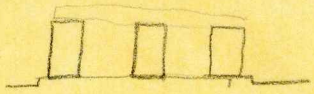
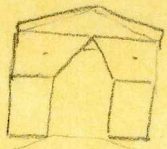
Handicaps

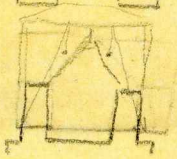
1 High walls
2 Roof Combs. (over rooms)
3 Second Stories.
4 Columns,
6 Heavy Roofs.
7 Piers
8 Wide Doorways
9 Flying Buttresses.
10 Roof Combs: over ~~short~~ walls (slight)
~~High walls~~
15 Slabsurfaced Facade.
16 Flat Vaults (with low ribs - i.e. dome margin).
17 ~~Short base~~ do.
18 Uneven Step vaults.

Balls web

5 Odd walls





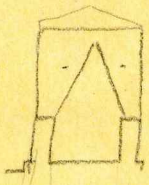


Hao.

Dec 18
vaults gets by

Helps to Stability

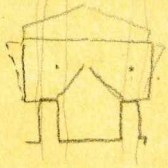
1. by lowering vaults



can soffit angle

or

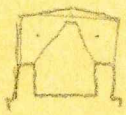
Dec 20



by outsetting upper facade or regular bottle it

Stability

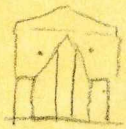
Dec 19



or by thinning roof.

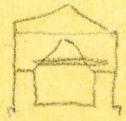
Dec 6

10



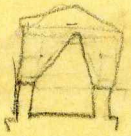
Pilasters, Parlours, short rooms.

12

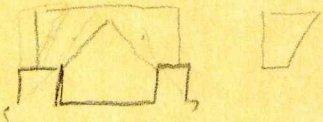


Beams.

14 2.

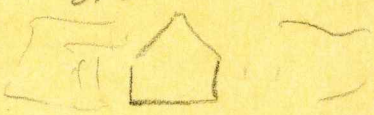


Narrow sofa arches (Semi-dome sloche vaults - raises counter thrust arm w.o. increasing thrust arm.

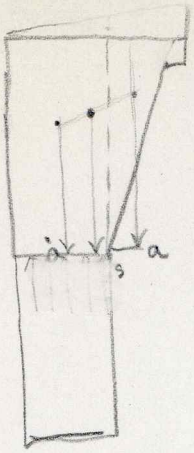


4 high walls

Erlan Bulkens



13/20?/2/22



Moment of Translation
" Rotation (angular).
Equilibrium
Stability.
Center of Gravity
Moments

Table

Factors other than knowledge and vault-building/ability which may affect wall thicknesses and vaultspans.

Plus sign indicates the factor tends to decrease the stability or increase the load, with a consequence tendency to increase wall-span percentages used in this paper, by thickneing walls or narrowing rooms, or both. Letters refer to discussion in the text. Cross (x) indicates no probable effect.

		Factor	Outer Wall Stability	Outer Wall Load	Inner Wall Load	Probable effect
1.	(g)	High vault-spring	Pl	Pl	Pl	
2.	(q)	Roof combs	Pl	Pl	Pl	
3.	(s)	Second Stories	Pl	Pl	Pl	
4.	(m)	Columns	Pl	Pl	Pl	
5.	(t)	Use of old walls &c,	x	Pl	Pl	
6.	(j)	Thick roofs	Pl	Pl	Pl	Slight
7.	(k)	Use of piers	Pl	x	x	Slight (if tension assists in mortar).
8.	(l)	Wide dporways	Pl	Pl	x	Slight "
9.	(n)	Flying facades	x	Pl	x	Slight One side only
10.	(p)	Pillasters	Min	Min	Min	
11.	(o)	Partitions, short R'ms	Min	Min	Min	
12.	(i)	Vault beams	Min	x	x	(May permit 1/2 slopes)
13.	(a)	Vault openings	Min	Min	Min	
14.	(h)	Cap-stone exposure	Min	Min	Min	Slight
15.	(a)	Sloping Upper zone	Pl	Min	x	
16.	(b)	Flat vaults	Pl	Min	Min	
17.	(c)	Inset upper zone	Pl	Min	x	Slight
18.	(e)	Unnecessary steep vaults	Min	Pl	Pl	Slight
19.	(d)	Neg. batter	Min	Plus	x	Slight
20.	(e)	Outset upper zone (Insert lower facade)	Min	Pl	x	Slight
21.	(b)	Space limitation	Pl	Pl	Pl	
22.	(M)	Function	Pl-M	P-M	P-M	

Minus sign indicates reverse.

(introduce side-thrusts or increase them, or to increase) ust

acc Masonry?

Ways to stand side thrusts for under rooms. (The room lowers the inder).

Raise soffit slope (i.e. vault height).

