Appendix C

Expedient Design Of Overhead Anchorage Systems

Assumptions

The following design sequence has been prepared as a reference for the design of overhead anchorage systems. (See figure on page 182.) Several assumptions have been made which simplify the standard design procedures. If these assumptions do not apply to a particular situation, or if an increased understanding of the design sequence is desired, refer to Chapter 8.

- All calculations are based upon the use of IPS cables.
- Deadmen will be constructed using logs or timbers.
- Flat bearing plates will be used on all deadmen.
- The depth of the ground water table at the bridge site is greate than 4 feet.
- Tidal variations or shore conditions do not require that the anchorage towers be placed a significant distance (over 75 feet) from the waterline.
- Standard Class 60 towers will be used to support the overhead cable.
- The designer is able to roughly estimate the tower to deadman slope ratio. See Chapter 8 for further guidance.

Design Data

The following information must be calculated or determined when designing an overhead cable system:

Cable data

Number of master cables ______________________

Size of master cable(s) (C_D) ______________________

Length of the master cable(s) (C_L) ______________________

Number of clips at each end of the cable ______________________

Spacing of cable clips ______________________

Initial sag (S) ______________________

Tower data

Actual tower height (H

Near shore ______________________

Far shore ______________________

Tower waterline distance (A)

Near shore ______________________

Far shore ______________________

Tower-bridge offset (O_1)

Near shore ______________________

Far shore ______________________

Deadman data

Depth of deadman (D_D)

Near shore ______________________

Far shore ______________________

Tower-deadman distance (C)

Near shore ______________________

Far shore ______________________

Towerd-deadman offset (O_2)
Near shore ______
Far shore ______
Deadman face (D_f) ______
Deadman thickness (D_t) ______
Deadman length (D_L) ______
Near shore ______
Far shore ______
Bearing plate thickness (x) ______
Bearing plate length (y) ______
Bearing plate face (z) ______

Overhead Cable Design Sequence

Step 1. Determine the size and number of master cables required. Refer to Table 57 for M4T6, Class 60, and ribbon bridge. Refer to Table 58 for light tactical bridges.

Step 2. Determine the distance between towers (1) in feet.
L = (1.1x G) + 100 feet
Where G = the width of the wet gap in feet.

Step 3. Determine the length of the master cable (CL) in feet.
C_L = L + 250 feet
Where L = the distance between towers in feet.
C_L =
Note. This is an approximation based upon the most extreme circumstances.

Step 4. Determine the number of cable clips required to secure one end of the master cable.
Number of clips = (3x C_D) + 1
Where C_D = the cable diameter in inches
Number of clips at each end =

Step 5. Determine the spacing of cable clips in inches.
Clip spacing = (6x C_D)
Where C_D = the cable diameter in inches
Clip spacing =

Step 6. Determine initial sag (S) in feet.
S = (.02x L)
Where L = the distance between towers in feet
S =

Step 7. Determine tower height (H) in feet.
a. H_R = 3 feet + S-BH
Where H_R = the required tower height in feet
S = initial sag in feet
BH = bank height in feet
Note. This calculation must be done for both the near and far shore since bank heights may be different.
b. Determine actual tower height (H). Refer to Table 59 which provides a list of possible tower heights. Compare the required tower height to the possible tower height. Select the smallest possible tower that is greater than or equal to the required height.
Note. If the near and far shore towers are determined to have different heights, steps 8 through 16 must be calculated separately for both near and far shores.
H near shore =
H far shore =

Step 8. Determine the distance from each tower to the waterline (A) in feet.

$$A = \frac{L-G}{2}$$

Where L = the distance between towers in feet
G = the gap width in feet
A near shore =
A far shore =

Step 9. Determine the offset from each tower to the bridge's centerline (0_1) in feet.
a. If the bank height (BH) is less than or equal to 15 feet, then 0_1 = H + 50 feet
b. If the bank height (BH) is greater than 15 feet, then 0_1 = H + BH + 35 feet
Where H = the actual tower height in feet
BH = the bank height in feet
0_1 near shore =
0_1 far shore =

Step 10. Identify deadman dimensions. Select a deadman from the available timbers and logs. Generally, the timber with the largest timber face/log diameter is selected. The largest timber face of that deadman is defined as D_f the deadman face. The thickness of that deadman is defined as D_t the deadman thickness.

