CHAPTER 5

FIELD MACHINE

SECTION 8

CALCULATION OF ANCHORAGES

0801. **Introduction**. In nearly all bridging operations and in work that involves the raising of weights by improvised means, fixed points of anchorage are required to which ropes can be attached. These points may be under water (anchors) or on land. In fact each and every engineer work requires some or other kind of anchorage and it is imperative to learn about various methods used in day to day combat engineering assignments.

0802. **Types of Anchorage**. Anchorage's may be of the following seven types:

a. Existing natural or structural holdfasts.
b. Picket holdfasts.
c. Ordnance pattern holdfasts.
d. Holdfast apparatus, rocket projected.
e. Wire Mesh anchorages.
f. Baulk holdfasts consisting of a combination of picket and log.
g. Buried anchorages.

0803. **Picket Holdfast**

a. Design a picket holdfast to resist a pull of 1636.36 kg (.45kg=1lb) with diagram

b. **Given data**.

(1) Resisting pull = 1636.36 kg
= 3636.35 lbs [.45kg=1lb]
= 1.64 tons [1ton= 2240lb]

(2) Find out. Design of picket holdfast

(3) Summary. Design 3:2:1 picket holdfast.

(4) Calculation.

Number of pickets require=$\frac{\text{Resisting Pull in ton x 20 (in cwt)}}{\text{Sustain Load of one picket (in cwt)}}$ [1 ton= 20 cwt]

$$= \frac{1.64 \times 20}{6} = 5.4 \cong 6$$

(As one picket can sustain 7 cwt. But due to bad condition or being old, considering it as 6 cwt)

[Auth: GSTP 1609 FEMW Basic FE Part II Section 68 Para 336 page 163]

0804. **Ordnance Pattern Holdfast (OPH).**

a. Design a Ordnance Pattern Holdfast (OPH) to resist a pull of 5.5 ton in fairly good ground (angle of pull not exceeding 20^0). Draw required diagram.

b. **Given data**

(1) Resist a pull of 5.5 ton

(2) Find out. Design of OPH.

(3) Summary. Design 03 holdfast in Y shape.

(4) Calculation.

One Ordnance Pattern Holdfast can resist 2 tons of pull on fairly good ground.

[Auth: GSTP 1609 FEMW Basic FE Part II Section 68 Para 341 page 165]

Number of Ordnance Pattern Holdfast = $\frac{5.5}{2}$ = 2.75 ≅ 3 Nos

We can use Y type holdfast.

0805. **Baulk Anchorage.** Design a 3:2:1 picket holdfast with log (Baulk anchorage) to sustain a reversal power of 8.25 ton. Find out the total number of picket's required. Length and diagram of the log. Check the log for sear. Consider a round log.

a. **Given data**.

(1) Picket holdfast 3:2:1.
(2) Reversal power 8.25 ton.

b. **We have to find out**.

(1) Total number of pickets
(2) Length of the log
(3) Diagram of the log
(4) Shear check

c. **Summary**.

(1) Total number of pickets = 36 Nos.
(2) Length of the logistics = 8.5 ft. [For consulting the table, consider 10']
(3) Diagram of the log = 9 inch.
(4) Shear check ok.

d. **Calculation**.

Number of pickets require= $\frac{\text{Resisting Pull in ton x 20 (in cwt)}}{\text{Sustain Load of one picket (in cwt)}}$ [1 ton= 20 cwt]

$= \frac{8.25 \times 20}{6} = 27.5 \cong 36$ Nos

(For equal distribute both sides, since 3:2:1 picket holdfast)

[Auth: GSTP 1609 FEMW Basic FE Part II Section 68 Para 354 (a) page 180]

(Though one picket can sustain 7 cwt, but due to bad condition or being old, considering it as 6 cwt)

[Auth: GSTP 1609 FEMW Basic FE Part II Section 68 Para 336 page 163]

Total 06 sets of 3:2:1 pickets holdfast

Length of the baulk = (5x 1.5') + 6" + 6"
= 8.5 feet [For consulting the table, consider 10]
[Note: Length of the baulk is measured through following figure]

As the chart starts from 10 feet length let it be considered as 10 feet length.