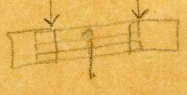
(increase moment arm of Op counter thrust (vertical other zone)

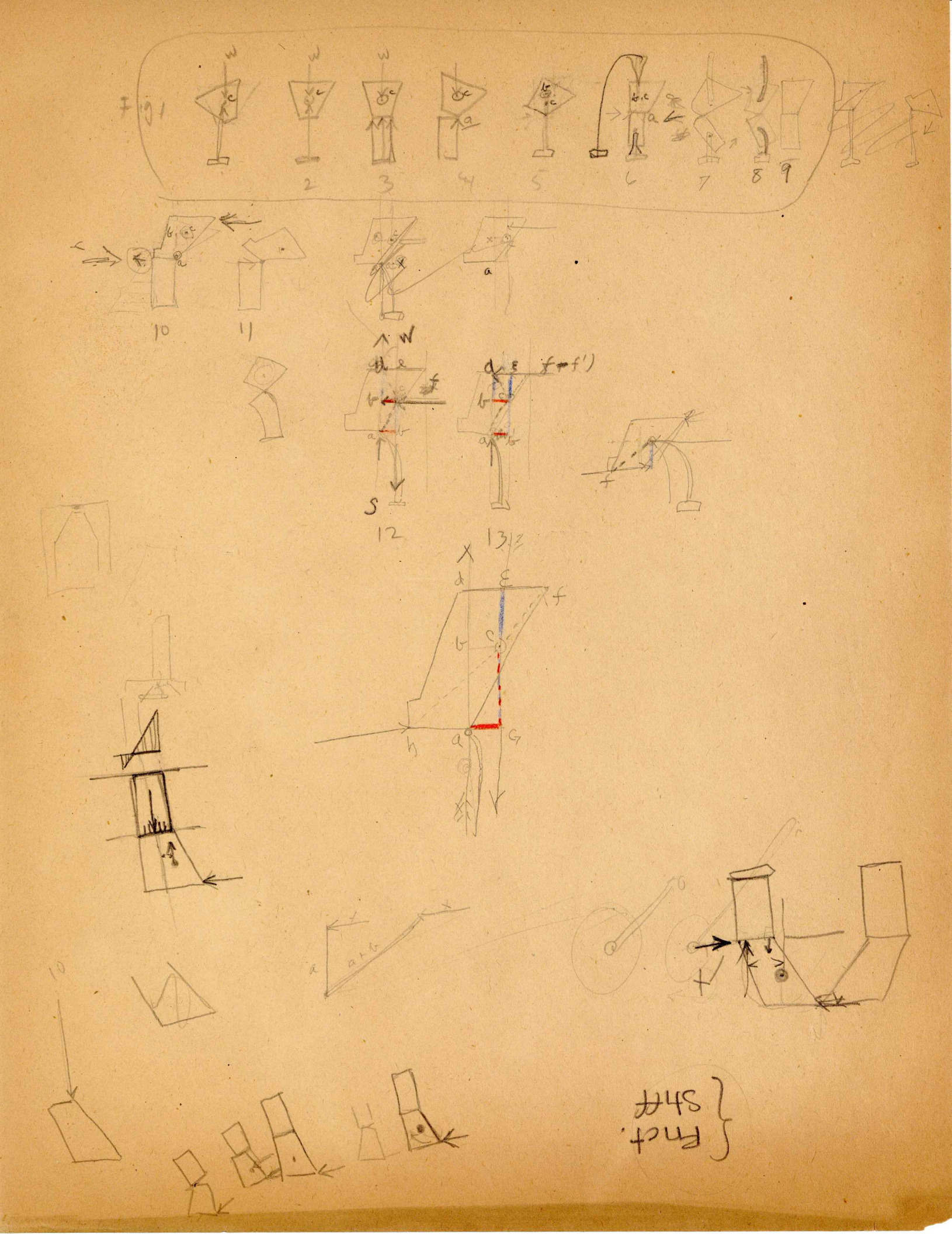
2 → (" " " more than that of weight cavity (sloping " ".

Reduce ~~width~~ height (i.e. vault-spring height).

