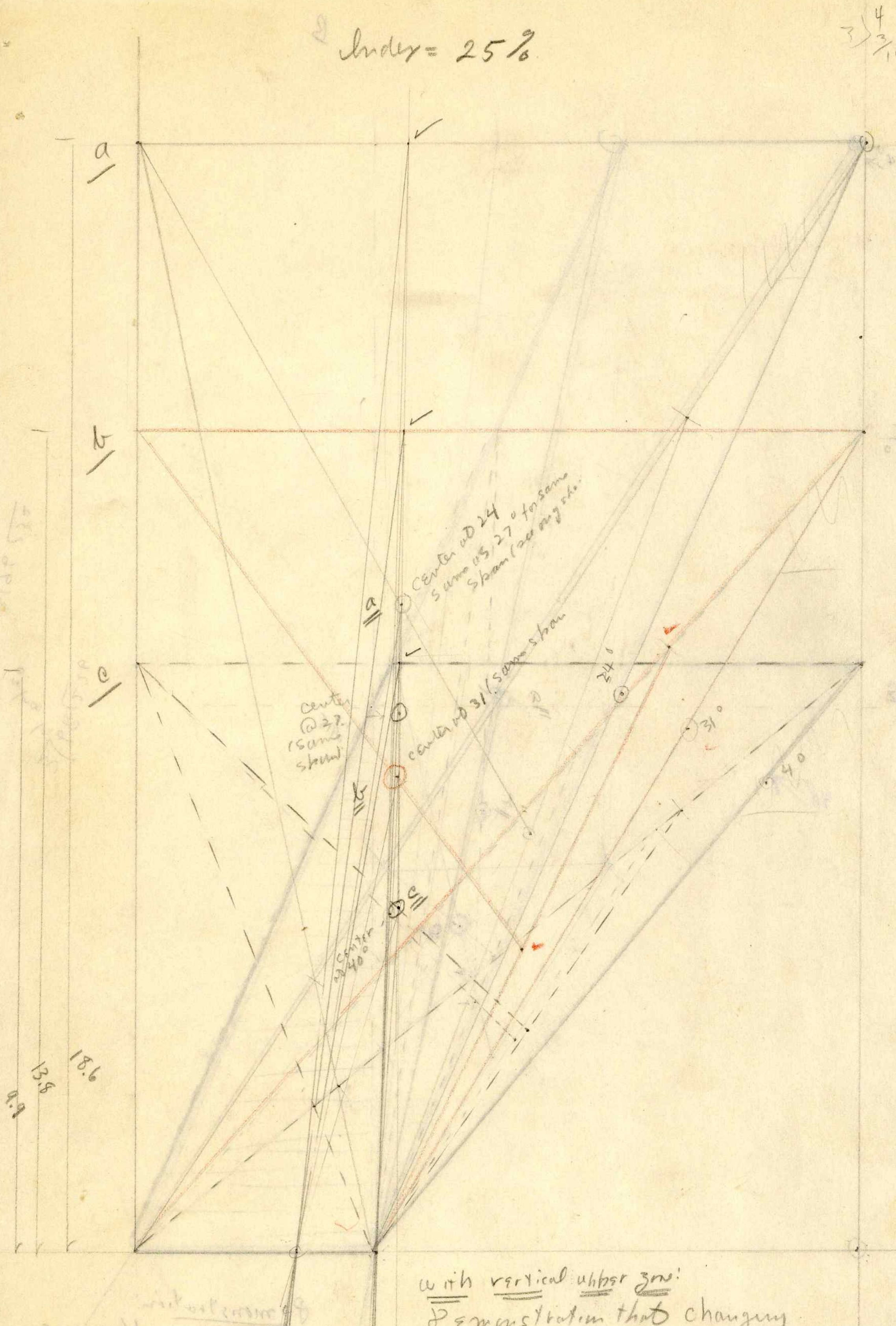
Oversized item not scanned

A

Index = 25%



Overhang areas (~~Span = 16~~) Overhang 8, ~~span~~

Stabb areas (wall = 4)

Wall Index

a 18.6 × 8 = 148.8; 2) 148.8 = 74.4 | 18.6 × 4 = 74.4 × 2 = 148.8

b 13.8 × 8 = 110.4; 2) 110.4 = 55.2 | 13.8 × 4 = 55.2 × 2 = 110.4

c 9.9 × 8 = 79.2; 2) 79.2 = 39.6 | 9.9 × 4 = 39.6 × 2 = 79.2

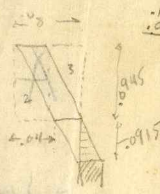
With vertical upper zone:

Demonstration that changing soffit slope 3° either way from 40° ~~does not change~~ stability, ~~if span is the same.~~

But ~~that at 40° the~~ stability ~~begins to increase.~~

See other sheet: same, 15° to 55°

.18.60
.09.15
945



Overhang areas | Stab areas | Weight Index

a
.0945
× 8
.7560

a
.0915
4
2].3660 .1830

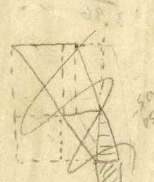
56
18
.74

.0945
4
.3780

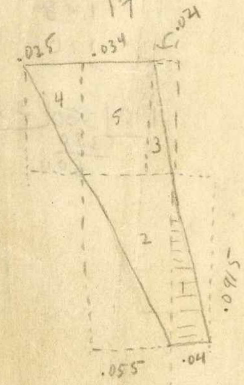
Ratio a 18/56

.756
− .378
.378
+ .183
.561

b



Stab area = 18.30



Overhang

2 − .0915
5.5
4575
4575
2].503252 .25162

Stab
.0915
4
2].3660 .1830

Ratio b 18/51

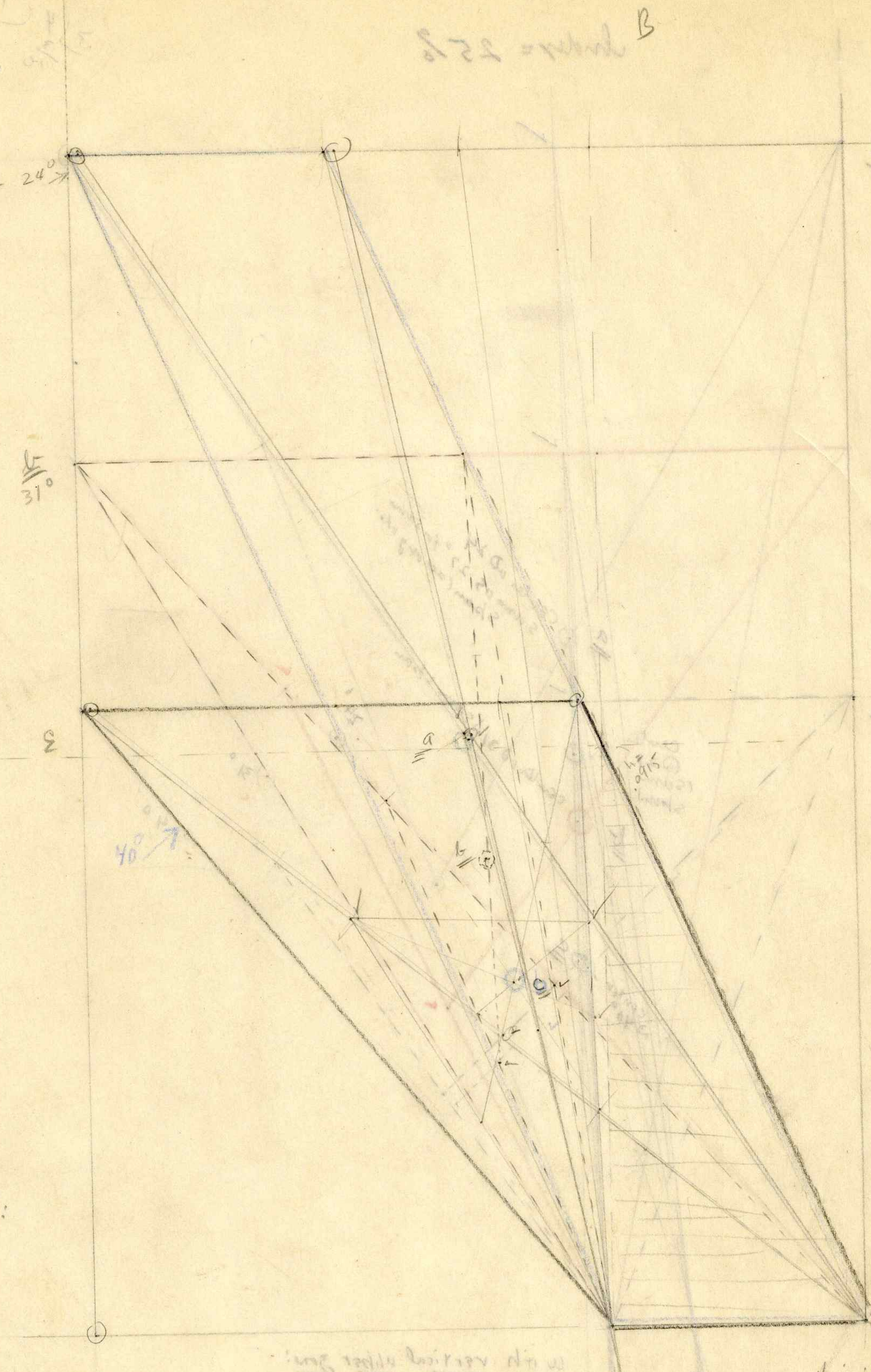
3 − .0465
2.1
465
930
2].097652 .04882

.251
.048
.058
.158
.515

Weight:
51
18
69

4 − .0465
2.5
2325
930
2].116252 .05812

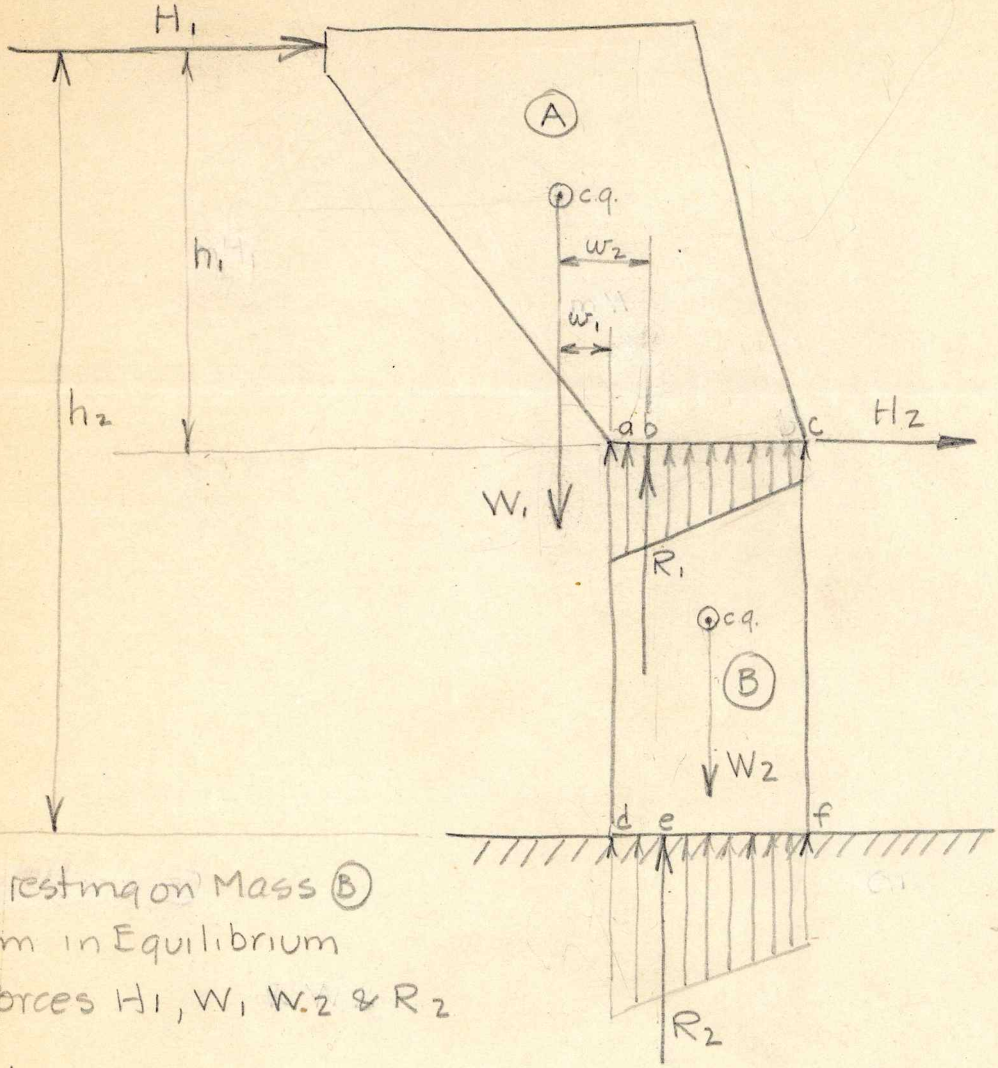
5 − .0465
3.4
1860
1395
.15810 → .15810



Demonstration:
with sloping upper zone.

