HERA Dimensions

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1 Hub and Support Spar

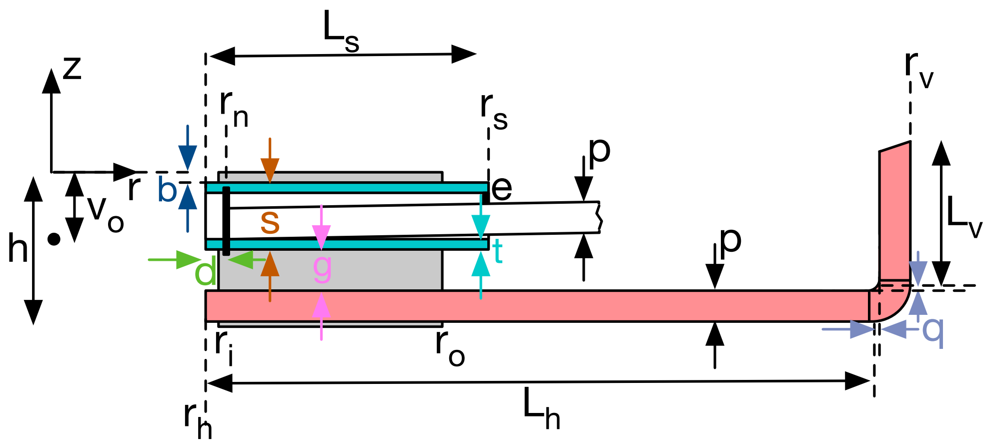

Figure 1: General dimensions of hub and support spar (colored light red).

h	height of hub
v_o	distance of vertex from top of hub
b	distance between top of hub and top of sleeve
L_s	length of sleeve
s	outer diameter of sleeve
t	wall thickness of sleeve
g	distance between bottom of sleeve and top of horizontal support spar
d	distance between nail and the inner edge of the sleeve
q	distance between 90^o coupler spar and and orthogonal edge
e	spacer-gap at outer edge of sleeve
h_v	distance between top of horizontal support spar and lower edge of vertical support spar
r_i	radial distance to inner edge of hub
r_o	radial distance to outer edge of hub
r_n	radial distance to nail
r_s	radial distance to end of sleeve
r_h	radial distance to inner edge of horizontal support
L_h	length of horizontal support spar
L_v	long length of vertical support spar
F	focal length of parabola
z	height z with 0 at top of hub
r	radial distance with 0 at center of hub
$\theta(r)$	$= \tan^{-1}(r/2F)$

The hub is a concrete "donut" made up of two concentric rings with holes cut in to allow PVC spars to be positioned. There are two sets of spar holes, each of which have twelve equi-spaced holes in the inner and outer rings. There is another small hole v_o from the top of the inner ring to accommodate a piece of rebar. The bottom holes have diameter p and the top holes have diameter s. The bottom holes are centered $b+s+g+p/2$ from the top of the hub and the top holes are centered $b+s/2$ from the top. The hub height is h.

1.1 Sleeve and Vertex Offset

To get the offset between the top of the hub and the vertex, we need to set the sleeve in one of two ways:

1: Given s, t, design the sleeve to the correct length L_s (so $e = 0$). Matching the angle at the exit from the sleeve to the proper parabolic angle (see Sec. 1.4):

$$r_s = \frac{r_n + \sqrt{r_n^2 + 8(s - 2t - p)F}}{2} \tag{1}$$

Then $L_s = r_s - r_n + d$.