Negat batter

Outset other zones




W
a
b
c
1
2
3
4
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7
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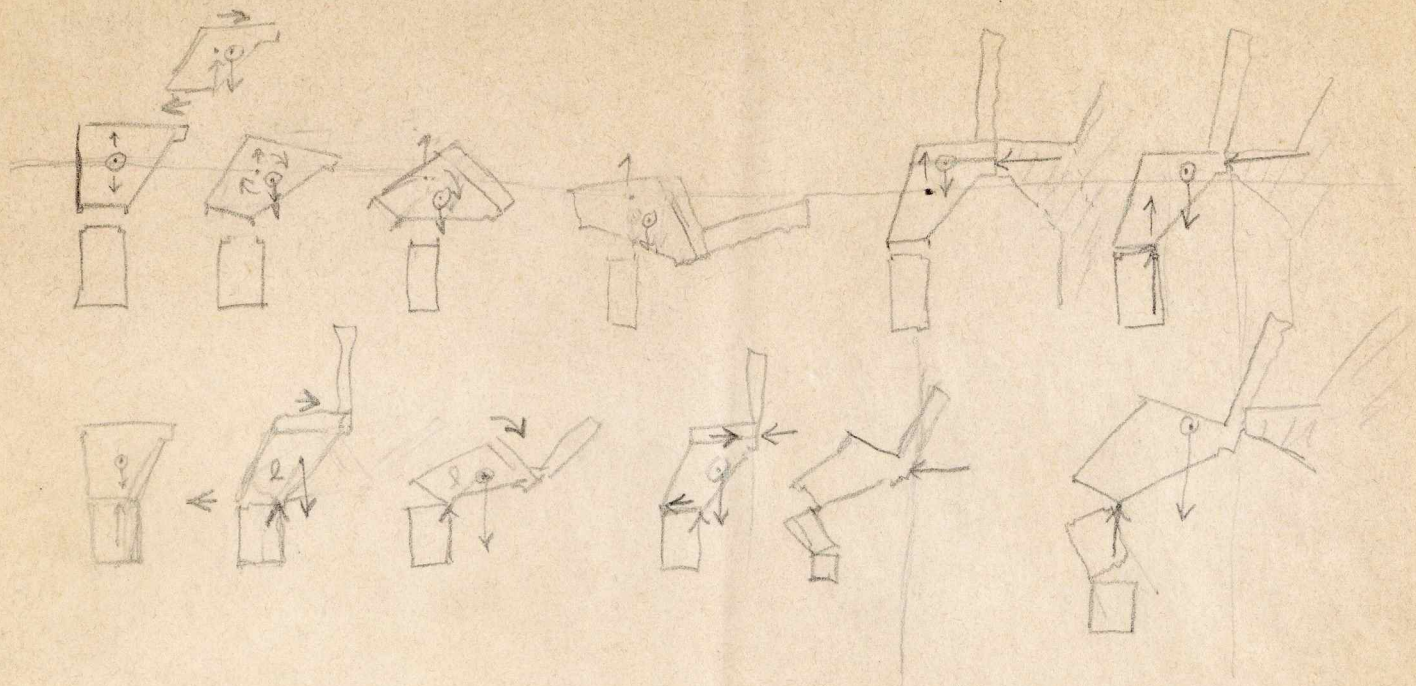
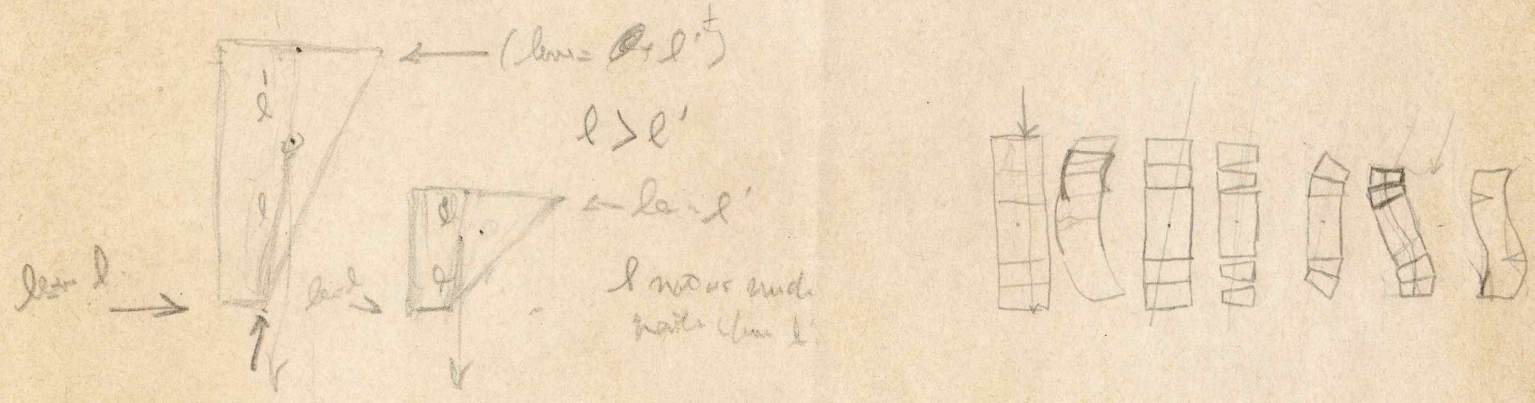
11
12
13
d
e
f
g
h
S
Fracture
Shaft

