WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

Project Kingston / Winslow Ferry Terminal - Overhead Loading Fac. Sheet No ..... of ..... sheets

S.R. Marine Made by TLH Check by ..... Date 8/29/86 Supv. .....

SUMMARY

PIER 1 & 2 54" SHAFT FOUNDATION :

Note: Use this curve based on discussion w/ Leroy W.

CONSTRUCTION OPTION	ANALYSIS MODEL	ANALYSIS METHOD	ALLOWABLE CAPACITY	COMMENTS
drilled shaft.	drilled shaft.	Reese	Use Curve #2 on page 10A/12	see bearing vs. depth graph. F.S. = 2.0
prebore & drive closed end can OR drive open-end can to required min. depth	driven pile	Load test @ Lake Wash.	300T	Analyzed for min. 10 ft depth assume $Q_s = 0$ F.S. = 3.0
		Meyerhoff	292 T	
		Thurman	716 T	

CONCLUSIONS : (1) For drilled shaft give design curve

(2) For other 2 options Q_{all} = 300 tons ; preboring req'd

(3) Minimum embedment = 10 ft. or depth required for lateral load capacity.

TOWER FOUNDATION :

Option (1) 24" P.C. pile , Q_{all} = 120 tons , preboring required

Option (2) 24" P.C. pile with H-pile tip , Q_{all} = 120 tons, tip reinforcement required. Give as an alternate if uplift (capacity) is needed.

10 tons uplift for 10 ft. embedment

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Project: Kingston/ Winslow Ferry Terminal - Overhead Loading Sheet No. 1 of 12 sheets

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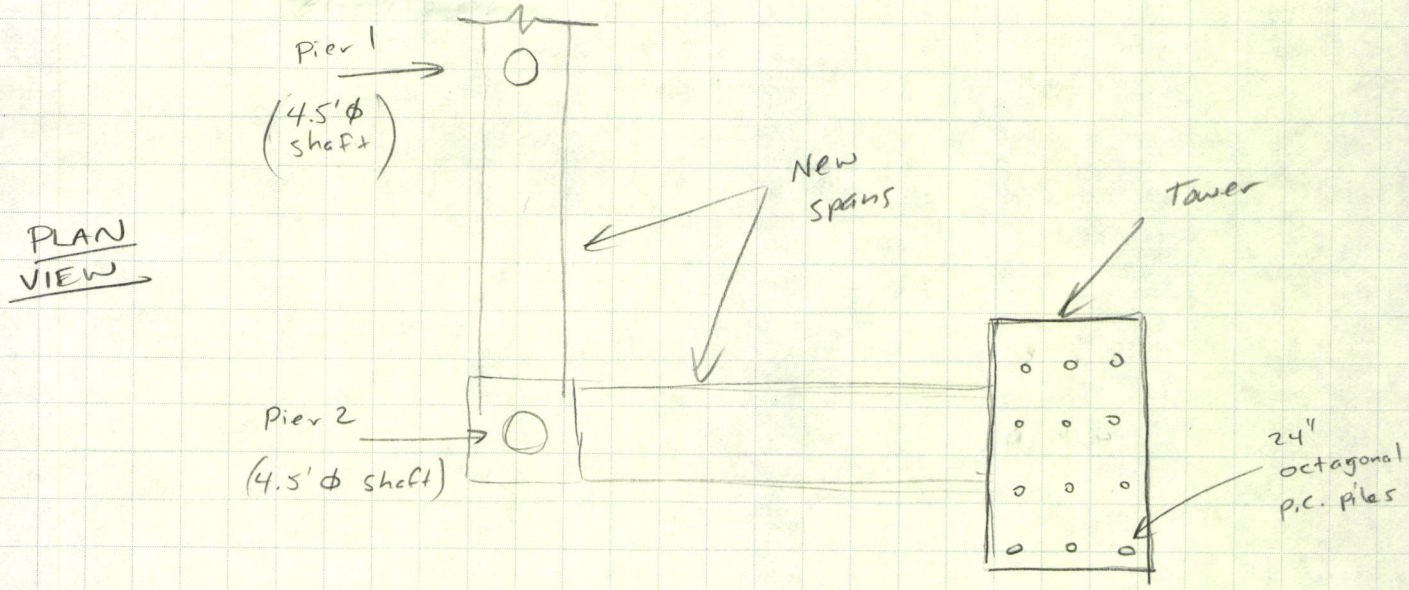
SCOPE OF WORK:

1) Proposed construction of pedestrian overhead loading facility:

- 2 pedestrian bridges with 84' & 90' spans. founded on 4.5' ϕ shafts (proposed).



- tower founded on 24" oct., p.c. concrete piles.

2) soils information from previous test holes.

holes H-1 & H-2 are closest to new structure

3) Soil profile is similar at both sites. Therefore, design is applicable to both sites.

