FIELD MACHINE

SECTION 10

CALCULATIONS FOR DERRICK, SHEER AND GYN

1001. **Introduction.** Derrick, sheer and gyn are found to be very important field machines for lifting and shifting loads. These are accumulation of various field machines like blocks, tackles, and anchorages etc which have been discussed during theoretical classes. Derrick is a single vertical spar with a lifting tackle lashed to its head. It has following parts:

a. **Butt of Spar**. It rests on ground to keep the derrick vertical.
b. **Tip of Spar**. It is the place where the guy ropes are attached.
c. **Guys**. Ropes secured by clove to the head of derrick at rig height angles to each other in plan.
d. **Lifting Tackle**. Used to lift the load attached at the head of derrick.
e. **Leading Block**. Used to change the direction of running end, normally this is a snatch block.
f. **Foot Ropes**. For adjusting with runner tackle.
g. **Holdfast**. For holding a load.
h. **Running Guys**. It has a tackle on it, which enables it to be adjusted. Running guys are used for all guys on whom the rig height will come when the derrick is in use.

1003. **Given Data**. Design a derrick for unloading packing cases from a 3 ton lorry and load it on a dumper. The other relevant data are as follows:

a. Weight of packing case 1.5 ton.
b. Size of packing case 2.5″ x 3′ x 2.5″
c. Height of dumper and lorry from ground 4′-0″.
d. Sides of dumper and lorry above floor -2′-0″.
e. Height of sling (4 legged sling making 30″ with vertical line)- 3′-0″.
f. Choc a Block 4′-0″.
g. Overall width of dumper -8′
h. Distance between dumper to 3 ton lorry -1′-6″
j. Overall width of 3 ton lorry -8′.
k. Free Space-3′.
l. Work space 3′.
m. New steel wire rope or good cordage has to be used.

For design purpose other relevant data's may be assumed.

1005. **Size of Spar/Log.**

a. **Length of Spar**.

(1) **Minimum Height of the Spar**. Min height of spar can be estimated by considering the maximum vertical height to which the load must be raised (occurs over the truck)

Height of the floor of lorry and wagon	4′ 0″
Height of side wall of lorry	2′ 0″
Height of packing case	2′ 6″
Choc A block	4′ 0″
Height of Sling	3′ 0″
Allowance from lashing to tip of spar	3′0″
Allowance for butt underground	1′
Allowance for fixing block to spar	1′
Free work space over the side of lorry	2′
Minimum Height of the spar	

22′6″

(2) **Maximum Height of the Spar**.

Max Horizontal Reach will be-Width of lorry	8′0″
Space between wagon and lorry	1′6″
Half of the width of wagon	4′0″
Work space	3′0″
Maximum horizontal reach	16′6″

Derrick work in the maximum slope of 3:1
Height of the spar= 16′5″x3=49′5″=50′

To ascertain the effective length of the spar to obtain this height at maximum slope, we have to add 1 in 20 to the height,

So the maximum length of the spar will be = 50+5% of 50′
= 50′+2′ 6″ = 52′ 6″

b. **Diameter of Spar.** The maximum stress induced in the spar is obtained from table-9(p/503), GSTP-1609. The max load to be lifted is 2 tons. The spar must withstand a load of:
The stress in derrick = 2.0 W = 2.0x 1.5 ton = 3 ton.

Since the effective length is 52′ 6″ and the maximum imposed load is 3 tons, the mean dia of spar should be 15″. [From table 10(Page-504), GSTP-1609]

1006. Determination of the Size of Lifting Tackle. The maximum weight to be lifted is 1.5 tons (1.5 x 20 = 30 cwt). The maximum safe load on 3″ cordage in a 3/3 cordage in a 3/3 tackle is 1.59 tons. So we will use 3/3 tackle with one leading block.

a. **Size of SWR/Cordage**.

We know, $P = \frac{W}{G}(1 + fn)$

Where P = Pull required on the running end of the fall.

W = Weight to be moved.

G = Theoretical gain.

n = Total no of sheaves including leading block.

f = a co-efficient of friction varying from 1/5 to 1/10 according to the state of tackle.

Here, W = 30 cwt (1.5 ton x 20 cwt)

G = 6 (figure-115, p-141, General Study Training Pamphlet-1609)

n = 3/3 tackle + 1 for leading block =(3 + 3) + 1= 6+1 = 7

f = 1/10 (as more friction in steel were rope

So, from the formula we get:

$$P = \frac{30}{6}\left(1+\frac{1}{10} \text{ x}7\right)$$

Pull required on the running end of the fall, P = 8.5 cwt (for cordage)

For accurate handling of the load a multi sheaves is convenient, but for rapid handling with lift of this dimensions the no of returns in the tackle must be kept down. So, in case of steel wire rope, we will use 2/2 tackle with 1 leading block.

For SWR, $P = \frac{30}{4}\left(1+\frac{1}{5} \text{ x } 5\right)$ = 15 cwt (for SWR)

For cordage, P = 8.5 cwt,

We know,

$C^2 = P = 8.5$

C = 2.92 = 3″ (considered)

For SWR, [from para 7, Appx Q, GSTP -1609]

$9C^2 = P = 15$

$C^2 = 15/9$

C = 1.29 = 1.5″ (considered)

Circumference of SWR in tackle = 3″ for cordage and 1.5″ for SWR

b. **Lashing of Block to Spar**.

