Arch. Summary.

Measurement of Lines and Angles.

A number of propositions respecting measurments and the laying-out of plans are more or less flatly stated below, for the sake of clarity and ready reference. They are hypotheses, with greater or less amount of evidence behind them. This is given in Appendix ____. They are important if true because they explain certain marked asymetries encountered where symetry is expected; and they indicate a striving for perfection thwarted by inability to mechanically lay out true right angle on a large scale, or else ignorance of the final effect of failure to do so. They also may help in spotting expected features of a partly or carefully excavated mound.

Lines were measured, presumably with cords for long ones, with considerable accuracy; absolute standard units such as our foot and inches may have been used, but were not necessary to produce the results observed. Lines meant to be equal may merely have been measured against the first one laid out, taking that as the unit for all. The procees would be "Make the rear facade equal the front", not "Make the front facade equal so many feet, make the rear equal the same number of feet".

Two adjacent sides were first laid out, the two others from the ends of these, with linear measurment, producing a basic outline. Interior points were measured from adjacent sides of this, in most structures producing a secondary outline from which points were probably in turn measured, in a similar manner.

There is some evidence that interior points were measured from the nearest pair of adjacent sides of the outline, without check-measurements to the other pair.

There is also some evidence that points on a established line (such as door-corners) might be measured serially, each being measured from the location of the next prior one. In such a case, and error in

in locating one point would tend to displace all later ones in the same direction, but would not affect later linear dimensions of itself.

There is some evidence that after laying out two lines supposed to be equal, each of these was used as the unit against which to measure some of the others. Errors in the two units used would tend to infect the series of measurements from each, producing a plus and minus patterning in the actual dimensions of each series. Such patterning tends to deny the use of standard units of measure, but the evidence available is slight.

Errors in linear measurement are apparent and expected. These would tend to cancel out or accumulate by chance as one proceeds from the outer basic outline to secondary and later bases from which to measure. Greater maximum discrepancies in interior lines theoretically equal are therefore expected, as found.

The initial angle of the basic outline was judged, not mechancially laid out, and is therefore only occasionally an approximately true right angle, by chance. But measurement from the sides enclosing this angle determines the other angles of the basic outline; measurment from the basic outline to reproduces the same angles in cooresponding secondary and later outlines, except as modified by linear measurement errors, or where there is a break in the series of measurments. Therefore all outlines tend to be similar paralleograms, rectilinear only if the intial angle was ninety degrees. (Fig. 3) Where not otherwise noted, "paralleogram" herein means "non-rectilinear paralleogram". Since non-rectilinear paralleogram basic outlines of considerable accuracy occur in ball courts, palaces and temples, they were scarcely intended for functional reasons. Examples of approximate rectiliniety, and of a rectangular combined with a non-rectangular end, among the palaces, guarantee

Further evidence is that sometimes the acute angle of a parallelogram outline is on the left, sometimes the right of an observer facing the front or rear. (Cp. Fig 1 with Fig 8).

the common-sense view that rectilinear plans were intended.

"Displacement", as here used, means a given point is ~~to~~ to one side or the other of the position it would ~~occupy on a~~ if the plan were strictly rectiliear, but of the same linear dimensions. ~~plan having one side in coomon with the actual plan.~~

~~Expected displacement~~ With a basic paralleogram outline, accurate measurmements from either side, or series of measurements ~~from~~ starting from either side, will automaticaly displace interior points in one direction only, and in the amount by which, on reaching the same distance behind the common facade, the actual sides have diverged from rectified sides. ~~If both sides are neither at right angles to the common facade, nor parallel to each, the direction and amount of expected displacement depaends on which side was used as the measurment base.~~ With a rectilinear outline no displacement is expected; the axes coinciding. with a known basic non-paralleogram outline either of two displacements (or a displacement and non-displacement) is expected; depending on which side is the basis for measurement. with the more common paralleogram outline, only one displacement is expected. In any case, the farther the point is behind the selected facade, the greater the expected displacement with reference to a rectilinear side (or axis) erected on it. Since observers tend to look at a facade on a line at right angles to it, displacements of ~~interior points~~ points behind the facade, if visible, tended to destroy the symetrical effect usually aimed at. This is much more noticeable on small-scale elevation drawings than on the buildings themselves. There is no evidence that any attention was paid to it by the Maya in their construction of ball courts, or of palaces, ~~or~~ sweat-houses, and other free standing buildings, nor in laying out the substructure terraces and outer wall-lines of pyramid temples buildings.

The divergence between a true and a rectified axis, starting from a point in the same facade, gives the same thing, + here ergo on Fig. 3 define the varying displacements of central doorways using an expected original angle.

The stairway of a pyramid or other platform extends both inside and outside the outline. Its side walls cross ~~both~~ the basic outline and reach, or nearly ~~the~~ reach, the innermost outline at the

top. On pyramid temples the inner outline may be well behind the outer, and displacement at the top considerable. Laying out the stairway to agree with both sets of points, on a pyramid of a known basic angle, would distort it noticeably, and swing its center line, apparently an important ceremonial axis, to one side, and distort it noticiably as seen from the front (Fig 6, a).

Probably in one case at least the stairway axis was swung from the measured center at the top by sighting, and the walls lines meaaured from this. Similar proceedure on higher units would straighten the stairways, but accentuate the displacements between the top of one and the base of the next higher. (Fig 6, c).

Such a situation probably existed, but whether it is a conscious adjustment to displacement is a question. There is some evidence that in judging stair-wall angles, better approaches to right angles were obtained than in the basic outline. Such a situation would have a specific effect on terrace lengths on either side of the stairway - plus on the acute angle side of the pyramid or platform, minus on the other, discrepancies being greatest at the bottom.

For a more thorough adjustment there is very good evidence that all stairways were laid out from sighting from or to the temple building - probably the axis only being sighted, sidewalls measured from it. Symmetry of Temple building, stairways, altars and central stela (in the final phase) was thus achieved, all showing the displacement expected only for the building facade. (Fig. 7) In this known case, the displacement is about 1.15. At the base this full amount is added to the length of terrace on one side of the stairway, subtracted on the other, producing a discrepancy of 2.30

Evidence as recorded in Appendix —, b. —, indicates the pyramid stairway was proportionaly off-center at the top also, as required for centering on the building.

an actual one of 2.20, in dimensions of parts of the primary outline which should have been equal, (two standard units were used) This could be otherwise effected only by one measurement error, and not by a cumulative series.

Taking all periods of this structure together, it is clear that stairways were sometimes not only "straightened", but also lined up on a single axis from the temple facade center, and this must have been a conscious adjustment.

Displacement on a paralleogram pyramid tended make the silhouette steeper than that of a true cross-section on one side, less steep on the other, provided one looks at the facade at right angles to it as in an elevation drawing (Fig. 6, a and c). Outsets, presumably measured equally from the corner points defining these solhouettes, would show a similar horizontal crowding on the obtuse side, streching on the acute side of any facade. Allowing for irregularites due to cumulative errors there is some evidence that this actually occured. In any case, irregular horizontal spacing of a risijg series of

It is probable that altars within the temple, and altar niches when present, were also carefully set on this ceremonial axis. There is a little evidence that sometimes the interior of the temple room (but not the exterior) was laid out from the axis, to displacement of the inner rear wall being adjusted so that the niche could be centered it and also be accurately centered on the ceremonial axis.

corresponding outsets was tolerated, though easily

detectable.and, one would suppose, easily adjusted with eye.

All adjustments of displacement occur on pyramid temples only, and those surely conscious seem referable to a requirment that a single straight line on stairway axes of ascent be maintained from the bottom of the pyramid to the central temple doorway, and perhaps thence to the temple altar and niche, if present; possibly there was also a special conscious effort to get this line at right angles to the facade. This line, from the plaza to the center of the temple facade, we have called the ceremonial axis, since it is frequently marked with altars.

While the evidence for some of the above notions is not as complete as might be desired, the existence of rather accurate careful linear measurment on all types of structures seems to the writer conclusive. Such care had no structural or ritually important value and must therefore have been aimed at aesthetically pleasing symetry. For practical purposes it achieved its aim and produced nicely balanced facades excdpt on complexes. pyramid temples. Angular measurments were as clearly bad as linear ones were good, and here caused trouble. These Maya must have been poor geometricians. Either they could not mechanically on the ground lay out one line at right angles to the other, except by chance; or individual skill; they or failed to realize how a badly judged initial angle would, with careful linear mesurement thereafter, pile up trouble with the ceremonial axis in the end.

For a given number of terraces and basic outline angle, the higher the terrace, the flatter its slope and the greater the depth of the recessed terrace tops used, the greater the displacement of the tops of a unit. All these factors contribute to the distance of the upper and lower outline to bend the original one.

Appendix

Intro.

(1) (2)

Figs

1 - K-6

2 - P-1

3 - Theoret Pal

4 - J-11

Ball Courts - tables - linear meas. demonstrate (3)

Hypothetical Bldg - (4)

Intro - 4.

How laid out (5)

Parallelogram Plan (5)

Ball Courts as illust. of. (6)

Displacement (6)

Ball Courts as illust. (7)

Practical application of divergent axis.

Interior points -

stages - accumulating errors (8)

Instances (Theoret. Bldg (9)

Divergent jambs (9)

One error infecting a series. (9)

- Rebuilding Pattern instance (9)

- Non use of graduated tapes? (10)

Correction of Displacement

- doorway jambs (11)

doorways (11)

" (12)

Actual Palace measurements. (12)

J-11 (13 & 14)

J-9 (15)

Inner vs outer (15)

Displacement conscious? (16)

Ex. of accumulated error (17) - (18)

Bi-lateral dimension pattern. (18) - (19) 20

6

Use of uniform ▱s. (21)

St. J-2 ▱ ''

J-21 '' (22)

J-13 - Rectilinear (22)

J-23 '' +
displacement
(linear & non-
piece-meal
measurement. (22) (23)

J-12 - non ▱. (23)
displacement
from one
end. (24)

P-7 - non ▱ (24)
'' (25)

Temples - clutz. (25) (26)

Hyphatia (Fig 6) (26)

27

Stay correct only 28

All stay correct.
K-5-3rd 29
30

K-5-2nd-&1st 31

Hard to lay out
(theory). 32

Bel. better stain angles ~~34~~
Ev. for -R.16 (33)
-R.9 34

Other Ev. Ev.
- R-3 35

→ End layout of
Temples. (35)

Asymm. Silhouettes
(Pyr.) (36)

Architectural Summary

(1)

appendix ——.

Linear measurment and estimated angles.

We have a very fair body of ~~accurately~~ structural remains accurately surveyed as they now survive. There are, of course, small errors in our own surveys, and it is unlikely that in building the Maya followed their own guiding lines with absolute accuracy; and some cases given points, such as corners, have very clearly moved from their original positions through settling. Nevertheless, an examination of the plans forces one to the conclusion that the buildings could not have been built without linear measurement, that is, taping. Through most of the buildings, for instance, one may say that standard pier widths were used, and room widths fall into groups. This is not to argue for the existance of an arbitrary standard unit of measure, like our foot. An early pier might be taken as proper for later pier widths. A string, stretched across the early pier and knotted or otherwise marked would be sufficient to produce the observed tendency toward standardization in this regard. If a new dimension was decided on, such as a wider or narrower doorway, it could be standardized for the new building by the same expediant, the first doorway laid out becoming, in fact, the unit for this feature. While standard units may have existed they were surely not necessary to produce what we find; but measurement in empirical units must have been used. For long distances cords would seem the obvious means of taping, and would introduce errors due to humidity, which varies with the time of day and the season, and with tension on the cord. The best structures on which to note

(2)

Because of this, and because long lines would be most difficult to estimate without measurement, ~~lxxgxixnexz~~ the close correspondence of long lines which in theory should be equal will constitute the best evidence of that measurement occurred, and how accurate it could be.

actual
In order to present ~~evidence for the above conclusions~~ evidence of taping, we first select the two ball courts, ~~which~~ the plans are simple,
of which/~~xxhixhixz~~ consist mostly of long lines, and which are close to bed rock and have settled little if at all. Then we will examine some palaces and ~~&~~ temples, ~~xafaxingx~~ and try to work out some consequences of the supposed accurate linear measurement combinded with poor
right
estimation of ~~right~~ angles. In the figures points are numbered. ~~and~~
identified
Lines/ measurments, scaled from the plans, are ~~indicated~~ by these numbers preceding the measurement. Each lettered group of measurements pertains only to lines which in theory should be equal. In brackets at the bottom is the maxium variation or discrepancy for the whole group.

~~Figurexxixandx2~~
The discrepancies in the various measurement groups of Figs. 1 and 2 seem to the writer to be of the order one should expect if the plans were originally laid out on the ground with reasonably
linear
careful/measurement of the sort we are postulating; it does not seem
that
possible /the discrepancies could be be so little without it. In working backward from our plans to those of the Maya we must allow for a number of sources of error, any or all of which may be reflected in our figures. Our own errors may arise from shrinkage or expansion of paper, in scaling from the plan, in drawing it, in the surveyes themselves and in selecting the exact spot on a poorly dressed stone as a corner. Maya errors might arise from failure to actually place a corner at the exact point laid out for it, from differential stretching of measuring cords due to varying humidity, and of course from plain carelessness.

discussing the non-retilinear but nevertheless parallelogram form of the outlines of these structures, and before

Before proceeding with actual free-standing buildings, the hypothetical one of with their more complicated plans, let us examine Fig. 3 .

Broken lines show a rectilinear building plan super-imposed on one of non-retilinear paralleogram plan, with a much exagerated error in the angles. All later dimensions are identical in the two plans. Theoretically room widths and wall thickness should be slightly less in the paralleogram (shaded plan) as they would be if end-walls, and door-jambs were exactly equal in each building. This inconsistency does not affect our use of the diagram, and makes it much simpler.

In each case we have chosen the length of the front and one side at random, and laid off the side from one end of the front, in one case making it 90 degrees, in the other chossing it at random. Three corners are thus fixed. Now when the fourth corner is determined it will determine the lengths of the other side and rear, or conversely, those lengths will determine the position of the fourth corner. To obtain the degree of correspondence in these lengths observed in the ball courts, the simplest proceedure would seem to be this. Two men would stretch a cord from Y to X Z, mark the length and walk toward the rear. Two others would mark the length Z-X on another cord and walk to the left. One end of the long cord would now be held at X, and one end of the short one at Y, the cords stretched and the other ends then brought together. The fourth corner is now loacted and Corresponding sides are equal, except for errors in this proceedure, which, of course, are to be expected.

Without measuring any angles a paralleogram is automatically produced, opposite angles being obtuse and accute respectively if we started with an obtuse or acute angle. If we started with Y-Z-W and a right angle, all angle would of necessity be right angles, and the plan a rectilinear paralleogram. Since this is never the case we can restrict the term "paralleogram" to mean one like V-X-Z-Y in which opposite pairs of angles are obtuse and acuute respectively.