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Project: Kingston/ Winslow Ferry Terminal – Overhead Loading Sheet No. 2 of 12 sheets

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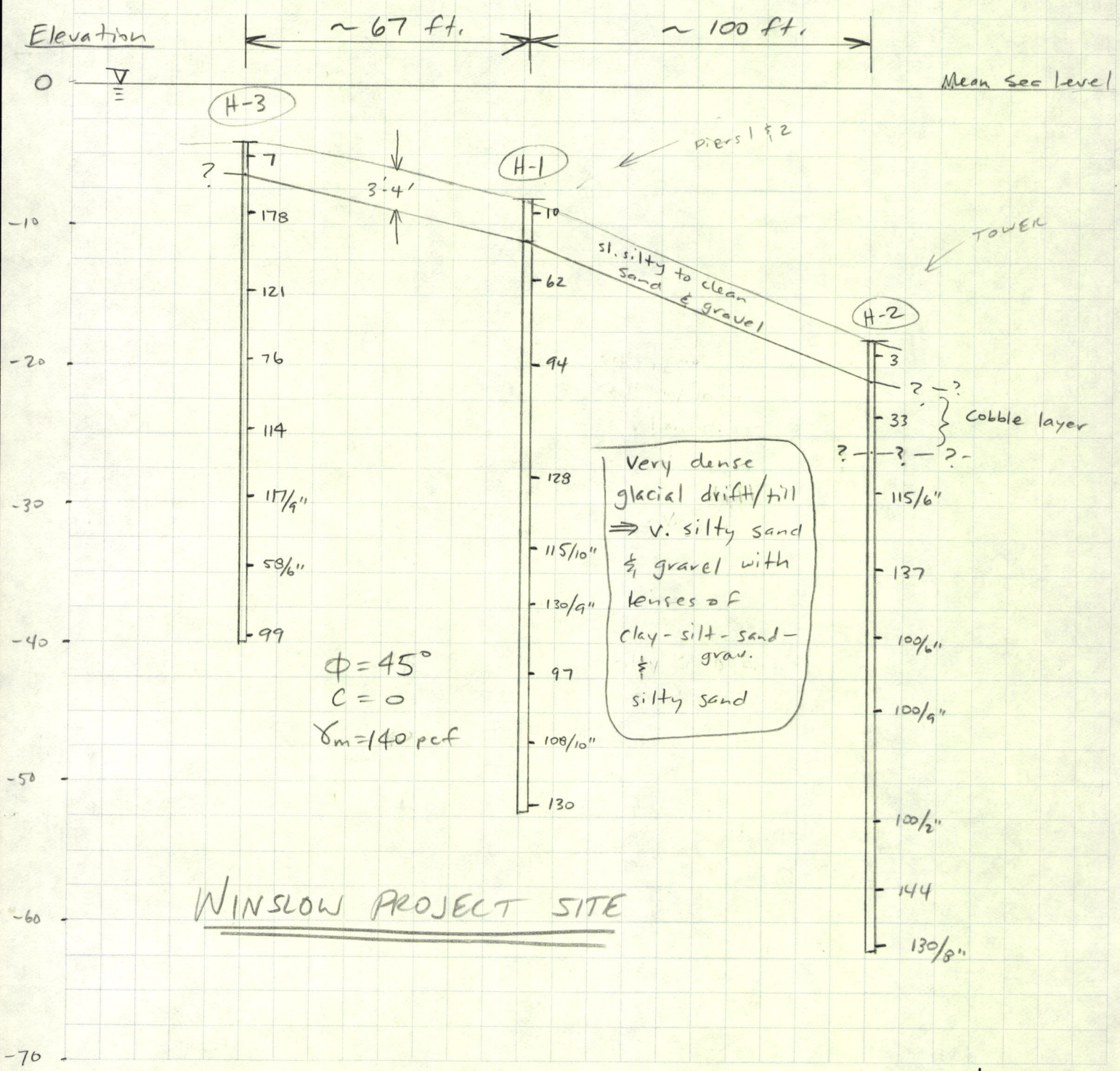
Soil Profile: (soil profile is similar at Kingston site: not shown)

* look at A-A' through H-1, H-2, H-3 (see plan on pg. 3/)