~~Reducing~~ Increasing soffit slope, for same upper zone slope, increases stability (from 24° to 40° on a straight line). Also to 55° (see other sheet) with keeps upper zone outside ~~[illegible]~~ overhang.

STRESS ANALYSIS



Mass (A) resting on Mass (B)
System in Equilibrium
under forces H_1, W_1 W_2 & R_2

$W_1 = R_1$

$W_1 + W_2 = R_2$

$W_1 \times w_1 = H_1 \times h_1$ (moments around point a.)

If W_1 were great enough to increase the unit loading between points a + b so that failure of mass (B) under compression between these two points occurs then:-

$W_1 \times w_2 = H_1 \times h_1$ (moments around point b)

$H_1 = H_2$ (since friction is great enough along a-c to prevent slippage)

If W_1 ~~is~~ increased to point of failure of the structure:-

1. H_1 will increase to counteract the overturning

moment $W_1 \times w_1$ (or $W_1 \times w_2$)

2. R_1 and R_2 will increase by the same amount

3. H_2 will increase to equal H_1

If W_1 is then slightly increased causing failure one or more of following results will occur

If (B) remains does not tilt

Case I (A) will slide along (B) on line a-c (due to increase in H_1)

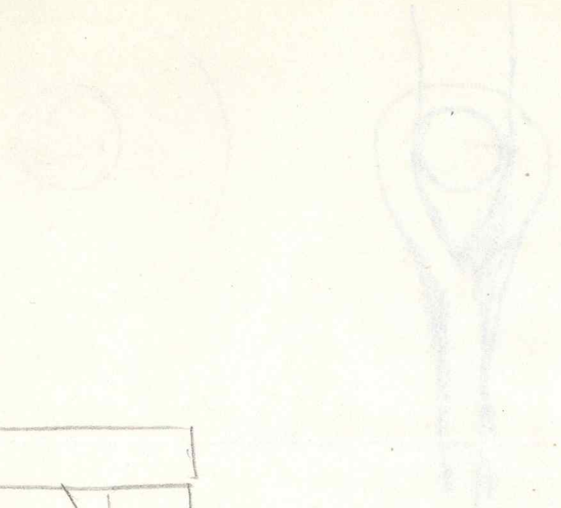
Case II (A) will fail in flexure as an inclined beam

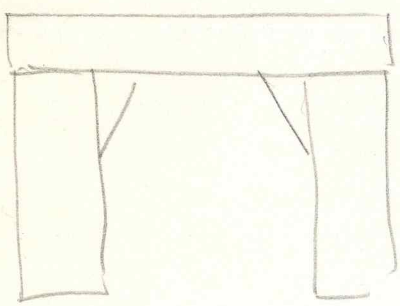
Case III H_1 will fail

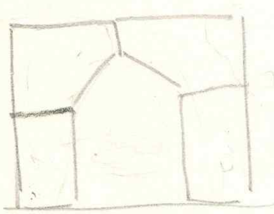
Case IV (B) will crush

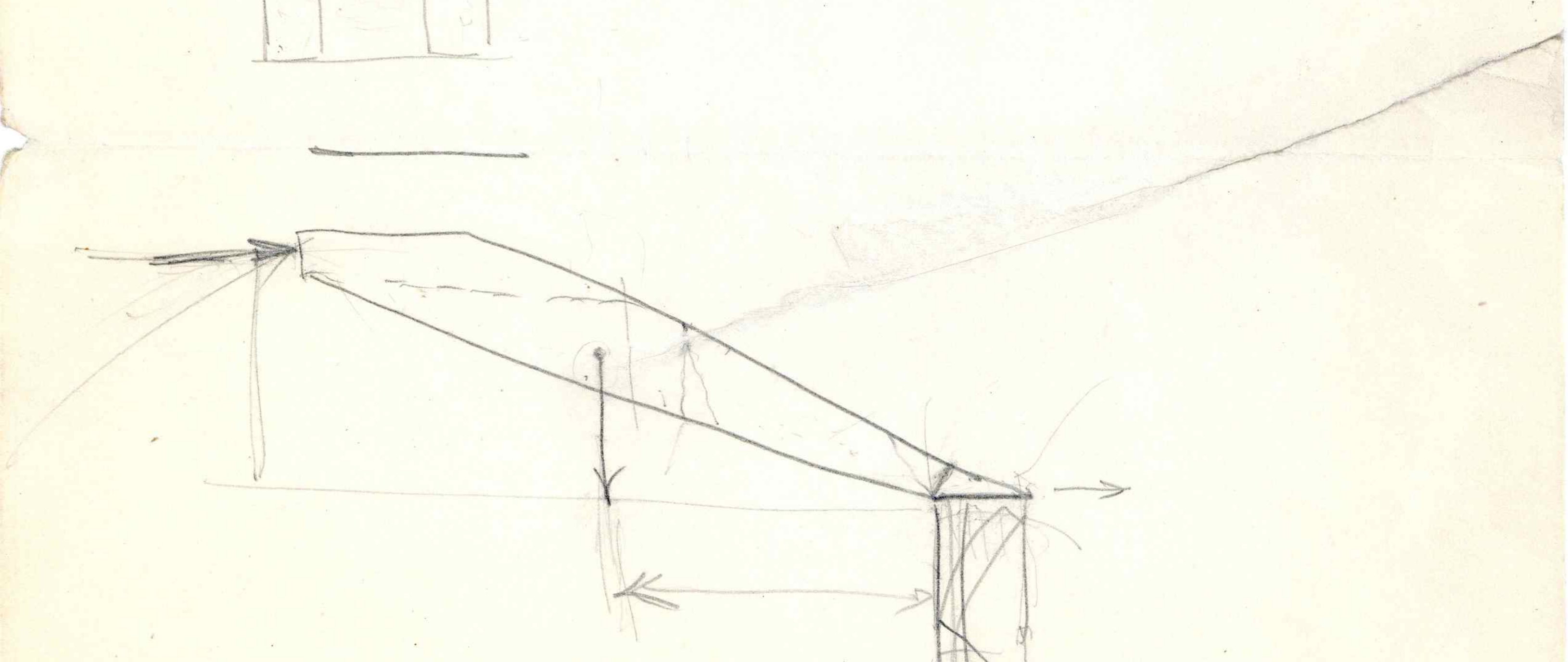
Case V (B) will fail as a column

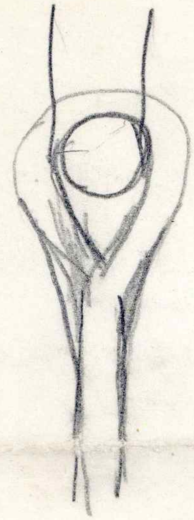
Case VI (A) will fail in shear near support of mass (B)

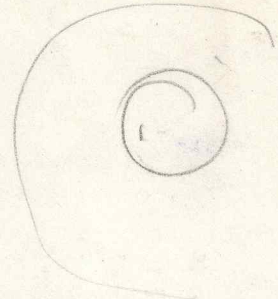












Oversized item not scanned

Vert outer zone.

See Figure A

a w = 148.8
c arm = 4

c Moment = 148.8
× 4
595.2 (moment)

~~9.9 F = 595.2~~

F = ~~9.9~~) ~~595.20~~ (6.01 +
594
120

18.6 F = 595.2

F = 18.6) 595.2 (32
558
372
372

b w = 110.4
arm = 4
441.6 (Moment of c)

13.8 F = 441.6

F = 13.8) 441.6 (32.
414
276
278
↑
error in display

c w = 79.2
c arm = 4
c Moment = 316.8

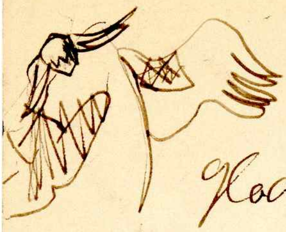
9.9 F = 316.8

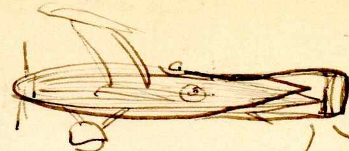
F = 9.9) 316.8 (32.
297
198
198

4/4 (13.8/18.6 is it equal to w of b / w of a ?)