The paralleogram plan is obvious when looking down on small-scale drawings, but not very apparent when looking at the buildings themselves. Its presence seems an adequate indication that linear measurement of considerable accuracy has been resorted to. Conversely, the correspondence of theoretically equal lines is a measure of the accuracy of the paralleogram. Glancing back at the ball-court plans we see that each structure is an approximate paralleogram so far as points are known, as required by the correspondence of meaaurements already cited. Further that for each

court each structure fits into a larger paralleogram if we join their inner corners, proving, as we take it, that the twin structures and the alley field were laid out as a single unit from single longitudinal and transverse base-lines, and that a single initial error in the direction, and to a large extent the amount of in estimating the angle between them has determined all the other errors in the angles in both structures. There is no reason to suppose that rectilinear paralleograms were not intended, and this becomes practically certain when we find the same situation in other types of structure.

First we return to our hypotheical buildings of Fig. . On either plan the distances from any door-jamb to the end walls are the same, line 1-3 equals 5-7 and so on, and also equals and 2-4 and 6-8, etc. But, taking the axis A-B of the rectilinear plan which we believe was intended as a reference line, there is what we shall call a displacement of points in the paralleogram plan. The line 1-3 is displaced to the position of 2-4, and 5-7 to that of 6-8, and so on throughout the building. Starting, as we have done, the two axes from one point in a facade (at E), as we proceed inward or rear-ward their divergence measures the amount of displacement and direction expected along any longitudinal line toward. For instance, 1-3 is shifted toward D*C, and the amount not only equals 3-4 and 5-6 but also the divergence between the axes at the line of the inside of the front wall and end walls. This follows because the two sets of jambs are parallel respectively to the axes. Of course, the divergence between any pair of lines, parallel to these axes and meeting in that facade line common to both plans yields the same result.

Since these lines steadily diverge the farther we go from the facade, and so an exaggerated note, the medial wall and rear doorways are greatly displaced with reference to the front one in the shaded figure,

and the rear twice as much as the medial. Being centrally placed they are on the axis C-D instead of A-B.

Turning back again to the ball courts we see this theoretical displacement demonstrated in Structure R-11 by the positions of the side marking stones, which are approximately true transverse axes, not on lines running from the facade centers at right angles. In this unusual case, where the buildings face each other and fit into a larger paralleogram, the simplest way to measure the displacement is to

Expected

are on the correct sides of rectified axes and their centers, at the bottoms, are reaonably close to being on the true axes. At these distances from the alley sides, the expected displacement is about 50 cms. Four meters further in it would have been a meter. Taking cognizance of this simple principle may be of practical value in less than complete excavation. Failure to do so might lead to missing suspected feautures by excavating on a rectilinear rather than true axis. The first step would be to excavate an adjacent corners to determine the direction of divergence, and as a check, an adjacent corner. Theoretically, if both turned

We cannot claim or assume that measurements of the outline always were so accurate as to produce the paralleogram form. Therefore an adjacent corner should be excavated. Theoretically, if both turned out acute or obtuse a search for interior central features should be inititiated on the rectilinear axis, but extended to either side if not found there. It might be displaced by measurement of either of one-half the facade length from one side only. In this way, good measurement combined with earlier bad might explain a displacement otherwise supposedly intentional.

Returning again to Fig. , which contains many points within the exterior outline, analagous to the centers of the ball court markers. Suppose, after laying out the paralleogram outline VXYZ with careful measurement but some error, the room corners are now laid out from it, again with some error. It would be simplest and natural to next lay out the interior door jambs from the room corners by a third set of measurments, again with some errors. These errors in related but separate sets of measurments would tend to accumulate or cancel themselves by chance, and so modifiy the correspondence of theoretically equal lines, and amounts of displacement, in an unpredictable manner. But in general maximum discreptancies could, due to accumulated individual errors, rise higher for series of interior measurments than in those defining the outline, although the actual maximum error in any one taping operation was the same.

in the positions of the inner wall-sides themselves. Therefore, less consistency in the correspondence of theoretically equal lines is to be expected for interior measurements. For instance, if point 2 was actually 20 cms left of its correct position, as shown, and used as a base for the line 2-4, point 4 would be shifted 20cms to the left also. If 6 was measured from 4 it also would be displaced to the left, was already correctly located as an interior corner of the parallelogram, and the line 6-8 would be 20cms longer than 2-4. Now suppose in

measuring from the misplaced point 2 to 4, there was a plus error of 20 cms. Line 2-4 would be the longer, now 6-8 remaining the same, the difference still being 20 cms. But suppose this measurments was 20cms short, Line 6-8 would be 40 cms longer than 2-4, two 20-cm errors having accumulated.

Still assuming point 2 dispalaced 20 cms to the left, suppose 4 was accurately measured from it, but 6 was not measured from 4, but from 8, again accurately. The result would leave lines 2-4 and 6-8 equal, but the left doorjamb would diverge from the right. Non-parallel jambs do not necessarily disprove presence of fairly accurate measurments, since the amount of their divergence from the expected pattern is most likely to reflect combined with inaccurate ones, the errors of which may sometimes be cumulative.

Through a series of related measurments one error might affect the whole series, or a given part of it, depending on the proceedure. Suppose in Fig. the line 2-4 is first laid out, and then 10-12 and the other corresponding wall lengths to the left of the axis is checked against it, accurately. They will all be equal. Now 6-8 be checked with 2-4, but with a 20-cm plus error. Accurately/Checking 14-16 against this, and so on would make all the longitudinal lines to the right of the axis greater than those to the left, a single error being responsible. There is basis for believing this occurred in Str. J-9, as we shall see, and such grouping of differences confirm the presence of linear measurements, of considerable accuracy, as well as the presence of errors.

Can read labels of parallelogram outline angles with the facades & han do the sides of the buildings and also in the same building diverging from this in either direction.

measurment errors by the Maya architects. Our own errors could not produce such a pattern of differences, since each of our measurments, whether in the field or on the drafting table, is made by separately reading tape, rod, scale, transit and protractor, graduated to a standard scale. Or own errors would repeat themselves only by chance, and therefore rarely.

V. Possibly this sort of pattern, if detected often enough, might justify the negative conclusion that tapes graduated to some standard, were not used. Certainly they were not necessary to produce what is found.

K-6

Similarly, in the R-11 ball court of Fig.1, Group A, the The maxium discrepancies on either single structure are .11 and .05 respectively, all lines of one (last two figures) being at least 24 cms longer than any of the other. This may be the maximum single error in measurement, the grouping by structures resulting from laying them out within the general plan, but at different times.

in which logical sub-groups of measurements show plus or minus tendencies,

We should consider another possibilty that might affect the correspondence of interior line lengths. Suppose the bad angles of VXYZ are due to mere carelessness. In less exagerated amounts they would not affect the appearance appreciably. Then suppose in laying out the door jambs, where the displacement of inner corners is more noticeable, this was corrected, to make the jambs form true right angles with the facade, and this was repeated at the medial and rear doorways, working in from the front. Line 2-4 would be shortened to 2-3 and 6-8 lengthened to 5-8, and so on. Passing from front to rear on the left side of the axis, 2-3 would be short, 10-12 correct, V-35 short. To the right of the axis 5-8 would be long, 14-16 correct, 36-X long. We have not detected any such pattern in actual building measurements. While sometimes several jambs are more nearly at right angles than are the sides of the buildings, others diverge in a contrary direction. The very common failure of jambs to parallel the sides probably results from errors in lateral measurement, which, by the time the jambs are reached, may be either cumulative or canceling.

The evidence does not seem to support the idea that the Maya knew how to judge or lay-out mechanically truer angles than they used for the outline. However, it is at least possible that on occasion they determined the angle of a jamb without measuring to the side walls, and any such independent judgment would tend to augment the non-correspondence of interior lines theoretically equal.

Another possibility might be the shifting of the doorways from displaced positions as dictated by measurment on a paralleogram plan, toward the rectilinear axis, in order to place them truly behind one another. To do this in Fig. ___ we would retain the shaded plan except that door 13-14 would be shifted to position 11-13, and 29-30 to 27-28. This would cause dimensions otherwise identical in theory to vary in a definite pattern. Line 2-4 decreases to 10-11, and this to 26-27. To the right of the axis, passing from front to rear, the lengths would increase from 5-8 to 28-32.

We shall see that in Str. J-9 two out of three groups of measurements reflecting locations of three pairs of doorways show this pattern, but we have their concluded this may be by chance.

Since it does not appear in the case of the three doorways giving passage clear through Structure J-2, where it would seem most desirable, again the evidence for correction of displacement seems negative. But one can scarcely be sure that some correction of displacement never occured, since the pattern in measurements would be disturbed by the errors already discussed.

Thus far one might say that the Maya were unaware of these displacements caused (be believe) by an initial bad angle, or at least did not care about it.

Below we present groups of measurments from a number of actual palaces, in the same way as we did for the ball courts. They seem to show the same order of accuracy in laying out original outlines, similar errors in angles, lateral measurement to intermediate points, but often greater final errors in locating such interior points, as expected.

In Fig 4

Groups A to E refelect the accuracy in laying out the main masses of the facades, which is of the same order as encountered in the ball courts. The last two figures of Group D also show how accurately the central feature of an end facade, a doorway, was placed. Its center is one-half their difference, Groups F and G show the centralization of a pier in the rear, and of a doorway in the front facades, in both cases despite the longer measurments concerned.

Among the interior measuresments note that within the first four figures, applying to the rear sides of medial wall sections, the maximum difference is .07, and for the remaining figures, the front sides it is .10. Only by combining front and rear measurements is the indicated maximum of .19 obtained. Disregarding the lateral medial wall doorways (Group I)

Group I reflects surprising accuracy in placing the central medial wall doorway in the center of the medial wall as a whole. One should remember that in moving a doorway or other feature from a correct to an incorrect position, we add to the length of wall on one side and subtract the same amount from the length on the other. Therefore the difference between these lengths, which is what is reflected in our tables, is twice the amount the doorway is out of place. Here, on the rear, this difference is .07 and on the front .06, so we may say the doorway is centered on the wall within less than .04.

center of the central medial wall doorway is within about 5 cms of the center of whole medial wall; Group J shows it is within 2 and one-half cms of the midpoint between the transverse walls, which run approximately parallel to the end walls. The doorway therefore though meant to be directly behind the outer doorway 32-33, should be displaced toward the buildings left, by reason of this accurate measurment. With reference to the outer end walls, this should be a little over 15 cms, but is actually about 25 cms. The reason is not far to seek: Point 19 is about 15 cms farther from the right side wall than is Point 28 from the left. Location from the interior transverse walls, indicated in Group J, would add this error to that inherent in the paraeleogram outline of the building. Accumulating or canceling errors in the original lay-out must evidently be allowed for.

Group K treats the other two medial wall doorways in the same manner and confirms that medial wall ddorways were laid out from the transverse walls, or vice-versa. Note that the only measurement varying more than 2 cms reflects the fact that the line 10-21 runs sharply counter to the general direction expected.

Part of the displacement of the medial wall center doorway seems to result from the errors in angles when laying out the outline, as was the case with the transverse markers of the ball courts; and part from a secondary proceedure in which the principle is the the same, but the results of two errors accumulate. The inner doorway being very much narrower, the outer jambs of complex design and, finally, other medial wall doorways necessarily to one side of outer door centers, the dispalcement was evidently unimportant.

Laying out short lines such as doorjambs without refeference to the outline of the building, perhaps with the eye alone, seems demonstrated, and is analogous to the line J-Ø of Fig . Such a practice there

Structure J-11, just considered, is probably the latest, certainly the most complicated in plan of the palaces. Str. J-9 is the simplest and probably the earliest of the vaulted palaces.

Dimension Groups A and B cover the outline, again a parallelogram. Of the ten outdoor doorways, 8-9 may be a secondary feature. The others are grouped in threes, or form three tri-partite doorways, with a maxiumum variation of 20 cms in width (Group C). But the two rear ones, ~~seen at the same time,~~ are almost exactly the same width. Group D shows the front one closely centered, while Groups E and F show the two others a close to symetrical placement in the rear facade. They are therefore displaced with reference to a rectilinear axis, but this could not be checked with the eye when observing the building itself. ~~Groups~~ G checks the ~~central position of the~~ respectively Groups G, H and I check the central and symetrical placements of the center doorways of of these three tri-partite units.

Groups J and K show dimensions on the inner outline of the building. Comparing the discrepancies with those of the outer parallelogram, (Groups A and B) J shows a larger diffeence, K practically none. If the each outer wall thicknesses separately, from the outer outline, both cumulative and canceling errors may be involved. Group L repeats for the inside the location of the central front doorway, the discrepancy being nearly double that on the outside (Compare with Group D). Group M does the same for one jamb of the rear tripartite groups, each of the central doorways of the rear group, and is comparable with Group F. Again the interior discrepancy if much greater.

A correction of expected displacement of points 23 and 26 would tend to cause this difference, but not in such an amount. If correction has occured it should have been applied also to the central doorways of these groups and to the points defining the medial wall doorways obviously meant to be directly behind these latter. Group N checks this for one side of such a pair, and the figures decrease in the manner expected. if a correction was made. But this may be by chance since the displacement of the medial doorway is slight, and even so is not in fact fully corrected. Lack of point locations prevents checking for this pattern for the other rear pair, but point 35 is displaced about .20 as called for by the parallelogram outline. Conversely, considering the central medial wall doorway, which is almost exactly behind the central front doorway and, but the measurments of Group O, referring to it, do not yilled the pattern expected from a correction. Rather this groups indicates slavish measurments from the end walls, with errors largely correcting the displacement of the medial wall doorway by chance, and causing the jambs of the outer doorway to take paralleogram axis direction. run against the far Note that all dimensions to one side of the building axis are identical, those equal to each other, to the other nearly so, but all greater, and decidedly so.

This is the type of pattern already refered to as suggesting that abstract standard units were not used. Part of the discrepancy of 40 cms or about 14 cms in this group has probably accumulated from location of the outside of the facade doorway (Group G). At Point 49 the end wall is about 15 cms thicker than is the other end wall at point 56, and a discrepacny of 29 cms between the first and last three figures would be expected, if no further errors occured. From here on Good measurment on either side of the axis, but with an error of 21 cms in moving the tape from one side to the other,

Candor requires us to note explicitly that Points 33, 40, 41 and 49 were destroyed by the Maya, and in restoring them we have assumed perfectly straight end walls. The figures involving these points would vary somewhat from those given, if we knew the exact locations of these points, but probably not much.

Using it (group C) as an example we can try to figure out how this discrepancy of 40 cms might come about without conscious correction of displacements and without such large errors in any single measurement.

