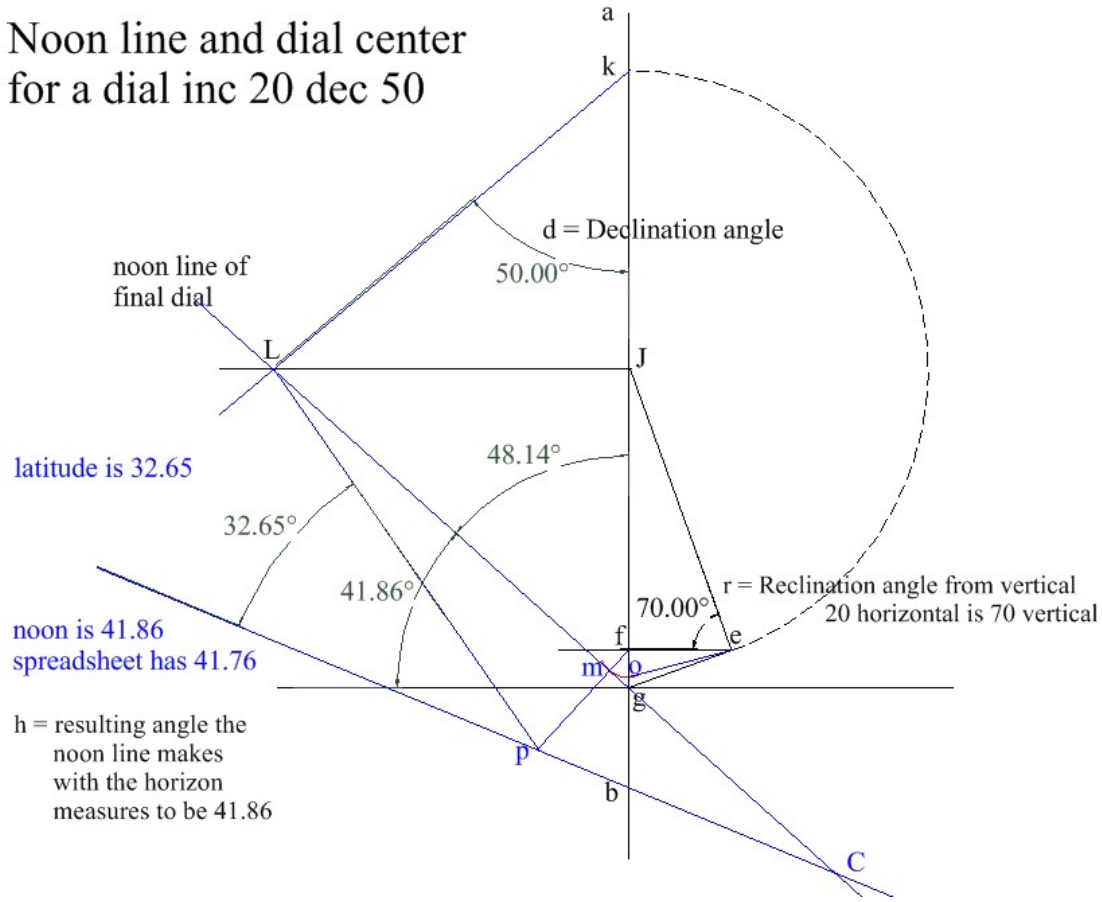
Oct 31, 2006

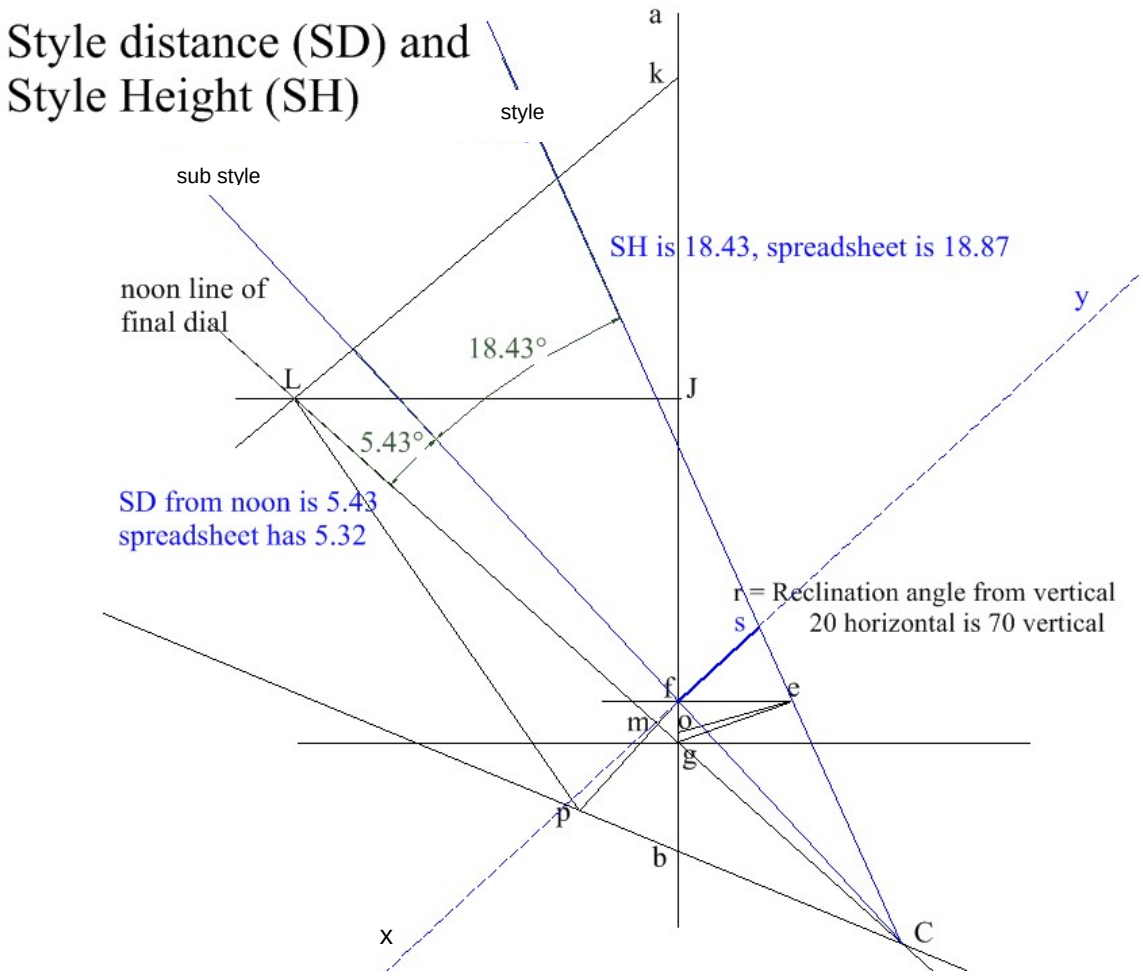
A southwest declining dial – S 50°W inclined up a gentle 20° – using geometry
three major steps
noon and dial center, SD/SH, and the hour lines

NOON LINE AND ITS OFFSET: A vertical line (ab) is drawn, and then a horizontal line (fe) is drawn. Then a line (eg) is drawn downwards at the angle of the dial plate's inclination up from the horizontal. Downwards for gently reclining slopes. That reclining line (eg) meets the vertical line at (g). And then a perpendicular to that slope is drawn a line which meets that original vertical line at (J), and it has a length. That line is rotated until it meets the vertical line at the top (k) from whence a line is drawn down at an angle equal to the dial plate's declination where it will intersect with a horizontal line drawn (LJ). This intersection (L) has a line (Lg) drawn from it down to point (g) on the original vertical line (ab). And that line (Lg) makes an angle equal to the angle of the noon line with the horizontal, and it was measured as 41.86, or 48.14 back from the vertical.



DIAL CENTER: From point (f) draw line (fm) which is perpendicular to line (Lg). This line will later be extended. On the vertical line (ab), make line (fo) equal to line (fm), an arc is used for this. Then draw a line from point (o) to the earlier point (e) as line (oe). From point (m), extend the line away from point (f) to a new point (p) where the length of (mp) is equal to the length of line (oe). Connect point (p) to earlier point (L) making a new line, (Lp), best seen in the picture above. Back off from line (pl) by the latitude of the dial, and draw that new line extended, so it meets the extension of line (Lg) at a new point (C) which is the dial center.