552 > 744

552/744



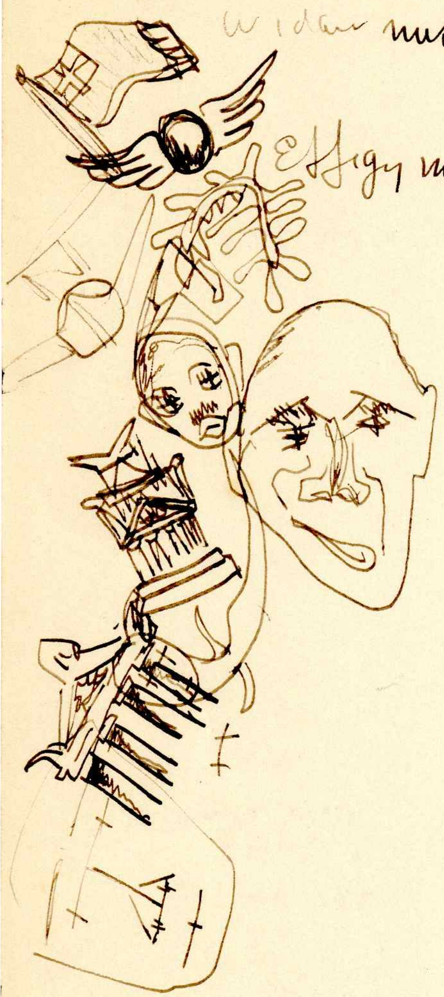


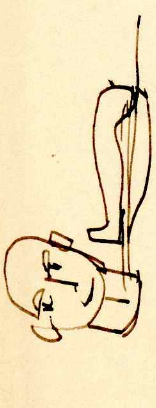
Winnebago

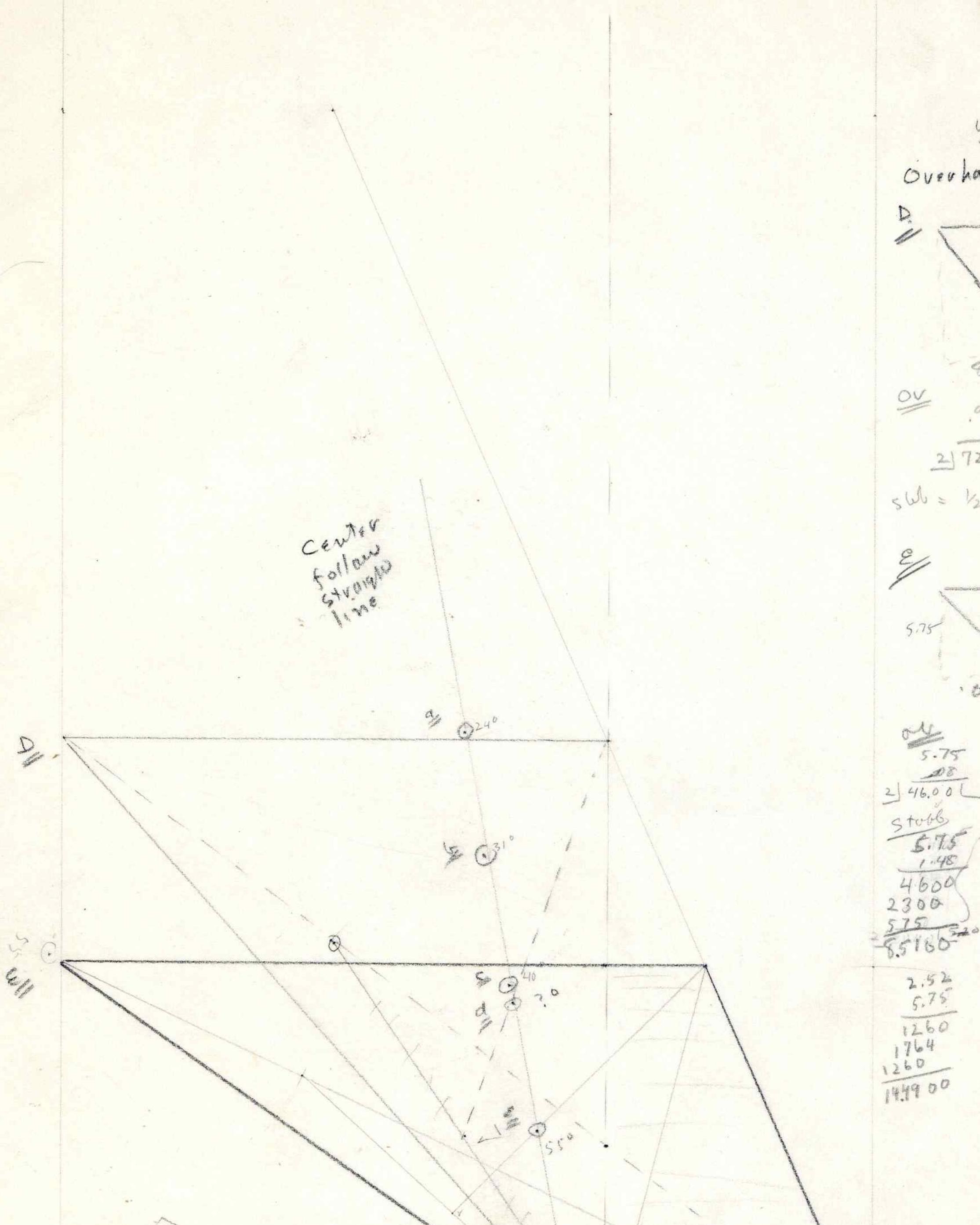
Feast of death – the rites for the decedant.

Widow must enjoy herself, forget the decedant.

Effigy mounds – some thought to represent clan animals.



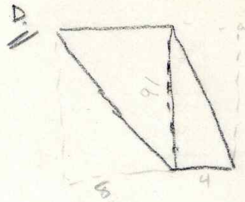




Weights

Overhang.

D.



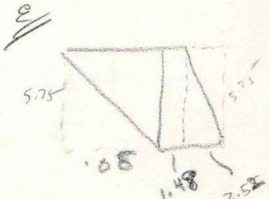
OV

.91
8
2 | 728 | 364

stub = 1/2 = 182

556

E



ov

5.75
.08
2 | 46.00 | 23.00
8.51
14.49
46.00

stub
5.75
1.48
4600
2300
575
8.5100

2.52
5.75
1260
1764
1260
14.49 00

4.00
1.48
2.52

Demonstration:

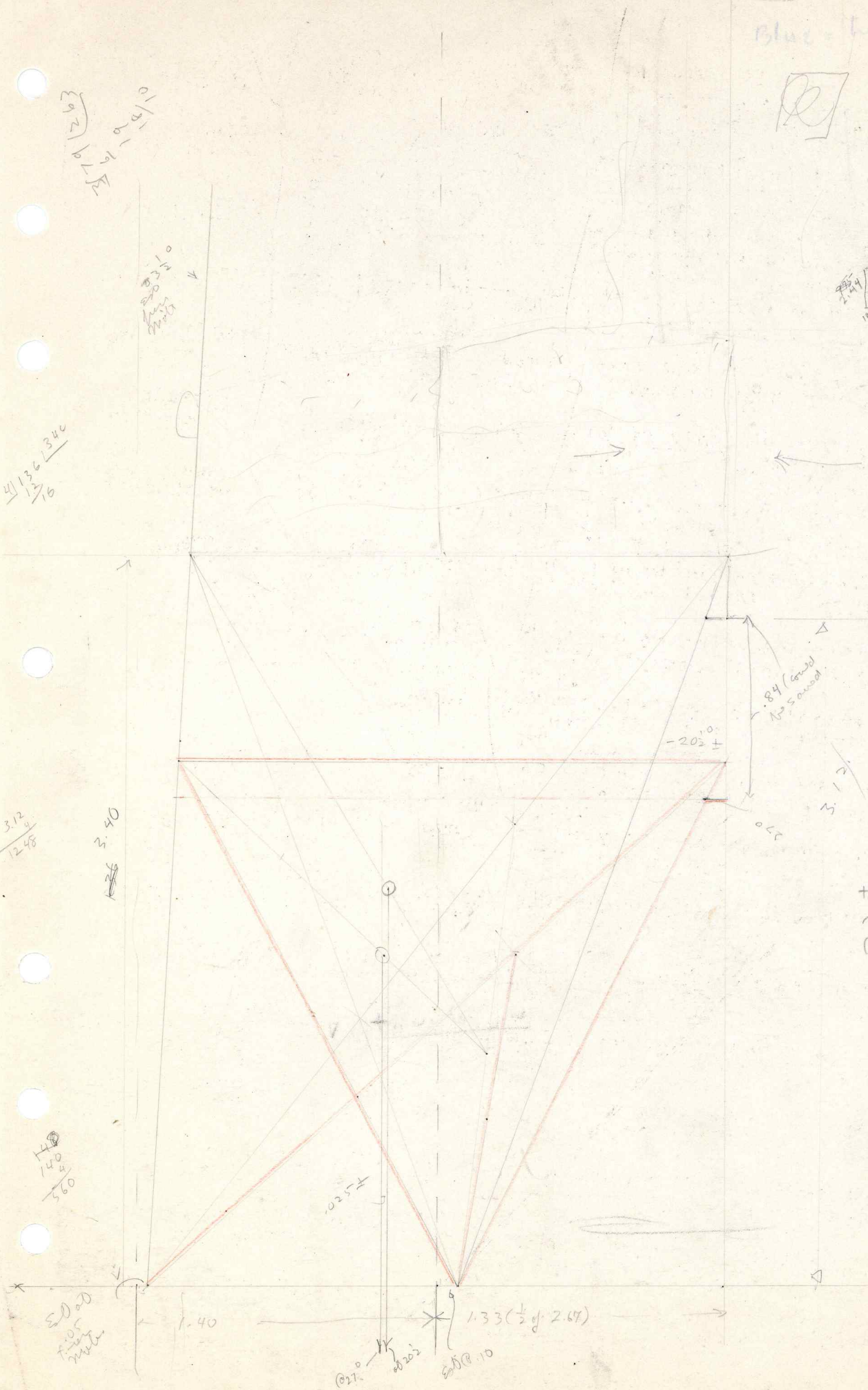
with sloping outer zone:

Flattening soffit slope increases stability

For 20°, 31°, 40° see other sheet (points traced).

∴ with sloping zone, flatter the vault, the lighter + more stable = lower effect on index.

Str 20, Yaxchilan



3.40 × .10 = .3400

3.40
1.23
1020
680
340
2) 4.1820 — 2.0910
2.4310

Rat: 1.33 / .99 — 3.40 / 2.43

2.44 × 10 = .2440

2.44
1.23
732
488
244
2) 3.0012 — 1.5000
1.7440

Rat: 2.44 / 1.74

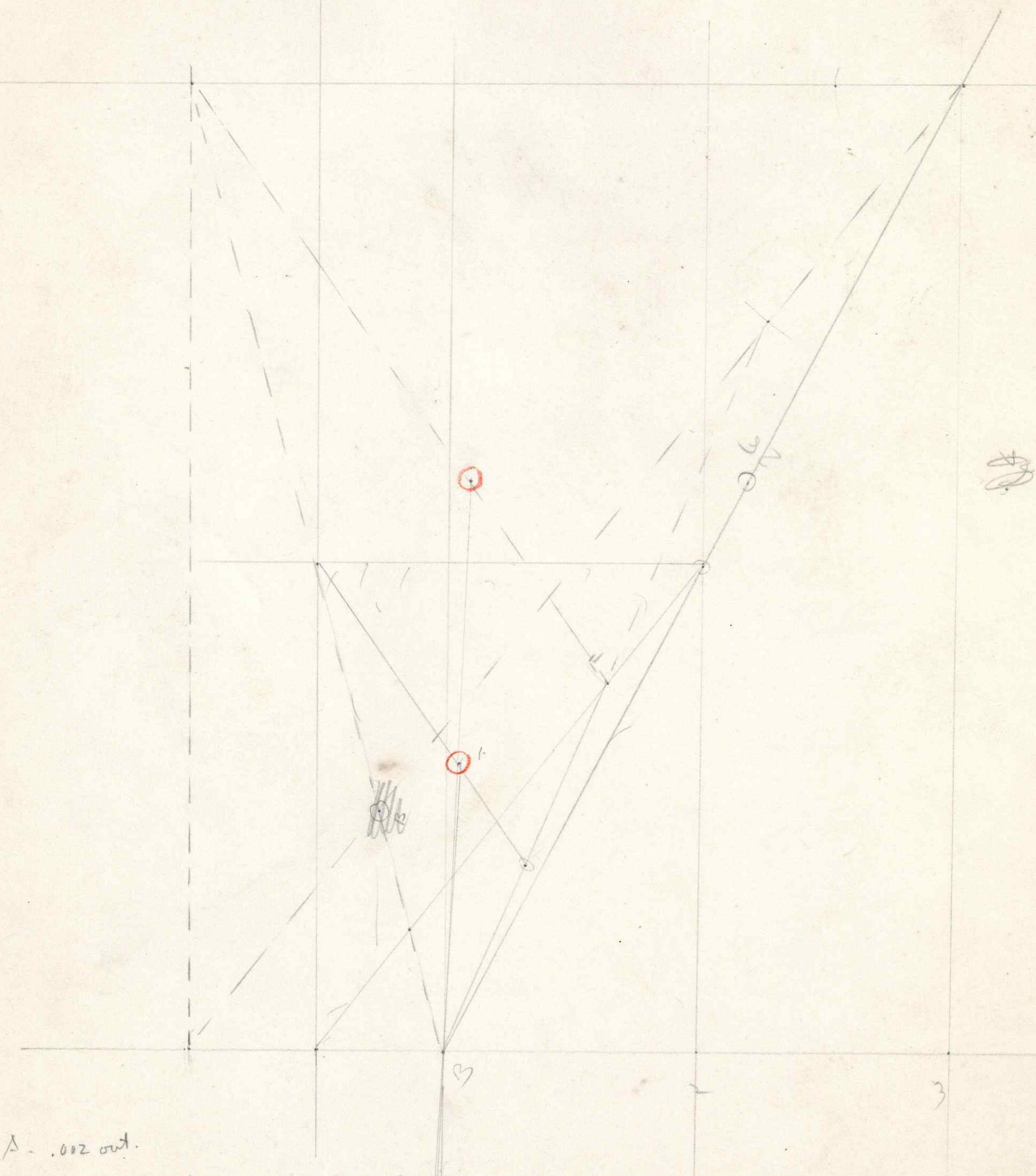
2.43) 3.40 (1.4
243
970
972

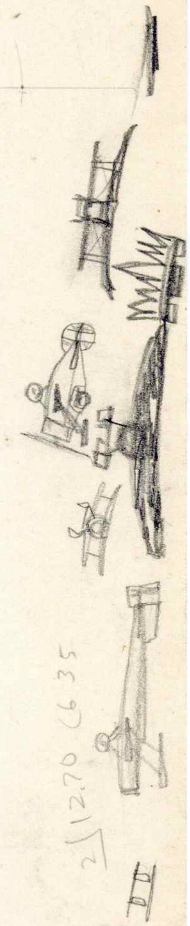
1.74) 2.44 (1.4
174
700
696

The ratios show that the flatter vault requires no more (the same) cohesive strength against shear (sagging).