Assume the inside corners 49 and 56 show accurate expected displacement, which is true within narrow limits, and that lines 57-58 and 63-64 have been laid off to fix the tripartite doorway, with a plus error on the right of the axis of .17 (Group D). Now, to locate the rear corners of these jambs, points 50 and 55, measure 57-58 from the side of the outline, or this distance minus a wall thickness from point 49 to get point 50; for point 55, repeat the process on the other side, but start with 63-64 as the unit of measure. If this natural operation is done accurately, the discrepancy of .17 will be carried to the inner sides of the front wall. Point 55 in fact approximately meets these conditions; but point 50 is about .17 left of its expected position, so that the jamb line 50-58 is at right angles to the facade, instead of more or less parallel with the sides, as is the jamb 55-63. The discrepancy of Group D may be the sum of these two errors.

Now from these jambs perhaps points 52 and 53 were located in the same manner (Group B). In checking 50-52 against 58-60 there is a plus error of 4 cms in one direction; but in checking 53-54 against 61-63, a plus error of 14 cms in the opposite direction. The net effect is to add 10 cms to the 34 cm discrepancy for points 50 and 55, or for points 53-56. 44 cms. This is 11 cms less than shown for these in Group C, due probably to our own cumulative errors in scaling, and assumptions in the points transferred directly.

But a 14 cm error in the short measurement 53-55 could only be due to carelessness, not stretching of cords or some such cause. ~~and need not be postulated. Suppose 53 as well~~ The angles of the pier of point 53 ~~is an approximate parallelogram, indicating that its sides were measured fairly accurately. Its angles~~ are much

poorer than those of any other pier in the building, including that next two it, which suggests that ~~an additional error occurred~~ a bad error did occur of this pier, in locating either point 53 or 54, after which good measurment would produce the observed paralleogram form, in a direction counter to that of the outline.

While we have postulated measurement for ~~xx~~ points 53 and 54 from point 55, we couod as well assume measurement from point 50, minus with a ~~negative~~ instead of ~~positive~~ error. plus

~~Thexdixxxxxpxxxxy~~

Now in locating points 45 and 37 of the medial w all doorway, in order to place it behind the outer one, the lines 53-56 would be the natural unit, and it would be measured from points 48 and 40, during which 10 cms of additional error could accumulate. Group 0 shows this as plus, and therefore tending to correct the displacement of the jamb. ~~37-45~~. Suppose for argument, in locating the other jamb they measured the same unit 53-56 from points 41 and 33. They would immediately discover something was wrong, the resulting medial doorway being very much too narrow. They would abandon a centralized position for it and move the second jamb position for a full-width doorway. ~~The~~ The same proceedure using the shorter unit 49-52 would make it too wide. on both sides

Or, more likely, instead of ~~using~~ attempting to use 53-56 as the unit ~~for~~ to locate the other jamb they would measure 49-52 out from points 41 and 33 in the first place. Two circumstances indicate that this was done: the identity of the first three measurements of Group 0 and the fact that medial wall doorway is about 10 cms narrower than any of the front ones as measured in the facade, where they are ~~xxxxxxxxxxxxxxxxxxxxxxxxx~~ very close to ~~identical~~

Or they might lay off the second jamb from the first without any check measurment to the other side wall, or use 55-56 and 49-50 as ~~the~~ two units on either side respectively, in which case the door width would come

out about correct. They may or may not have realized the discrepancy reflected in Group 0. In the building itself measurment would be required to demonstrate it.

in these units. We have, without assuming anything very improbable, shown how a large discrepancy might build up from smaller ones, and how it might infect a series of later measurements, whether realized or not.

#5
20

dividors
Setting a pair of ~~xxixpsxxxxxx~~ at ~~ixxsx~~ 1.25 in our orignal
(1 to 100) the seven
~~xxx~~ plansand then checking ~~of~~ pier widths of Str. J-11, they are all
found to ~~xx~~ vary only a cm or two except one, which drops to about
outsides of the six
1.20, Setting them at 1.20 and repeating this process for the ~~nine~~
piers of the tripartite doorways
~~piers~~ of Str. J-12, they vary in the same way above and below this
new setting, except for one, which drops to about 1.10. For the
inner sides
available four ~~insides~~ of these same piers the result is the same,
1.10
with the minimum measurement on the same pier. The difference between
1.20 and 1.25 for a pier width is of course inconsequential and we
can say they were meant to be equal in both buildings. But the
suggests
consistent differences as between the two buildings ~~xxxixxxxx xxxxx~~
in each building
~~xxxxxxxxxxx~~ the use of some one pier as the standard for check ~~measurment~~
measurments of the others in that building. However, less consistency
in this matter can be seen in other plans, notably of Strs. J-2 and J-12.

~~J-12~~

Since by and large wall thickness are of constant thickness, only exterior a paralleogram/ outline necessitates a similar interior one, with minor changes in the angles. The converse is also true, so we are justified in using interior outlines only to demonstrate the supposed tendency toward parallelogram outline in buildings, where (This is necessary) position of one or more exterior corners is lacking, or may be affected by accomodation to something else. Shifting from exterior to interior outlines where necessary, we now illustrate this tendency in more places, which seems to take it out of the realm of chance. Abandoning the tabluar presentation of figures, dimensions will be give in the order ~~xxxxar~~ rear, front, building's left, then right.

For Structure J-2 (Fig.) these are on the interor /30.75, ~~xxx~~ 30.80 known 4.32 and 4.33, discrepancies of .05 and .01. The outside of one end wall and both interior transverse walls follow the expected non-rectilinear outline. ~~Txxxxix~~ Of the ~~six~~ exterior doorways six were meant to be opposite six others in the other facade, and show displacement in the ~~xxpxxxxxd~~ direction and approximate amounts expected. Displacement of two medial wall doorways meant to be behind outer ones is clear for one jamb only in each case. They are less than standard exterior doorway width, which may cloud the picture, and the expected displacement is not great.

For Structure J-21 we have a variable neither four exterior or interior corners. But adjacent acute and obtuse exterior angles, with trend, and an acute interior angle ~~one~~ opposite the ~~ixx~~ exterior one leaves little doubt of a ~~xxxx~~ paralleolgram outline. We can check its probable accuracy by measurments ~~xx~~ of a ~~the~~ paralleogram enclosing all exterior doorways, with ~~theix~~ outer ~~jamb~~ jambs points of the extreme ~~doorways~~ as corners. The figures are 10.08, 10.13, 7.14 and 7.16, with differences of .05 and .02 respectively. All doorjambs of one facade show the

with respect to those of the other.
expected displacement/~~and~~ the transverse interior wall, on the side known, runs in the expected direction. Medial wall doorways, here narrow, were probably meant to be directly behind piers, and are dispalaced ~~in~~ toward the paralleogram axis.

We should expect that occasionaly the first angle laid out of a building on the outline would be close to a right angle, even without an accurate ~~may~~ of measuring it. Str. J-13 illusrataes this. The interior outline measurements are ~~11x23~~ 11.05, 10.93, 4.30, 4.06. Settling/may have increased the discrepancies of of one corner .14 and .24. The angles are approximately right angles and we expect little or no displacement. The interior transverse wall ~~cross~~ is at approximately a right angle and the rear doors almost exactly behind the corresponding front ones. The one exterior angle known is ~~s~~mewhat acute. However, few facade lines are absolutely straight and the rest of the end wall may have cancelled this paralleogram tendency. The non-displacement of exterior as well as interior jamb-points suggests that it did.

The medial wall doorway is dispalced a little, within the limits easily produced by linear measurment errors.

Str. J-23 (Fig.) shows considerable evidence of movement by settling, and one corner is entirely lacking. However, medial and interial transverse/walls are not affected by this and are at approximate right angles. The plan as a whole looks like a rectalinar one disturbed by settling, in agreement with the interior walls. On the buildings ~~left~~ right, front and rear righ jambs show no displacement, as expected in a rectilinear plan. But passing from here to the left, ~~xxx~~ front jambs do show a consistent displacement toward its left, ~~with~~ known with reference to the corresponding jambs in the rear facade. The reason seems clear. All pier widths are very close to equal, and so are all door widths except the

right front one, which is nearly 20 cms greater. The displacement is probably caused not by an angular error and consequent paralleogram outline, but by a linear measurment error infecting a series. This interpretation implies that in laying out the jambs a doorway was incorrectly laid out; the adjacent pier measured from this; the next jamb from the pier, and so on, all without further error. Judging by this example, consistent displacements do not necessarily imply a non-rectinear(or even a rectilinear) paralleogram outline; but they still seem to imply accurate linear measurment. This, combined either with an initial angular or linear measurment error, would tend to produce consistent displacements.

It seems to the writer we have demonstrated a decided tendency of linear measurment to produce paralleogram outlines, either approximately rectilinear or not. But errors would naturely on occasion work against this tendency, especially in longer buildings. Structure J-12 (Fig.) the reamining free-stansing palace on which we have much accurate data is an interesting example. Its right end shows the typical non-rectilinear parallelogram situation, its left in net effect a rectilinar one, both left corners showing slightly obtuse angles, but a line joining their interior corners being at an approximate right angle.to the facades. The measurements of the interior outline are 33.80, 35.55, 5.90 5.70. The differences, .25 and .20 would tend to be a little greater for an exterior outline.

The left transverse wall is parallel with the left end wall, the right with the right. There for mudroom each was laid out from its The

nearest end walls, and one is approximately rectilinear, the other not. Both are approximate paralleograms, indicating (the cereful measurment. Now if the door-hambs are laid out from other those of one facade should show with reference to those of the left end ~~they should show~~ little displacement apart from chance error. If laid from the right all should show such displacement, which they do. Since we know only three of the ~~extre~~ four extreme jambs, and initial linear error such as ocurred in Str. J-23 might prodice ~~the same~~ this result. But this would not affect the medial wall doorways. A line passing through the center of ~~thi~~ this, and parallel to the"paralleogram end"of the building comes close to bisecting ~~opposite~~ outdoor doorways. It was probably meant to be centered on these, and, if working from the right end, this line would automatically be the axis of the three doorways.

This is the last free-standing palace on which we have ~~muc~~ much data. The Sweat-house P-7 is accurately ~~drawn~~ drawn, but being only partly excavated many points are well above floor level, and one corner is badly settled. In addition, the floor-plan of an earlier building may have been used in laying it out, with added chance of accumulating errors. A large Correction for settling would tend to give a paralleogram outline, with which the direction of the passage would agree. But an almost exactly symetrical placement of the four front door-jambs would be destroyed by such reconstruction, and these are ~~located~~ known at ground level. Corresponding sides of the steam room are very close to equality and a rear doorway is neatly centered in its wall, in each case some points being seen only above floor level. We add this building to the discussion to

be fair and toemphasize that while accurate measurments will yield typical types of plans, their mixture with bad or accumulating small errors may prevent it. And also to butress our conclusion ~~fxxxx~~ in Str. J-12, that measurement from one side only, if it is not at a right angle to the facade, may cause displacement of points further back. In this case the displacement of the steamprom door, while slight, is probably connected with the direction of the left end wall, although the right wall would have no such connection. Implied is a failure to use check-measurments from each side for one point. In the paralleogram or rectilinear buildings, this would not be apparent in the resulting plans. That ~~xxxx~~ they were not made, ~~xxdxpxxixxxxxxdixxxxxx~~ isna fact of some importance. Any displacement, the bad angle of which agrees with/either side, is probably caused by accurate lateral measurment, and therefor not intentioanl.

In allthese building, the displacement is inconsequantial from the visual point of view, and there is no evidence that it was realized or consciously corrected. But From rather meagre evidence on temples we think it became evident and resulted in compromise adjustments. We can best show visually why it should by use of another hypothetical plan, Fig. 6, No. This time the plan, while much simplified, is less hypotheical. Like R-16 it consists of pyramid, suuplementary platform, plinth platform and three-door temple, the whole set on a terrace crossed by the main stairway. For emphasis we have added column altars at points 2 and 3, by analogy with R-9. The Over-all restored dimensions and the reasonably accurate rectilinear cross sections of R-16 are used, as well as the actual angle between front and left side (others being unkown on that building).

~~Only~~ the rectilinear outline ~~at base level~~ is indicated in broken lines (VXYZ); this is distorted to UWYZ in accordance with the R-16 angle and contruction proceeds, using the R-16 cross sections at right angles to each side.

The Maya must have laid out the first terrace, built it, and then measured from its top for the base of the next. The top would not be perfectly ~~built~~. There is thus liklihood of ~~of~~ many/errors by the time one ~~reaches~~ ~~xxxxxxxxxxxxxxxx~~, assignable ~~xx~~ among six secondary outlines, and these affected by errors in the slopes of five terrace walls. ~~With~~ so many, ~~they~~ would tend to cancel out and ~~xxx~~ each unit should show the ~~same~~ parallelogram form, The last one should correspond to the first in direction, but ~~a~~ different angles would be expected. This situation is actually seen on Str. K-5-3d, Therefore displacement is to be expected, just as in the ball courts and palaces, though perhaps more affected by errors. The difference between pyramid temples and those structures lies in this: central features were conspicuous; and they are more displaced because of greater depth behind the base of the facade; ~~xxxxxx~~ The elevation ~~xxxxxxxxxxxxx~~ conforms to our plan and shows how very apparent is the increasing displacement ~~xxxxxxxxxxxxxxxx~~ column ~~xxxx~~ altars and the conspicous masses of stirways and temple doorways. ~~We have shadded the xxxxxx side walls in order to emphasize the front facade~~. Standing on the rectilinear axis, ~~this only~~ would not be visible until the observer had retreated over 100 meters from ~~it~~. The effective visiual displacement is therefore within the frame of the silhouettes rising from Y and Z.

The distortion of the main stairway, considered schematically, is apparent even at close range, if the observer looks at right angles to the terrace, which furnishes an adequate visual base-line.

The stairways are constructed as paralleogram in plan. Taking the main one as example, this would result from accurate measurments from corners to points 8 and 9 at the top, 10 and 11 at the bottom, provided lines thus established were extended to 12 and 13. But there was never any flat surface on which to lay out 8-10 and 9-11. Pyramids were always built before stairways, which extend beyond the outline. To make the extension a cord would be held at 9, the other end in the hands of someone on the plaza, with a third sighting to direct his movements until it passed over point 11. Under these conditions he would probably notice his bad angle and correct it somewhat markedly with his eye. Str. K-5-2nd combines a paralleogram pyramid nearly with a rectalinear stairway (Fig.), proving that stairways were not controlled by the pyramid outline. Because of that example, and because we have good reason to believe the R-16 stairway was approximately centered at the top let us suppose cords were swung from 8 and 9 as before, but by eye without regard to 10 and 11, and with good results. Applying the same principals to the other stairways, we get the elevation of Fig 6, c. shown below. Now it is possible to do directly at the stairway, place the altars on its center axis, and ascend from one to the other at right angles to the steps.