SUB STYLE AND THUS SUB STYLE DISTANCE (SD): from the dial center point (C) draw a line through the existing point (f). This line (Cf) is the sub-style, and when measured from noon it was 5.43 degrees or 47.29 from horizontal, or 42.71 from vertical since the noon line was 41.86 from horizontal or 48.14 from the vertical, which is within one tenth of a degree of some other figures.



STYLE HEIGHT (SH): through point (f) draw a line (xy) which is perpendicular to the recently drawn sub-style.

Make a line (fs) along line (xy) equal to the existing line (fe), an arc was used for this.

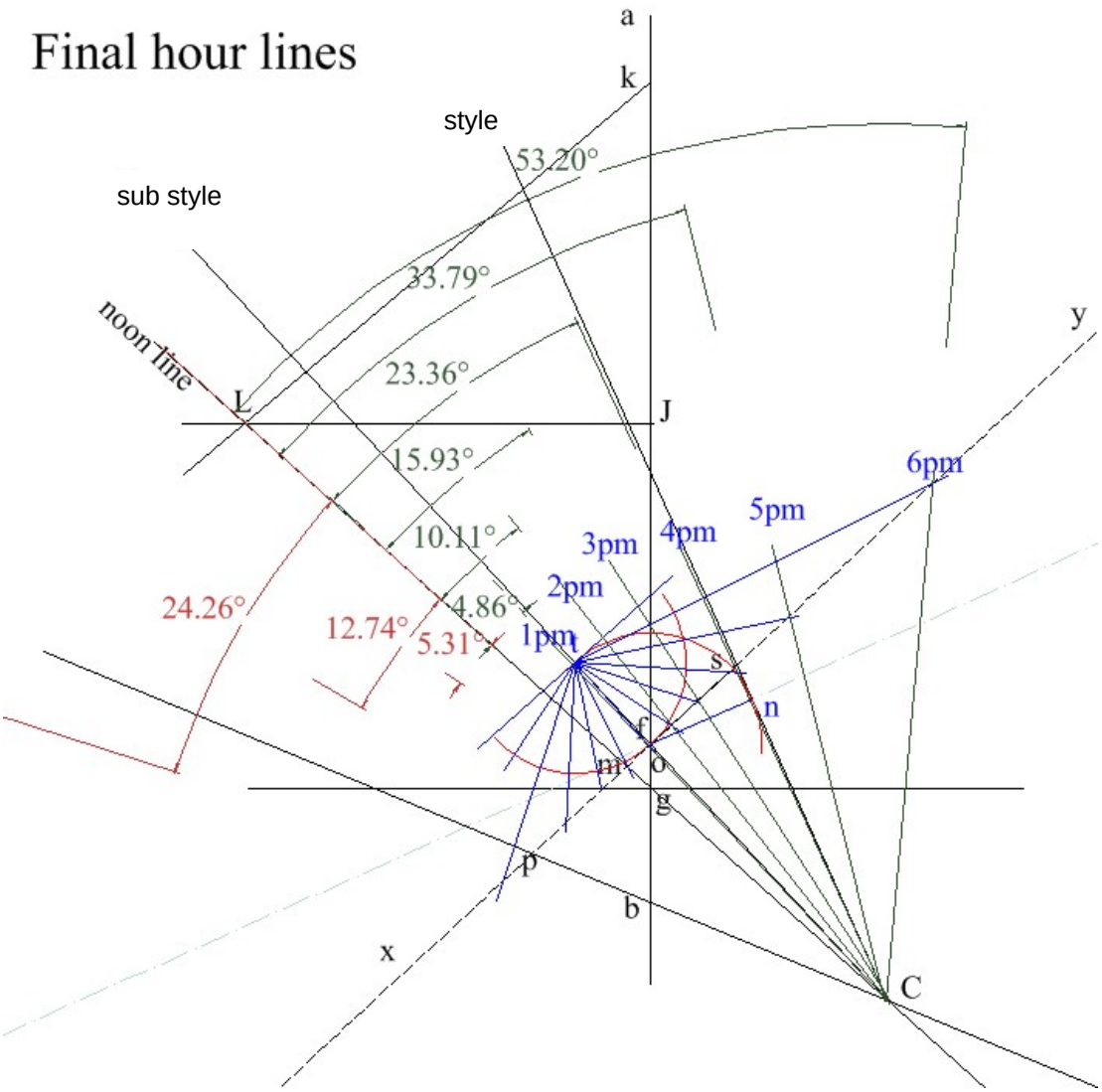
Finally draw line (Cs) which is the style, the angle between (Cs) and (Cf) was measured at 18.43 degrees which is within a degree of the other values derived in this section.

