4/10/70

Test of Surface Plate II

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1. Modifications

Surface Plate II was first manufactured as described in Attachment B (March 24). There was no mutual influence between side and interior points, but a strong influence within each side, especially from points C1,7 and K1,7 to the other ones. This seemed to result from the fact that a part of the lower side ribs had to be cut off at C1,7 and K1,7 for reasons of clearance. Thus 4 pieces of heavy channel were screwed over the weak spots for additional stiffness.

The bumpiness of the skin, between adjustment points, was too large, giving rms $\Delta \approx 11.7 \times 10^{-3}$ inch for the intermediate points, and 8.7×10^{-3} inch for the total of all points. Thus, 6 more short ribs were added, with 12 more adjustment points (raising the total to 36 adjustment points).

2. Initial Curvature

We proceeded as suggested in Attachment B, fixing all screws in a bent position of the plate. The plate then was measured at all 84 points with the result

$$\text{rms } \Delta_o = .021 \text{ inch} \tag{1}$$

which agrees nicely with the predicted value of .018 inch.

3. Mutual Influence

The mutual influence within the long sides is shown in Fig. 1. Even after the modification, it is still quite strong. There is no order of adjustments with "forward influence only." From one adjustment to the the next, the rms deviation decreases by a factor 3.1, and it takes 3 iterative adjustments for each side.

There is practically no influence between both sides, between sides and interior points, and between interior points themselves. Adjusting the 10 side points 3 times, and the remaining 26 points once, a total of 56 adjustments is necessary for the total of 36 screws.

This result is good enough for the present plate. But it shows that we could not make plates of double the width (as was hoped for), since then the inner ribs would have the same problem as only the side ribs have now.

4. Gravitational Sag

The results are

$$s_{max} = .0051 \text{ inch} \tag{2}$$

$$\overline{s} = .0016 \text{ inch} \tag{3}$$

$$\text{rms } (s-\overline{s}) = .0020 \text{ inch} \tag{4}$$

Value (4) is what matters and can be tolerated.

5. The rms Deviation

The 36 adjustment points plus the 4 corners gave

$$\Delta_{max} = .0020 \text{ inch,} \tag{5}$$

$$\text{rms } \Delta = .0009 \text{ inch,} \tag{6}$$

while the 48 intermediate points gave

$$\Delta_{max} = .0059 \text{ inch,} \tag{7}$$

$$\text{rms } \Delta = .0024 \text{ inch.} \tag{8}$$

From the total of 88 points (giving the intermediate points 20% more weight because of omitted small-size bumps), we obtain the total deviation as

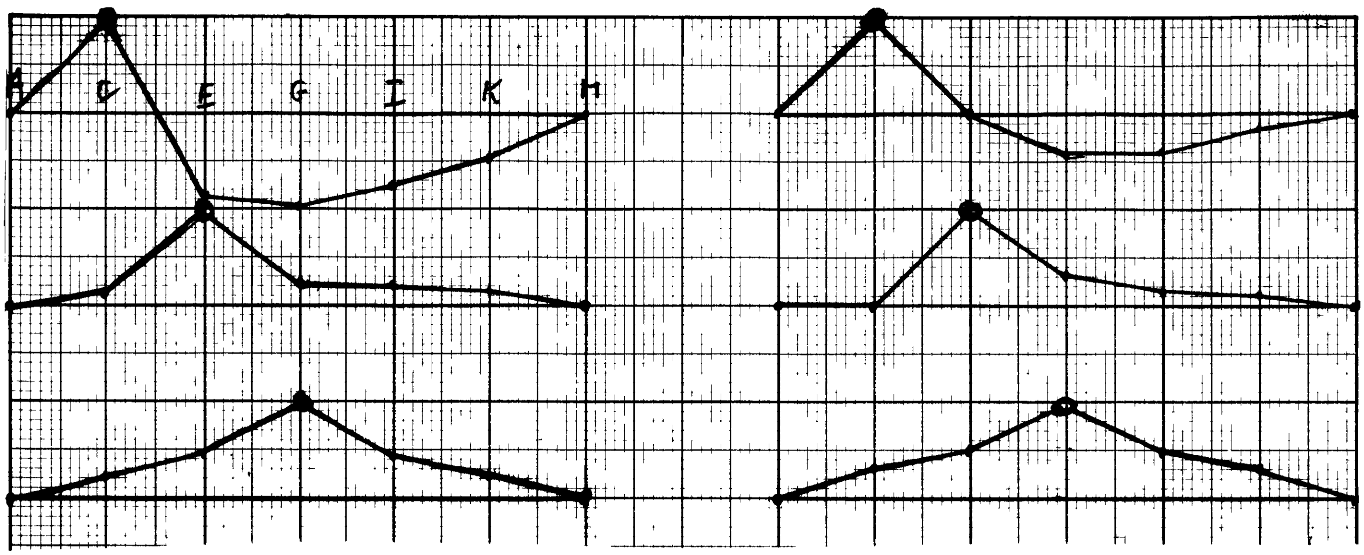
$$\text{rms } \Delta = .0020 \text{ inch.} \tag{9}$$

This result is even better than the demanded value of .0032 inch. It shows that adjustment screws (2.5 screws/ft^2) can achieve exactly the same accuracy as a good milled surface (.002 --- .003 inch according to Rohr Co.).