We believe the R-16 elevation, if we dug it out more completely, and added round inset corners and other decorative details, would closely approximate this elevation, which is exactly like Fig 6, a, the upper one except for rectification of the three sets of stairway side walls, and shifts in the altrs to correspond. In visual effect the displacement is less so between especially noticeable as between pyramid and supplementary platform, and between it and plinth platform. The stairways are of course asymetrical

but are not distorted in themselves.

with repect to their own units, Line 15-Z is longer than 11-Z on the plan, and Y-14 shorter than Y-10 on the plan so that at the base the first terrace is about 2.00 longer on one side of the stirway than on the other. Corresponding but diminishing discrepancies occur on the second and third terraces, reaching equality at the top of the later. ~~Xxxxxxxxxx~~ o

Instead of swinging the ~~the~~ side walls of the plan on points 12 and 13 from (Fig 6,b) points 8 and 9 at the top, we might have done so on points 10 and 11 at the bottom, This would accentuate the displacement between extending lines thus obtained to the top by sighting. pyramid and platform stairways, ~~and~~ transfer the same maximum linear discrepacny in terrace lenghts from the longer base to the shorter top, to which the stairway naturally leads the eye. Here it would be much more apparent. Since in Str. K-5 2nd and 1st, and presumably K-5-3d, a two-meter discrepancy occurs at the base, our choice of the top from which to make the correction seems justified, ~~since there~~, the points corresponding to 10 and 11 are being ignored. That it corresponds to what happened on R-16 is highly probably/~~xixxx~~ Points 1, 14 and Z on the plan and lower eleveation are in true relationship for R-16, point 14 being midway between side walls of the R-16 main stairway at second terrace level. That it is not exactlyin the center of our reconstructed stairway can be attributed to accumulating errors which are not reflected in the drawing. With ~~xxxx~~ stairway correction on points 10 and 11 (not excavated) it would be much farther to the right, as we look at it; were the stairway placed in line with units higher up, this center would be decidedly farther to the left.

(with this sort of displacement correction

Whether ~~such~~ a eleveation ~~as this~~ was ever actually constructed, (as we believe it was in R-16) we have shown how accurate linear/measurements/combined with a poor initial angle and

But on the structure itself ~~but~~ these discrepancies are not measurable with the eye except at a distance; displacements of upper stairways and building are visually minimized by the set-backs which contribute to them; and indivual stairway units are not distorted.

better judgment of stairway angles could produce it, unless some further adjusment was made. The conspicuous stairways, though each is rectified, are badly displaced with reference to each other. To correct this it would be easy to lay out all stairway side-walls at once, or from a single stairway center line, swinging from the temple instead of the pyramid top level. On our elevation we would push the platform stairway to the left till its center was under that of the doorway, and move the main stairway still more till its center was also below that point. This would further increase the discrepancies in terraces lengths on either side, but would yield a straight line of sight (Fig. 7) up the center of all stairways to the center of the temple. This is the most important visual line for observers near the base, as they would be during ceremonies. The marking of this line at bottom, top and two intermediate levels on Str R-9, shows the Maya were conscious of it. Such a procedure seems a logical next step.

The plan and elevation of Str. K-5-3d, much better known than R-16, can be explained in this way. Unfortunately the main stairway side walls were destroyed by the Maya, and must be restored. (Fig.). In spite of many other restored points, at least the front angles of the original outline were close to those of the paralleogram UWYZ or a slightly larger one enclosing the outsets, and not the rectangle VXYZ. As in Fig. 6, the axes of rectified and actual basic outlines, AB and CD are drawn through their common frontal front center.

~~The front of the~~ pyramid bulges forward of the

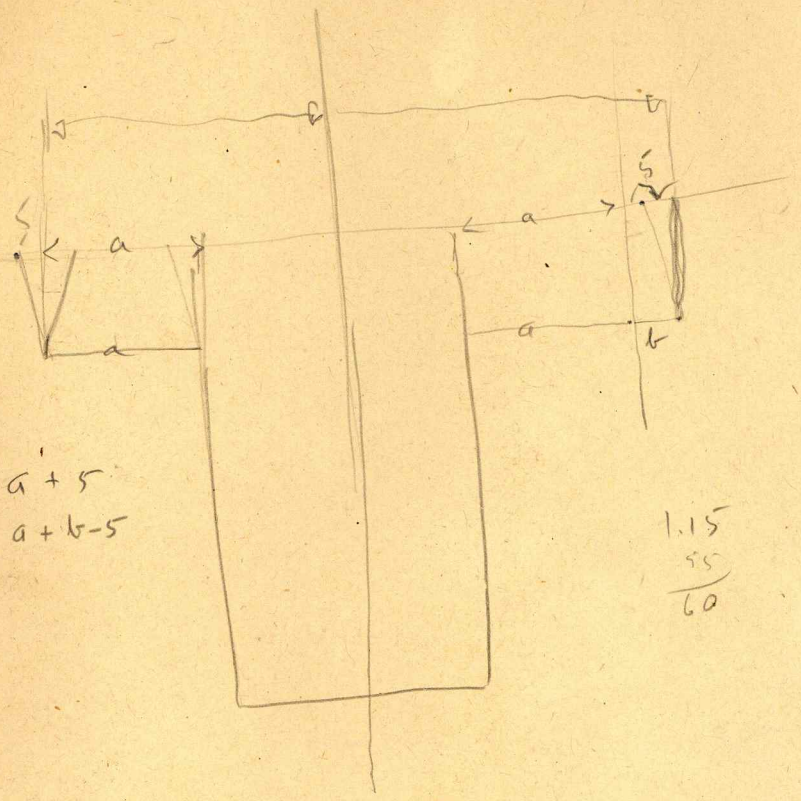
The use of outsets causes the actual basic outline to step outside the simple outlines UWYZ and errors in measurments for this may have twice caused the prominent irregularities at the base, which are not affected by settling. Higher pyramid points (known at the front only) have been affected by settling. Only the basic outline is restored on sides and rear. The points U'W'Y'Z' are the theoretical corner points of the top outline. At the front center, where settling is not involved, the pyramid top is about the expected distance forward of this, and very nearly parallel to Y'Z'

P

central
outlines, Ab and CD are drawn from the facade. The center of the/
door is fixed by assumption of three equal doorways, checked by the
known point on the right side/wall. This is only 15 cms from being
equidistant from the sides of the basic paralleogram : i.e. shows
the expected displacement, and is nearly on the true axis. But the
pyramid column altar, though far forward of this, shows almost
exactly the same displacement. and a line joing these two points
about bisects the most reasonable reconstruction of the platform
stairway. So far as it goes, this confirms the proceedure of of
Fig. 6,c as to one/stairway unit. Expected displacement of the
upper altar is increased about
75 cms to center on this and (presumably) the main stairway.

Series thus marked by the Maya we will call "ceremonial" axes,
whether they coincide with true or actilinear axes or not.

The temple altar was certainly intended to be centered behind the doorway, but it was removed and probably was, that is exactly on this axis. But it was removed during excavation after location by general measurements only. Its precise position cannot be used in this connection. The same remarks apply to the upper altar in the next period. If temple and pyramid altars were, as reconstructed, on adjacent sides of the true axis CD, the evidence for sighting from the temple facade, would be rather complete for altar placement at least, would be rather complete.



60

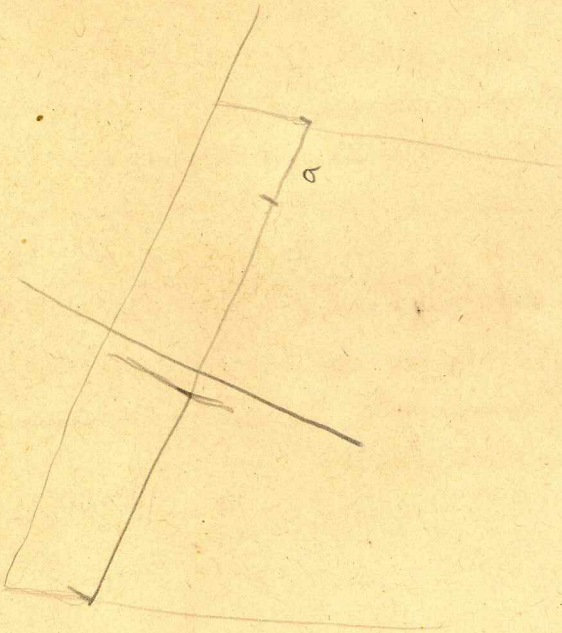
Ku du = b

Typ = b-5 +

a + 5

> a + b-5

1.15
55
60



By passing to later periods, all founded on the same two pyramid terraces, with repairs to the lowest at the rear, we can get more complete evidence. (Fig. 8 (Point 6)) We now lack the doorway, but have both a pyramid altar and a nearly complete stairway. (outline definitely located.) The new ~~latr~~ altar is 4.50 m above and 2.00 m behind the old. A line joining it ~~andxth~~ and the center of the pyramid stairway at plaza level almost excatly bisects the latter, and passes directly over the old altar and doorway-center; naturally It also ~~passes directly beneath the center of a still~~ later temple ~~doorway~~ and higher facade, bisects the ~~later~~ main stairway of the latest period, since this is a raising ~~incorporates~~ and extension of ~~and uses~~ the second one. ~~However, in this last period~~ But the same middle period ceremonial axis also passes directly below the center of the final period central doorway at the top and almost surely came close to bisecting the final period Stela 39 at the bottom. In all periods (when plans are superimposed), all stairway centers known and all intended axial points marked by altars, doorways and probably the stela are very close to being on a single line ~~when plans are superimposed~~; this common ~~line~~ ceremonial axis is nearly parallel to the rectilinear axis AB , but shows in its entirety the approximate ~~the~~ displacement expected theoretically only at the early building front facade line. ✓ We should ~~now~~ expect the observed ~~this~~ ~~axis~~ almost exact agreement in the later periods ~~only~~ if their building facades were directly over the earlier. This is true as to the two buildings known, while the intermediate platform (which may have been a plinth for a now vanished building) is almost exactly above and below the plinths of the others. ~~Errors in terrace layouts~~ ~~Close~~ accurate measurments in building up the later terraces would not ~~periods seem indicated, but doesnot run counter to~~ produce what we know of the final building outlines, which probably ~~had a~~ were paralleograms ~~outline~~ running counter to the basic one, accentuated somewhat by settling. ~~It~~ It's also partly known supplementary platform shows the same to a less degree, and carelessness or

Errors in terrace locations it as we think, if and affects this agreement, and depends not on measurement but on adjusting later points over earlier known ones.

probably

possibly accumulating errors are responsible. This was not true in the original period (Fig. 7) in which pyramid, platform and building show the same type of parallelogram outline, though not corresponding precisely, as expected. The reversal of displacement direction in the higher units of the final period would have shifted the doorway center appreciably nearer the rectilinear position, and away from the actual axis of the main stairway, already fixed in the intermediate period. It seems probable that the building was centered on the stairway by sighting, rather than by measurment from platform sides. In the early case everything indicates both stairways and the altar were centered on the building by sighting, and all therefore share the building facade displacement.

with continuous measurements from the bottom up,

and plinth were

(Since this did not occur it

axis

the building was located from the sides by measurement, and

pre-existing

pyramid

In either case

would

same

A simple proceedure for laying out the ceremonial axis can be easily imagined. The center of the central doorway could be easily judged, or measured by doubling a cord first stretched across the doorway- width length of cord. Stretch a long cord from this point to the plaze. A third man, well off from the pyramid would direct his movements in sighting a right angle. This fixed, he could direct the marking of points directly below this cord at platform and pyramid edges, and for location of altars. If, as Morris believes for Yucatan, the very simple device of the plumb-bob was availble, the actual ceremonial axis would be very close to a perfectly straight line. Points for the various stairway side walls could be measured out on either side from it. Errors in these measurements would tend to prevent exact but not the general coorespondence of such walls with the axis.

a man on

and

from the plaza

(Possibly this would be done by a third man well back on the plaza.

and plaza

What evidence is available for R-16 indicates the sighting for the main stairway was done from the center of the pyramid top, not from that of the temple. The evidence for sighting from the temple here is fairly specific, and also supports the proposition that the temple displacement is the sum of smaller displacements accumulating terrace by terrace.

Had the earliest period stairway been swung from the top of the earliest pyramid, rather than from the temple which is much farther back, the stair displacement would have been about 25 cms., the discrepancy in terrace lengths on either side zero at the top, 50 cms at the bottom. The stair displacement for all periods was probably determined at this time, yet in the next period the discrepancy at the bottom is known to be 2.10. If the early period altar was on the pyramid stair axis, whatever its width (which we have had to reconstruct), this figure is true for the early period also, apart from minor measurment errors.

If the pyramid stairway of the next period was swung from the center of its top, passing over the earlier altar only by chance, expected dispalcement would result in only about half the bottom discrepancy observed. It should, of course, be centered at the top of the top terrace. Direct measurements to upper terrace corners were not available, all being fallen. But outsets, probably measured from them, would maintain the same relationships. At the base of the upper terrace the inner pair survived and show an expected displacement of about 50 cms. The theoretical displacement of the stair, if sighted accurately from the temple, is 1.15, or 65 cms more than that of the terrace. This would produce a discrepancy in measurments from stair-walls to outsets of double this, or 1.30. The actual figure is 1.48, a close agreement. Reconstructing to the top of the terrace this would change things but slightly. At the top, the stairway was off-center about half this, or 74 cms, with reference to the outsets and, presumably, to the terrace as a whole.

This is too much to attribute to error in a single measurement. The outset positions on which this reasoning is based are probably almost exactly displaced the expected amount only because of cancelling errors. Those of the third terrace do not correspond so precisely. But there would be no accumulation of several errors in measuring to the center of the upper terrace once it was built. A blunder might produce what is found, but it would be very surprising that it should yield a stair axis in agreement with the earlier ceremonial axis.

A natural query is why a better angle for stair axes was achieved for stairway axes than for the original outline. The angular discrepancy seems to rule out knowledge or at least use of a mechanically accurate method of laying out right angles. Chance might account for the good angle of the K-5-3d stairway and measurement from it perpetuate it in the later periods. More evidence than is available will be necessary to disprove chance here, but there is some.

Stela 41 apears to have fallen straight backward, without subsequent disturbance. It probably was on the stairway axis. A line joing the center of the R-16 stairway at second terrace level (Pojnt 14 in Fig. 6,) and the center of the stela top passes within 25 cms of ~~the reconstructed~~ stairway center at the base, if reconstructed as a ~~perfect~~ rectangle. A line from the same point, but similar line, parallel with the side of the pyramid, cuts the stair base ~~ixis~~ 95 cms farther from the line to the stela. The stelae top is 6.50 m forward of the stair base, minimzing the effect of eroneously supposing it has fallen straight back. A stair angle better than the pyramid angle is probable here, if the stela was on the ceremonial axis, as it clearly was meant to be.