2) 2.67 (1.33

Demonstration For vertical upper zone, with constant soffit slope, approx. doubling of wall thickness permits doubling of span, with same stability.





2/1270 (635

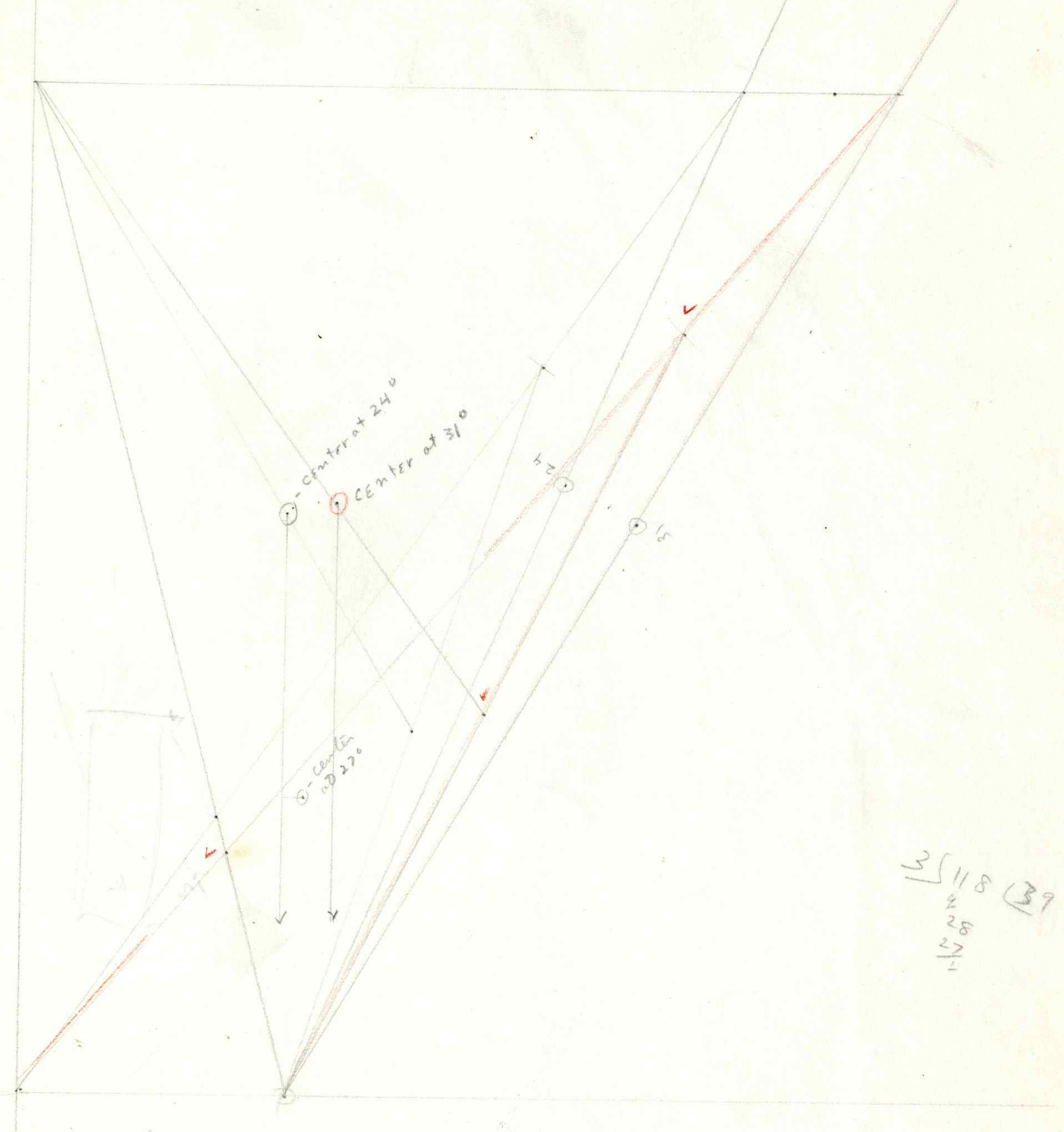
A - .002 out.

B: .003 (even in drawing, probably)

3/58 (193
3
28
27
10

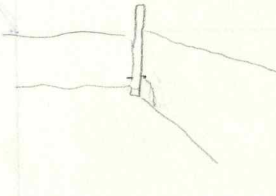
3/1180 (386
4
26
27
20

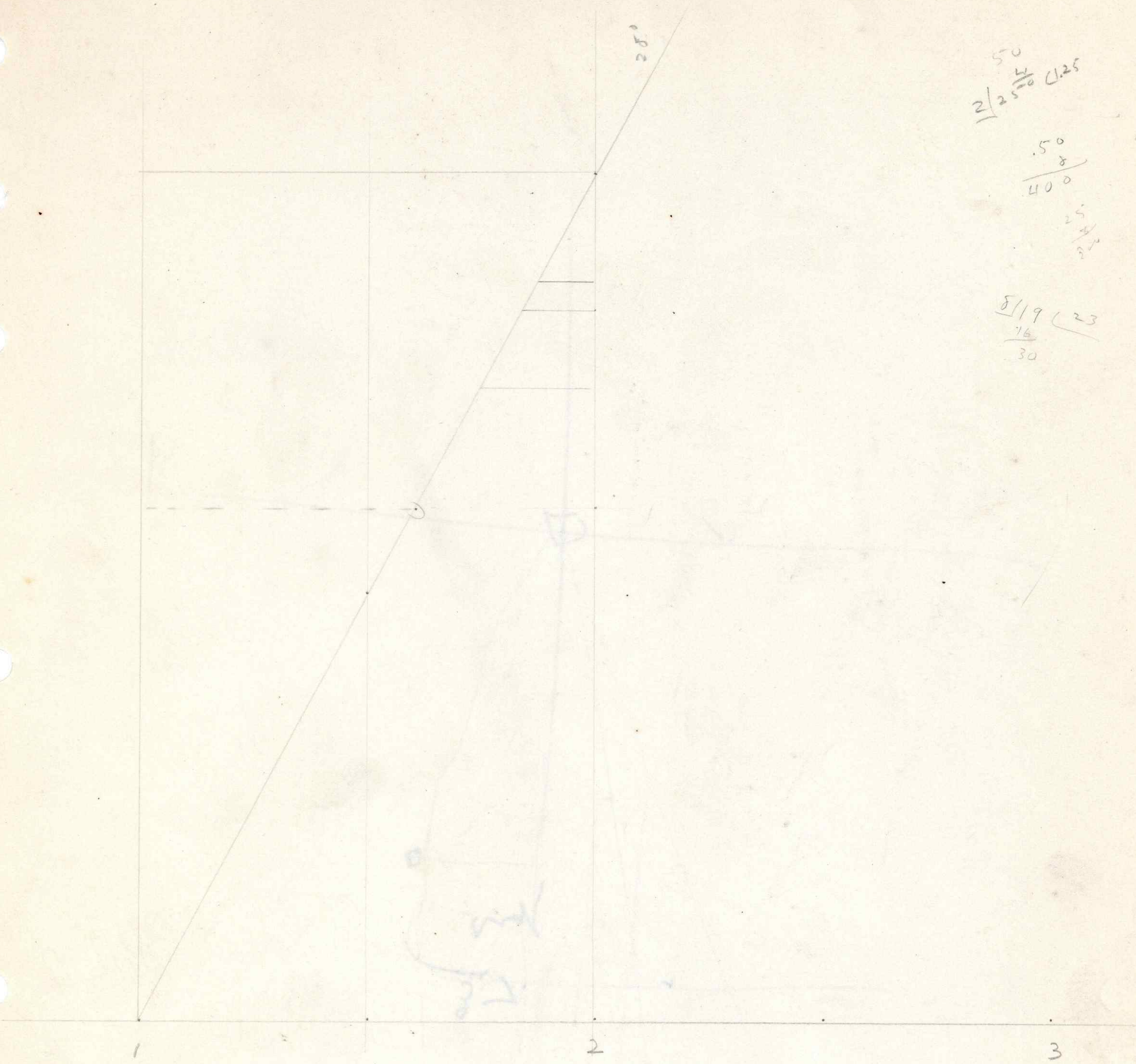
Demonstration that for a given design, base and vault height, the flatter the soffit angle the less the stability (but wider the span).