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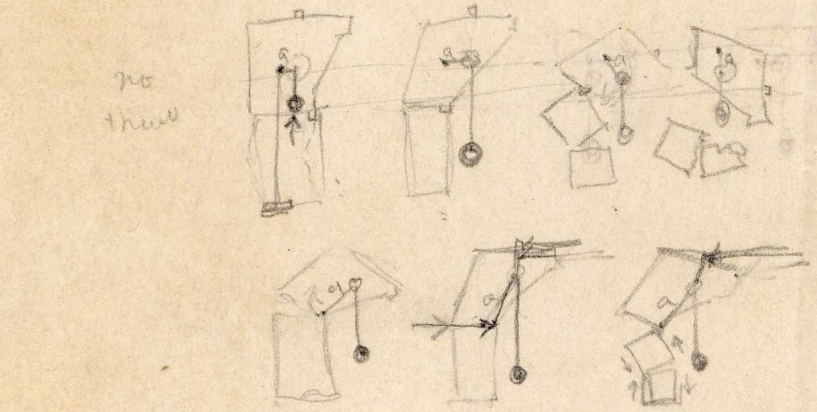
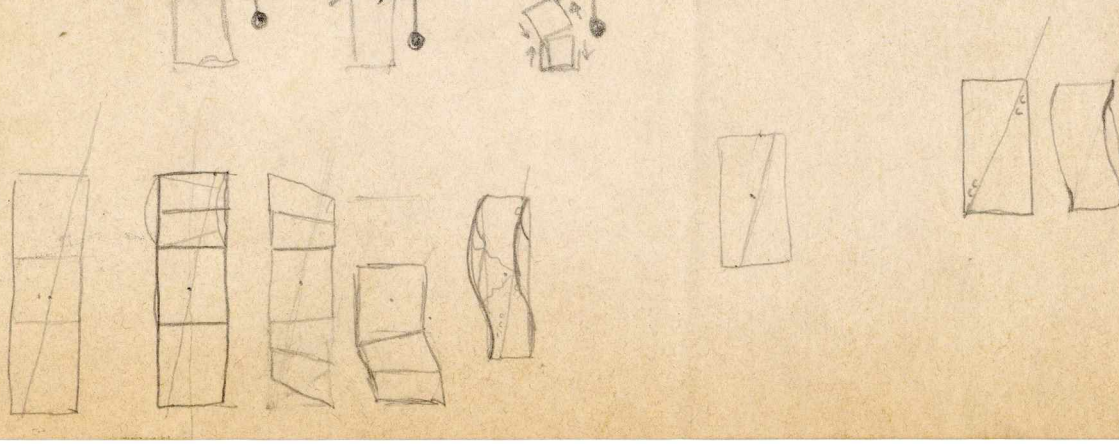
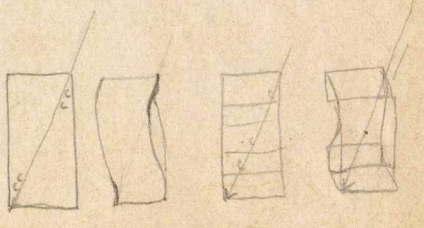
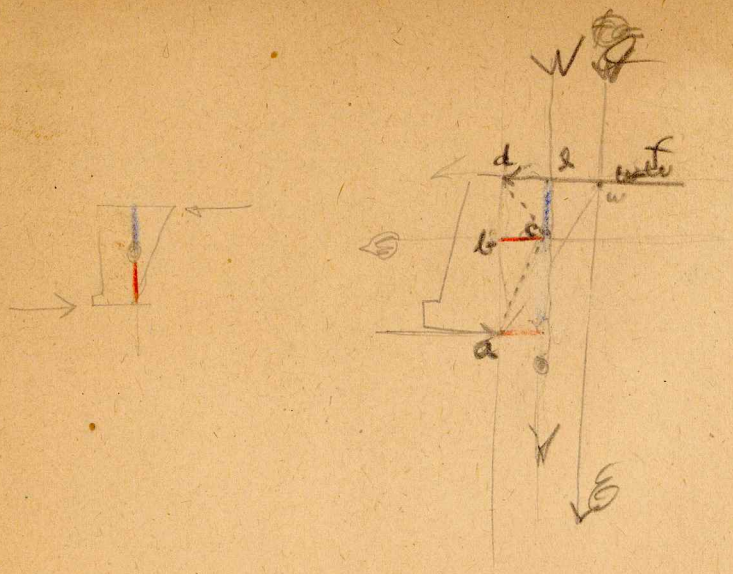
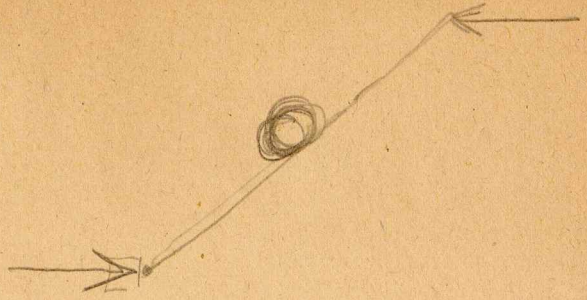


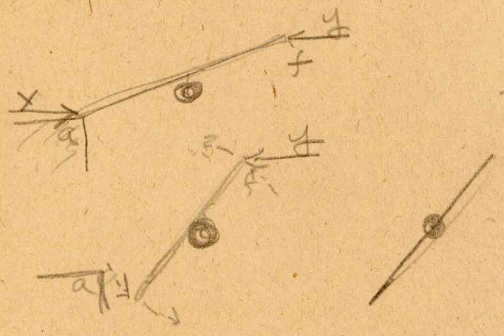








It is hard to relize that the weight force of the roof cops (f f') does not act against ~~the rotation~~ directly against the rotation around point (a). The solution is analogous to placing a weight in the middle of a lever. (~~Fig~~ In Fig — a is a fulcrum; f the free end of the lever. The weight force G·s x + y tend to rotate