From the table if the length of the log/spar is 10′, maximum 8.2 ton weight can be carried by 8″ dia. But, as weight is 8.25 ton, so dia of log = 9"

[Auth: GSTP 1609 FEMW Basic FE Part II Appendix V Table 10 page 504]

Shear Check = $^3/_4$ x fs x A

[Auth: GSTP 1609 FEMW Basic FE Part II Appendix T Para 7(b) page 496]

= $^3/_4$ x $^1/_3$ x πr^2 [for timber service is 1/3,for MS it is 5 ton per sq inch]

[Auth: GSTP 1609 FEMW Basic FE Part II Appendix T Para 7(b) page 496]

$= {}^3/_4 \times {}^1/_3 \times \pi \times (4.5)^2$
= 15.9 tons.

As it can sustain more than 8.25 ton so the log is safe.

0806. **Buried Anchorage.**

a. How deep must a log 16 feet and 12 inches diameter be buried in good ground in order to resist a pull of 55,500 lbs at an inclination of 1 in 1. Check the log for shear.

b. **Given Data**.

(1) Length of log 16 feet.
(2) Dia of log 12 inches
(3) Resist a pull of 55, 500 lbs
(4) Inclination 1 in 1

c. **We have to Find Out**.

(1) Depth of the trench
(2) Check the log for shear

d. **Summary**.

(1) Depth of the trench = 7 feet.
(2) Check for the shear ok

e. **Calculation**.

Shear $= {}^{3}/_{4}$ x fs x A

[Auth: GSTP 1609 FEMW Basic FE Part II Appendix T Para 7(b) page 496]

$= {}^{3}/_{4}$ x $1/_{3}$ x $\pi (6)^2$[for timber fs is 1/3,for MS it is 5 ton per sq inches]

[Auth: GSTP 1609 FEMW Basic FE Part II Appendix T Para 7(b) page496]

= 28.27 ton
= 62203.5 lb

As it is greater than 55,500 lb, so it can sustain.

Eff length = 16' - 2' (As the cable trench width is 2'

[Auth: GSTP 1609 FEMW Basic FE Part II Appendix U Para 2 page 498]
= 14'
Effective area = dxL

$= \frac{12}{12}$ ft x 14

$= 14$ ft^2

Distribution of load $= \frac{55500}{14}$ lb/feet^2

$= 3964.28$ lb/feet^2

From the table, [Auth: GSTP 1609 FEMW Basic FE Part II Appendix U Para 3 page 498] Mean depth of face of anchorage below surface is 7 feet.

0807. **Wire Mesh Anchorage**. After completion of Basic Course you have joined the unit. Your unit was tasked to prepare pontoon rafts and conduct rafting in the river MODHUMATI. The river current was too high and the rafts on the river bank needed heavy anchorage. But the river bank being sandy clay soil it was difficult to construct baulk or buried anchorage. The heavy current of the river creates a pull of 18 ton on the raft. CO of your unit asked your suggestion. Basing on your teaching of basic course you told. "Sir we can construct wire mesh anchorage". Your CO was convinced that a wire mesh anchorage in that clay soil could sustain the pull of 18 ton. He tasked you to calculate the number of pickets required and also the length of wire mesh. BRC Fabric of 3 inches wire mesh of 5 gauge wire and sheet width of 7 feet 3 inches to be used. Also calculate the permissible stress on each wire and maximum possible pull for the wire mesh. You must use two steel wire roof from the log to distribute the total pull.

a. **Given Data**.

(1) Sustain a pull of 18 ton.
(2) 3 inches wire mesh
(3) 5 gauge = 0.21 inches dia wire
[Auth: GSTP 1609 FEMW Basic FE Part II Appendix T Para 1(a) page 495]
(4) Width = 7 feet 3 inch

b. **We have to Find Out**.

(1) Number of pickets.
(2) Length of wire mesh.
(3) Permissible stress on each wire
(4) Maximum possible pull of the wire mesh

c. **Summary**.