3)118 (39
2
28
27
1

3)115 (38
9
25
24

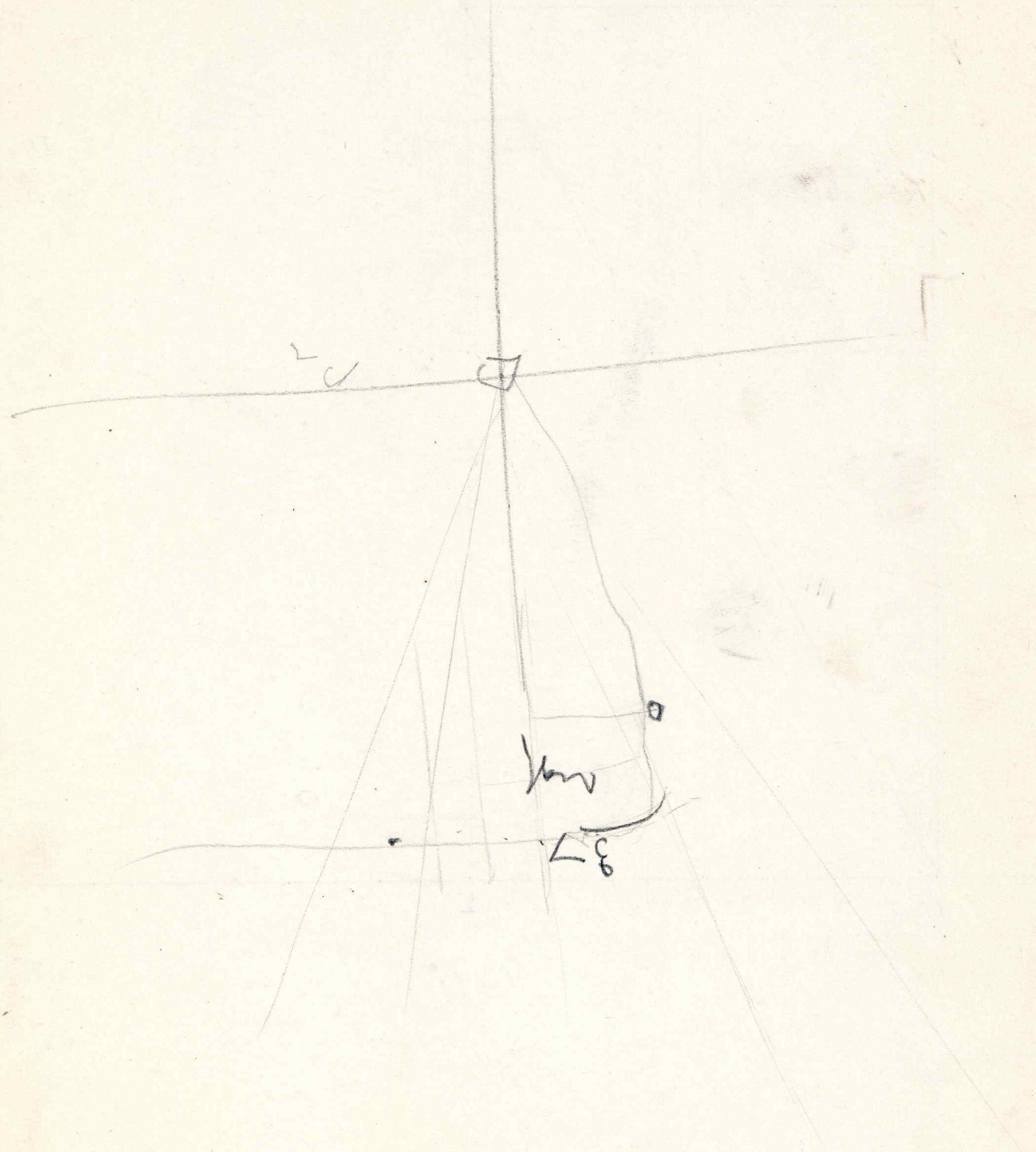


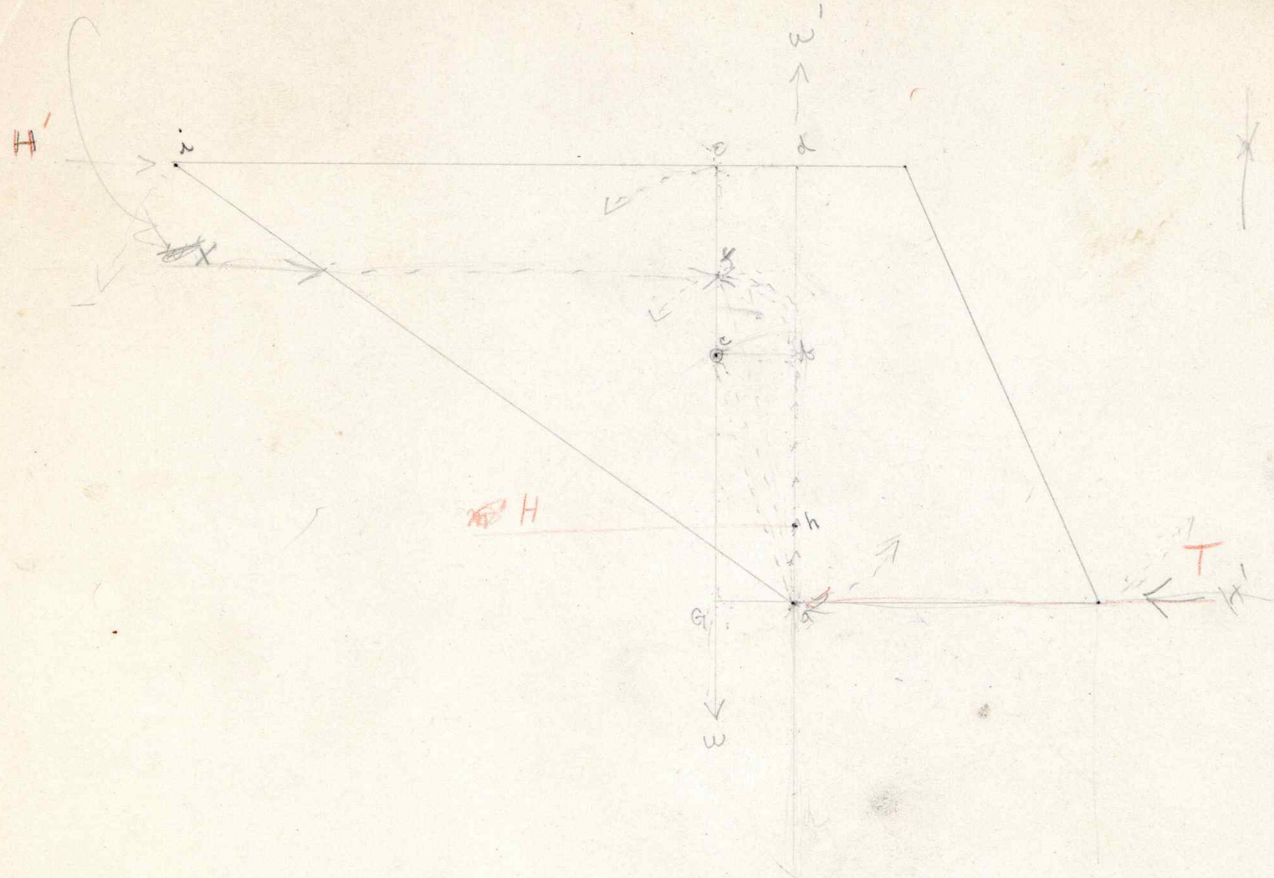


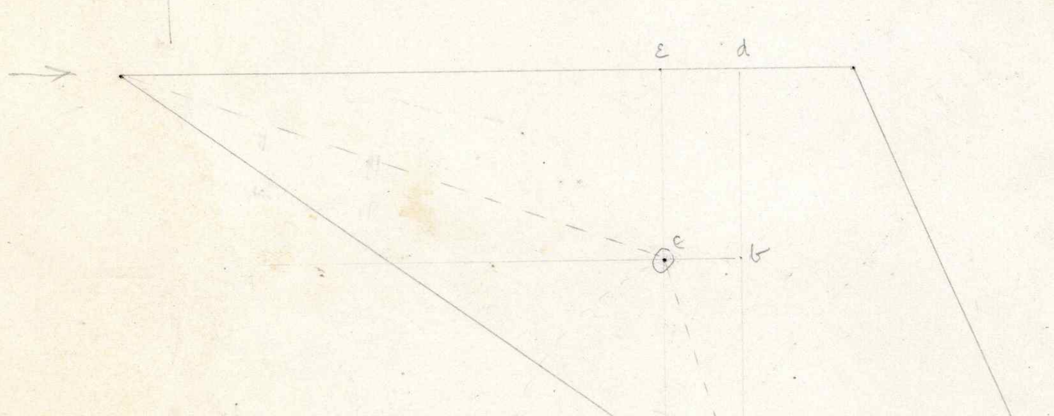
50
2/2.50 (1.25
4

.50
8
400

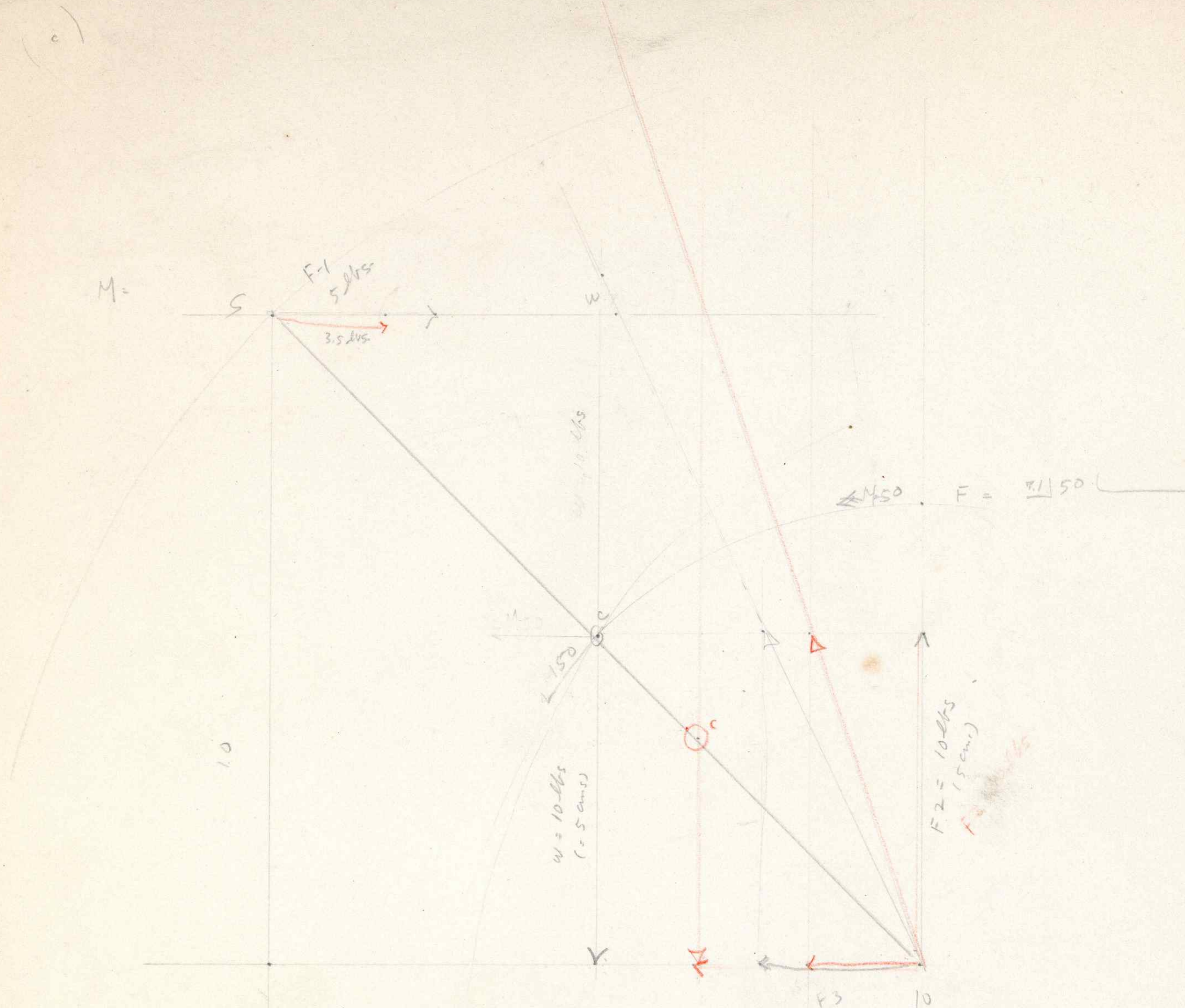
8/19 (23
16
30




H'
i
d
W'
X
c
b
H
h
G
a
W
T
X'


E
d
c
b
G
a

(c)



Eg =
Moment F_1 =
F_1 · arm = F_1 · 10 arms.

Mom. of C =
w · arm = 10 lb × 5 arm = 50
moment F_1 = Mom. C (equilibrium)
$10 F_1 = 50$
$F_1 = 5$

Mom @ c = 50
at S = F1 × 10 less moment of c (less 50)
= 10 F1 -

Moment of F_1 = F_1 × 10 = Moment of c = 3.5 · 10 (weight) = 3.5
$10 F_1 = 35$
$F_1 = 3.5$ lbs.

$\frac{F3}{5} = \frac{F3}{3.5}$

$\frac{F3}{5} = \frac{F3}{2.5}$

Mom of F.3 at a = 0
" F_1 = 5 × 10 = +50
M of w = −(10 × 5) = −50

5F3 = 2.5 F3
2F3 = F3
½F3 = F-3

$10 F_1 = 5 \times 10 = 5$
$F_1 = 5$

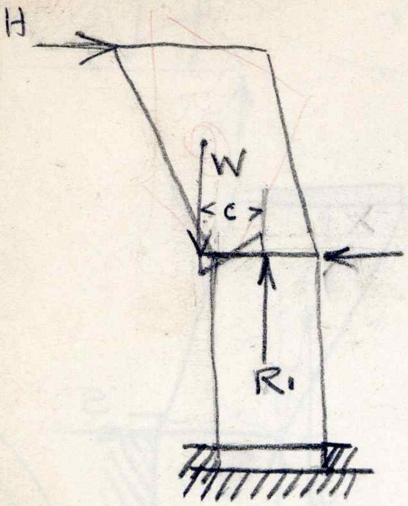
$\frac{F}{F'} = \frac{5}{3.5}$ arm of C = $\frac{5}{3.5}$ arm C' =

∴ $\frac{F}{F'}$ as $\frac{\text{arm } c}{\text{arm } c'}$ at same h of support & same weight.