WINSLOW PROJECT SITE

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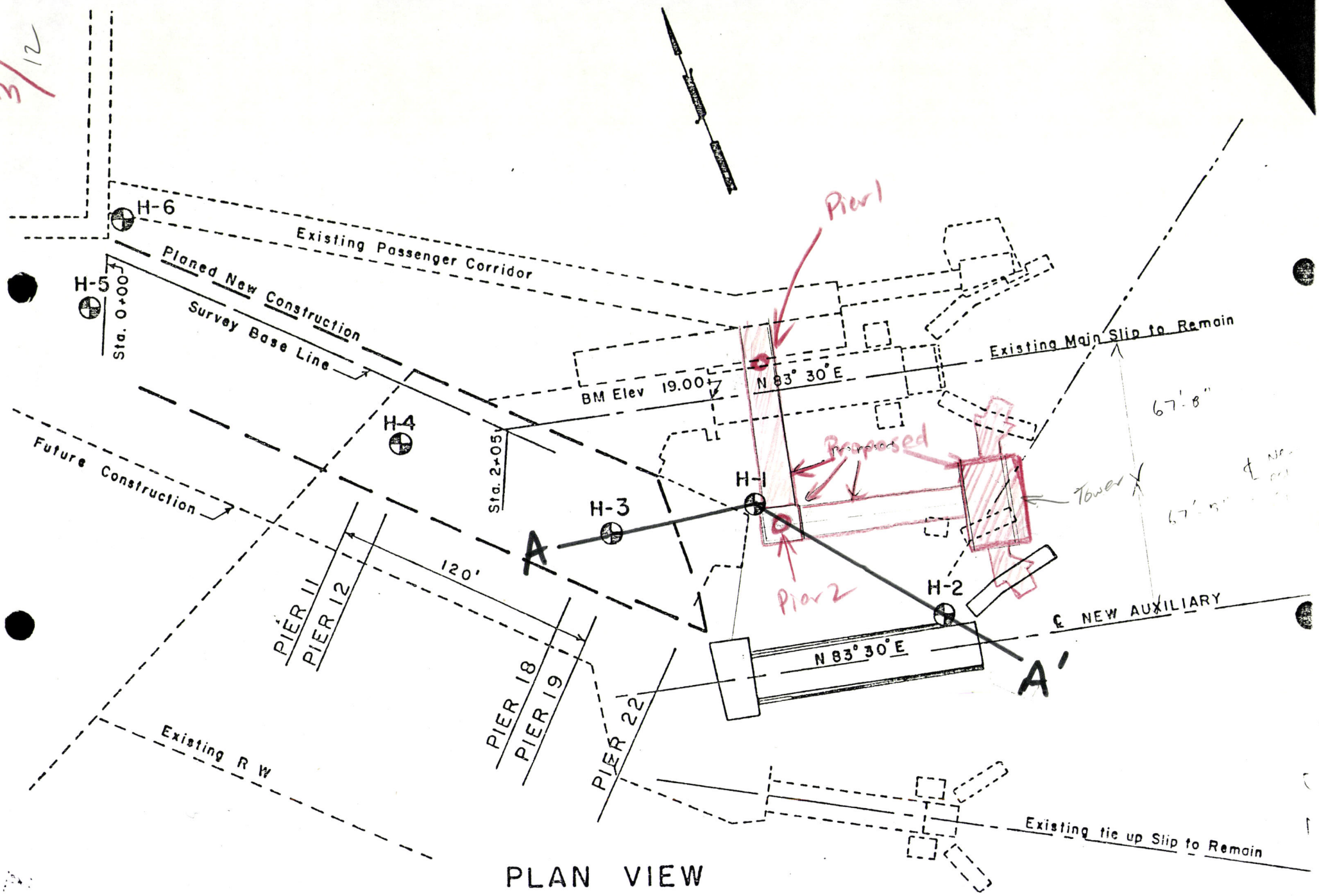

PLAN VIEW

WINSLOW FERRY TERMINAL

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Project Kingston/ Winslow Ferry Terminal – Overhead loading Sheet No. 4 of 12 sheets

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Phone Conversation with Michael Woo: 8/28/86

(1) Vertical loads for shafts ≈ 225 kips (112.5 tons)
~10% of vertical load for E.Q / lateral loading

(2) fixity of piles for lateral load capacity critical,

(3) open to options for alternatives to 24" octagonal p.c. piles for tower foundation.

(4) There is a concern about the construction equipment loads on the existing timber structure.

(5) Method of construction for shaft?

4.5 ft. ϕ SHAFT DESIGN

	Construction option	Model for Analysis	Comments
(1)	drive open end can to min. embedment criteria	driven pile	will require drive shoe, cobbles may present problems.
(2)	drilled shaft.	drilled shaft.	casing driven into good material before drilling
(3)	prebore to min. penetration, then drive closed end can to bearing	driven pile	sloughing of top 3 ft of material into hole. Prebore hole slightly smaller than 54".

Analysis for options (1) & (3)

① based on load tests in similar material at Lake Washington for 54" diameter closed end pipe:

$$Q_{ult.} = 1000 \text{ tons}$$

for F.S. = 3, $Q_{all} = 1000/3 \approx$ **300 tons**

② Thurman's Method for Q_p

assume $Q_s \approx 0$ for 10 ft. of embedment

$$Q_p = A_p \alpha P_d N_q'$$

$A_p = \frac{\pi}{4}(4.5)^2 = 15.9\ ft^2$

$N_q' = 500$ (for $\phi = 45°$)

$\alpha = 0.8$ (for $\phi = 45°$) * may be conservative since α is not given for $D/B < 20$

$P_d = (10\ ft.)(130 - 62.4) = 676\ psf = 0.338\ tsf$

γ_b

$Q_p = (15.9\ ft^2)(500)(0.8)(0.338) = 2149.7$ tons

F.S. = 3, $Q_{all} = \frac{2149.7}{3} = \underline{716\ tons}$

(3) Meyerhoff's method (assume $Q_s \approx 0$ for 10 ft. of penetration)

$Q_p = \frac{4N}{10}\frac{D_b}{B}A_p$

where:
D_b = depth of embedment
B = pile width

$N \geq 62$

$Q_p = (0.4)(62)\left(\frac{10}{4.5}\right)(15.9\ ft^2) = 876.3$ tons

F.S. = 3, $Q_{all} = \frac{876.3}{3} = \underline{292\ tons}$

CONCLUSION:

(1) For either option (1) or (3): $\underline{Q_{all} = 300\ tons}$

(2) Minimum penetration of 10 ft as required by standard Spec's or penetration required for lateral loads, which ever is greater.