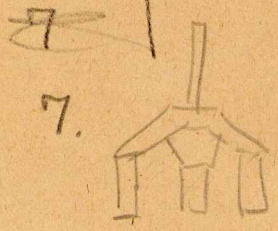


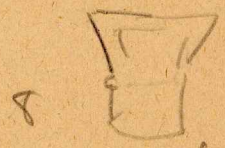
to ~~for~~ lever about the weight. This becomes clear when y is removed so that the two do not balance (Fig). The lever revolves as the weight falls, but about it (the center of gravity), not about a.

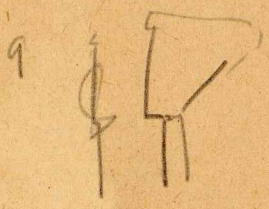
		Outer Wall Stability	Outer Wall Load.	Inner Wall or Columns Load.	Clues
±	a. Sloping upper Zone.	+	−	x	
±	b. Flat vaults.	+	−	−	
±	c. Inset upper zone.	+	−	x	
−±	d. Negative batter.	−	+	x (slight)	
±	e. Outset upper zone.	−	+	x (slight)	
±	f. Steep vaults	−	+	+	Steep Debris
⊗	g. Vault openings.	−	−?	−	Balanced by symmetry in design.
⊗	h. wide Cap-stone Exposure	−	−	− (slight)	plaster marks
√(5)	j. Thick Roof caps	+	+	+ (slight)	more debris
√(1)	k. High Vault-springs	+	+	+	more debris
√(6)	l. Piers	+	x	x (slight)	Plan
√(3)	m. wide doorways	+	+	x (slight)	Plan
√(7)	n. Columns.	+	+	+	Plan
⊗	o. Pilasters,	−	−	−	Plan
⊗	p. Partitions, Short Rooms.	−	−	−	Plan
⊗	i. Vault Beams	−	x	x	
√(2)	q. Roof Combs.	+	+	+	Steep debris
√(8)	r. Flying Facade.	x	+	x	
√(4)	s. Use of old walls	+	+	+	
−±	t. Space Limitations	+	−	−	
±	u. Function.	+ or −	+ or −	±	

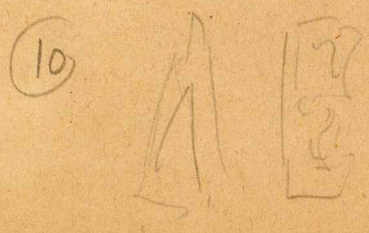
4

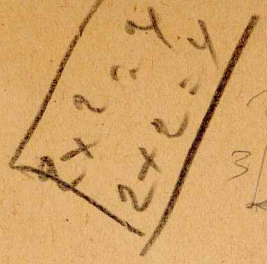
1











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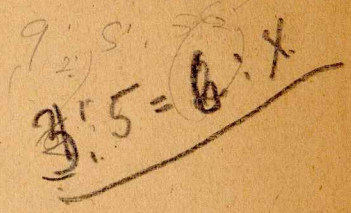

51.

25
75

~~75 | 100~~

100) 75.0 (75%
700
500

100 | 250 (25%
200
500

1.00
.586
.414

3) 5.0
3.0

2 limiting factors – the load a wall can stand
– the thrust it can resist.

Thin wall least able to stand given load (masonry).
" " " thrust (Stability).

Wide room – increases load – higher & wider vault.
– greater thrust.

∴ Reason to suspect technical progress among comparable buildings
a: in those with thinner walls
b: in those with wider rooms

In thinning the walls (other things being equal) in relation to load, the progress would be in such matters as improving the quality of the mortar, ~~[illegible]~~ of the bricks and concrete
– in bedding the stones
– by better selection or cutting
– " " chinking with stones

In relation to thrust – by more nearly approaching bound of collapse without actually reaching it. A stable wall with wide base can resist greater force seeking to push it over.

But changes in ~~either~~ wall thickness ~~(a) or Room width (b)~~ without progress in ~~either~~ masonry ~~or design for stability~~ technics might be made provided the other factor moves in the opposite direction. For example, a wall can be made thinner, yet support the same load, if the span is similarly reduced. The reason for this is that using the same corbel slope and cap-stone exhaustion the vaulted height, as well as width, and therefore its mass, is reduced.

Also changes in span (room width) can be made without affecting the margin safety as to stability, again using the same corbel slope and cap-stone exhaustion, provided the walls are made similarly thicker.