Vert. ch. Shift – adds weight but helps F with moment arm. (to greater extent)

Slip ch. S of " " (less amt)

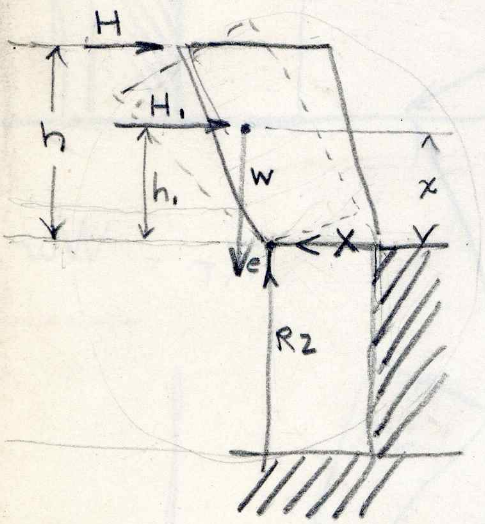
Case I



$W = R_1 = 100$

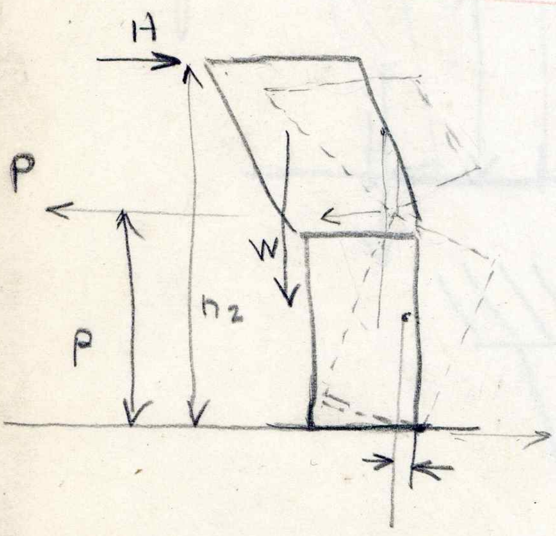
$Wc = R_1 c$

Case II



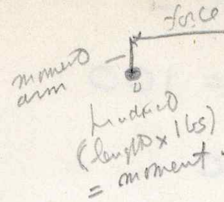
$We = Hh$

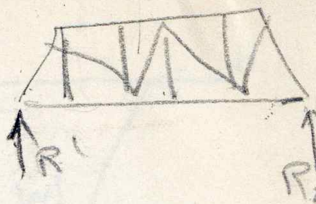
$Hh = H_1 h_1$



$Hh_2 = Pp$

Fow w' now acts on f





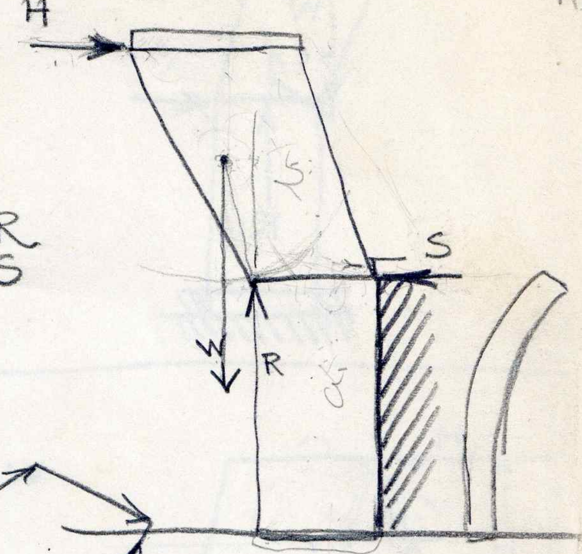
~~W = 10 Kil. Pocn~~

w = 10 Kilgm.
× 15 Poc. (CE length)

(CE) - 50 | 150 | 120 Poc. = 3 Kilograms. (H)

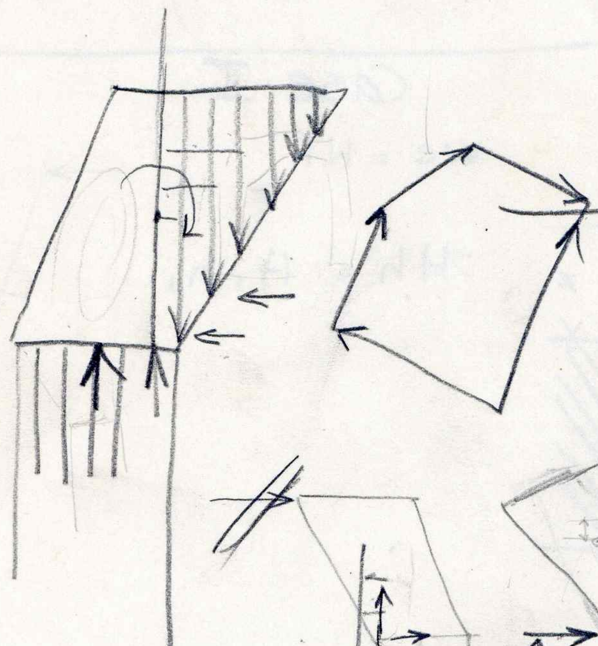
"moment"

$W = R$
$H = S$

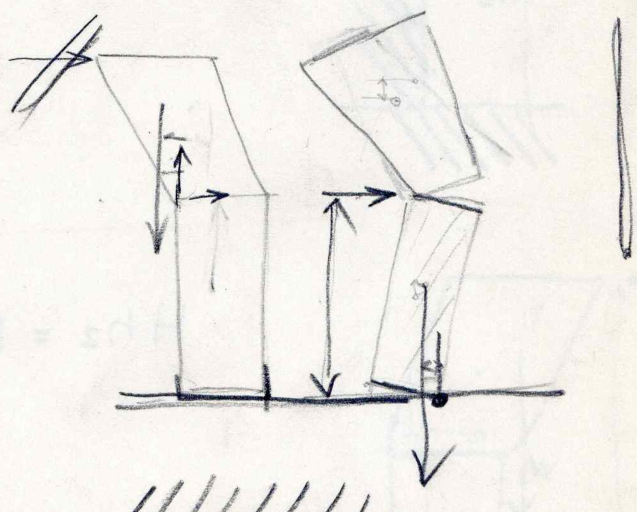


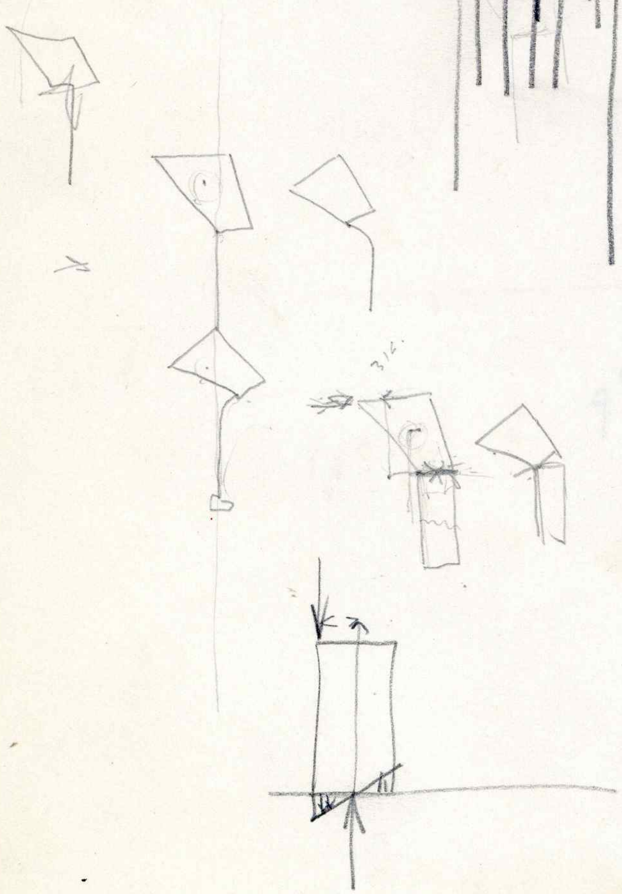
Pinch by moment arm at a

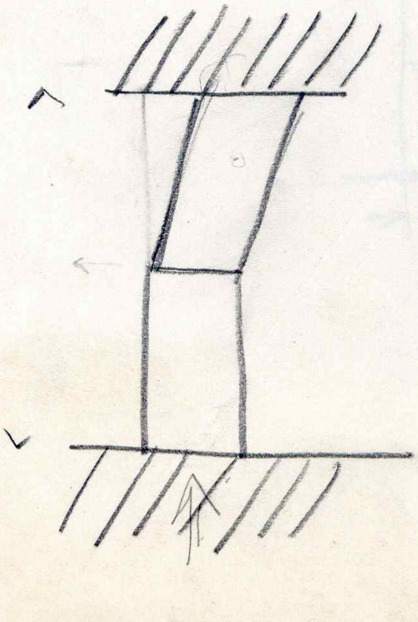
w = 10
× 15 (Torque (K-8))
75 | 150 | 2 Kil