Analysis for Option (2)

(1) Use Reese & Wright method

$Q_s = f_s A_s$ where: $f_s = K P_d \tan\phi \leq f_{s\,ult}$ (fig. 3.6)

$Q_p = q_p A_p$ where: $q_p = \frac{2N}{3} \leq 40$ tsf

assume 10 ft. penetration

$$f_s = (.7)\left[\underbrace{\left(\frac{130-62.4}{2000}\right)}_{P_d}\left(\frac{1}{2}\right)\right]\tan 45^\circ = 0.169 \text{ tsf}$$

$f_{s\,ult.}$ (from fig. 3.6) = 1.6 tsf (for $N \geq 62$)

use $f_s = 0.169$ tsf

then: $Q_s = (.169 \text{ tsf})(10 \text{ ft.})(\pi)(4.5 \text{ ft.}) = \boxed{23.9 \text{ tons}}$

$q_p = \frac{(2)(62)}{3} = 41$ tsf $\Longrightarrow$ use $q_p = 40$ tsf

then: $Q_p = (40 \text{ tsf})\left(\frac{\pi}{4}\right)(4.5)^2 = \boxed{636 \text{ tons}}$

Calculate mobilized resistance

assume settlement = 1.0 inches

$W_b = W_{mid} = 1.0$ inches

for $B = 4.5$ ft.: $W_b/B = \frac{W_{mid}}{B} = 1.85\%$

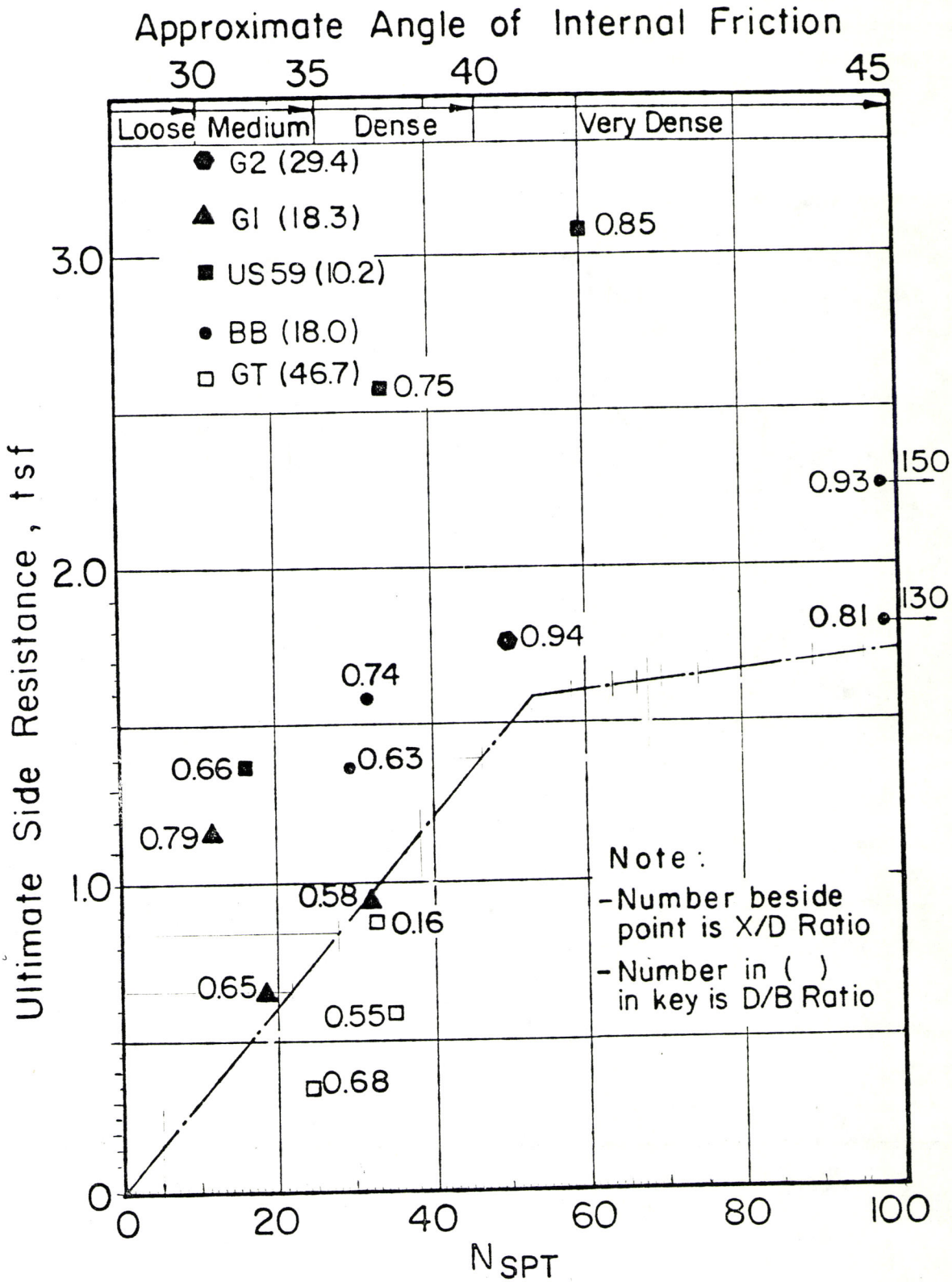


Fig. 3.6. Ultimate side resistance versus blow count (after Wright, 1977).

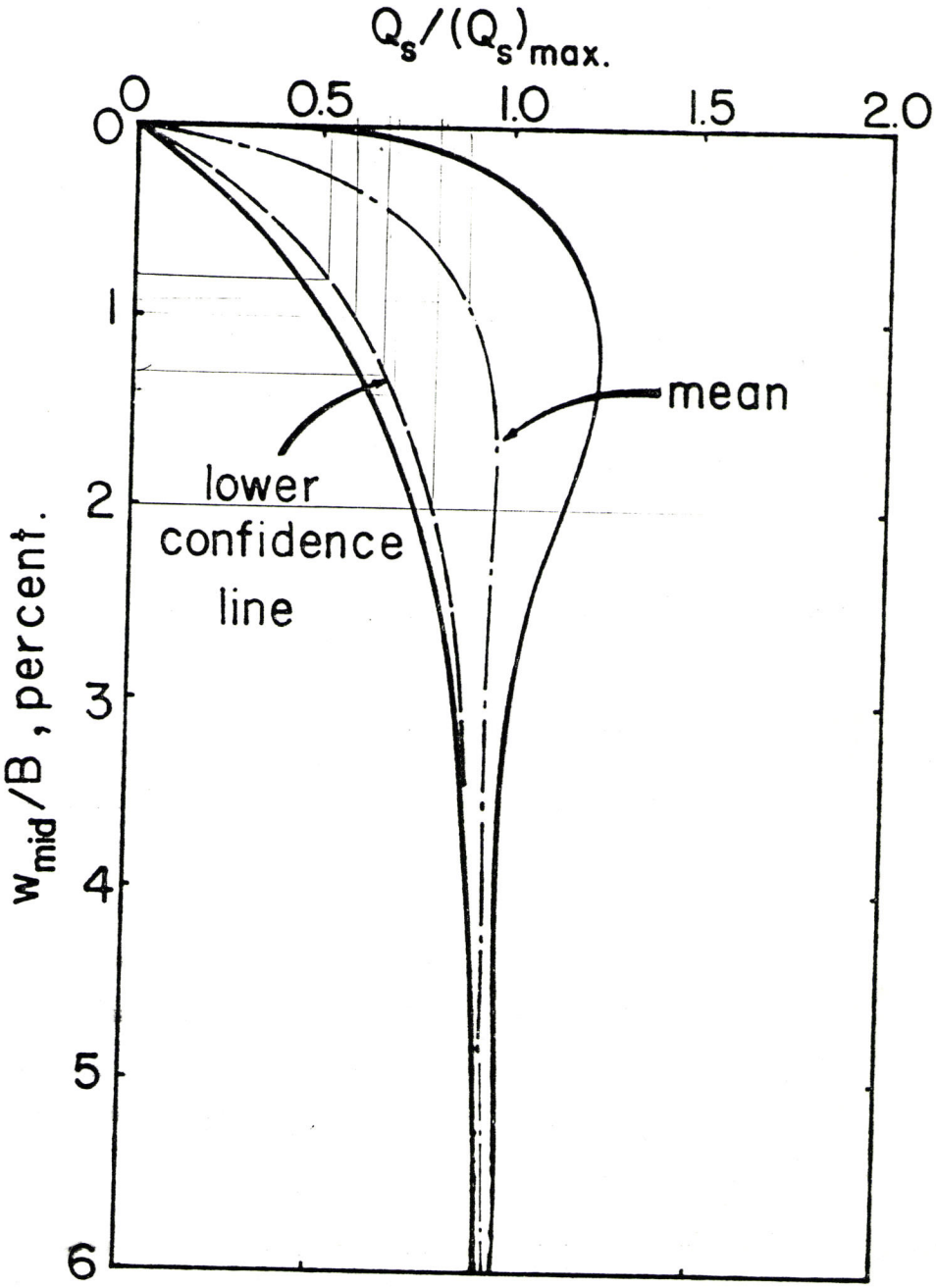


Fig. 3.4. Relative shaft resistance versus relative movement.

safety factors is discussed, and the load-settlement curve is constructed. It is recommended that the reader work these examples to become familiar with the procedure adopted here for the design of single drilled shafts under axial load.