On Structure R-9, a line joining the center of the building doorway and the plaza column altar touches both pyramid and basal terrace altars (within 10 cms of their centers), ~~almost exactly bisects the stairway base~~ pyramid at and is very close to a right angle to the pyramid facade. Destruction prevents knowledge of the the pyramid basic angles. But this line crosses the basal terrace, which is very much askew. Sighting to the higher points from without regard to ~~them~~ the terraces seems the simplest explanation of the position of the plaza altar, and the axis thus marked at four points is as good, as to angle, as the K-5 series. ~~We do not know the pyramid angle~~ The known main stairway side wall, however, is not parallel with this line, obviously meant to be its axis, ~~suggesting~~ perhaps ~~each stairway was laid out from a single sighted axis line,~~ suggesting with errors ~~occuring~~ in lienear mesurement from it. It is apparent from this that actual stairway side walls may ~~not coorespond~~ be more askew than on Str. K-5 but with a perfectly straight ceremonial axis and a better angle. ~~exactly to the axis mraked for them by the Maya, and turning back~~ nevertheless present. to K-5-2nd and first, we see that the sides of the main stairway ~~there are not eactly parallel.~~ Our only further evidence is certain single stair side walls, which would therefore very not be pertinent, except to say that none of them make so bad an angle with the pyramid as do the sides of K-5 and R-16.

Check up

If, with more data, ceremonial axes turn out consistently to make better angles with the pyramid front than do its dides, the reason may be that it is easier to judge the direction of acord ~~one end of which is~~ on the plaza high above the observer so that in eefect he sees a longer line. Or, if he is in the temple doorway, ~~looking~~ probably lies in the fact that this line is sighted against an already constructed substructure.

To complete the picture of available data of this sort for temples, we refer to Str. R-3 Fig. , which shows a non-parallelogram outline analagous the palace J-12. One front coner is nearly rectangular, slightly accute obtuse, but much more than for a true parallelogram. the other/accute. The known stairway side wall direction agrees with neither side , but runs about as much askew as the better (right) side wall, but in a contrary direction, confirming independent sighting. The doorway center is displaced about the expected amount with reference to basic outline, if measured from the more accurate side. The amlunt of this displacement, 15 cms. is to slight to be significant,but the direction is that expected from either side. There is this much confirmation of the hypothesis that the ceremonial center was sighted from the canter of the doorway. The line joining it to the known center of the stairway at first terrace level is parallel to the known side stairwall.

There is a little evidence that the ceremonial axis was on occasion carried inside the temple, and affected its design. The niche of the temple of J-4 is almost directly behind the central doorway and a line joing them is close to a right angle to the front of the platform, though the known side is at a marked acute angle. Presumably the outside of the temple conformed to this, but the inside does not. It may have been indepdetly laid out from the axis, to keep the niche in the center of the rear wall and still on the axis.

On R-16 a cache marks the probable location of the temple altar. It was not accurately located, but was close to directly behind the doorway. The left side of the plinth platform forms an accute angle with the front, as did presumbly the outside/of the left building. But the inside left runs in a contrary direction as if idependtly laid out.

Unfortunately the K-5-1st niche and alar, and/temple earlier altars were not accuratedly located before removal.

Returning to our theoretical Figure 6, thereis a marked asymetry in the silhoutes of the substructures, if viewed straight-on, in elevation. The terrace walls, rising from Y appear steeper than those rising from Z, and the terraces appear narrower, the whole being decidedly steeper. This results inevitably from accurate projection at right angles of thedistorted plan. As one ascends, each corner is behind the preceding, and therefore displaced points, from its rectilinear position away from ZX and toward YV. Conpared with a true rectilinear silhoute, the slopes appear flatter and terraces wider on the acute avgle side, steeper and narrower on the obtuse angle side. Lines projected below on the plan, projected at right angles from the corner points, illustrate this spreading and contraction in horizontal spacing, compared with that for the intended rectilinear plan.

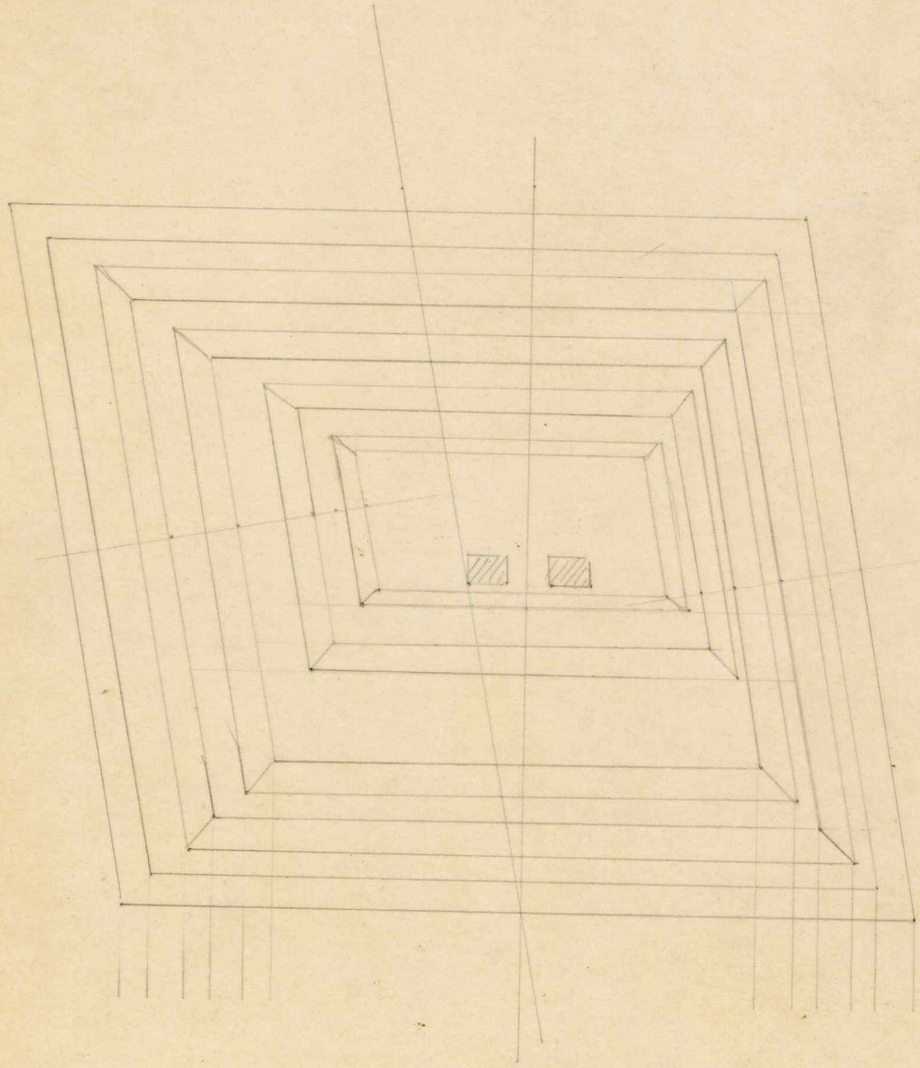
Accurate measurments in building up a pyramid would therefore tend to cause this type of asymetrical silhouette. Outsets in terrace walls, presumably measured from the corners (generally missing above ground level) would be similarly affected. We actually have by the horizontal this illustrated K-5-2nd front facade. The spacing of outsets should be irregular, as seen, due to accumulating errors. But at the near obtuse angle, while the spacing between outsets of first and second terraces is narrow, as required, the next is very wide. It seems fair to conclude that measurment and construction errors are a sufficient explanation of irregular outset spacings, and that a non-rectinilinear outline if present, would tend to throw them into a pattern. It would tend to make them steeper on one side than the other.

add? Running it into the ground?

least
In the final K-5 period there is a hint that in principle at/
to minimize this diffuclty
a way ~~xxxxxxxxxxxxxxxx~~ difficulty had been found. With the
a
ceremonial axis determined by/pre-existing stairway, the temple center
may have been located not be slavishly measuring in from the
sides of the substrucure, but by sighting over the ~~xxxxxxx~~ stairway.
This is admitedly not certain. ~~xx~~ Applied to a new structure, could not
the proceedure ~~would be~~ have been to correct the measured center of the
top of the first terrace by sighting for a right angle over the
measured center of the base, and to lay off the second terrace front
on an axis thus fixed.[2] If this process were repeated at each
continued
level, errors in judging the angle would not have a/cumulative
~~xxxxxx~~ displacement effect. Corrections would be made ~~xx~~ level
minor
by level, right up to the temple. ~~The result would be~~/irregularities
in the widths of terrace tops at the sides, such as exist anyway,
and in outset spacing Measuring out the stairways from the
axis thus finally fixed, they would lie in the centers of the
substructure masses served by them, with only minor discrepancies.
~~For step by step~~
~~/Such an adjustment we have no evidence.~~

hardly
Such a correction of terraces was ~~not~~ feasible, once
the first was laid down with a bad angle. Suppose, in Fig.6,b,
the ~~xxxxx~~ displacemnt of the front of the supplemttary platform
and of pyramid terraces
had been fully corrected, as it would tend to be by this process.
horizontally
Its corner would be/about 1.80 nearer the bottom of the first
horizontal distance
terrace at the same distanxe back from the front. The/neceesary
horizontal components of
to the intended cross-section here is about 7.75; terrace slopes and
to this point
depths would have to be compressed into a horizontal distance of
5.75, and correspondindy stretched on the other side, ~~with a~~

Such a correction, once the bad initial angle had been an entire built upon, would produce a front elevation symetrical as to the bases of each unit, but would run counter to common sense. is such an adjustment of Fig. 6, and would be Fig. 9 shows what would result. The terraces are greatly narrowed on one side, greatly widened on the other. Different silhouettes would be actually constructed , a hardly desirable result. The K-5-1st correction, if made as supposed, applied only to the temple building in relation to its plinth, It was a small one on a relatively spacious surface, and there was a pre-existing reason for it.

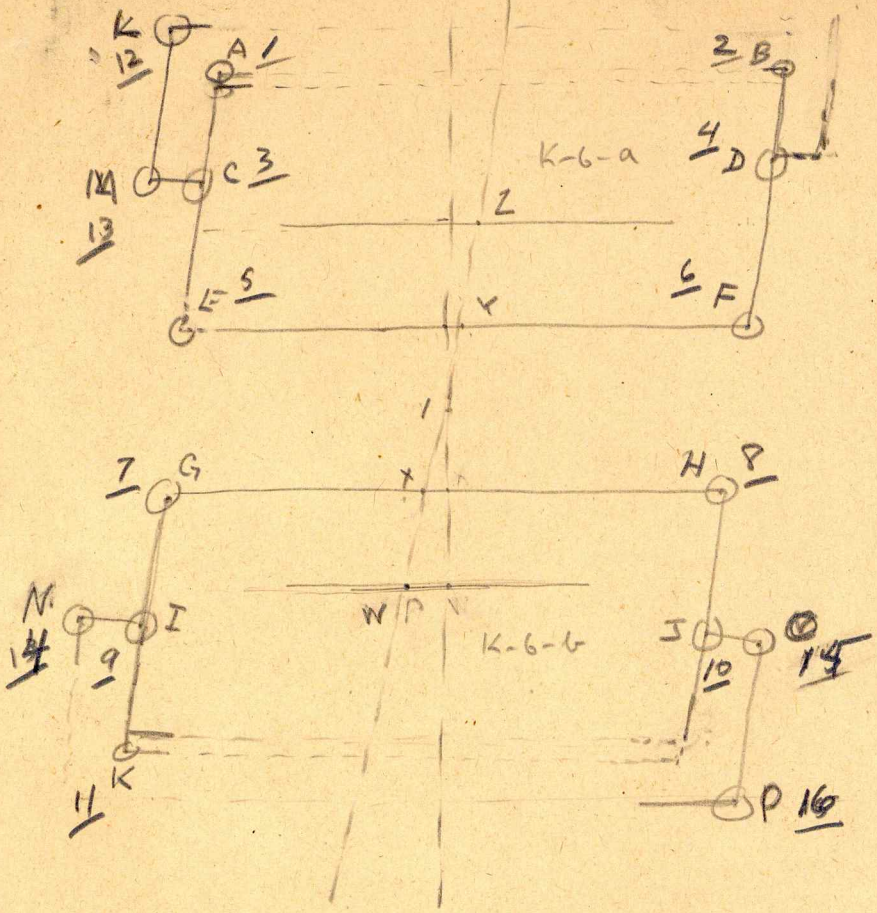


Boars of terraces
etc. modified

Str K-6

Original sketches for measurements: copied with numbers on new figure sheets

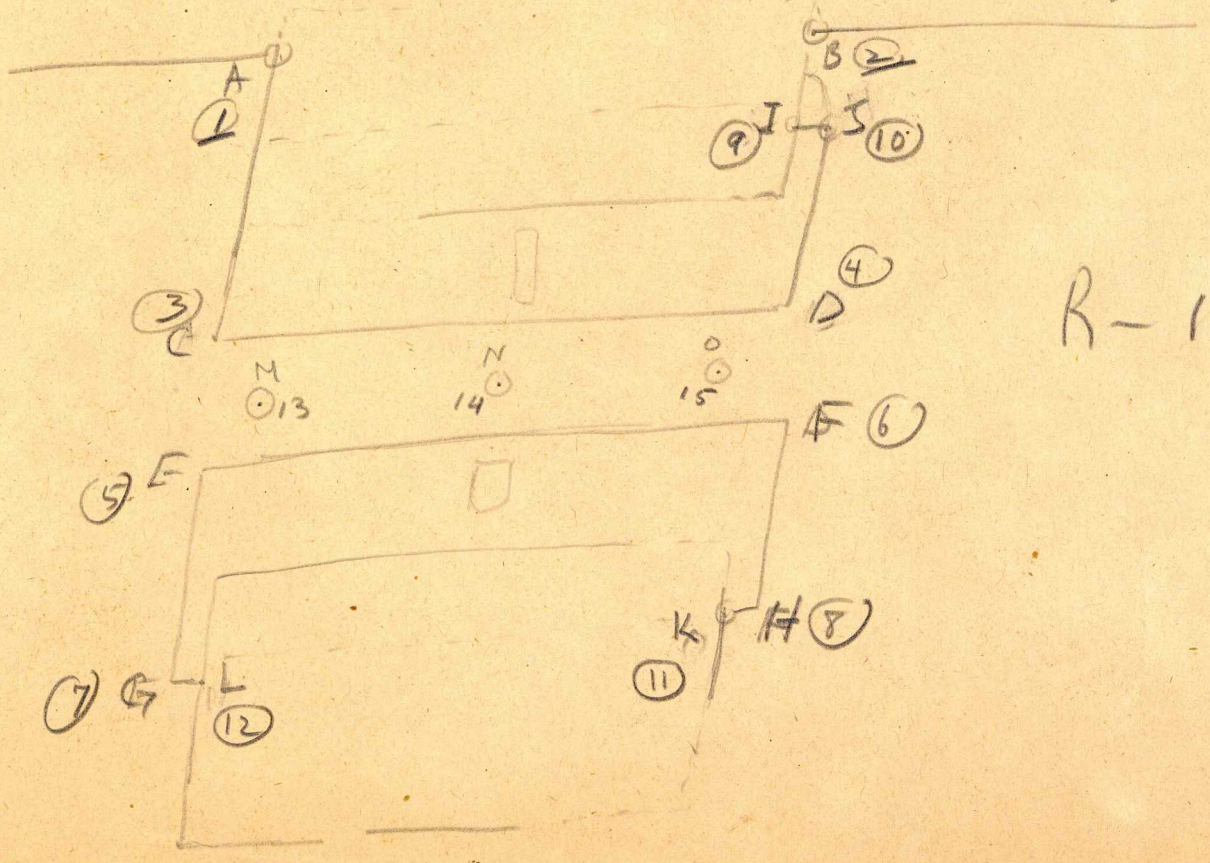
Fig 1



K-6

Fig 2

Str



R-11

The best structures on which to detect the use of taping are the ballcourts, which are of considerable size, consist of structures obviously meant to be identical, and which are close to bed rock and so have not settled. (Figs.)