2: Make a sleeve (s, t, L_s) then include a spacer e. Then $r_s = L_s + r_n - d$ and

$$e = (s - 2t - p) - \frac{r_s(r_s - r_n)}{2F} \tag{2}$$

Then

$$v_o = b + t + e + \frac{r_s^2}{4F} \tag{3}$$

1.2 Parabolic Offsets from Top of Hub

Height from the top of the hub surface to the top of the spar (z_t) at radius r:

$$z_t(r) = \left(\frac{r^2}{4F}\right) - v_o \tag{4}$$

Height from the top of the hub surface to the bottom of the spar (z_b) at radius r:

$$z_b(r) = z_t - \left(\frac{p}{\cos\theta(r)}\right) = \left(\frac{r^2}{4F}\right) - \left(\frac{p}{\cos\theta(r)}\right) - v_o \approx \left[\frac{r^2}{4F(1 + p/2F)}\right] - (v_o + p) \tag{5}$$

1.3 Vertical Support Spar

Length of the vertical support piece at the end of the support:

$$L_v = z_b(r_v) + b + s + g - q = \left(\frac{r_v^2}{4F}\right) - \left(\frac{p}{\cos\theta(r_v)}\right) - v_o + b + s + g - q \tag{6}$$

where $r_v = r_h + L_h + q + p$.

1.4 Some Derivations

For Eq. 1, note that the angle of spar in sleeve

$$\tan\theta_{exit} \approx \frac{s - 2t - p - e}{r_s - r_n} \tag{7}$$

should match the angle at radius r_s so

$$\frac{s - 2t - p - e}{r_s - r_n} = \frac{r_s}{2F} \tag{8}$$

From which Equations 1 and 2 follow.