Note that line (xy) is not associated with line (fmp), their closeness is coincidental.

HOUR LINES: On the line (Cs) draw a line (fn) perpendicular to it from point (f). The intersecting point is (n), the "n" signifying the nodus.

Extend the line (Cf) to point (t) such that the length (ft) equals the length of line (fn). An arc was used, however the arc centered on point (f) through points (nt) is not associated with the arc centered on point (f) through point (s), their proximity is co-incidental. This in essence is taking the circle of radials and projecting them from the nodus to the dial plate.

Centered on point (t) draw an arc to hold the radials, this arc is of any size. A line is drawn from the center (t) to where the noon line intersects the line (xy), point (m) on the (LC) line. And beginning with the line (tm), draw a set of 15 degree hour angle depictions from the sun. The radials from the center of the circle with the 15 degree hours lines are extended to ensure they meet the line (xy). From the dial center (C), lines are drawn and these are the final hour line for the dial plate.



Finally the hour line angles are measured, for consistency they were measured from noon. Of course the angle of the noon line with the horizontal or vertical was previously determined on the first of the geometric worksheets.

The hour lines were measured as shown and were:-

	0900	1000	1100	1200	1pm 1300	2pm 1400	3pm 1500	4pm 1600	5pm 1700	6pm 1800
geometric	24.26	12.74	5.31	0	4.86	10.11	15.93	23.36	33.79	53.20
spreadsheet	25.01	13.24	5.70	0	4.98	9.91	15.46	22.63	33.55	53.63

And these are in very close agreement. Some of the angles were larger thus having points of intersection closer in which allowed for increased accuracy compared to a 45 degree declining 20 degree inclined dial.

Reiterating the prior data:-

noon line from horizontal	41.86	from vertical	48.14
SD 5.43 from noon	47.29		42.71
SH	18.43		

Longitude considerations

A major question is whether to design the difference between the dial design location, and the location of the legal time meridian.

As a rule, dials that are portable, or may be relocated later, should not have the longitude correction built into the dial plate, rather, there should be a tailored equation of time that blends the equation of time (EOT) with the difference in time between the dial design location and that legal meridian.

However for large dials that are designed and built in place, with no intention of subsequent movement, then the longitude correction can be built in.

The choice is left to the diallist. However if there are several dials on the property, it may be simplest to have them all designed the same way.

The next section shows how the geometric method easily accommodates the longitudinal correction.

