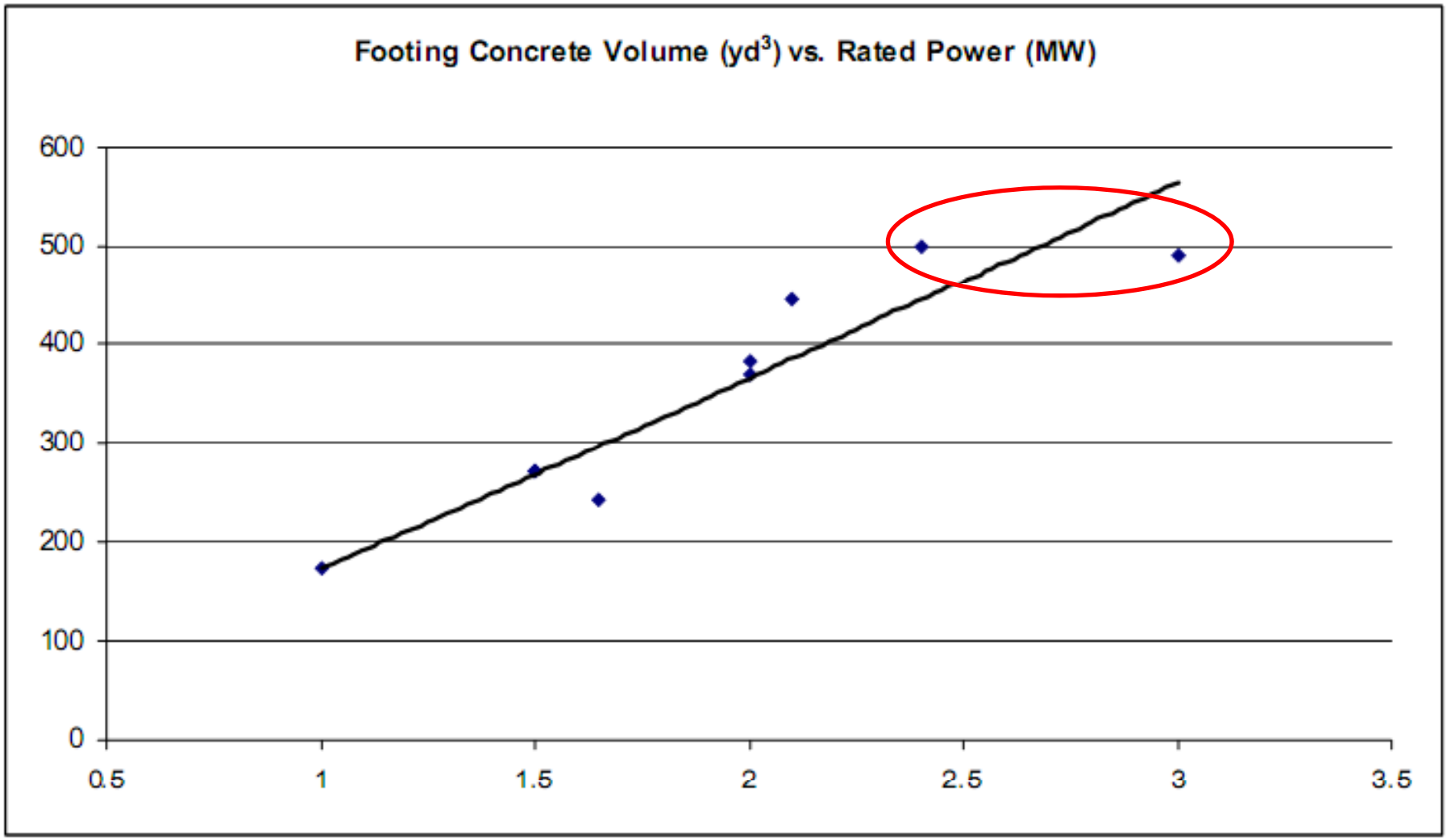


Figure 1

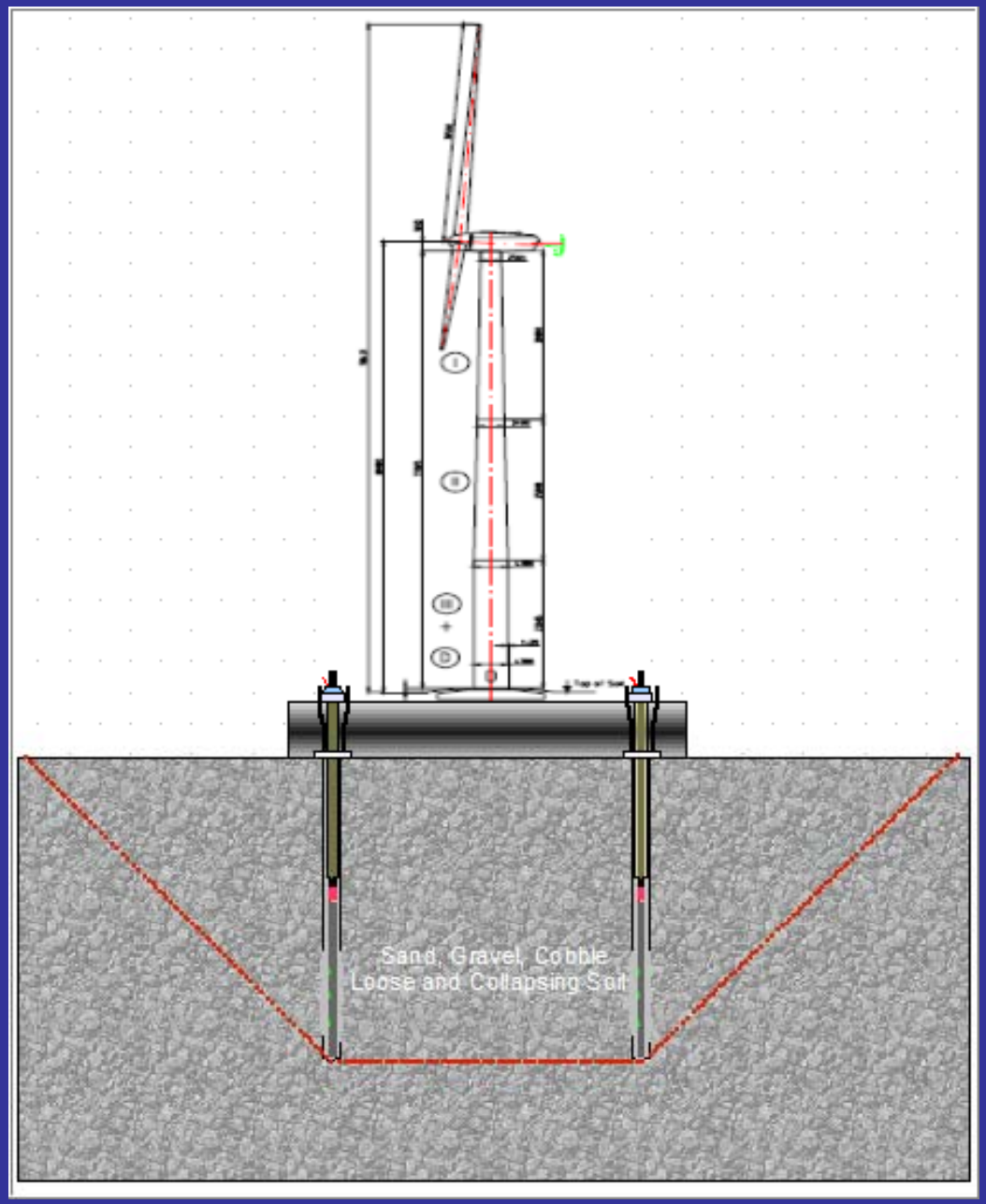
Source: Morgan, K., Ntambakwa, E., Garrad Hassan America, Inc., Wind Turbine Foundation Behavior and Design Considerations, AWEA Windpower,Conference, Houston, June 2008

The Solution:

Alternative Foundation Systems with Micro Piles, Post-Tensioned Ground Anchors, and New Groutable Void Form (GVF) Technology

Deep Foundation Post-Tensioned Ground Anchors use ground mass to resist the overturning moment.

The foundation is pre-tested to its design loads and higher.