The following dimensions, scaled from the plans are instructive.

~~Lengths:~~ ~~R-11a~~ The dimensions in question are indicated by letters on Fig. Each group contains dimensions which theoretically should be identical, ~~with the maximum difference indicated in parentheses below.~~ The scaling for K-6 is probably a little more accurate than for R-11 since the latter drawing had been inked, the former not.

Naturally, the longer the measurement, the more probable that ~~these~~ error factors have contributed to the observed discreptandy. They can hardly account for the difference between the short lines IM and OP, which were therefore not measured, except with the eye. An occasional exception, especially in laying out minor secondary contructions, is perhaps to be expected.

Structure K-6

AB 21.15	AE 8.95	CE 6.60	LM 3.70	MC 1.25	EG 6.60
CD 21.25	BF 8.96	DF 6.55	OP 3.25	NI 1.25	FH 6.70
EF 21.26	GK 8.97	GI 6.56		JO 1.23	
GH 21.50		HJ 6.50			
IJ 21.55					

A(.35) B(.02) C(.10) D(.45) E(.02) F(.10)

Structure R-11

AB 17.55	BI 4.35	JD 6.90	IJ .53	CE 4.35	MN 7.85	
IJ .52	JD 6.90	FH 6.82	KH .52	DF 4.35	NO 8.00	8.02
18.07	11.25	EG 6.83	GL .38			
CD 18.00	AC 11.34					
EF 18.15						
GH 18.28						
	(.09)	(.08)	(.15)	(.00)	(.17)	

(.28)

The discreptancies seem to the writer to be of the order one should expect if we assume the plan was laid out on the ground with careful linear measurement, but allow for probably stretching of cords, for failure to building exactly to the line, and for our own errors in selecting the exact spot for a corner (the stone is not well dressed), and in surveying, drawing and scaling. A glance at these plans shows that while each unit is an approximate parallegram (as it must be, given the observed accuracy of linear measurment of corresponding lines) all are far from

Str K-6 lengths (1)		depths (2)		depths (3)		depths (4)		outsets (5)		Field depths (6)	
AB	21.15	AE	8.95	CE	6.60	LM	3.70	MC	1.25	EG	6.60
CD	21.25	BF	8.96	DF	6.55	OP	3.25	NI	1.25	FH	6.70
EF	21.26	GK	8.97	GI	6.56			JO	1.23		
GH	21.50			HJ	6.50						
IJ	21.55										

AE passes .30 inside of G and of I (i.e. 11 but displaced lines)
DF " .10 outside of H and .25 outside of J (not quite 11, + displacement less

Str. R-11 lengths (1)		depths (2)		depths (3)		Field depths (6)		altar		Outsets (5)	
AB	17.55	~~AE~~		JD	6.90	CE	4.35	MN	7.85	IJ	.53
IJ	.52	BI	4.35	FH	6.82	DF	4.35	NO	8.00	KH	.52
	18.07	JD	6.90	EG	6.83					GL	.38
CD	18.00		11.25								
EF	18.15	Ac	11.34								
GH	18.28										

(x) 7

15.85
7.85
8.00

AC projected passes .10 inside of E and .20 inside of G
.15 " " F .25 " " H

Checked to no copies

11.25
6.90
435

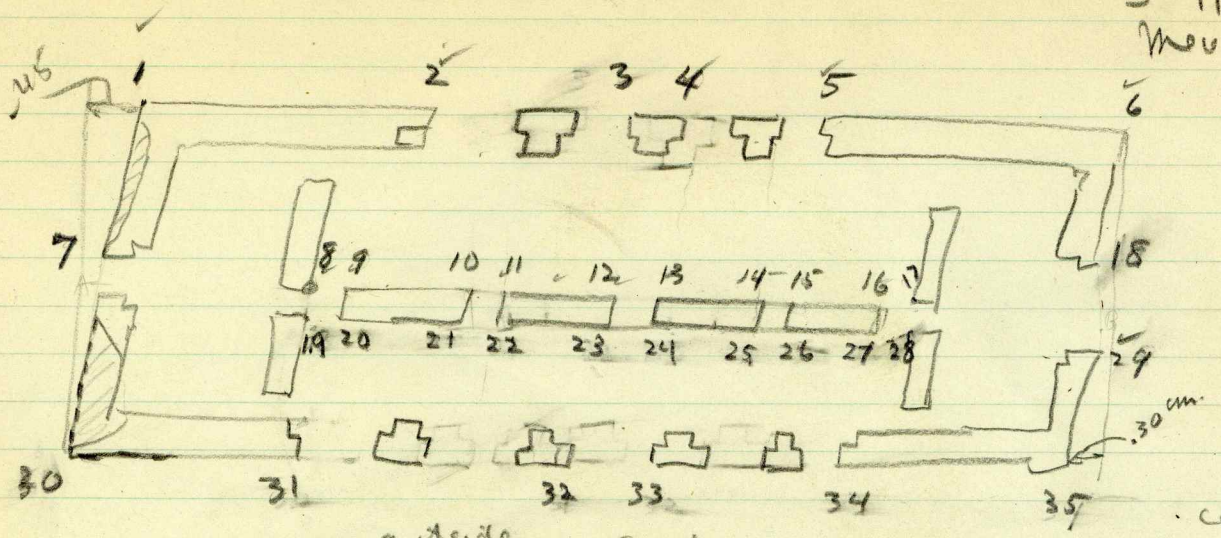
11.05
10.93
.12

4.24
4.06
.2

2 dp?

deviations ?
7

J-71
Moustn.



· center elements

overall				outside curbs											
1-6	23.66	1-30	7.65	1-2	6.25	1-7	2.59	30*-31	4.05*	1-3	11.19	30*-32	10.87
30*-35	23.82	6-35	7.72	5-6	6.24	6-18	2.63	34-35	4.63	4-6	11.12	33-35	10.82
						28-35	2.84						
A	(.16)	B	(.07)	C	(.01)	D	(.25)	E	(.02	F	(.07)	G	(.05)

mid wall radius		inside. side mid down.		center mid down.			
9-10	2.95	8-10	3.74	8-12	7.61	9-12	6.82
11-12	3.00	15-17	3.86	13-17	7.60	13-16	6.75
13-14	2.91	19-21	3.85	19-23	7.61	20-23	6.86
15-16	3.02	26**-28	3.87	24-28	7.56	24-27	6.80
20-21	3.06*					I	(11)
22-23	3.00						
24-25**	2.98						
26-27**	3.10						
H	(.19)	K	(17)	B	(.05)		

A-23 } diff. 15
24-B } from to right. 7½

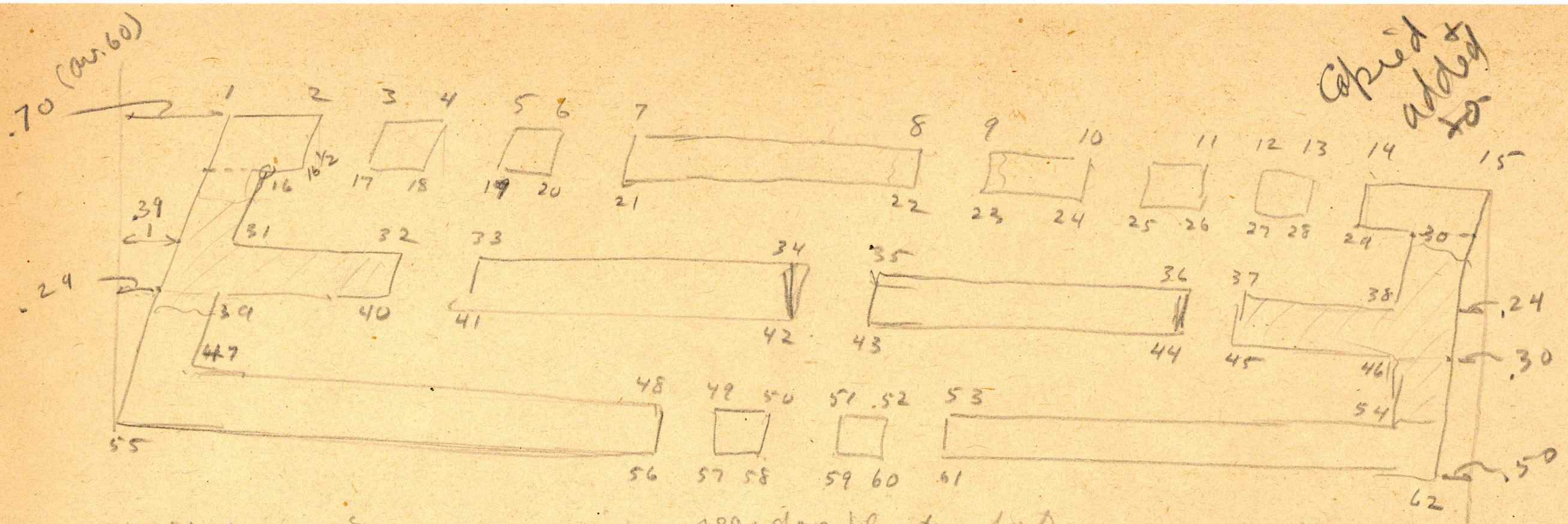
down curb 23-24 is .25± NO of L curving from 32-33.

30 45/37½ 37½ 18

* Point 30 may have moved slightly.
** Points 25 + 26 well above floor level.

I-9

Copied & added



averages

16-30	29.76
	29.50
	.26
16-47	4.40
	4.30
	.10

Outside: corners

				rear door block				front door blk			
1-15	31.66	1-55	6.86	1-2	1.84	1-7	9.36	55-56	12.20	55-58	15.06
55-62	31.83	15-62	6.85	14-15	1.96	10-15	9.40	61-62	12.37	59-62	15.20
Diff:	(.17)		(.01)		(.12)				.06		

Inside — center mod door

mod wall

31-34	13.65 *
35-38	14.25 *
39-42	13.65 *
43-46	14.25 *

avg. 14.25
13.65
.60

front wall

47-50	13.65
51-54	14.20

mod doors ↑

rear wall

rear tube center

~~16-21~~	~~8.40~~
24-30	8.05

.35

rear doors

overall inside. .06

16-30	28.75	16-47	4.43
47-54	29.45	30-54	4.45
	.70		.02

sides

ends

central Frame Pay.

47-48	10.90
53-54	11.24
	(.34)

inside front tube doorways

mod side doorways

~~31-73~~	~~5.59~~
~~39-41~~	~~5.65~~
36-38	5.15
45-46	5.10
	(.55)

checks Fowler

2) 31.90 15.95

overall

~~actual~~ tube front doorways outside

2-7	7.50
10-14	7.82
56-61	7.32

16-21	8.35
24-30	8.10

14.20
13
14.07
13.75
.32

13.70
.5
13.75

16.72
15.06
2) 1.66 .83

15.06
.83
15.89

15.43 (see at 14'9)
14.82
.61

15.85

* These points are restored on straight lines from 16 to 47 & 30 to 54

× one point restored

5-9 Parallels

Here we have to deal with inside and outside measurements of free-standing walls. At a glance the plan shows the same non-rectangular paralleogram form of the outer walls; but also that the jambs of the many doorways in general do not. They are more nearly at right angles to the front and rear, than are the side walls. Evidently they were laid out indepentdently. A rigid system of measurement from the outline of the building would have made them paraellel to the side walls. This departure affects the lengths of inside lines running to doors which otherwise should be equal, and therefore inside measurments are grouped separately.

Outside and over-all				Inside							
1-15	31.60	1-55	6.86	1-2	1.84	1-7	9.36	2-7	7.50	1-5	6.52
55-62	31.70	15-62	6.85	14-15	1.96	10-15	9.40	10-14	7.52	11-15	6.52
A	(.10)	B	(.01)	C	(.12)	D	(.04)	56-61	7.32		
								E	(.20)		(0.00)
55-56	12.20	55-58	15.06	16-30	29.75	16-47	4.43				
61-62	12.37	59-62	15.20	47-54	29.45	30-54	4.45				
F	(.17)		G(.14)	H	(.30)	I	(.02)				

Inside to Doorways

16-21	8.40	31-34	13.65*	16-19	5.54	47-48	10.90	16-19	5.54
24-30	8.05	39-42	13.65*	31-33	5.59	53-54	11.24	31-33	5.60
J	(.35)	47-50	13.65	39-41	5.65			26-30	5.22
		35-38	14.25*	26-30	5.22			36-38	5.12
		43-46	14.25*	36-38	5.15				
		51-54	14.20	44-46	5.10				
J	(.35)	K	(.60)	L	(.55)	LM	(.34)	N	(.48)

*One point restored on lines joining points 16 and 47 and 30 and 54.

Groups A and H would have shown the same differences if the outer walls were of precisely uniform thickness

This table indicates linear measurement of the same order of accuracy as do those for the ball courts. The only major discreptancy is on Group K, which involves the front center doorway and the central medial wall doorway behind it. The front doorway was located very close to true center, its center being outside of the .07 cm off (one-half of the difference of .14, Group G.)

If we suppose that the outside was first laid out, and then measured from, this initial error in locating the cnter doorway would automatically be added to further errors in laying out corresponding/inside lines. Instead of .60 (Group K) the maxiumum additional discreptacny is therefore about .46, which still seems high, and poor measurment seems indicated. However, notice in Group K that all the measurments to the buildings right are alike, and those to the left very nearly so, which suggests careful measuring carried an initial error through each set.