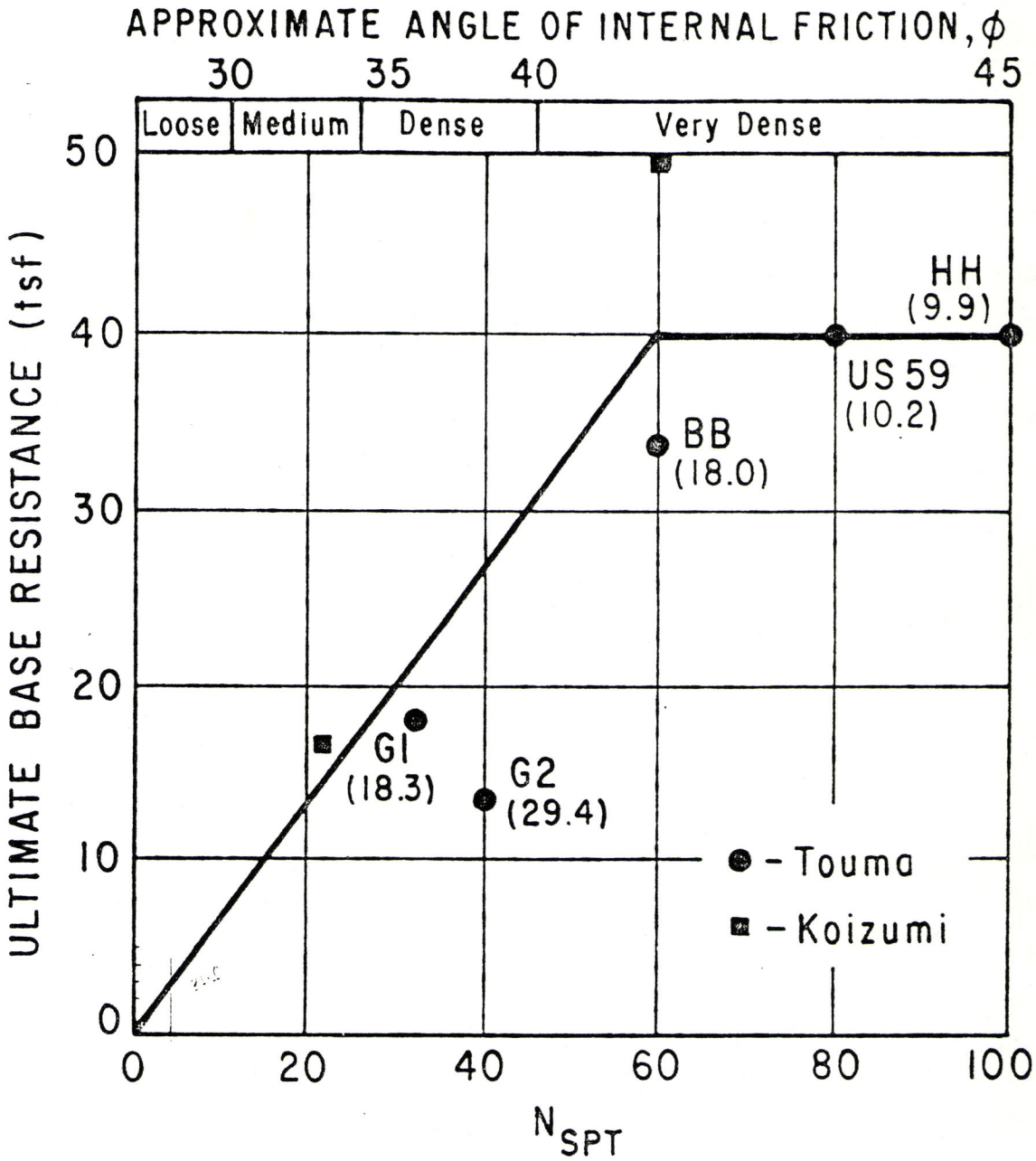


Fig. 3.10. Ultimate base resistance in cohesionless soils (at a settlement of 0.05B) (after Reese, 1977).