D_f =

D_t =

Step 11. Determine mean depth of deadman (D_D) in feet.

a. There must be a minimum of 1 foot of undisturbed soil between the bottom of the deadman and the ground water level (GWL). Therefore the deepest the deadman can go (D_Dmax) is calculated as:

$$D_Dmax = GWL - 1\ foot - \frac{D_f}{2}$$

where D_f = the deadman face in feet

GWL = depth of ground water level in feet

b. The minimum deadman depth is always 3 feet.

c. The maximum deadman depth is always 7 feet.

d. Compare D_Dmax to these minimum and maximum values to determine the actual mean depth of deadman (D_D).

D_D near shore =

D_D far shore =

Step 12. Determine length of deadman (D_L) in feet.

$$D_L = \left(\frac{CC}{HP \times Df}\right) + 1$$

Where CC = the capacity of the anchorage cable in pounds/1,000 from Table 60.

HP = required holding power in pounds/1,000 square feet from Table 61.

D_f = Deadman face in feet (for log deadman use log diameter (d))

D_L near shore =

D_L far shore =

Step 13. Check minimum thickness of deadman (Dt) in feet.

For timber: $\frac{D_L}{D_t}$ must be less than or equal to 9

For logs: $\frac{D_L}{d}$ must be less than or equal to 5.

Step 14. Determine the tower to deadman distance (C) in feet.

$$C = \frac{H + D_D}{slope}$$

Where H = the actual tower height in feet

D_D = the mean depth of deadman in feet

slope = the tower to deadman slope

C near shore =

C far shore =

Step 15. Determine the tower to deadman offset (O_2) in feet.

0_2 = (C x 02 feet)

Where C = the tower to deadman distance in feet

0_2 feet = a factor determined from Table 62

0_2 near shore =

0_2 far shore =

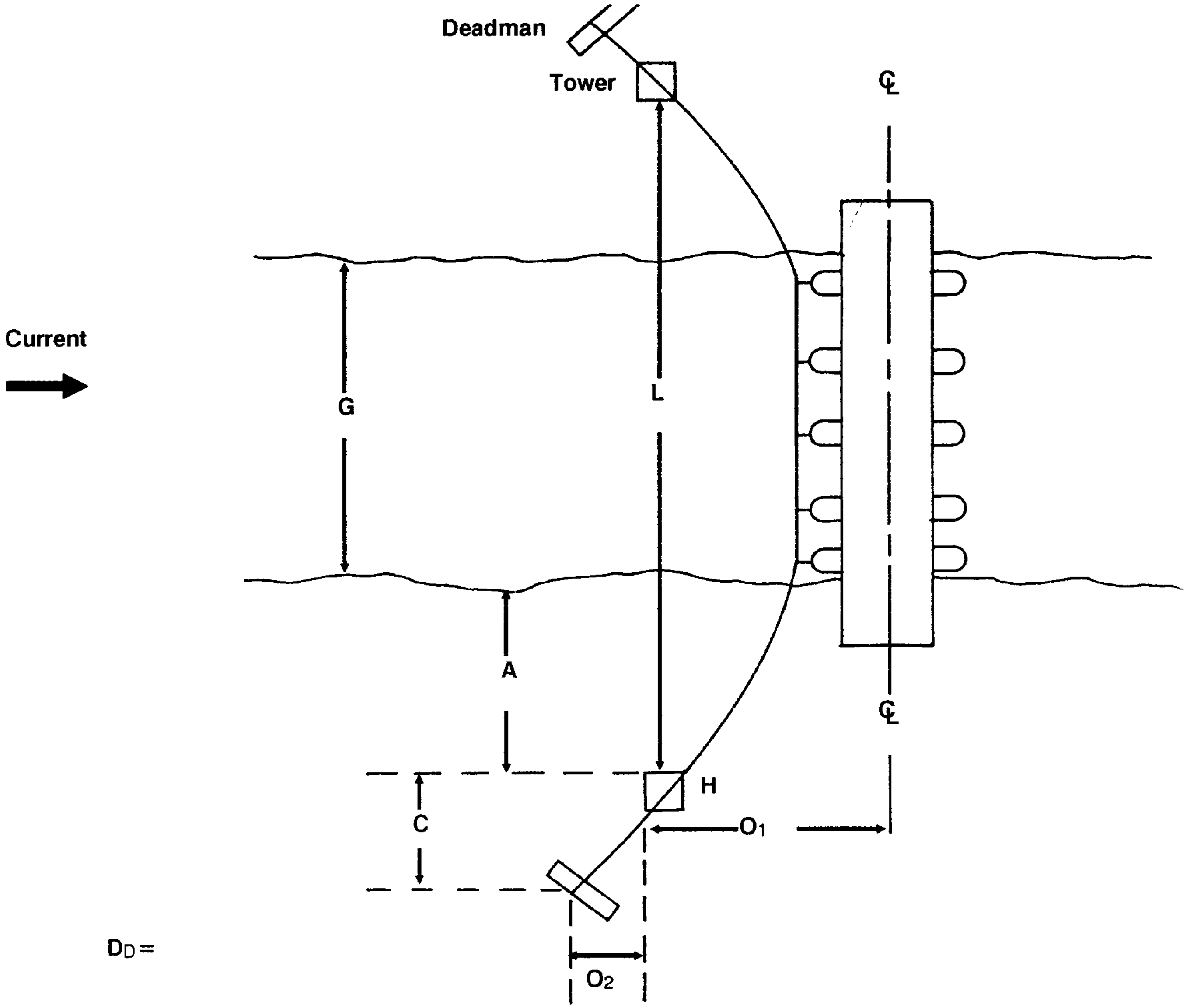
Step 16. Design a bearing plate for each deadman. Given deadman face (D_f) or log diameter (d) and the size of the master cable (C_D), refer to Table 63 to determine the length, thickness, and face of the deadman bearing plate.