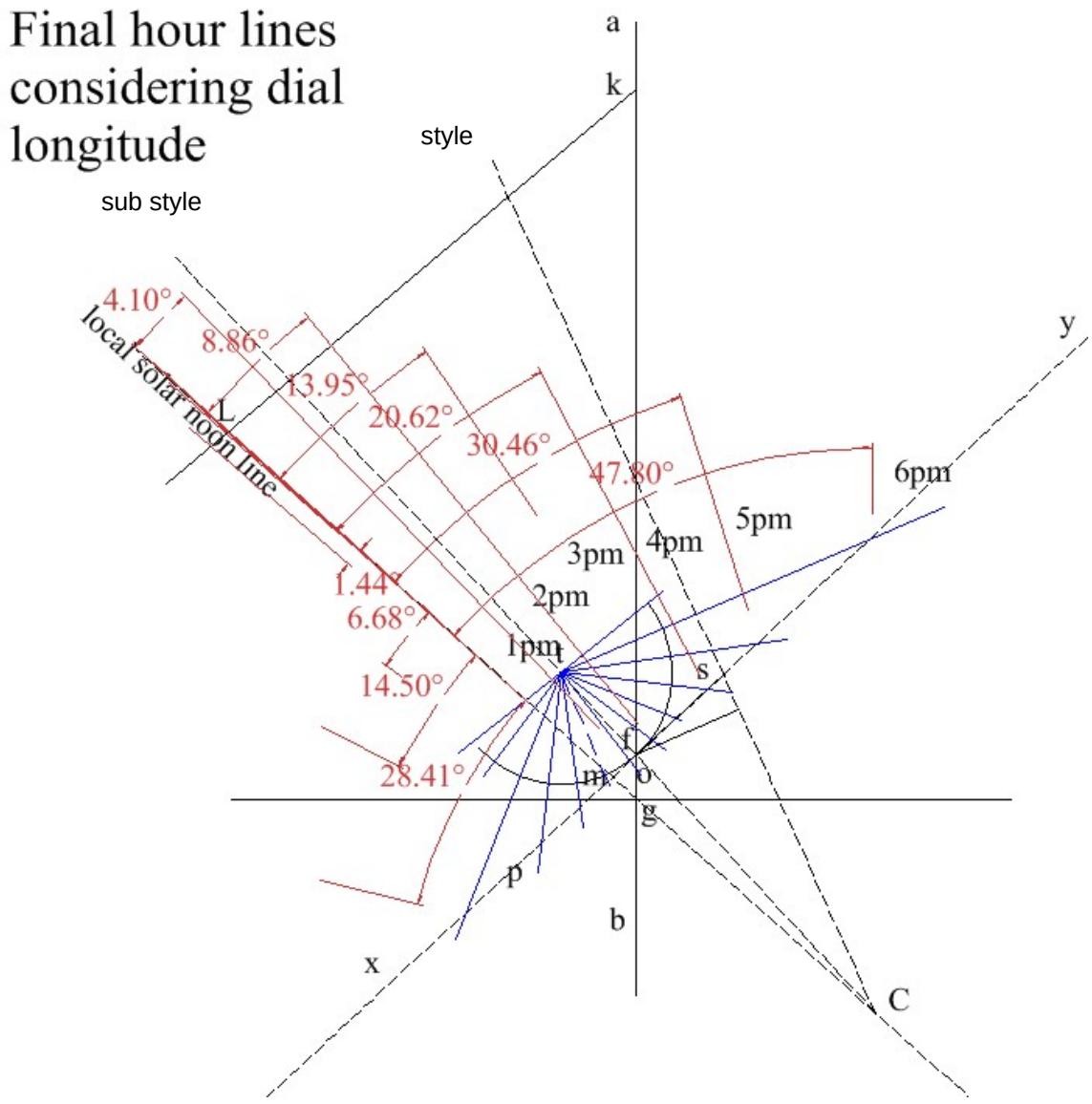
There is no change to the location of the noon line for that is the local noon, and similarly the angles from the noon line to the vertical and horizontal do not change. The dial center does not change, nor does the style distance and style height.

All that is needed is a simply rotation of the 15° radials and the re-drafting of those final hour lines themselves.

A southwest declining dial – S 45°W inclined up a gentle 20° – using geometry
longitude considered

HOUR LINES CONSIDERING LONGITUDE: the process is exactly the same as in the last step with one exception. The sole exception is that while the original noon line is retained since that is local solar noon, and the basis for all construction of hour lines, the 15° radials, and consequentially their associated hour lines are merely affected. Those 15° radials are rotated using a simple algorithm

In the northern hemisphere the 15° radials are rotated clockwise when west of the legal time zone, counter clockwise if to the east. The opposite direction for the southern hemisphere. The amount of the rotation is the longitudinal difference. For the design location for this dial that meant a clockwise rotation of 3.2 degrees.



Finally the hour line angles are measured, for consistency they were measured from noon. Of course the angle of the noon line with the horizontal or vertical was previously determined on the first of the geometric worksheets.

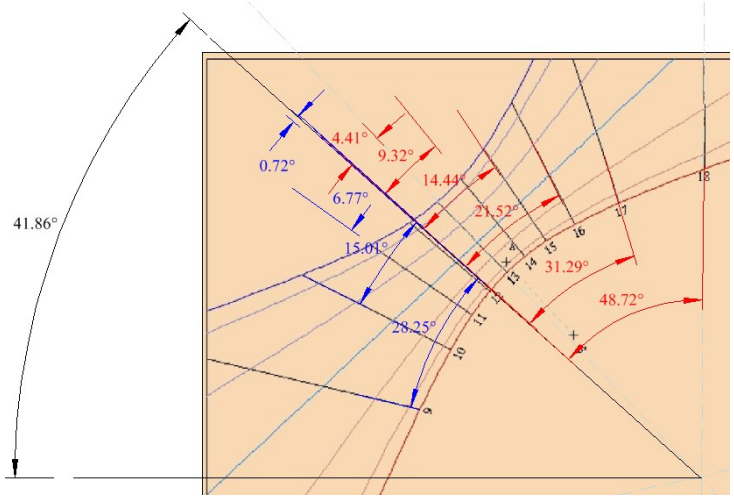
Reiterating the prior data that did not change with a longitudinal consideration:-

local noon line from horizontal	41.86	from vertical	48.14
SD 5.43 from noon	47.29		42.71
SH	18.43		