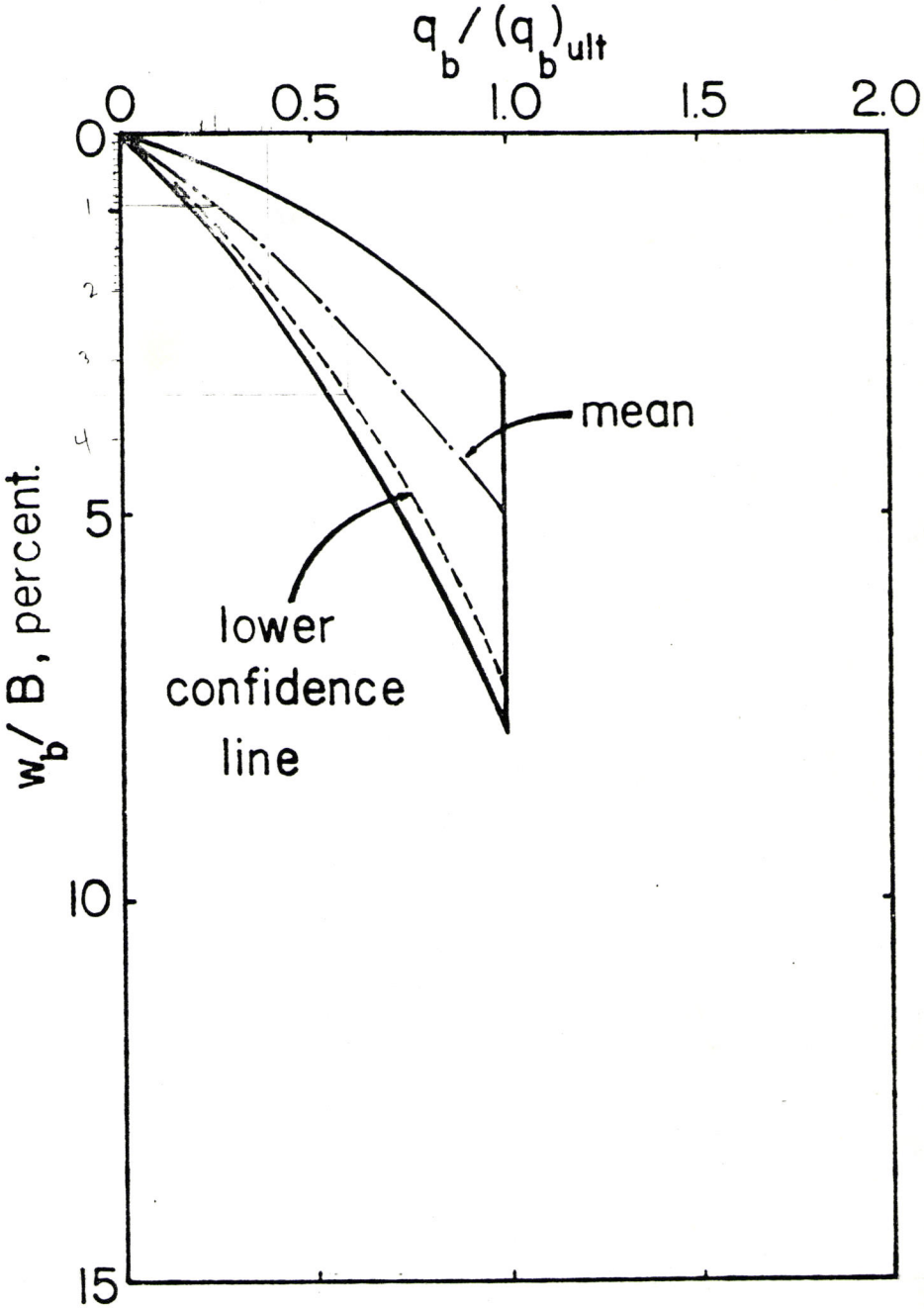


Fig. 3.9. Design curves for base resistance in cohesionless soils.

$C = \pi d \approx 14.1$ ft

from fig. 3.4 : (use mean line)

$Q_s / Q_{max} = 0.95$ ∴ $Q_s = (.95)(23.9 \text{ tons})$

$\boxed{Q_s = 22.7 \text{ tons}}$

from fig. 3.6 : (use mean line)

$Q_b / Q_{bult.} = 0.40$ ∴ $Q_b = (.40)(636 \text{ tons})$

$\boxed{Q_b = 254.4 \text{ tons}}$

* Use overall F.S. = 2.0 since design curves are conservative for dense till.

$$Q_{all} = \frac{22.7 + 254.4}{2.0} = \boxed{139 \text{ tons}}$$

Look at other depths to develop design curve :