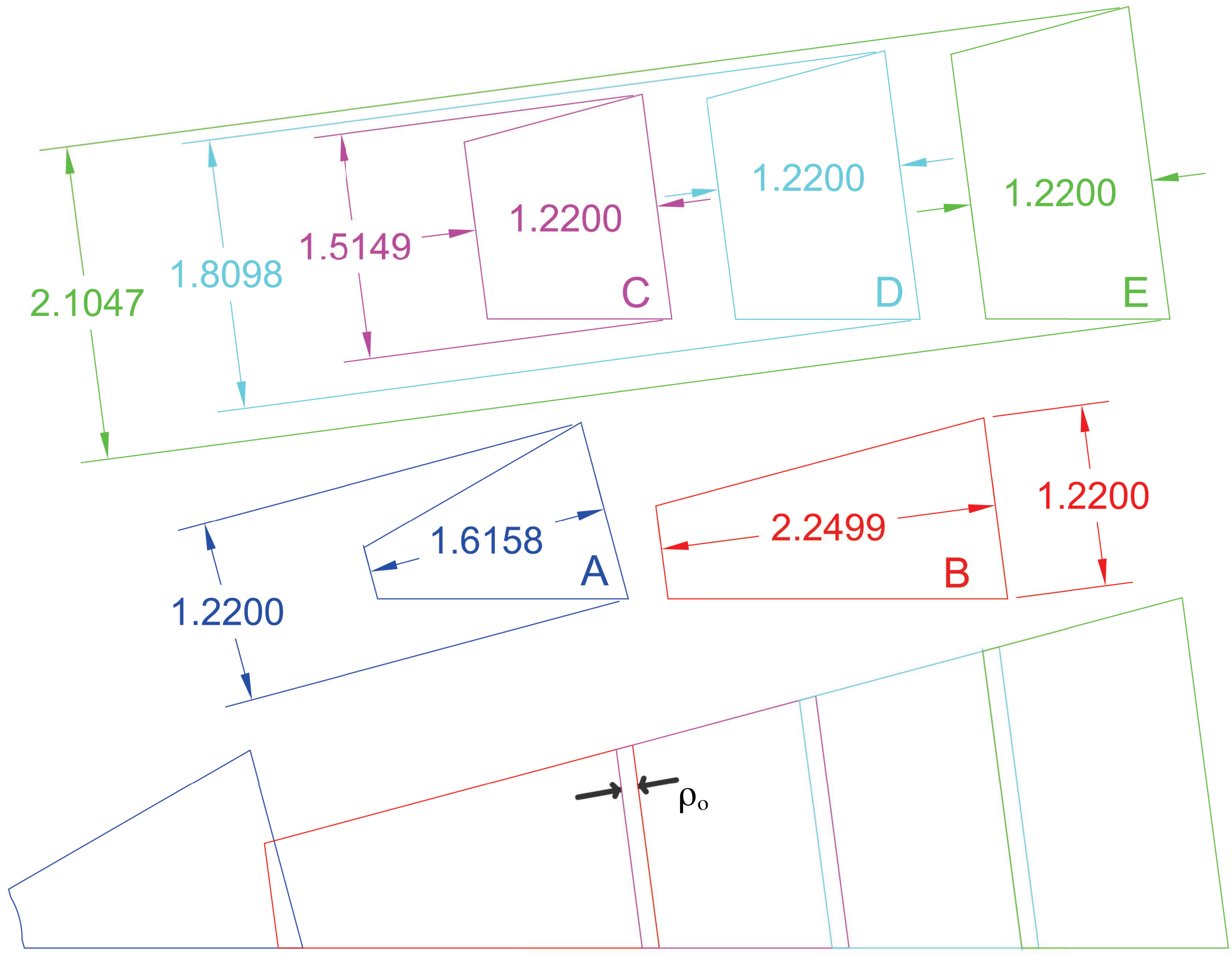

Figure 2: Panel layout. Bottom shows the (flat) arrangement as on antenna.

The surface are panels cut from galvanized and cross welded ∼6mm mesh coming from a standard width role of 1.22m, as shown in Figure 2. There are 5 panel types, labelled A-E. There are 12 A panels and 24 B-E panels. One B panel is used as an access door. The panels are overlapped as shown in the bottom of Figure 2, with an overlap width of ρ_o =100mm.

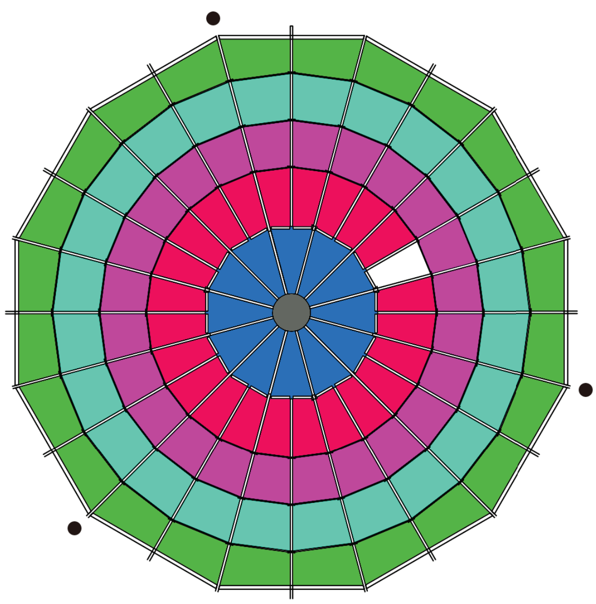

Figure 3: Panel plan.

3 Surface Spars and Bracing

As shown in Figure 3, the parabolic spars and associated cross bracing support the mesh. The A-B panel overlap has a PVC cross-brace ("cross-piece"), which all holds the inner end of the intermediate support spar. The other overlaps (B-C, C-D, D-E) have a metal strap between them. The strap is on the upper side of the PVC. The spacing is set by the size of the mesh.

The position of the cross-piece is set by the hub and the size of panel A. Denoting the distances as 'A' - 'E' as shown in 2, we can compute the position of the *far* edge of the cross-piece. Note that the mesh follows the shape of the PVC, and the planar radial value, so it is easiest to compute the parabolic path length (denoted by s, where $s = 0$ at $r = 0$) as opposed to the radial distance. Radial distances may be computed numerically from the path length and vice versa. As a shortcut here, define the mapping from radius to path-length as $f(r)$ and from path-length to radius as $f^{-1}(s)$.

Since we can mark the spar while flat on the ground as opposed to pivot along a radius, we will compute in terms of path-length s, but specify in terms of length along the long spars (σ_L) and the short "intermediate" spars (σ_S). The offsets (shown later) are s_{oL} and s_{oS} respectively. That is $\sigma_{\{L,S\}}(s) = s - s_{o\{L,S\}}$.