The hour lines were affected by longitudinal considerations, the new angles were:-

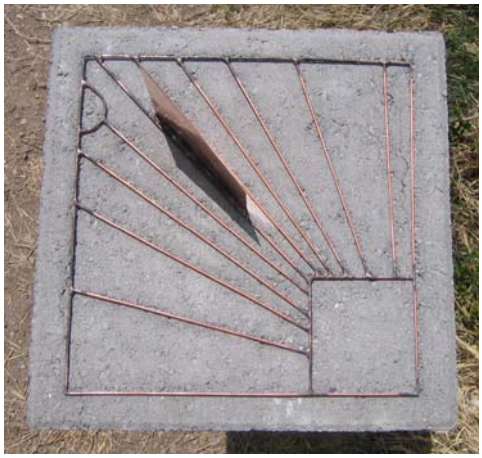
					1pm	2pm	3pm	4pm	5pm	6pm
	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800
geometric	28.41	14.50	6.68	1.44	4.10	8.86	13.95	20.62	30.46	47.80
	- - - - - - - - - - - - - - - - - -			left	right -					

These angles show a displacement that is appropriate, and the new noon will happen earlier than solar noon, which is correct.



The angles can be checked by using the spreadsheet, as before, except that the base time would need to be adjusted by the longitudinal difference, being 1° for 4 minutes. In this case, the SHADOWS software was used and the angles found to be in close agreement. Since the geometric method uses the local solar noon as the base, and SHADOWS does not, it is important to add into the SHADOWS depiction the local solar noon, and measure angles from thence.

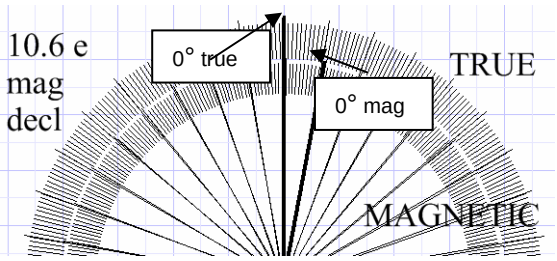
A cardboard dial plate and gnomon were made, and the site prepared. The column to the right was to be normal clay brick, was put together without mortar, but the top had been leveled and the dial plate set with a compass after considering magnetic declination. The style alignment and dial plate inclination was also checked. One common level has a magnetic base thus when compass readings are taken, it must be removed.



Every hour the shadows were checked on the cardboard dial plate, with consideration to the equation of time. If for example the EOT table said 10 minutes was to be added to sun time, then on the hour it would actually be 10 minutes past, so the dial would be checked 10 minutes after each hour.

The mock dial plate worked so the final dial plate was constructed. Copper wire 12 gauge was used and straightened by rolling with a block of wood, then placed on the mockup dial plate and soldered. The gnomon was soldered to the dial plate, and the entire plate then secured to the concrete slab with an epoxy that would survive the elements.

The site for the dial just looked a but too close to the picket fence, so it was move a couple of feet, and then the column built. The slope was managed by cutting an 8x8x8 block at 20 degrees.



location lat:	108.2° W
location long:	32.65° N
magnetic declination: (variation)	10.6° E
Dial declines	S 50 W
inclines	20
S 50 W true is	S 39.4 W mag
230 true	220 magnetic

To get the final dial plate declining 50 degrees to the west, 230° magnetic, the 8x8x8 sloped cap was rotated with a compass until the alignment read a tad short of 220° magnetic. That wedge was secured mortar placed in the wedge, and with some excess, the final dial plate was mounted.

The top and bottom of the dial plate was checked for level and alignment with the cap it rests on, as well as with the magnetic alignment.

When cured, some quarter round wood was cut and secured with epoxy on the lower part of the wedge as well as the upper, this would secure the dial plate from accidental jarring. In fact, the brick column's concrete cap was similarly secured. The dial shows local sun time corrected for the longitudinal difference to the legal standard time meridian, thus all that is needed is the EOT correction.