If the two factors move in opposite directions, progress is strongly indicated; and this other line ✱ on sx and is still unbroken, advance. But if no advance while the others retreats, we must know which the retreat is in fact fully compensated for. The ordinance in the other figure we are sure of showing progress

of ~~our constants~~ on ~~hopes a half vault and locates the center of~~ gravity. For instance, Other things remaining equal, a doubling of both wall thickness and span will leave the center of gravity of the half vault ~~the same distance~~ in the same vertical line. One may demonstrate this graphically using the method. Roys. · &c.

Possibly in such a case, where everything is made larger, there may enter an additional strain on the cohesiveness of the mortar in the vaults (as opposed to its power of resisting pressure) but we are not in a position to measure this property of Maya mortar.

While merely larger buildings, of the same relative proportions, may represent progress in building design, the progress ~~is not necessarily~~ may not be in (measured by) structural technics, and must be more subject to doubt. ✱ It therefore appears to the writer desirable to supplement the absolute measurements of walls & spans by an index which ~~includes~~ reflects both, when comparing various buildings. ✱ An ideal index would accurately reflect increase in load on the walls, and the relative margins of safety from the point of view of stability.

No idea how to do this

Would be useful only among buildings completely known, since both load & stability are affected by the form, as well as span of the vaults.

Proposed some form of percentage of walls to spans, which can be determined even in almost completely collapsed buildings.

Oversized item not scanned

TABLE 1 : DOUBLE*RANGE BUILDINGS, FREE-STANDING.

A-Vaulted

		Walls			Rooms		Tot.	Per Cents		
A	B	C	D	E	F	G	H	I	J	K
J-9	Plat.	1.30	1.05	1.16	1.67	1.73	6.91	51	75	69
J-2	Plat.	1.05	.95	1.05	1.70	1.70	6.45	47	62	62
J-13	Plat.	.87*	1.02*	.87	1.62*	1.62	6.00	47	54	54
J-23	Plat.	.70	1.04	.70	1.40	1.40	5.24	47	50	50
J-21	Plat.	.80	.80	.80	2.42	2.43	7.25	33	33	33
J-18	Plat.	.80*	.95	.80	2.60*	2.60	7.75	33	31	31
J-11	Plat.	.52	.95	.70	2.88	2.60	7.65	28	18	27

B-Non-Vaulted

U-3	Plat.	1.20	1.50	1.20*	1.70	1.70*	7.30	53	71	71
J-12	Plat.	1.05*	1.10	1.05	2.30*	2.30	7.80	41	46	46

TABLE 1 - continued.

	L	M	N	O	P	Q	R
(J-9)	1.50	1.50	1.50	Yes	Yes	Acrop.	
(J-2)	1.40	1.00	1.20	Yes	Yes	Acrop.	
(J-13)	1.65	1.10	1.38	Yes	Yes	Acrop.	
(J-23)	1.60	1.00	1.30	Yes	Yes	Acrop.	
(J-21)	2.25	.75	1.50	Yes	Yes	Acrop.	
(J-18)	2.25	1.00	1.63	Yes	Yes	Acrop.	
(J-11)	1.80	1.00	1.40	Yes	Yes	Acrop.	
(U-3)	.50	.15	.33	No	No	South	
(J-12)	1.00*	.35*	.68	No	No	Acrop.	

TABLE 2 : SINGLE-RANGE BUILDINGS, FREE STANDING.

A-Vaulted

K-5-W	Pyr.	1.40	×	1.65	2.15	×	5.20	59	65	77
O-12	Pyr.	1.10	×	1.50	1.80	×	4.40	59	61	83
R-5	Pyr.	1.05	×	1.23	2.10	×	4.38	52	50	59
J-4	Pyr.	1.10	×	.75	2.05	×	3.90	47	54	37

B-Non-Vaulted, Stone Walled.

R-3	Pyr.	1.30	×	1.30*	1.50	×	4.10	63	87	87
J-20	Plat.	1.00	×	1.00	3.20	×	5.20	38	31	31
J-17	Plat.	.70	×	.75*	2.90	×	4.35	33	14	26
K-5-3d	Pyr.	1.10	×	1.10*	5.00	×	7.20	31	22	22
V-1-2nd	Plat.	.35	×	.35	2.60	×	3.30	21	13	13

TABLE 2 - continued

(K-5)	1.50*	1.30*	1.40	Yes	No	West	9.9.8.?.?.
(O-12)	1.00*	1.00*	1.00	?	No	East	
(R-5)	1.10	1.00	1.05	Yes	Yes	South	9.11.15.0.0
(J-4)	1.60	1.20	1.40	?	No	West	
(R-3)	.80	.70	.75	No	No	South	9.5.5.?.?.
(J-20)	1.00	.80	.90	No	No	Acrop.	
(J-17)	.80	.80	.80	Few	No	Acrop.	
(K-5-3d)	×	×	×	×	No	West	
(V-1-2nd)	×	×	×	×	No	S.E.	

Tables 1 + 2

Table 3 : SINGLE-RANGE "BUILT-ON" VAULTED BUILDINGS.