Only small equipment is required and the amount of concrete is largely reduced

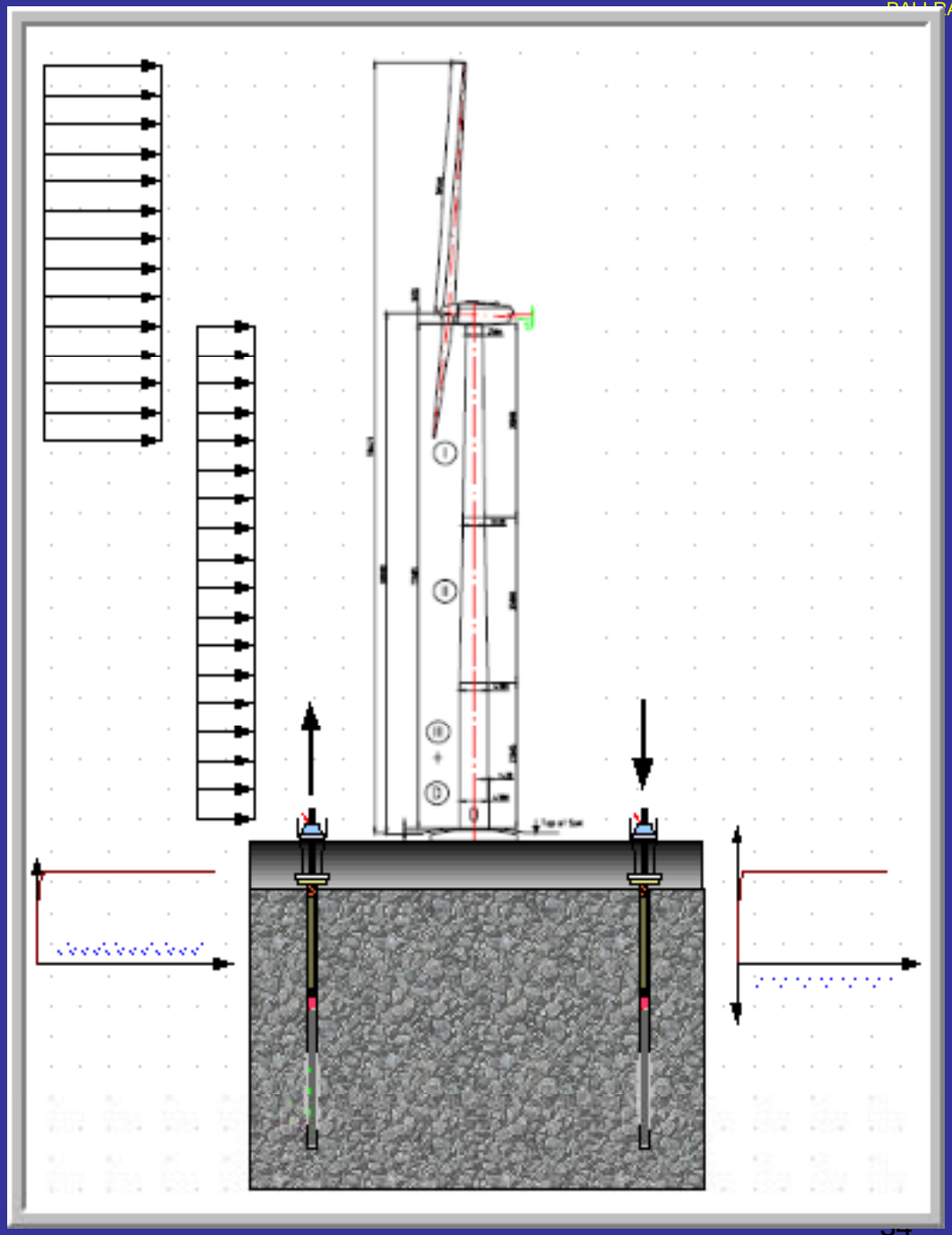
Types of Tendons used for Post-Tensioning Wind Turbine Foundation Ground Anchors

- **7 Wire strand anchors 270 ksi low relaxation**
- **Solid bars 150 ksi for post-tensioning**
- **Injection Bore Anchor, hollow bar system**

The Key to Post-Tension and Testing Wind Turbine Foundations Is The Groutable Void Form (GVF) Concept

(patent pending)