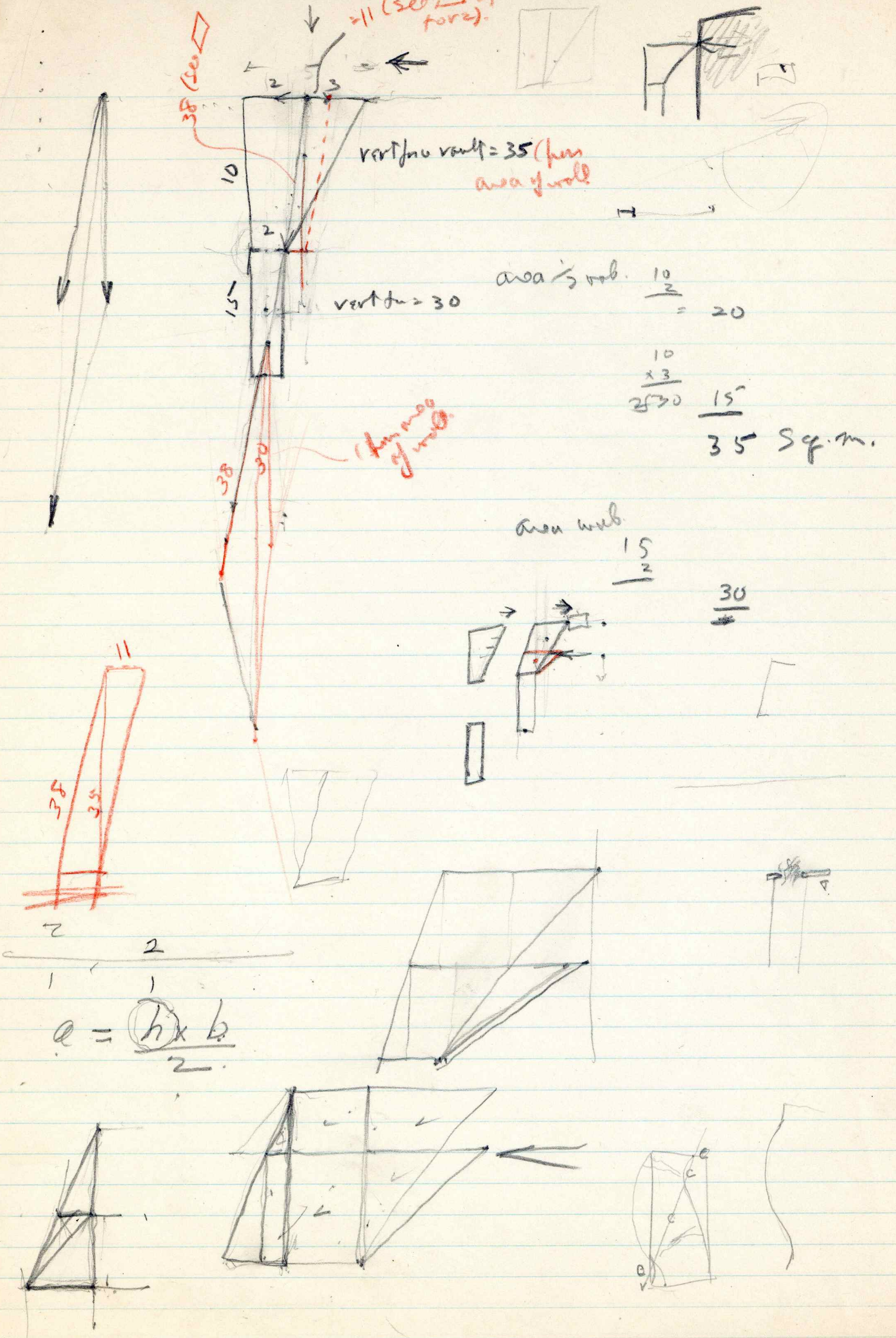


Rr = Ww

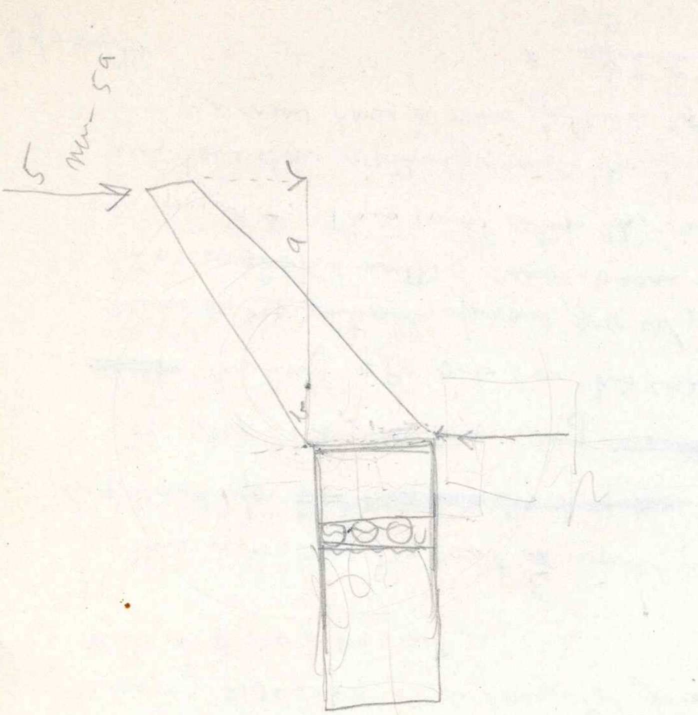


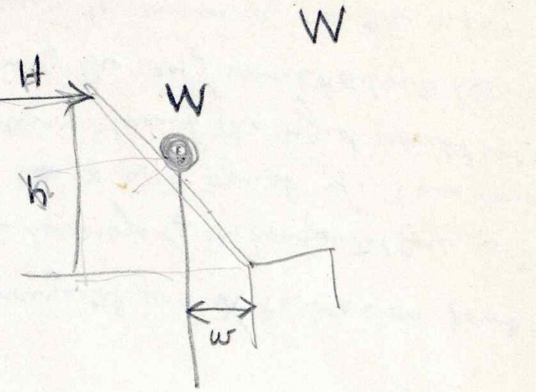


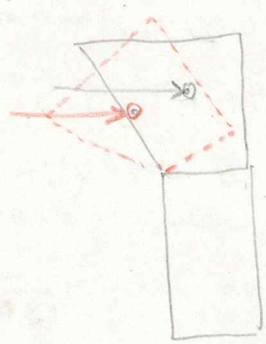


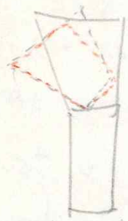


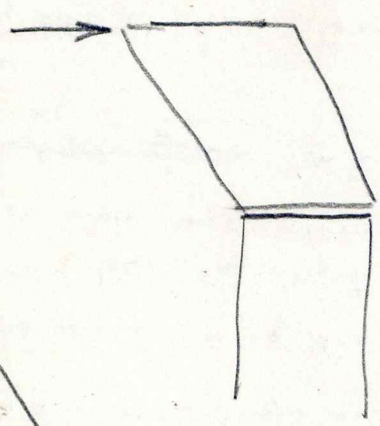
=|| (see ▱ of force).
38 (see ◇
2
3
10
vert force vault = 35 (from area of vault)
2
15
vert force = 30
(from area of wall)
38
30
11
38
35
2
2
1
1
a = h x b / 2
area of vault 10/2 = 20
10 x 3 = 30 15
35 Sq. m.
area web 15/2
30

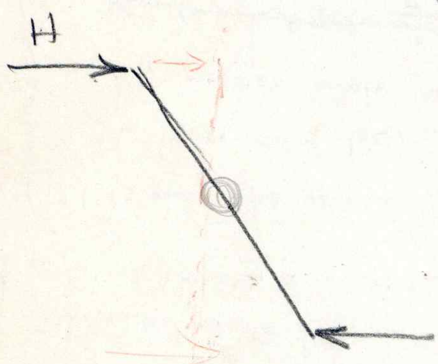



W
H
W
h
w








H

|| If any force is applied to any solid at a point not its center of gravity, the body will revolve around the center of gravity unless prevented by other forces

|| w pulls down on ©- seeks to move whole straight down. - no rotating effect.

|| w' (equal reaction) tends to push straight up; but off center, through (a)

it works on © through lever a.c, which is equivalent to working at (b) through ~~on~~ lever c b. ~~+ b.~~

This introduces a torque about © equal to w' x bc; but w'=w and ~~b~~c = Ga. therefore the torque equals

This what would happen if c were supported and then force w' x bc was applied through a. - i.e. the torque would take effect.

|| It is only the upward force through a which has any torque effect (due to the lever arm bc). The weight acts directly on center of gravity and merely pushes whole mass straight down. - no torque effect ~~through c, of~~ on "c", but around it.

~~The ... but only of w'.~~

~~Torque force~~

If a is held in place is becomes a fulcrum and c will rotate around a.

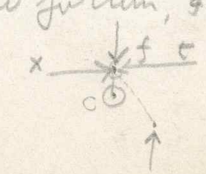
~~But the horizontal force~~ w c then acting (through ©) on the lever ca (= Ga in effect) the effective force being w x ca. But w = w' + ga = cb. therefore the torque about a (if it is fixed) is the same in amount as that about © if it is free to move.

Purely vertical pressure on a cannot prevent the torque about c from moving sidewise. ∴ a horizontal force equal to the torque at a must be put on it to prevent.

This is to say the point ~~a~~ c would move to left and down, the point a to right and up. ~~But the force Both of the~~

To stop this we can bring ~~force~~ horizontal force X to bear on point f, ~~which~~ making cf = c-b; in this case the leverage of the horizontal force is the same as the vertically upward force w', and ~~the~~ x will equal w'. This might be accomplished with a cross-beam, operating through the rigid vault interior to point f. This will stop the rotation of the half vault about ©; but we have done nothing about the force trying to move a to the right.

We now have a new fulcrum, f. with forces:

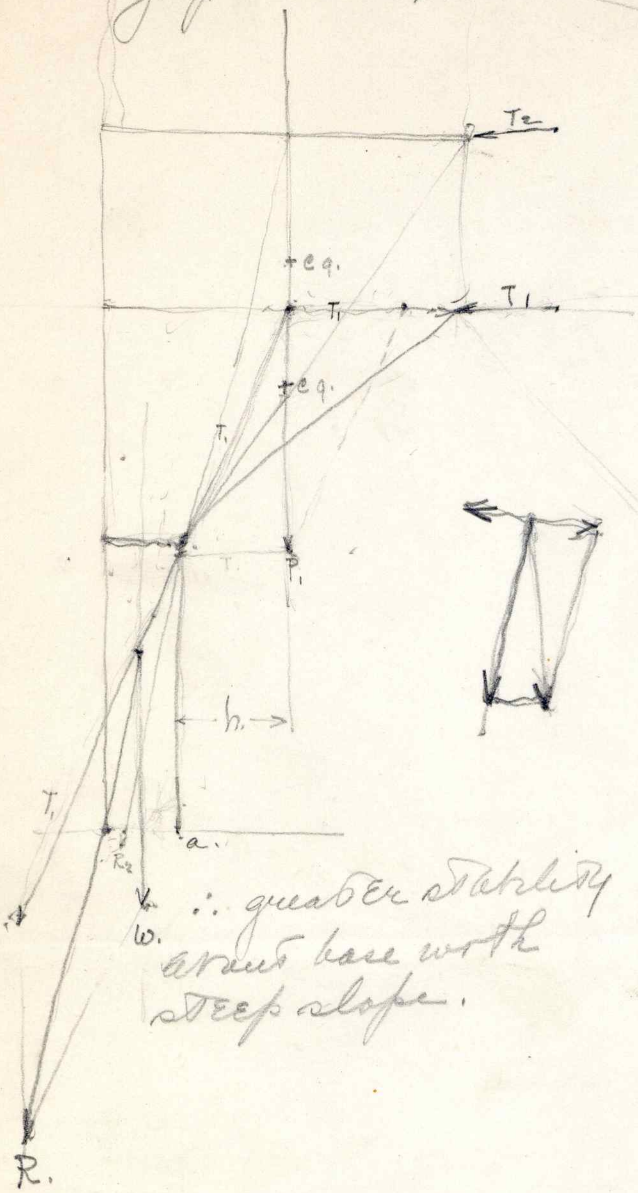


Rr = moment of a vault

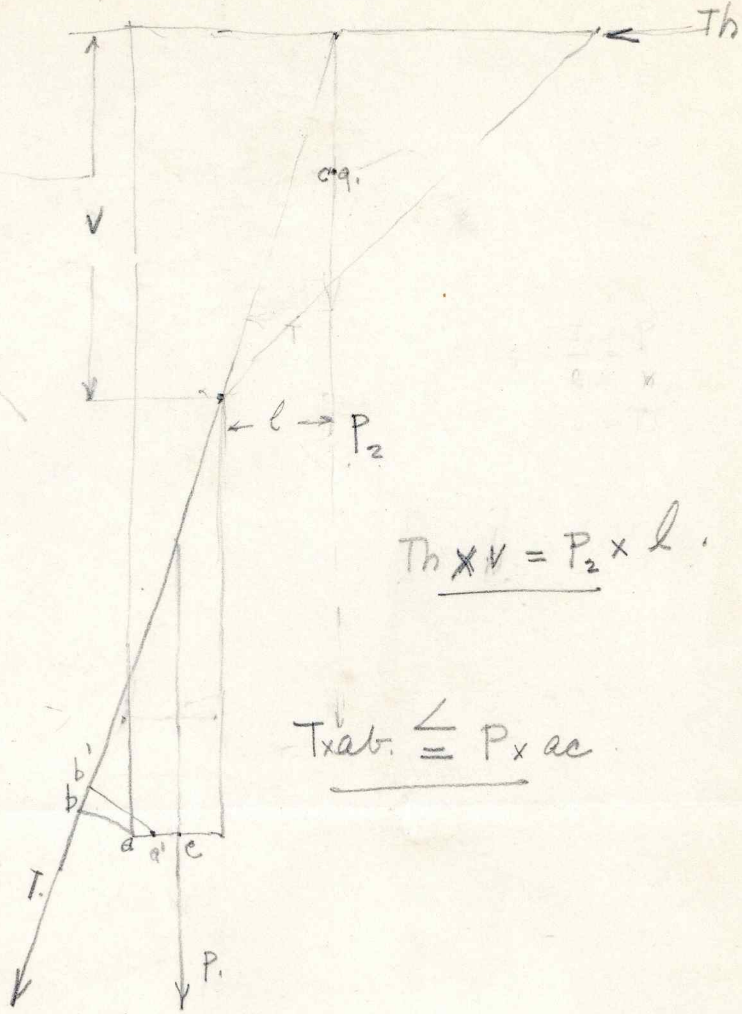
Ww =

f = force in lbs.