(1) Number of pickets 176 Nos
(2) Length of wire mesh 61.5 feet
(3) Permissible stress on each wire 0. 35 ton
(4) Maximum possible pull of the wire mesh 21 ton

d. **Calculation**.

Width of mesh = 7'3" = 87 inches

Number of wire = $\frac{87"}{3"}$ = 29+ 1 = 30 Nos.

Gap between two wire is 3"

One wire of cross sectional area 1in^2 can sustain 10 tons of loads
[Auth: GSTP 1609 FEMW Basic FE Part II Appendix T Para 1 page 495]
For 0.21 inch dia
Area = πr^2
= $\pi x (\frac{0.21}{2})^2$
= 0.0346 in^2
So, it can sustain = 0.0346 x 10
= 0.346 ton
= 0.35 ton (For single wire)
For 30 wire it can sustain = 0.35 x 30
= 10.5 ton
For top and bottom layer = 10.5 x 2
= 21 ton (maximum permissible stress)
Number of pickets require = $\frac{18x20}{2}$ (Clay soil can resist 2 cwt)
[Auth: GSTP 1609 FEMW Basic FE Part II Appendix T Para 2 page 495]
= 180 Nos
In one row along width = $\frac{7.25ft}{1ft}$ = 7.25 ≅ 8 Pickets are reqr
So number of row along length = $\frac{180}{8}$ = 22.5
Let it consider 22 nos of row
So the number of pickets = 22x 8
= 176 Nos

AB = 4'
BC = 11 X 1.5 = 16.5'
CD = 4'
DE = 16.5'
AC= 20.5'

Total length of mesh = 61.5 feet.

0808. **References.** GSTP 1609 FEMW Basic FE Part II Appendix V Table 10 page 504

Serial	Effect length of spar(ft)	Safe load in tons spars of mean diameter as under										
		6"	7"	8"	9"	10"	11"	12"	13"	14"	15"	16"
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(j)	(k)	(l)	(m)	(n)
1	10	3.4	5.4	8.2	11.8	15.9	20.8	26.4	32.9	40.8	46.7	56.9
2	15	108	2.6	5.1	7.6	10.4	14.0	18.6	22.9	29.9	36.3	41.3
3	20	0.9	1.9	3.3	5.1	7.3	10.3	13.5	17.6	21.5	27.4	32.9
4	25	9.4	1.0	2.0	3.4	5.1	7.2	10.0	12.9	16.6	21.1	25.2
5	30		0.4	1.1	2.1	3.5	5.3	7.4	10.1	12.9	16.4	20.5
6	35			0.5	1.3	2.3	3.6	5.4	7.4	10.4	12.8	16.0
7	40				0.5	1.3	2.4	3.8	5.6	7.7	10.4	13.1
8	45					0.5	1.3	2.5	3.9	5.8	7.9	10.0
9	50						0.4	1.4	2.7	4.2	5.9	8.0
10	55							0.5	1.5	2.6	4.2	5.9
11	60								0.6	1.5	2.8	4.4
12	65									0.5	1.7	2.8
13	70										0.6	1.7
14	75											0.5
15	Size of Equivalent Square baulk(in)	5.0	5.8	6.7	7.5	8.3	9.2	10.0	10.8	11.7	12.5	13.3

Table-10: Size of Spar for Derrick, Sheer and Gyn, GSTP-1609

Serial	Mean depth of face of anchorage below surface	Safe resistance in IB per square feet anchor face when force drawing the anchorage (in a direction perpendicular to face) is inclined at			
		1/1	1/2	1/3	1/4
(a)	(b)	(c)	(d)	(e)	(f)
1	1	110	150	160	175
2	1/2	250	320	360	390
3	2	410	580	650	700
4	3	950	1300	1450	1500
5	4	1750	2200	2600	2700
6	5	2800	3600	4000	4100
7	6	3800	5100	5800	6000
8	7	5100	7000	8000	8400

Table-8: Size Resistance of Earth Face in a Buried Anchorage, GSTP-1609

0809-0900 Reserve.