$54''$ dia $\approx \pi r^2 \approx 15.9$ ft^2

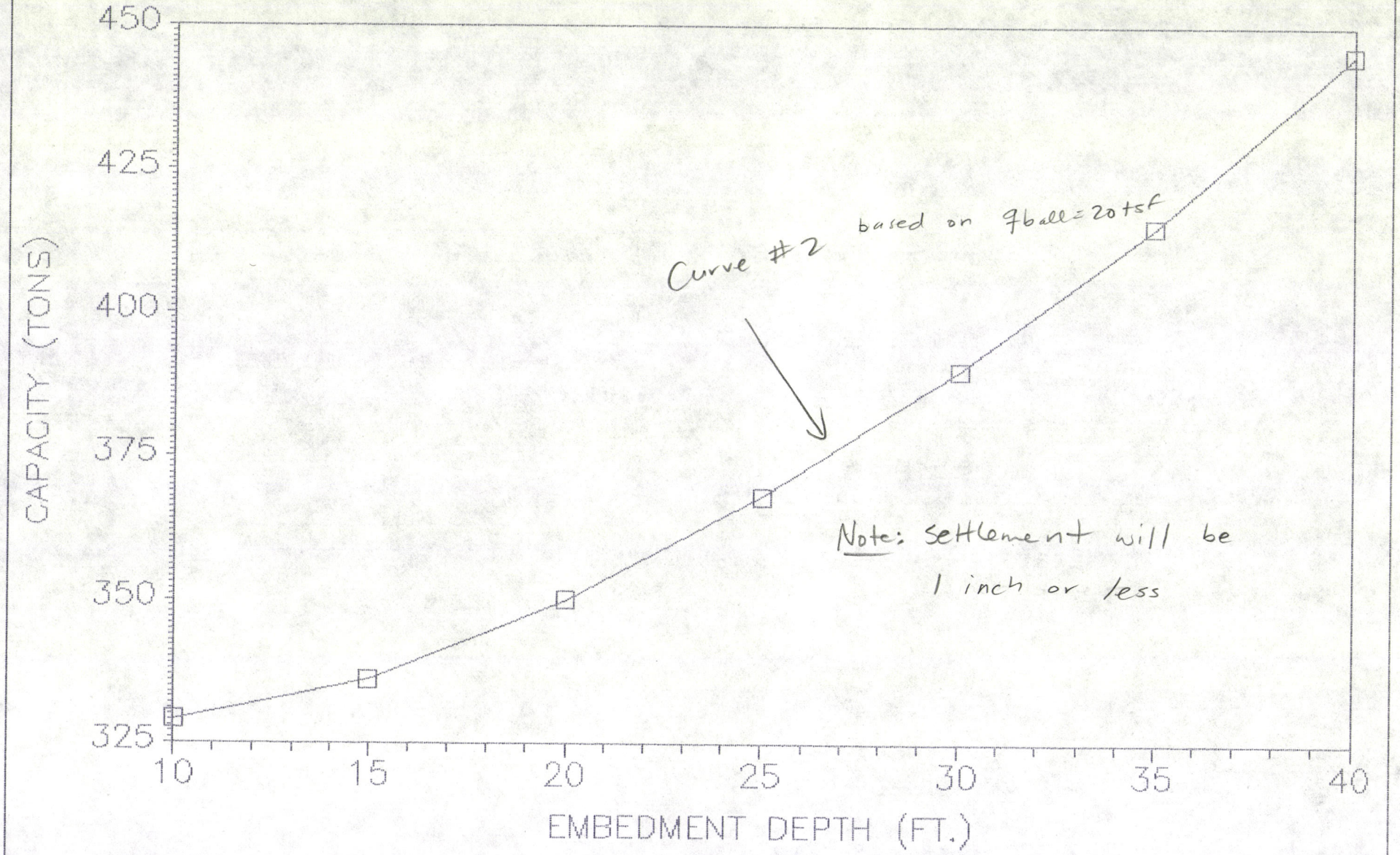
calculate Q_s :

depth	P_d (tsf)	$N_{ave.}$	f_s	$\leq f_{s\,ult.}$
15'	0.254	78	0.178	1.6
20'	0.338	>90	0.236	1.6
25'	0.423	>90	0.296	1.6
30'	0.507	>90	0.355	↓
35'	0.592	>90	0.414	
40'	0.676	>90	0.473	

use these values for calculations

10A/12

TOTAL ALLOWABLE SHAFT CAPACITY VS. DEPTH



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Project (Kingston) Winslow Ferry Terminal Sheet No. 11 of 12 sheets

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Tower Foundation Analysis

1) 24" ϕ octagonal P.C. concrete piles have been proposed.

Look at:

① preboring — assume pile will penetrate to 3 ft above preboring depth.
— cobble layer present in test hole H-2

② P.C. pile with H-pile tip — will eliminate need for preboring (?)
- assume precast pile will penetrate 3 ft. or less into dense material
- drive shoe on H-pile required
- length of tip equal to required penetration

Qall for both options = 120 tons

(see calc's on next page)

Analysis for 24" P.C. Piles

Meyerhoff (assume $Q_s \approx 0$): depth = 10 ft.

$$Q_p = \frac{4N}{10}\frac{D_b}{B}A_p$$

where: D_b = depth of penetration
B = pile diameter

use: $N \geq 90$
$D_b = 10$ ft. $\Rightarrow$ $Q_p = \frac{4(90)}{10}\left(\frac{10}{2}\right)\pi\left(\frac{2^2}{4}\right) = 565.5$ tons

$$Q_{all} = \frac{Q_p}{3} = \boxed{188 \text{ tons}}$$

Thurman's method (assume $Q_s \approx 0$): depth = 10 ft.

$$Q_p = A_p \alpha P_d N'_q$$

$\alpha = .80$
$N'_q = 500$
$A_p = \pi$
$P_d = \left(\frac{130-62.4}{2000}\right) 10 \text{ ft} = 0.338$ tsf

$$Q_p = \pi(.8)(.338)(500) = 424.7 \text{ tons}$$

$$Q_{all} = Q_p/3 = \frac{424.7}{3} = \boxed{142 \text{ tons}}$$

$$Q_{all}\ (\text{average}) = \frac{142+188}{2} = 165 \text{ tons}$$

say $\boxed{Q_{all} = 120 \text{ tons}}$ (easier for construction equip.)