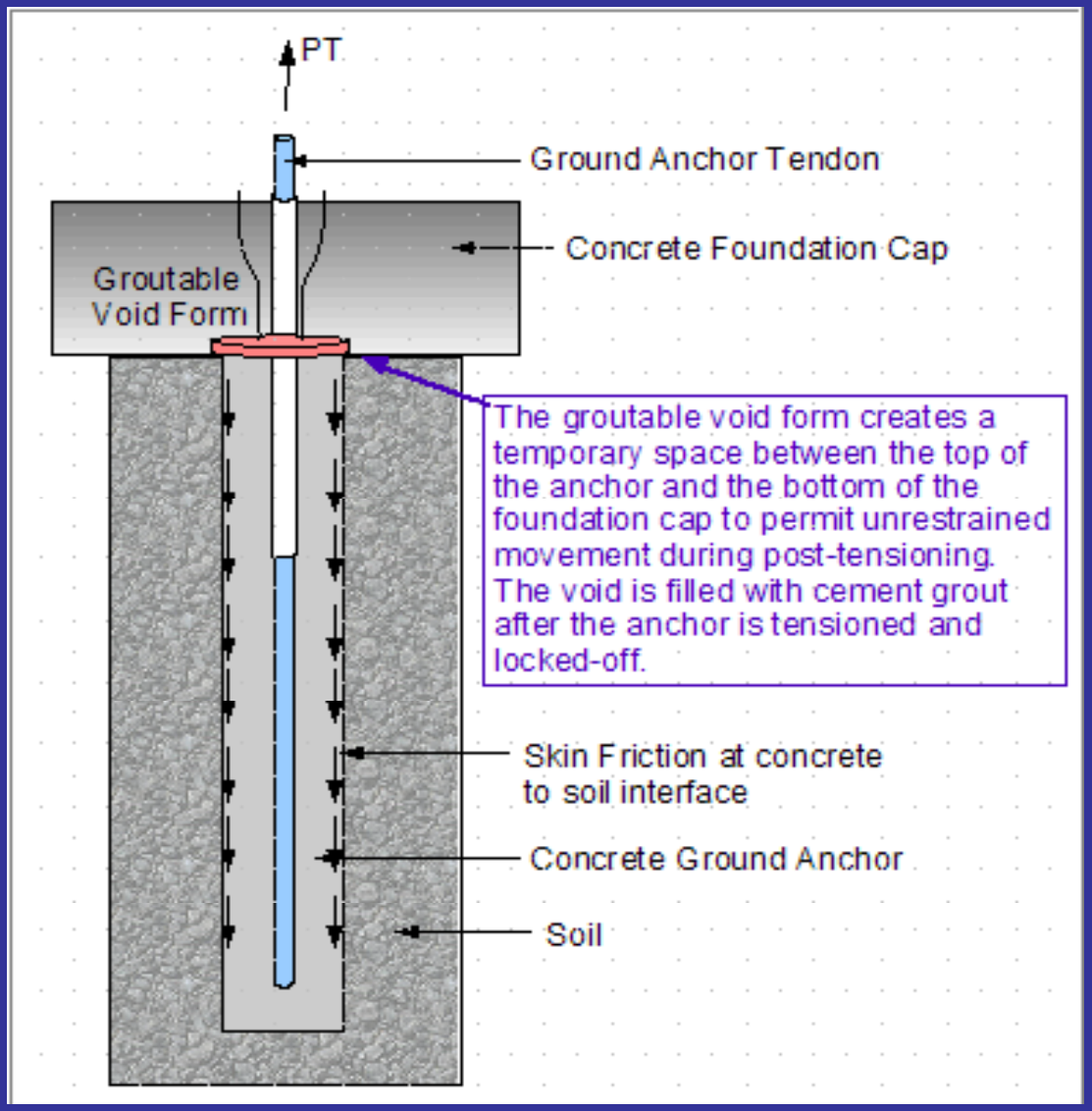
Wind Turbine Foundation with Post-Tensioned Ground Anchors using Groutable Void Form (GVF)