x=

y=

z =

Design of an overhead anchorage system



$D_D =$

Table 57. Determination of cable size and number of cables for M4T6, Class 60, and ribbon bridges

Wet gap width (G) (feet)	Type bridge assembly	Size (inches) and number of cables for specified river velocities											
		5 FPS			7 FPS			9 FPS			11 FPS		
		Single	Dual	Triple	Single	Dual	Triple	Single	Dual	Triple	Single	Dual	Triple
200	Normal	1/2	3/8	3/8	5/8	1/2	1/2	3/4	5/8	1/2	7/8	3/4	5/8
	Reinforced	5/8	1/2	3/8	3/4	5/8	1/2	7/8	3/4	5/8	1- 1/8	7/8	3/4
400	Normal	5/8	1/2	1/2	3/4	5/8	1/2	1	7/8	5/8	1-1/4	1	3/4
	Reinforced	3/4	5/8	1/2	1	3/4	5/8	1-1/4	1	3/4	1-1/2	1-1/4	7/8
600	Normal	3/4	5/8	1/2	1	3/4	5/8	1-1/4	1	3/4	1-1/2	1-1/4	7/8
	Reinforced	1	3/4	5/8	1-1/8	1	3/4	1-1/2	1-1/4	7/8	*	1-1/2	1-1/8
800	Normal	7/8	3/4	5/8	1-1/8	7/8	3/4	1-3/8	1-1/8	7/8	*	1-1/2	1-1/8
	Reinforced	1-1/8	7/8	3/4	1-3/8	1-1/8	7/8	*	1-3/8	1	*	*	1-1/4
1000	Normal	1	7/8	3/4	1-1/4	1	7/8	1-1/2	1-3/8	1	*	*	1-1/4
	Reinforced	1-1/4	1	3/4	1-1/2	1-1/4	1	*	*	1-1/8	*	*	1-3/4
1200	Normal	1-1/8	7/8	3/4	1-3/8	1-1/8	7/8	*	1-1/2	1-1/8	*	*	1-3/8
	Reinforced	1-3/8	1-3/8	7/8	*	1-3/8	1	*	*	1-1/4	*	*	*

Table 58. Determination of cable size for light tactical bridges

Wet gap width (G) in feet	Current velocity			
	5 FPS	7 FPS	9 FPS	11 FPS
200	3/8"	3/8"	1/2"	1/2"
300	3/8"	1/2"	5/8"	3/4"
400	1/2"	1/2"	5/8"	3/4"
500	1/2"	5/8"	5/8"	3/4"
600	5/8"	5/8"	3/4"	7/8"