Placing th medial wall center doorway to the right of of the true paralleogram axis has resulted in placing it almost directly behind the outer corners of the front doorway. From this fact we might deduce that the bad angles of the building as a whole are due to mere carelessness, As a result, by strict measurement this doorway would be displaced to one side, with reference to the front doorway; but, being actually able to judge or measure much better angles, it was placed where it belonged, behind the front doorway, and therefore off center with reference to the medial wall itself. But this reasoning does not apply to the measurements 47-50 and 51-54, which show almost the same difference; nor to the sizable increase in the discreptancy of Groups F and J, outside and inside measurements to the outer jambs of the triple front doorway considered as a whole. We must concede that relatively high linear measurement/errors were made, but their occurance would not account prevent conscious such an adjustment as suggested above. In Group K, part of the maximum/difference may be carried over from the error reflected in Group G., part to new errors in laying out inside points, and still another part to an conscious adjusment of the interior doorway.

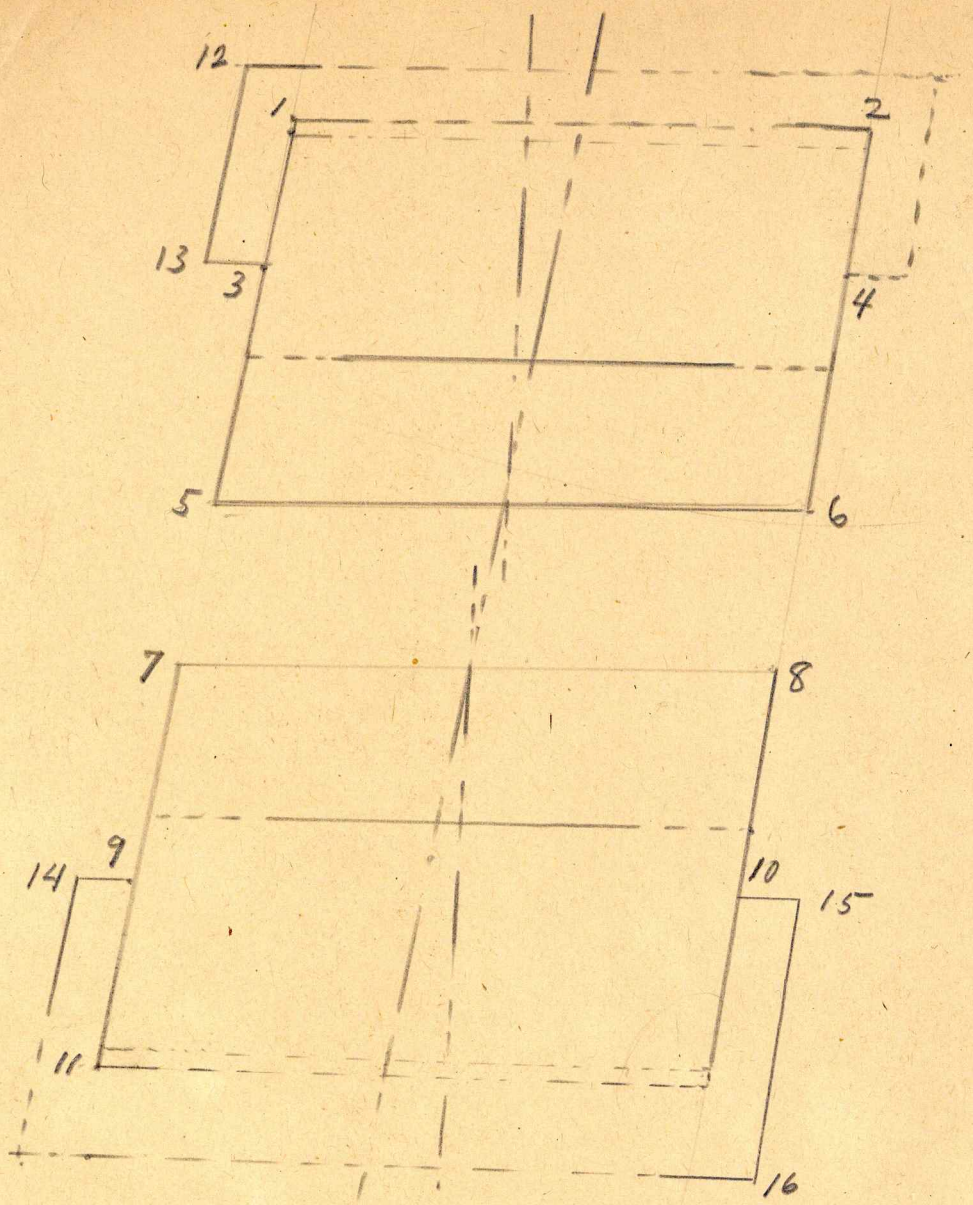
We have already pointed out that door-jambs are laid out without

xxxxxxxxxxxx without being controlled by measurements from the sides of the building, so that they are more nearly at right angles to the facade than are the sides, or two or three cases diverge in an opposite direction. This would tend to vary xxxxxxxxx expected measurements from the sides, lenghtening xxxxxxxx them on one's right and shortening them on one's left as one proceeds toward the interior, from either front or rear, if the jambs form better right angles than do the sides. If, as suggested, medial wall doorjambs were also independently located xxxxxxxxxxxxx in an effort to place them truly behind corresponding outer wall doorways, this patterning would be carried through to medial wall measurments. We can check this as to one medial wall jamb on either side. As expected, the first three measurement of Group I (on our right as we proceed inward from the rear) increase, the last three (on our left) decrease. The maxium differences within each half of the group are only .11 and .12 respectively, insufficient to place the medial wall jambs correctly, but they are in the right direction, and may be intentional. If so, the maximum difference for the group as a whole is non-significant. The true measure of error would be the diference between the xx first and fourth figures, none of which or .32, which has not accumulated from outside measurements.

raisies the question whether inner doorways may not have been adjusted to correspond with outer ones more closely, but on the whole fails to

Fig 1

Str K-6

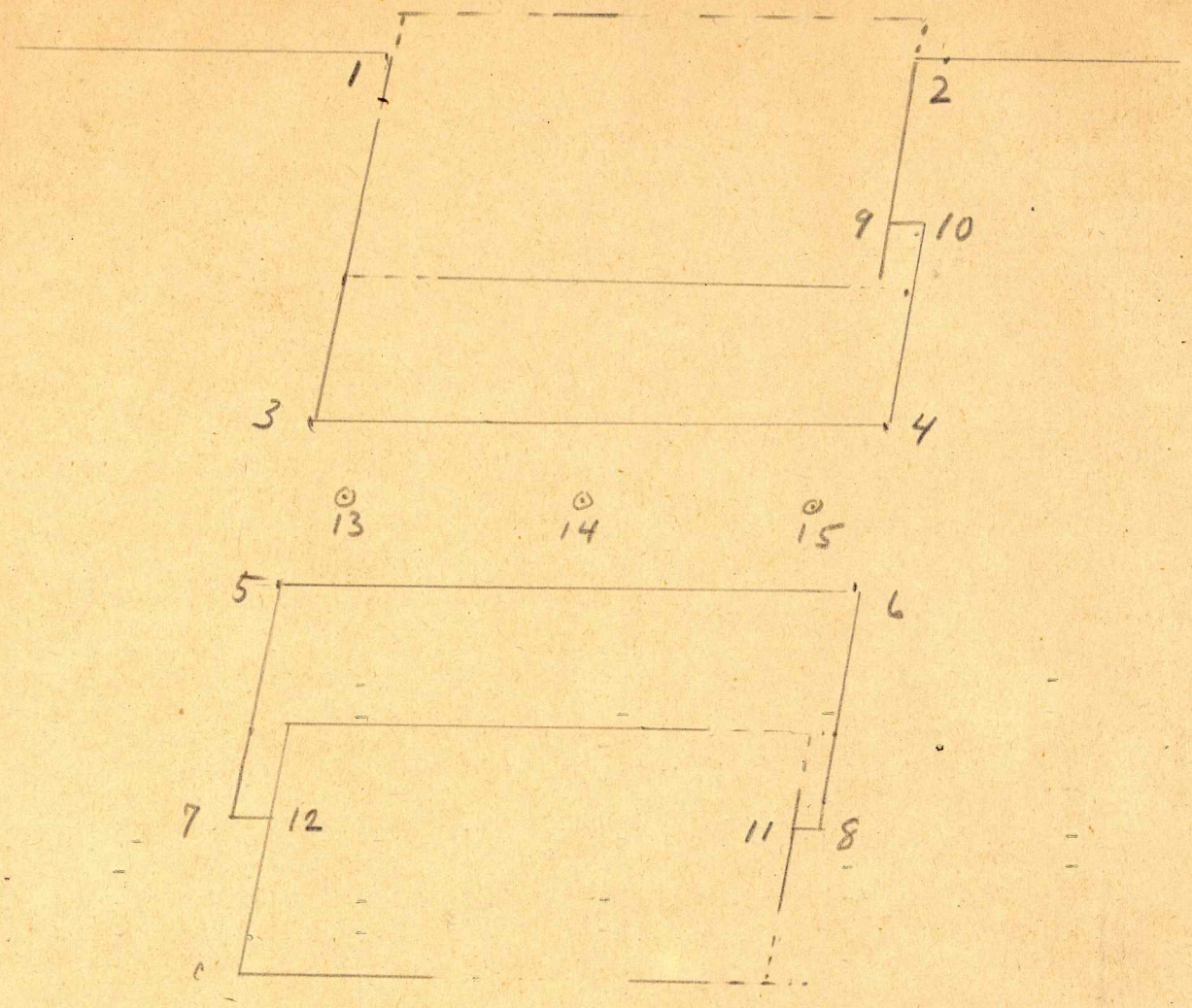


1-2	21.15	1-5	8.95	3-5	6.60	12-13	3.70	13-3	1.25	5-7	6.60
3-4	21.25	2-6	8.96	4-6	6.55	15-16	3.25	14-9	1.25	6-8	6.70
5-6	21.26	7-11	8.97	7-9	6.56			10-15	1.23		
7-8	21.50			8-10	6.50						
9-10	21.55										
A	(.35)	B	(.02)	C	(.10)	D	(.45)	E	(.02)	F	(.10)

Fig. 1. Structure K-6 (West Group Ball Court).

Fig 2

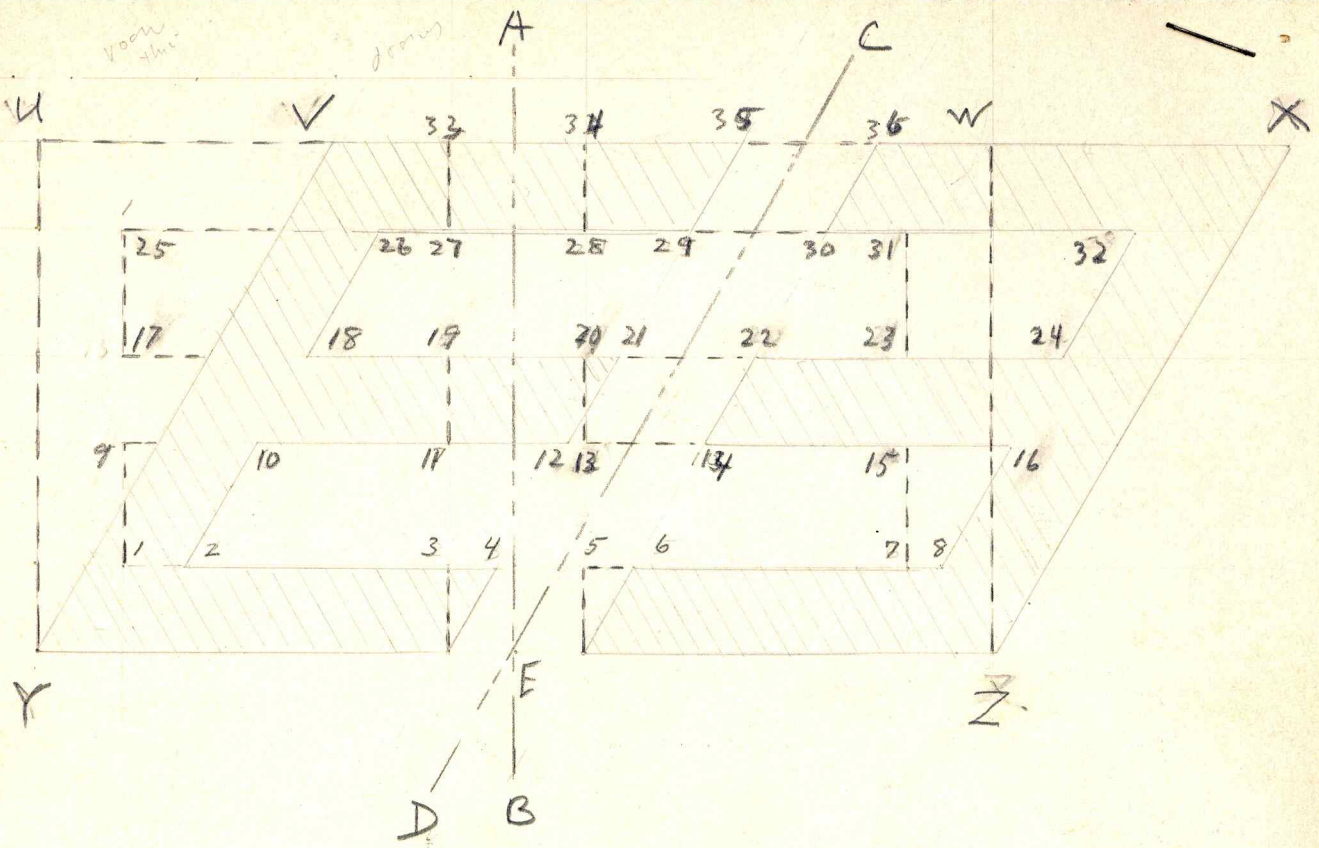
Str. R-11



1-2	17.55	2-9	4.35	10-4	6.90	9-10	.53	3-5	4.35	13-14	7.85
9-10	+.52	10-4	+6.90	6-8	6.82	11-8	.52	4-6	4.35	14-15	8.02
	18007		11.25	5-7	8.83	7-12	.38				
3-4	18.00	1-3	11.34								
5-6	18.15										
7-8	18.28										
A	(.28)	B	(.09)	C	(.08)	D	(.15)	E	(.00)	F	(.17

C+C.