A	B	Walls C	D	E	Rooms F	G	Tot. H	Per Cents I	J	K
J-6-2nd, (a)	Plat.	1.25	x	x	2.50	x	x	x	50	x
J-8	Plat.	.75	x	x	1.59	x	x	x	47	x
J-10	Plat.	.58	x	x	1.25	x	x	x	46	x
J-6 (Rm.3)	Plat.	.90	x	x	2.15	x	x	x	42	x
J-6 (Rm.1)	Plat.	.75	x	x	2.10	x	x	x	36	x
J-22	Plat.	.70	x	x	2.00	x	x	x	35	x
J-2 (Rm.6)	Plat.	.50	x	x	1.65	x	x	x	30	x
J-6-2nd, (b)	Plat.	.75??	x	x	2.90	x	x	x	26??	x

Table 4: PYRAMID SUPERSTRUCTURES - PROBABLY STONE-WALLED BUILDINGS; SINGLE-RANGE FREE-STANDING, NON-VAULTED.

R-1	Pyr.	.90	x	?	2.15?	x	?	?	?	?
R-4	Pyr.	?	x	?	?	x	?	?	?	?
R-9	Pyr.	.85	x	?	?	x	?	?	?	?
R-10	Pyr.	1.10	x	?	?	x	?	?	?	?
R-16	Pyr.	1.30*	x	?	?	x	?	?	?	?

Table 5: TWO VAULTED BUILDINGS OF COMPLEX PLAN

O-13 (Rear Rms)	Pyr.	.90	1.10	1.40	1.30	1.00	5.70	60	69	140
P-7 (Sant'y)	Plat. Plat.	.82	x	.73	2.20	x	3.75	41	37	33
P-7 (outer)	Plat.	.80	.90	.90	3.70	3.80	10.10	26	22	24

TABLE 3 - continued

	L	M	N	O	P	Q	R
(J-6-2nd, (a)	x	x	x	x	Yes	Acrop.	
(J-8)	2.00	1.50	1.75	Yes	Yes	Acrop.	
(J-10)	2.00	1.50*	1.75	Yes	Yes	Acrop.	
(J-6, Rm.3)	2.20	1.75	1.98	Yes	Yes	Acrop.	
(J-6, Rm.1)	2.00	1.00	1.50	Yes	Yes	Acrop.	9.17.15.0.0.
(J-22)	2.25	1.00	1.63	Yes	Yes	Acrop.	
(J-2) Rm.6	2.00*	1.00*	1.50	?	Yes	Acrop.	
J-6-2nd, (b)	x	x	x	x	No	Acrop.	

TABLE 4 - continued.

(R-1)	.90	.90	.90	No	No	South	
(R-4)	.75	.75	.75	No	No	South	
(R-9)	.60	.40	.50	No	No	South	
(R-10)	.85	.30	.58	No	No	South	
(R-16)	.35	.35	.35	No	No	South	

TABLE 5 - continued.

(O-13, Rear Rms.)	3.00*	3.00*	3.00	Yes	Yes*	East	
(P-7, Sanct.)	1.60*	1.60*	1.60	Yes	Yes	East	
(P-7, outer)	1.60*	1.60*	1.60	No	Yes[1]	East	

1. Roof of outer rooms of Str. P-7 believed to have been combination of vault and beam-and-mortar construction, See text.

Tables 3, 4 & 5

wide Margin on right side - type to face Tables 6 on right.

Key to Table 6

S Height of Vault-spring above floor.

T Approximate angle of soffit slope of main vaults, based on measurements of remnants in position. Measured from vertical.

U Vault height; equals vertical distance from vault spring to under side of cap-stones. These are computed figures based on approximate soffit slopes and therefore subject to considerable error, except in case of J-8, where cap-stones are in place, Room 6 of J-2, and Sanctuary of P-7, where cap-stones are in place.

V. Approximate roof-height; equals vertical distance between floor and top of roof, assuming flat roof; where given, indicated by floor levels behind "built-in" buildings.

V. Cap-stone height; equals vertical distance between floor and under side of cap-stones, that is the maximum height of rooms; equals sum of Columns S and U and therefore subject to same errors as in Coulmn U.

W Thickness of roof-cap; equals vertical distance from under side of cap-stones to upper surface of roof, assuming flat roof; equals Column X minus Column V.; approximations only.

X Approximate total height of building; equals sum of Columns S, U and W.

Y Minimum width (distance from doorway to doorway) of piers in outer walls. Maximums do not vary greatly from this figure.

Z Maximum width of doorways (distance between jambs). Minimums do not vary greatly from these figures.

Notes: (x) indicates no statement because feature is absent in building.
(?) indicates no statement because feature is fallen, or note was not recorded.
(*) indicates an approximate figure, based on photographs, inference from known facts, &c.

Table 6: MISCELLANEOUS DATA ON VAULTED BUILDINGS OF TABLES 1, 2, 3 and 5.