The pull on lashing is W +P for lifting tackle. [para 8, Appx R, GSTP -1609]
Pull or lashing = W + P = 30 + 8.5 = 38.5 cwt (for cordage)

For convenience use 3″ cordage, as for the main tackle and assume a lashing of N turns (2N returns). Then making allowance for sharp bends and unequal distribute of stress, we get for 3″ cordage:
$2N \times C^2 \times 2/2 \times 4/5 = P$ [para 8, approx Q, GSTP -1609]

$$2n \times (3)^2 \times \frac{2}{3} \times \frac{4}{5} = 38.5$$

$$2N = \frac{38.5 \times 3 \times 5}{9 \times 2 \times 4} = \frac{577.5}{54}$$

$$N = \frac{577.5}{54 \times 2} = 4.01 = \text{turns (consider for cordage)}$$

Pull or lashing = W + P = 30 + 15 = 45 cwt (for SWR)

$2N \times 9C^2 \times 2/3 \times 3/5x = P$ (para-8, approx Q, GSTP-1609)

$2N \times 9 \times (1.5)^2 \times 2/3 \times 3/5 = 45$

N = 2.77 = 3 turns (considered for SWR)

So, number of turns = 4 (for cordage) and 3 for SWR.

c. **Lashing for LeadingBlock to Spa**r. The pull in the fall is 8.5 cwt for cordage and 15 cwt for SWR.

Load on the leading block = $\sqrt{2}$ P [para-9, Appx. R, GSTP 1609]
= $\sqrt{2}$ x 8.5 (for cordage) and = $\sqrt{2}$ x15 (for SWR)
= 12 cwt and =21.21 cwt for SWR

Using 1.5″SWR we know,

$2N \times 9C^2 \times 2/3 \times 3/5 = 21.21$

N = 1.3 = 2 turns

Using 3″ cordage we know,

$2N \times C^2 \times 2/3 \times 3/5 = 12$

N = 1.25 = 2 turns

No of turns for both wire is 2 turns.

d. **Size of Sling for Support the Load**

The formula for the angle between the legs of sling is:

W = n P cos ϴ [para 20b, Appx Q, GSTP 1609]

$P = \dfrac{30}{n \cos \theta}$ $P = \dfrac{W}{3.44}$ [table, para 20b, Appx Q, GSTP 1609]

$P = \dfrac{30}{n \cos \theta}$ $P = \dfrac{30}{3.44}$

P = 8.72 cwt

Now, for steel were rope = $9C^2$ = P = 8.72
C^2 = 0.96
C = 1″

Now, for cordage = C^2 = P = 8.72
C = 2.95
C = 3″

So, circumference for sling steel were rope 1″ and for cordage 3″

1007. **Determination of the Size of Various Guys.**

a. **Size ofSteel Were Rope/Cordage for Back Guy.**

From table-9, Appx V, p-503, GSTP 1609 we get the maximumstress on back guy 0.7 W = 0.7 x 30 = 21 cwt without splitting back guy and 2/2 tackle.

We know, $P = \dfrac{W}{G}(1 + fn) = \dfrac{21}{4}(1+4/10)$ = 7.35 cwt for cordage

Again,We know, $P = \dfrac{W}{G}(1 + fn) = \dfrac{21}{4}(1+4/5)$ = 9.45 cwt for SWR

So, C^2 = P = 7.35
C = 2.71″ = 3″ for cordage

So, $9C^2$ = P = 9.45 C^2 = 9.45/9
C = 1.02″ = 1.5″ for SWR

Circumference of SWR is 1′5″ and for cordage 3″

b. **Size of Cordage for Other Guys.**

From table-9, Appx V, p-503, GSTP 1609
Maximum stress = 0.3 W = 0.3 x 30 = 9 cwt.

We know, $P = \frac{W}{G}(1 + fn) = \frac{9}{4}(1+4/10) = 3.15$ cwt for cordage

We know, $P = \frac{W}{G}(1 + fn) = \frac{9}{4}(1+4/5) = 4.05$ cwt for SWR

Now for cordage the size of rope will be:

$C^2 = P$
$C^2 = 3.15$
$C = 1.77 = 2''$

So, $9C^2 = P = 4.05$ $\quad C^2 = 4.05/9$
$C = 0.67'' = 1''$ for SWR

Circumference of SWR is 1″ and for cordage 2″

c. **Type of Tackle for Guys**. Usually 2/2 tackles are used;

d. **Length of Steel Were Rope/Cordage for One Guy**.

The horizontal distance of back guy = 2x effective spar length.

So the length of back guy = [{(2 x eff spar length) + eff spar length} + 20% allowance (para 10b, Appx. V, GSTP 1609)
= {2x(52.5 -4)} +(52.5-4) + 20%}
= (2 x 48.5) + 48.5 + 20%
= 145.5 + 20%
= 145.5 + 29.1
= 174.6′

e. **Anchorages for Guys**. Stress on back guy is 21 cwt. So 3: 2: 1 picket holdfast (2 ton) may be used, stress on other guys is 9 cwt each.So, 1:1 picket holdfast (14 cwt) may be used.

1008. **Determination of the Size of Foot Ropes.**

a. **Number of Footropes**. As our direction of work is only one side so, one footrope is required. But for safety and better operation if stores available, then 2 footropes to be given.

b. **Length of the Footrope Using 3/3 Tackle**. We know the distance of footrope

= 1.5 x eff spar length crossingno of returns of 3/3 tackles
= 1.5 x (52.5 - 4) x 6
= 436.5′

c. **Type of Anchorage**. 3: 2: 1 picket holdfast is normally used.

1008-1100 Reserve.