Fig 3


A
C
U
V
W
X
Y
Z
E
D
B
25
26
27
28
29
30
31
32
17
18
19
20
21
22
23
24
9
10
11
12
13
14
15
16
1
2
3
4
5
6
7
8

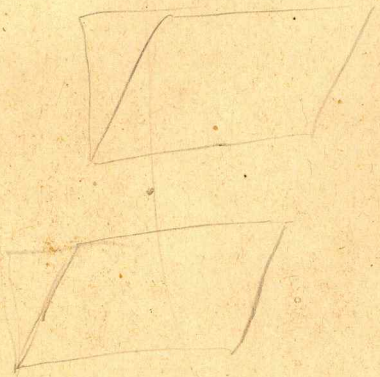
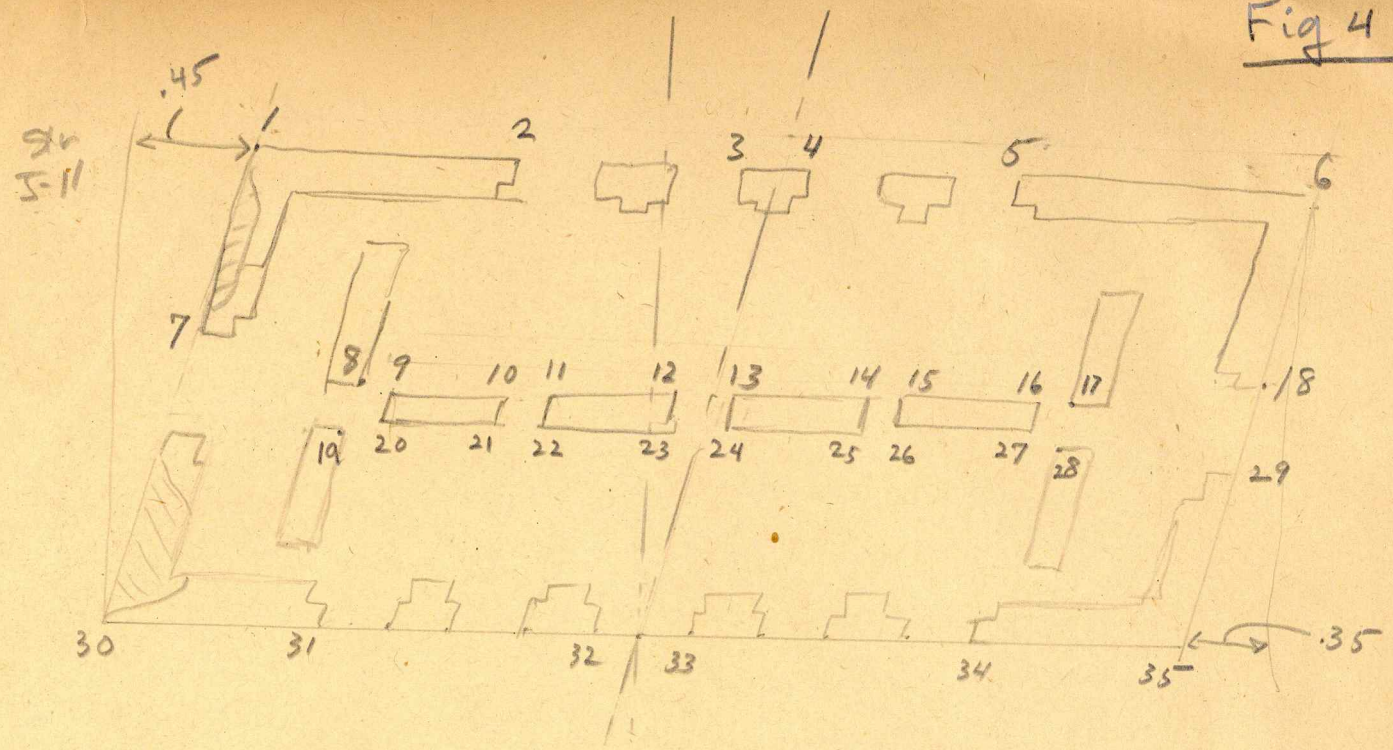


Fig 4

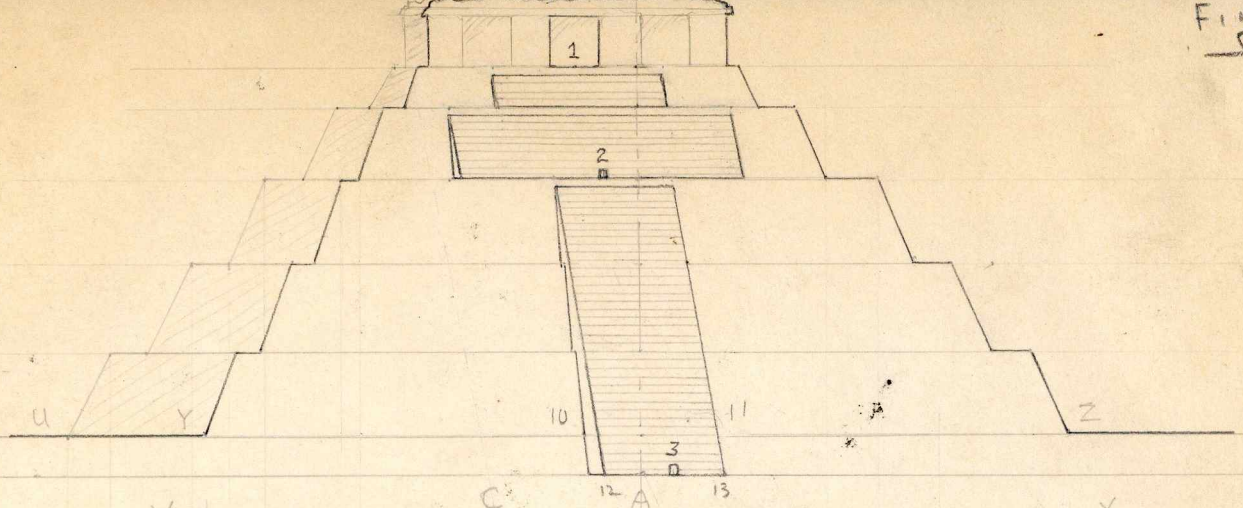


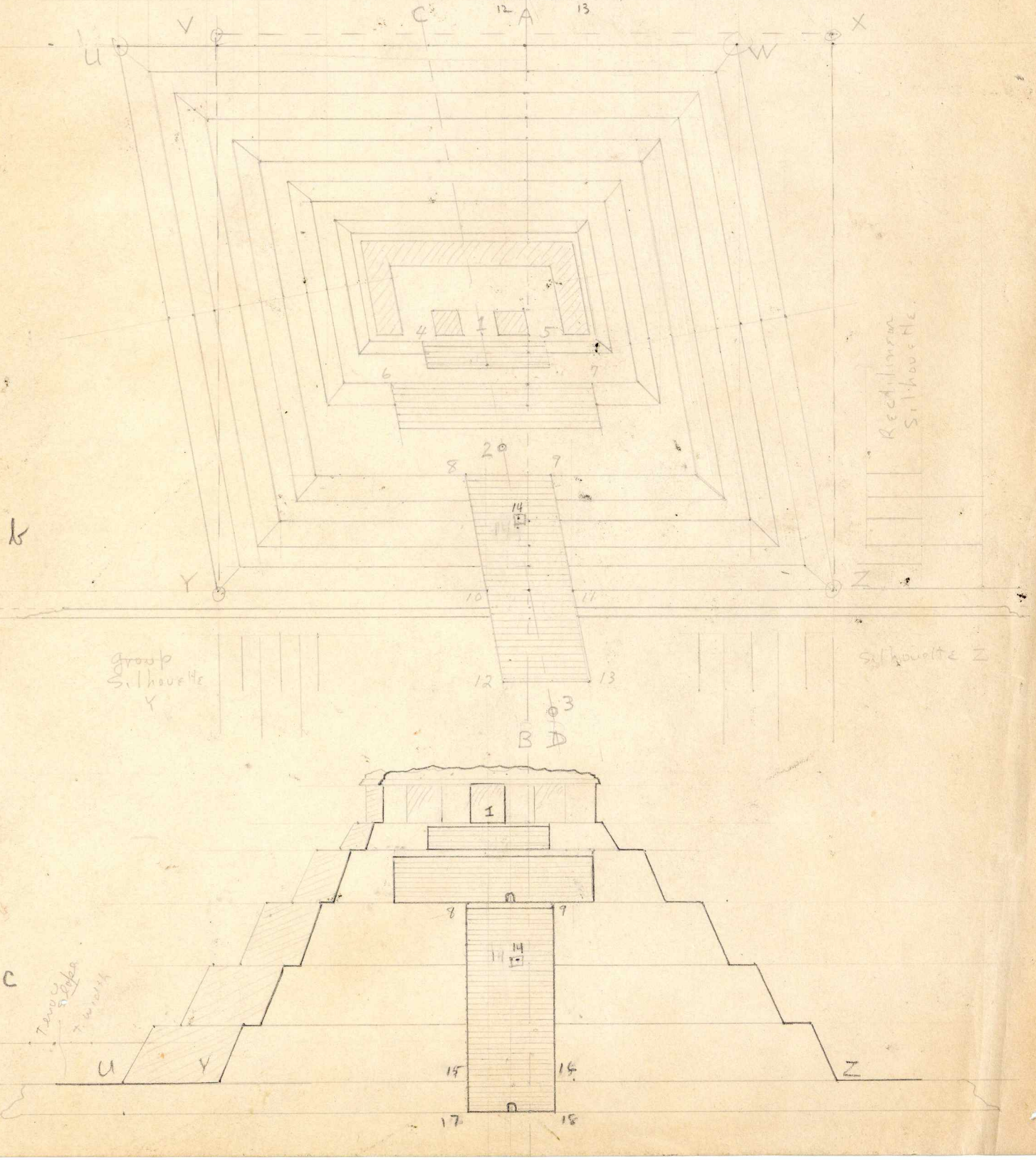
Outside											
1-6	23.66	1-30	7.65	1-2	6.25	25	1-7	2.59	30-31	4.65	
30-35	23.82	6-35	7.72	5-6	6.24		6-18	2.63	34-35	4.63	
A	(.16)	B	(.07)	C	(.01)		29-35	2.84			
A*	(.16)	B*	(.07)	C	(.01)		D	(.25)	E*	(.02)	

Inside											
1-3	11.19	30-32*	10.87	9-10	2.95		8-10	3.74	8-12	7.61	9-12	6.82
4-6	11.12	33-35	10.82	11-12	3.00		15-17	3.86	13-17	7.60	13-16	6.75
				13-14	2.91		19-21	3.85	19-23	7.61	20-23	6.86
				15-16	3.02		26-28	3.87	24-28	7.56	24-27	6.80
				20-21	3.05							
				22-23	3.00							
				24-25	2.98							
				26-27	3.10							
F	(.07)	G	(.05)	H**	(.19)		K	(.17)	J	(.05)	I	(.11)

* Point 30 may have moved slightly
** Points 25 and 26 seen only well above floor level.
Note also that points 32, 33 and 34 probably have moved forward in settling.

Fig 6
a

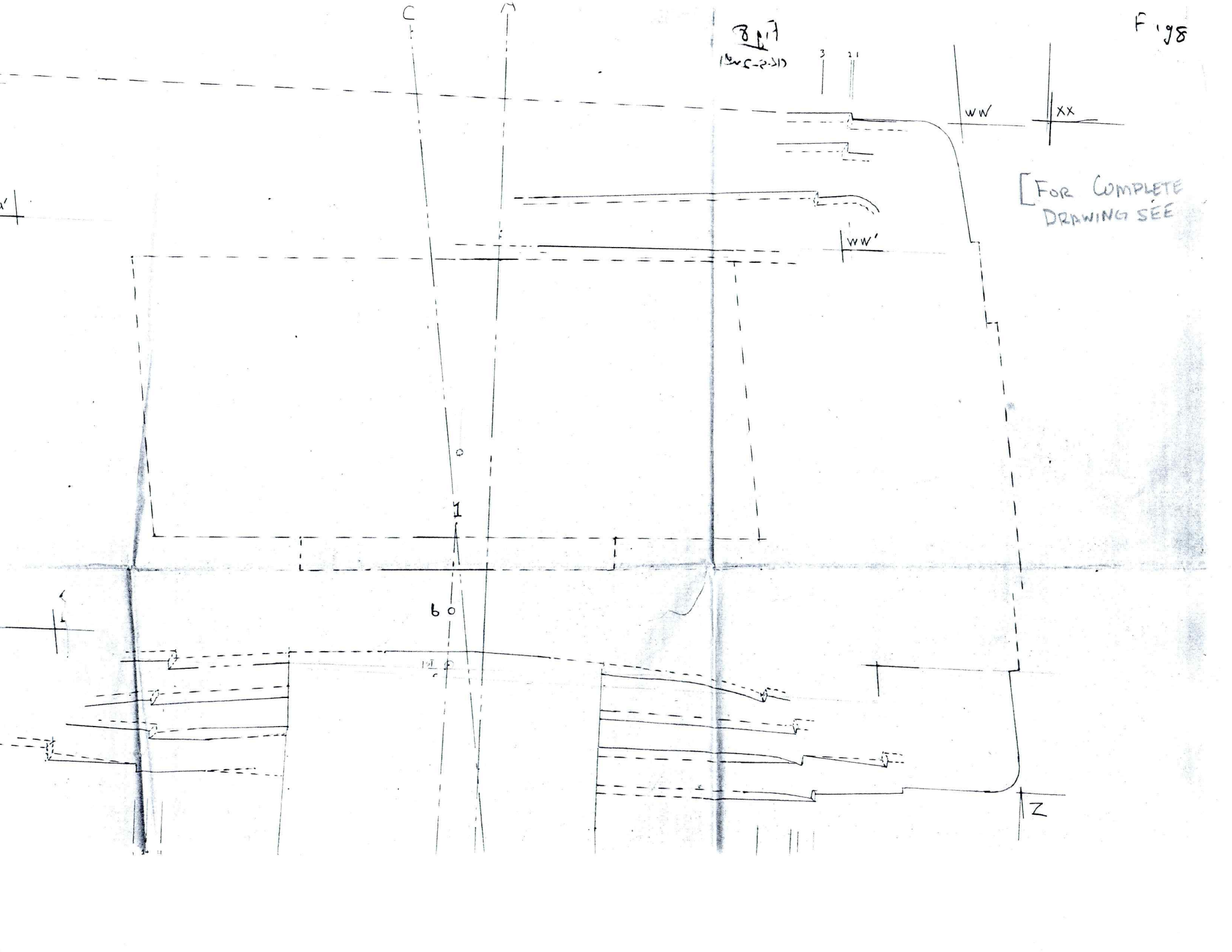

1
2
3
U
Y
10
11
12
13
Z


V
C
A
X
U
W
4
1
5
6
7
2
8
7
14
Y
10
11
Z
Rectilinear Silhouette
group Silhouette Y
Silhouette Z
12
13
3
B
D
1
8
9
14
C
Tower Silhouette
U
Y
15
16
Z
17
18

K-5-2nd Plan. Pencil on tracing paper.

Removed to:

Piedras Negras—
Oversize Plans and Drawings—
Str. K-5 Plans—
M-61-10


F.98
WW
XX
WW'
[FOR COMPLETE DRAWING SEE
1
Z

K-5 Plan. Pencil on tracing paper.

Removed to:

Piedras Negras—
Oversize Plans and Drawings—
Str. K-5 Plans—
M-61-10

Fig 7

[FOR COMPLETE DRAWING SEE