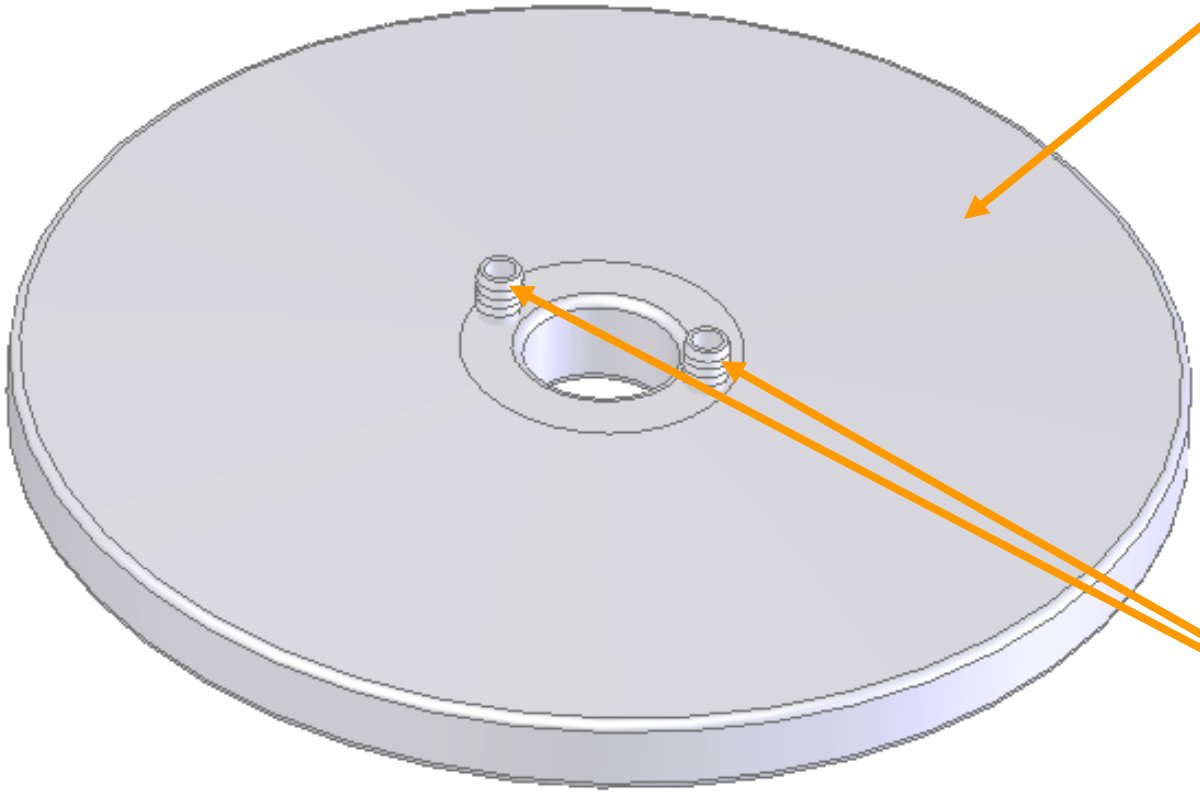
Con-Tech Systems Ltd.

Groutable Void Form

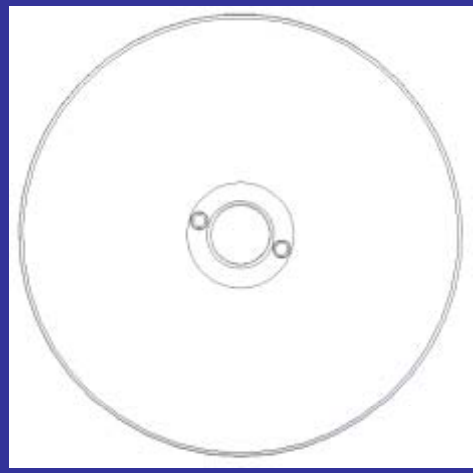
- **Void between ground anchor and foundation cap filled with cement grout after tensioning**