It is also helpful to compute the radius at which the intermediate spar starts, which is denoted r_i in Fig. 4.

3.1 Cross-Brace Spar

The cross-brace spar is located by where panel A would end, taking the overlap in consideration. The PVC pipe intersects the long spars on either side at an angle of 15^o. The reference point on the spar is taken to be where the long side of the cross piece intersects the long spar.

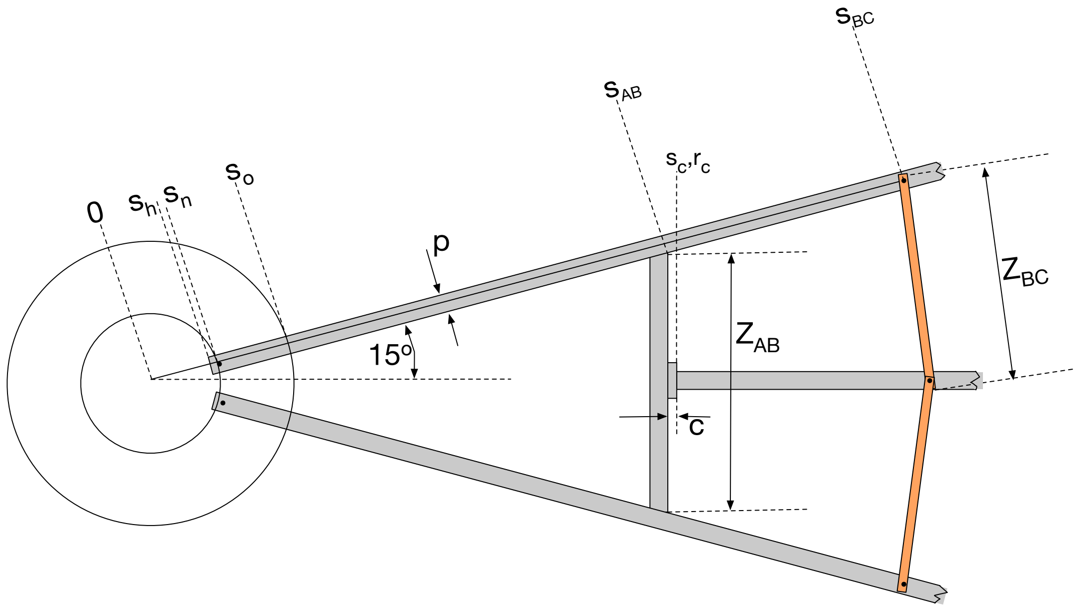

Figure 4: Spar dimensions.

$$\sigma_{A,L} = s_{AB} - s_h = \frac{A - \rho_o/2 + p/2}{\cos(15^o)} - \frac{p * \tan(15^o)}{2} - s_h \tag{9}$$

The width of the cross-brace spar is

$$Z_{AB} = 2f^{-1}(s_{AB})\sin(15^o) - p/\cos(15^o) \tag{10}$$

3.2 Metal Strips

The metal strips go between the long and short spars. We've seen that the offset for the long is

$$s_{oL} = s_h \tag{11}$$

and now we find

$$s_{oS} = s_{AB} * \cos(15^o) + c \tag{12}$$

We find that the location of the metal strips are at

$$\begin{aligned} s_{BC} &= s_{AB} + (B - \rho_o)/\cos(7.5^o) && (13) \\ s_{CD} &= s_{BC} + (C - \rho_o)/\cos(7.5^o) && (14) \\ s_{DE} &= s_{CD} + (D - \rho_o)/\cos(7.5^o) && (15) \\ & && (16) \end{aligned}$$

The spar markings can be found by subtracting s_{oL} or s_{oS} as appropriate.

The length of the metal strips

$$Z_x = 2f^{-1}(s_x)\sin(7.5^o) + p/\cos(7.5^o) \tag{17}$$

where $x = [BC, CD, DE]$