REPORT 2

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REPORT NO. 2
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PROJECT: LFSP
SUBJECT: Homology Deformation

To: J. Hungerbuhler
From: S. von Hoerner

Telescope Model for Homology Test

J. Hungerbuhler suggested building a telescope model, as soon as R. Jennings would have succeeded in calculating homologous structures, in order to test at least one of these structures. The basic difficulty is the fact that gravitational deformations go with the square of the antenna diameter. For decreasing model size, the deformations are soon below the limit of measurment, whereas a larger model would be too expensive. The following is a suggestion of how it could be done. In order to compare the homologous model with a non-homologous available structure, I recommend building a model of 36 feet diameter, the same as the millimeter telescope at Kitt Peak.

1. Measuring Accuracy and Method

According to formula (8) of my antenna paper, the shortest wavelength λ for a tiltable antenna of diameter D is (with $K = 1.5$ as the weight factor)

$$\lambda = 8.0 \text{ cm } (D/100\text{m})^2, \qquad (1)$$

and for $D = 36$ ft $= 11.0$ m we have

$$\lambda = 1.0 \text{ mm}. \qquad (2)$$

The structure I suggested (Report No. 1, of Oct. 20, 1965) should pass this gravitational limit by about a factor of 10 in wavelength, giving

$$\lambda = 100\,\mu. \qquad (3)$$

The rms deflections then would be $\Delta h = \lambda/16 = 6.3\mu$, which would call for a measuring accuracy of about

$$\delta = \pm 2.5\mu. \qquad (4)$$

A distance around 10 m cannot be measured with this accuracy. But any change of this distance by a few mikron, during measurment, could be seen with an optical interferometer. The best way might be to have a laser at the feed point. We split up the beam in two, let the first part be reflected at one of the surface points and let it then

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interfere with the second part to which we have given a slight tilt. This results in a set of parallel fringes, and the set will be shifted by two fringes when the distance to the reflecting point is changed by one wavelength.

We set everything up in zenith position, then turn the model slowly into horizon position; during this turn, we count, with photocell and Sanborn recorder, the number of fringes moving over the photocell. This procedure, then, is repeated with a different surface point, and so on.

2. Congruent Deformation

This method would of course work best, if, in the ideal case, no change at all were expected for any distance. This means we should have, if possible, a type of structure where the gravitational deformations not only are homologous, but are congruent, allowing only translation and rotation, and leaving the combined system of surface points and feed point internally undeformed. At present, I think that this is possible.

I will try to work out a structure of this type together with R. Jennings. It seems to me that even the structure suggested in my first report would have congruent solutions, at least for certain geometrical shapes. For example, it turns out to be almost trivial to make the feed point move congruent with the surface; the problem to be solved is to find a homology solution for the surface where the focal length stays constant.

Suppose we find a structure of this type, and Jennings obtains congruent solutions numerically. If a model is built according to this result, and is measured with the optical interferometer during an elevation turn, then any shift of the fringes during this turn is a direct measure of the deviation from congruency.

If congruent structures are not possible but only homologous ones, the interferometer method still would yield the deformations from homology, if also the surface points are measured against each other, and the data then are processed in a computer.

3. The Model

Most probably, the model will look similar to the second structure suggested in my report 1. The basic structure is an octahedron, hanging in a suspension. The suspension

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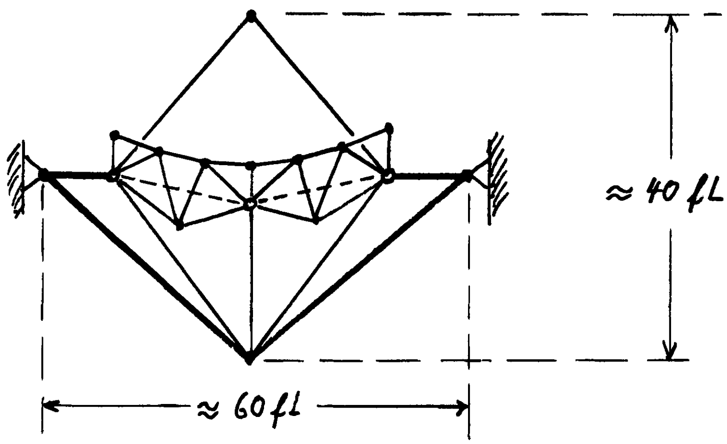
is held at two bearings, which, for this model, might be fixed to two towers, walls or posts; no accuracy is needed for the mounting of this model. The elevation drive again does not need any accuracy, one just could pull the antifocus point with a rope.

The plane of the octahedron, with its somewhat lowered center, yields five homologous points. From these five basic points we go up in one layer and reach 21 surface points:



Since we use pressure-stable cells in this layer, it seems possible to obtain congruent deformations of the surface although the five basic points have only homologous deformations.

Suspension, bearings, mount and drive do not need any accuracy. How much accuracy is needed for the octahedron and layer structure is hard to estimate but will be found by the numerical calculations I suggested (see "Sensitivity"). I guess that a few per cent of tolerance in lengths and cross sections will be allowed.

The model should not have a real surface, but the weight of a surface must be simulated by attaching weights to the 21 surface points. The model should not be built (or adjusted) to form an accurate paraboloid. Its only purpose is to measure its gravitational deformations and their departure from homology. The model should not weigh more than a few tons. It should show whether or not a numerically obtained homology solution is realizable in an actual structure.