If the telescope could be measured and adjusted with the same accuracy, and if we had no other sources of error (telescope close to zenith, no wind, no temperature differences), we would have a total surface error of $.002\sqrt{2}$ = .0028 inch = .072 mm. Multiplied by 16, the shortest wavelength of observation then would be

$$\lambda_o = 1.15 \text{ mm.} \tag{10}$$

This clearly shows the crucial importance of good surface plates. If the present accuracy can be achieved, the telescope can observe between 1 and 2 mm wavelengths for a limited part of the sky during a limited fraction of time.



a) original b) modified

<u>Fig. 1.</u> The mutual influence along the long plate sides.

If the heavily marked point is turned up by one unit, the other points move as shown.

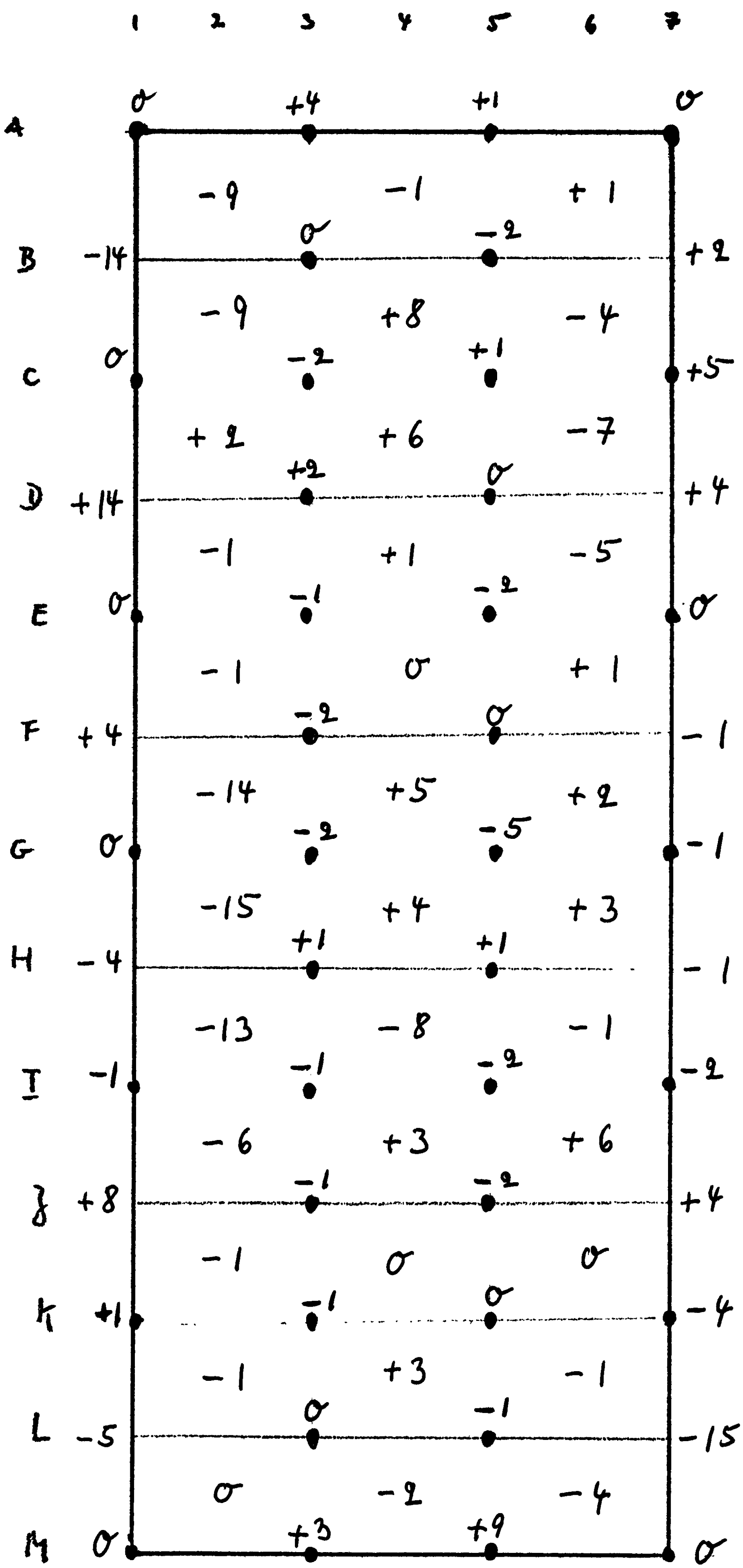


Fig. 2. The deviation Δ from a paraboloid, in 10^{-3} cm. Heavy dots are adjustment points.