	S	T	U	V	W	X	Y	Z
J-9	2.06	29	1.22*	3.28*			1.12	1.70
J-2	2.50*	?	?	?	?	?	1.25	1.78
J-13	?	?	?	?	?	?	x	1.75
J-23	2.10	?	1.55*	3.65*	?	?	1.80	1.70
J-21	?	?	?	?	?	?	1.08	1.75
J-18	?	?	?	?	?	?	1.27	2.16
J-11	2.25*	24 ~~27.5~~	2.50*	4.77*	?	?	1.25	1.83
K-5	?	?	?	?	?	?	1.25	1.80
O-12	?	?	?	?	?	?	1.20	1.60
R-5	?	?	?	?	?	?	1.30	1.50
J-4	?	?	?	?	?	?	x	1.55
J-6-2nd (a)	2.00	30 ~~33.5~~*	1.32*	3.32*	.58*	3.90*	?	?
J-8	2.03	30*	1.17	3.20	?	?	1.20	1.88
J-10	2.00*	?	?	?	?	?	?	?
J-6 (Rm.3)	2.16	28.5	1.67*	3.83*	.43*	4.26*	1.20	1.70
J-6 (Rm.1)	2.17	?	?	?	?	4.26*	1.20	1.70
J-22	2.18*	?	?	?	?	?	?	?
J-2 (Rm.6)	2.25	?	.95	3.20	?	?	x	1.25
J-6-2nd (b)	2.00?	?	?	?	?	?	?	?
O-13 (Rear Rooms)	?	?	?	?	?	?	x	1.55
P-7 (Sanct.)	.90	35	1.75	2.65	?	?	x	.71
P-7 (Outer Rooms)	3.20	22	?[1]	?[1]	?	?	2.90	2.50

1. Vault height of outer chambers of Str. P-7 would be 4.18, assuming complete vault and projecting known slope, giving the improbable cap-stone height of 7.38. Roof believed to have been combination of vault and beam-and-mortar. See text.

Table 6

Table 7: PIER AND DOORWAY WIDTHS IN NON-VAULTED BUILDINGS.

A	Y	Z
U-3	1.60	2.25
J-12	1.20	1.77
R-3	x	1.55
J-20	?	?
J-17	x	.75
K-5-3d	1.20	3.65
V-1-2nd	?	?
R-1	x?	1.95
R-4	?	?
R-9	1.00	1.60
R-10	?	?
R-16	?	?

Key to Table 7:

A. indicates structure number.

Y indicates minimum known width of piers.

Z indicates maximum known width of doorways.

Notes: (x) indicates no statement because feature is absent in building.
(?) indicates no statement because feature is fallen or note not ~~recorded~~ made.

TABLE 8: Interior doorway widths; (*) equals known to be vaulted.

	Front to Rear		To End Rooms.	
	Min.	Max.	Min.	Max.
----- Vaulted -----				
J-9	.70	1.40	.75	.80
J-2	1.25	1.60	x	x
J-13	?	?	.81	?
J-23	.75	.75	.75	1.05
J-21	.85	?	.70	.85
J-18	.75	.80	.85	?
J-11	.70	1.25	.70	?
---- Non-Vaulted --- —				
U-3		2.00*	x	x
J-12	.70	1.00	.68	.75
- Two Vaulted Buildings of Complex Plan -				
O-13 (Rear Rooms)		1.55	x	x
P-7 (outer Rooms)	.90	1.15	x	x

Note: In Structures J-9, J-13, J-21, J-18, J-11 and J-12 there probably are doorways not visible without further excavation. Table gives figures for known doorways; where only one is known it is placed in minimum column unless it is kown to be the only doorway, when it is placed in the maximum column.

(*) equals approximation based on one known jamb and contours of debris.

Key to Tables 1, 2, 3, 4, & 5.

A Structure No.

B Type of Substructure.

C Wall thickness - front

D " " -medial if any

E " " -rear, if free-standing.

F. Room width - front; equals span if vaulted.

G. " " - rear ; " " " " "

H. Total width of building above plinth; equals sum of Cols. C to G.

I. Percentage of cross-section occupied by walls; equals sum of Columns C to E divided by Column H, to nearest percent.

J. Ratio of front wall thickness to front room width; equals Col. C divided by Col. F, to nearest per cent.

K. Ratio of rear wall thickness to rear room width; equals Col. E divided by Col. G, to nearest per cent.

L. Maximum depth of debris on floor of room where section is taken; usually the front room; maximum usually is at rear of room.

M. Minimum depth of debris on above floor, within inner side of front wall; minimum usually at front of room.

N. Average depth of debris; equals average of Columns L and M.

O. Answer to question: "Was there a profusion of stone slabs in debris on the floor?"

P. Was there positive independent evidence of stone vaulting on building?

Q. General location: West Group, Acropolis within West Group, East Group, South Group, or Southeast Section.

Dates

R. ~~Carved~~ on supposed lintels and a throne associated with buildings; readings according to Morley.

Notes: (x) indicates no statement because feature is absent in building.
(?) indicates no statement because feature is fallen, or note was not recorded; except in case of J-6-2nd (b) where it expresses doubt of the actual existence of a vault at the point under consideration.
(*) indicates an approximate figure, based on photographs, inference from known facts, &c.