Table 59. Possible tower heights

Number of tower sections	Tower height (H)
Cap, base, and pivot unit	3 ft 8 1/4 in
With 1 tower section	14 ft 6 1/4 in
With 2 tower sections	25 ft 4 1/4 in
With 3 tower sections	36 ft 2 1/4 in
With 4 tower sections	47 ft 1/4 in
With 5 tower sections	57 ft 10 1/4 in
With 6 tower sections	68 ft 8 1/4 in

Table 60. Determination of anchorage cable in pounds/1,000

Type of cable	Cable size (in inches) (C_D)									
	3/8 "	1/2 "	5/8 "	3/4 "	7/8 "	1 "	1-1/8 "	1-1/4 "	1-3/8 "	1-1/2 "
IPS	12.6	21.6	33.2	47.4	64.4	84.0	106.0	130.0	157.0	185.0
PS	11.0	18.8	28.8	41.2	56.0	73.0	92.0	113.0	136.0	161.0
MPS	10.0	17.0	26.2	37.4	50.8	66.0	83.0	102.0	123.0	145.0

Table 61. Determination of required holding power in pounds/1,000 square feet

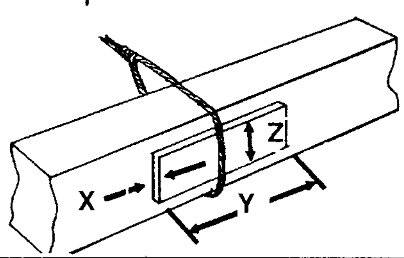
Depth of deadman (D_D)	Tower to deadman slope			
	1:1	1:2	1:3	1:4
3 ft	.95	1.3	1.45	1.5
4 ft	1.75	2.2	2.6	2.7
5 ft	2.8	3.6	4.0	4.1
6 ft	3.8	5.1	5.8	6.0
7 ft	5.1	7.0	8.0	8.4

Table 62. Determination of O_2 feet

Type of assembly	Current velocity				
	3 FPS	5 FPS	7 FPS	9 FPS	11 FPS
Normal	.09	.11	.14	.17	.19
Reinforced	.11	.14	.17	.19	.23

Table 63. Determination of bearing plate dimensions x, y, and z (in inches)

Deadman face (D_f)		Cable size (C_D)								
		3/8"	1/2"	5/8"	3/4"	7/8"	1"	1–1/8"	1–1/4"	1–1/2"
8"	x	7/16"	7/8"	1–1/4"						
	y	4"	8"	11"						
	z	6"	6"	6"						
10"	x	7/16"	11/16"	1"	1–3/8"					
	y	4"	6"	9"	12"					
	z	8"	8"	8"	8"					
12"	x	7/16"	9/16"	13/16"	1–1/8"	1–7/16"				
	y	4"	5"	7"	10"	13"				
	z	10"	10"	10"	10"	10"				
14"	x	7/16"	7/16"	11/16"	7/8"	1–1/4"	1–9/16"	2"		
	y	4"	4"	6"	8"	11"	14"	18"		
	z	12"	14"	12"	12"	12"	12"	12"		
16"	x	7/16"	7/16"	9/16"	13/16"	1–1/8"	1–3/8"	1–11/16"	2–1/8"	
	y	4"	4"	5"	7"	10"	12"	15"	19"	
	z	14"	14"	14"	14"	14"	14"	14"	14"	
18"	x	7/16"	7/16"	7/16"	11/16"	7/8"	1–1/4"	1–9/16"	1–13/16"	
	y	4"	4"	4"	6"	8"	11"	14"	16"	
	z	16"	16"	16"	16"	16"	16"	16"	16"	
20"	x	7/16"	7/16"	7/16"	11/16"	7/8"	1–1/8"	1–3/8"	1–11/16"	
	y	4"	4"	4"	6"	8"	10"	12"	15"	
	z	18"	18"	18"	18"	18"	18"	18"	18"	
24"	x	7/16"	7/16"	7/16"	9/16"	11/16"	7/8"	1–1/8"	1–3/8"	1–7/8"
	y	4"	4"	4"	5"	6"	8"	10"	12"	17"
	z	22"	22"	22"	22"	22"	22"	22"	22"	22"



Note.
The values in this table are based upon the use of Improved Plough Steel (IPS) cable, where:
x = bearing plate thickness
y = bearing plate length
z = bearing plate face