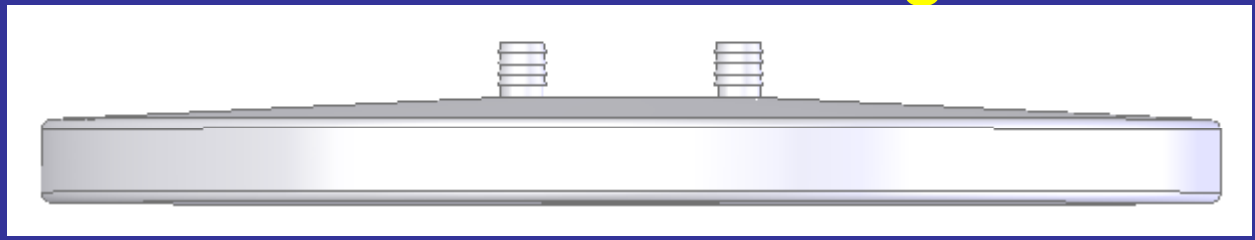
CTS Groutable Void Form

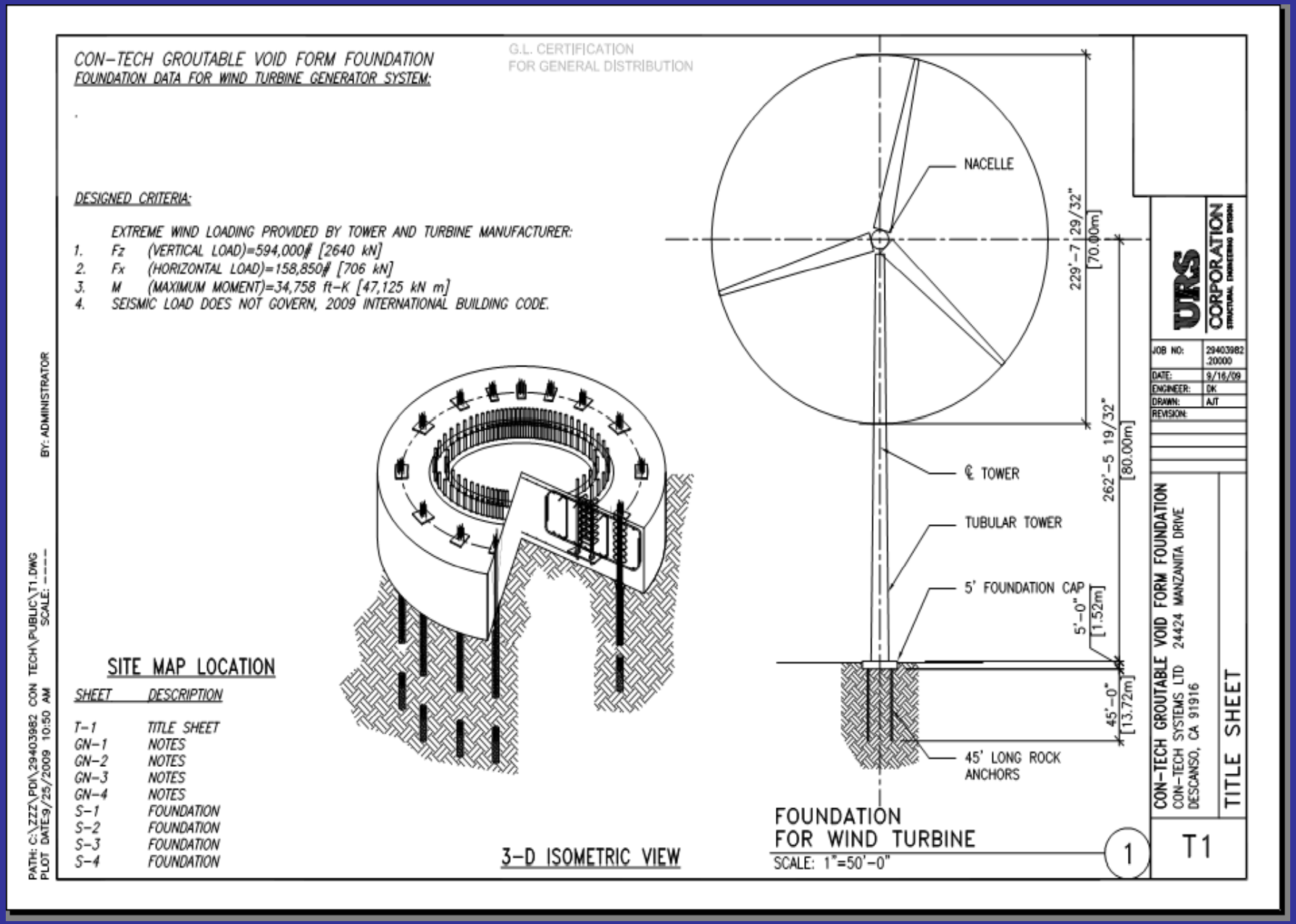


Hard Plastic or sheet metal shell



Barbed fittings for grout tube





Con-Tech Systems Ltd.®

Foundation for a present project in Canada

Conclusions

- Over 75% reduction in foundation area
- Over 40% reduction in concrete consumption
- Over 70% reduction in reinforcing steel consumption
- 20% to 30% preliminary estimated total foundation cost reduction
- Pre-tested foundation in tension and compression to design loads or higher


Thank you