Graphic method.



Mathematical method.



$Th \times V = P_2 \times l$.

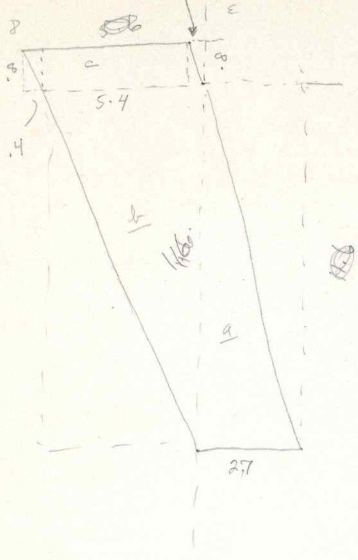
$T \times ab \leqq P \times ac$

Modern factors of safety.

Principle of middle third — (case 1) when R is within middle third there is no tendency to failure by tension at a. [$\frac{1}{3}$ = c.g. triangle of forces when a = 0]

(Case 2) — moments are computed from pt. $\frac{ac}{2}$ (a'c, a'b')

J-11 See 1934 Reconstruction of front Room.



c/ 11.6
2.8
812
232
2) 41.32 = 20.66

b/ 11.6
5.4
464
580
2) 62.64 = 31.32

c/ .8
5.4
4.32 = 4.32

.8
.2
2) .16 = .08

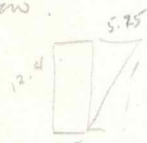
.8
.4
2) .32 = .16

20.66
31.32
4.32
.08
.16
4) 56.54 = 14.13 @ 1:100

= 1.40 sq. m.

Outer half wall.

Vertical zone.



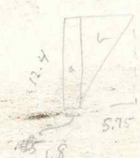
12.4
2.5
620
248
31.00

5.75
2.5
2875
1150
2) 14.375 = 7.18

4) 7.18 = 1.79

Outer v. 1.79 sq m.
Inner v. 1.44
Roof .30
3.53

2.88) 3.53 (1.23 those over debris. (g.01.30)
288
650
576
740



.45
4
1.80

12.4
1.8
992
124
22.32 a = 22.32

12.4
5.75
620
868
620
2) 71.300

35.65
4) 57.97 = 14.44

= 1.44 sq m.

1.40
1.44
.61
3.45

Roof

4) 8.2 = 2.05
.15
1025
205
.3075

Roof caps of .50
odd
.15 (meters)
× 3.20
1600
45
.6100

4) 13 = 3.20
12
10

= .61 sq m.

Rear room.

1.70
1.00
2) 2.70 = 1.30 (~~regained front wall only 1.19~~) @
+ outside room. (including a lot of outer wall.

Regained therefore 1.20

3.45

X × 2.88 = 1 × 3.45

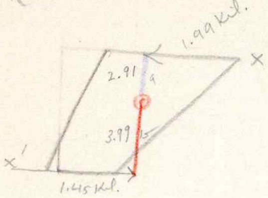
3.45 X = 2.88

X = 2.88) 3.45 (1.19
288
570
~~288~~
2820
2592

1.20

Trans sheet 5-11 front.

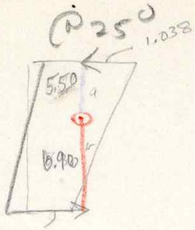
@40°



$3.99 \overline{)2.910}$ .72+

b is 72% of a

@25°



$6.90 \overline{)5.500}$ .798

b is .78% of a

b 7% better. (but "torque force" is greater).

@40°

2.91 + 3.99 = 6.90

$6.90 \overline{)3.990}$ .578 (b)

@25°

5.50 + 6.90 = 12.40

$12.40 \overline{)6.900}$ .556 (b)

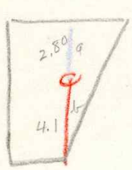
.578
.556
2.2% better @ steep values.

@25°, vert.
b = 58.8%
@25°, slope
b = 55.6%

58.8
55.6
3.2 greater moment with vertical than with sloping facade.

@40°
vert, b = 59.4%
Slp. b = 57.8
1.6% greater moment with sloping facade.

2.91
3.99
6.90
4.10
2.80

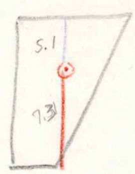


$4.10 \overline{)2.800}$ .682+

2.80
4.10
$6.90 \overline{)4.100}$ .594+ (b)

69.8
68.2
b 1.4% better. (torque force is the same.

5.1
7.31
12.4



$7.3 \overline{)5.10}$ .698

5.1
7.3
$12.40 \overline{)7.300}$ .588+ (b)

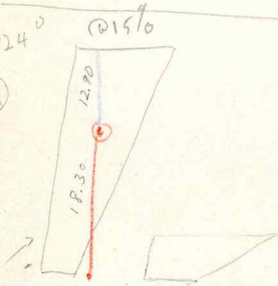
59.8 +
59.4 +
only .4% better

For given change in soffit slope:
Lever arm of anti thrust force is increased more with vertical facade.
The torque lever remains same for vertical, but becomes greater for slope.
∴ steep slope more effective with vert. facade.
The vert. facade increases the has greater advantage over sloping one at steep soffit (i.e. in high vaults)

@24° @15%

Stp 20° ~~Tenthl~~

vert



$18.30 \overline{)12900}$ .69+

18.30
12.90
31.20

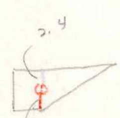
58.6%
41.3%
17.3% advantage.

3% better lever arm: or

$31.2 \overline{)18.30}$ .586

$31.2 \overline{)12.90}$ .413

@55°



$3.30 \overline{)2.400}$ .72+

5-11

Vent uphe zon

@ 25° overhang area = 12.4 × 5.25 = 620, 248, 620 → 2 | 65.200 = 32.6 sq cm.

(small area)

lever a = 7.4: 32.6 (area) × 7.4 (lever) = 1304, 2282 → 241.24 = thrust index.

slabb area 12.4 × 2.5 = 620, 248 → 31.00

Vault + area 32.6 + 31.0 = 63.6 (all at Kilos)

at 1 cm = 1 Kil of force per lineal unit of vault.

V. height (12.4) is diagonal of parallelogram. ~~63 12.4 (Kilos)~~?

let it represent: 12.4 cm = 63.6 Kilos.

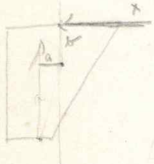
1 cm = 12.4 | 63.60 = 5.128 Kilos.

Limit w + t = 12.5 × 5.12 Kilos per cm = 250, 125, 625 → 64.000 Kilos (resultant).

thrust 7.8 (horiz of ▭) = .8 Kilos.

The torque is the same

∴ the amount of ~~thrust~~ resultant force is greater for higher slope vault.



a = .8 63.6 (vault weight) × .8 = 50.88 thrust index? (weight × moment)

b. = 2.82 63.6 × 2.82 = 1272, 5088 → 521.52 (counter thrust index?)

thrust = .8 Kilos.

b. x = .8 Kil

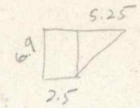
5.1 x = 5.1 | .80 = .157

The counter-torque lever is greater

∴ the counter thrust force (+ thrust) is less.

Vent uphe zon

@ 40°



overhang = 5.25 × 6.9 = 4725, 3150 → 2 | 36225 = 18.113

slabb = 6.9 × 2.5 = 345, 138 → 17.25

18.11 + 17.25 = 35.36 (calc at Kilos)

@ 1 cm = 1 kil.

6.9 = 35.36 Kilos.

1 cm = 6.9 | 35.36 = 5.124

w + t = 6.98 × 5.12 = 1396, 698, 3490 → 35.7376 Kilos (resultant).

thrust = .8 Kilos?

The torque is the same (see the 2 parallelogram (horizontal members are the same).

b = 5.1 × .8 = 3.08

35.36 × 5.1 = 3536, 17680 → 180336

b'. x' = .8 Kilos (thrust)

counter thrust

2.8 x = .8

x = 2.8 | .80 = .28

The counter torque lever is less ∴ counter-thrust + thrust is greater

J-11-frenbroom

Vert. cil. @ 40°

B

Shafmidt Zero

a/ w = 74.0

cam: 2.15
3700
740
1480
159.100

F = 18.6) 159.100 (8.553+
1488
1030
930
1000
930
700
558

not equal

?

b/ w = 51.5

cam × 1.85
2575
4120
515
95.275

F = 13.8) 95.275 (8.33
904
465
414
510
414

d/ w = 55.6

Cam: 1.4
2224
556
77.84

F = 9.1) 77.84 (8.554
728
504
455
490
455
450

450
364

855
833
855
816

e/ w = 39.8

cam: 1.0
39.8

5.75) 46.00 (8.16+
4600
950
575
3750
3470
280

855
816
855) 3900 (.04%
3420

max variation

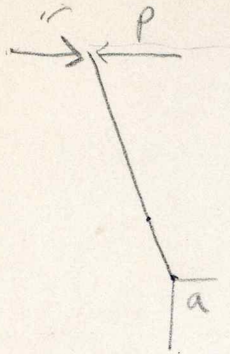
1.55 / 2.15   13.8 / 18.6   298 / 288

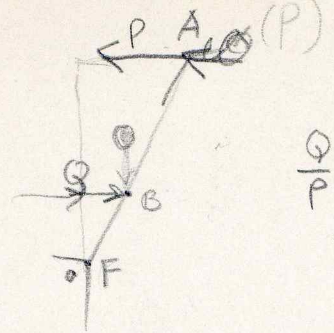
2.15
13.9
1935
645
215
298.85

1.55
1.86
930
1240
155
288.30

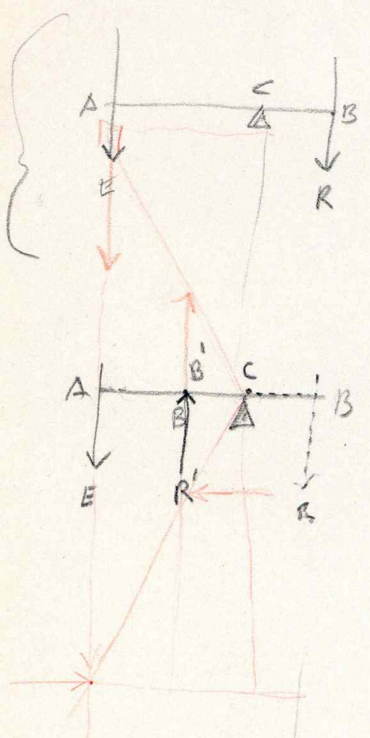
186) 138.0 (?
138
138) 48.0 (35% ridem in v heals.
406
740
690

2.15
1.55
155) 60.0 (38% narrow cam.
465
1350
1240





$$\frac{Q}{P} = \frac{AF}{BF}$$



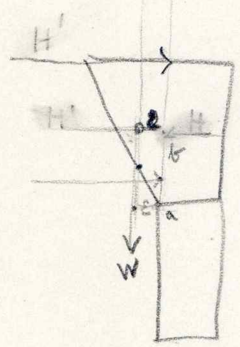
From Carhart p 213

The mechanical advantage of the lever equals the inverse ratio of its arms:

$$\frac{R}{E} = \frac{AC}{BC}$$

Effect of R'@B' = R@B surely.

$$\therefore \frac{R'}{E} = \frac{AC}{B'C} \text{ or } \frac{E}{R'} = \frac{B'C}{AC}$$



WE = moment about a ~~[struck out]~~

W = 20; E = 2 ∴ H = 20·2 = 40