VLBA ACQUISITION MEMO #342

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Subject: Theoretical wear profiles for headstack with soft spacers

With uniform wear of the ferrite and spacer material, the equilibrium profile of the headstack will be cylindrical with radius of curvature

$$R = (P + L)/\theta$$ (see VLBA Acq. Memo 179)

where

L = half the length of the headstep (150 μm)

θ = half the wrap angle (5°)

P = characteristic bending length

For the parameters of our headstack and 16 μm tape

$$R \sim 3000\,\mu m$$

If the ferrite wears down faster than the spacer, then these areas will become eroded. VLBA Acquisition Memo 256 provides some estimates of the degree to which the tape will deform to accommodate this erosion. A more accurate theoretical model might be used to estimate the relative wear rates of the ferrite and spacer materials from the profile along the headstack.

With non-uniform wear, the tape must be supported by a non-uniform pressure across the stack. Under the assumption that the wear rate is proportional to pressure the equilibrium pressure distribution will be inversely proportional to the material's wear rate.

Consider the support of a beam on an elastic foundation - a problem solved by Timoshenko (see page 1, volume 2). Non-uniform support across the headstack will result in two restoring forces. The first is due to the banding of the tape as a beam and the second is due to the compression resulting from a local change in cylindrical radius. The pressure P which results from a deflection y is given by

$$P = yY_m t/R^2$$

where

Y_m = Young's modulus in machine direction

t = tape thickness (16 μm)

and the differential equation which satisfies the bending and compression is

$$\left(\frac{Y_t t^3}{12}\right)\frac{d^4 y}{dx^4} = -\left(\frac{Y_m t}{R^2}\right)y \qquad \text{(Timoshenko Equ. (1))}$$

whose solution is of the form

$$y = e^{-Bx}\left(A\ \cos\ Bx + C\ \sin\ Bx\right) \qquad \text{(Timoshenko Equ. (2))}$$

where

$$B = \left(\frac{Y_m t\,12}{4R^2 Y_t t^3}\right)^{1/4}$$

For the parameters of the headstack and 16 μm tape the characteristic bending (1/B) is 166 μm assuming $Y_m = Y_t$. The profiles along the headstack and across the headstack are shown in the figure.

For a maximum deflection y_m, far from the ferrite, the pressure P_1 is

$$y_m Y_m t/R^2$$

since the bending term has decayed. Also the forces from the pressure perturbations must balance so that

$$bP_1 = a\,P_2.$$

The ratio of total pressures (ambient plus perturbations) on the headstack is given by

$$V = \left(\frac{Po\ -\ P1}{Po\ +\ P2}\right) = \frac{(Po\ -\ P1)}{Po\ +\ (b/a)P1} = \frac{1-(P1/Po)}{1\ +\ (b/a)(P1/Po)}$$

where

Po = average pressure on headstack (~ 7 psi)

b/a = (698-38)/38 = 17.4

We have measured a value of y_m for a fotoceram headstack of 1 μm which implies $V \sim 0.2$ or a wear rate for the fotoceram spacer material ~5 times that of the ferrite.

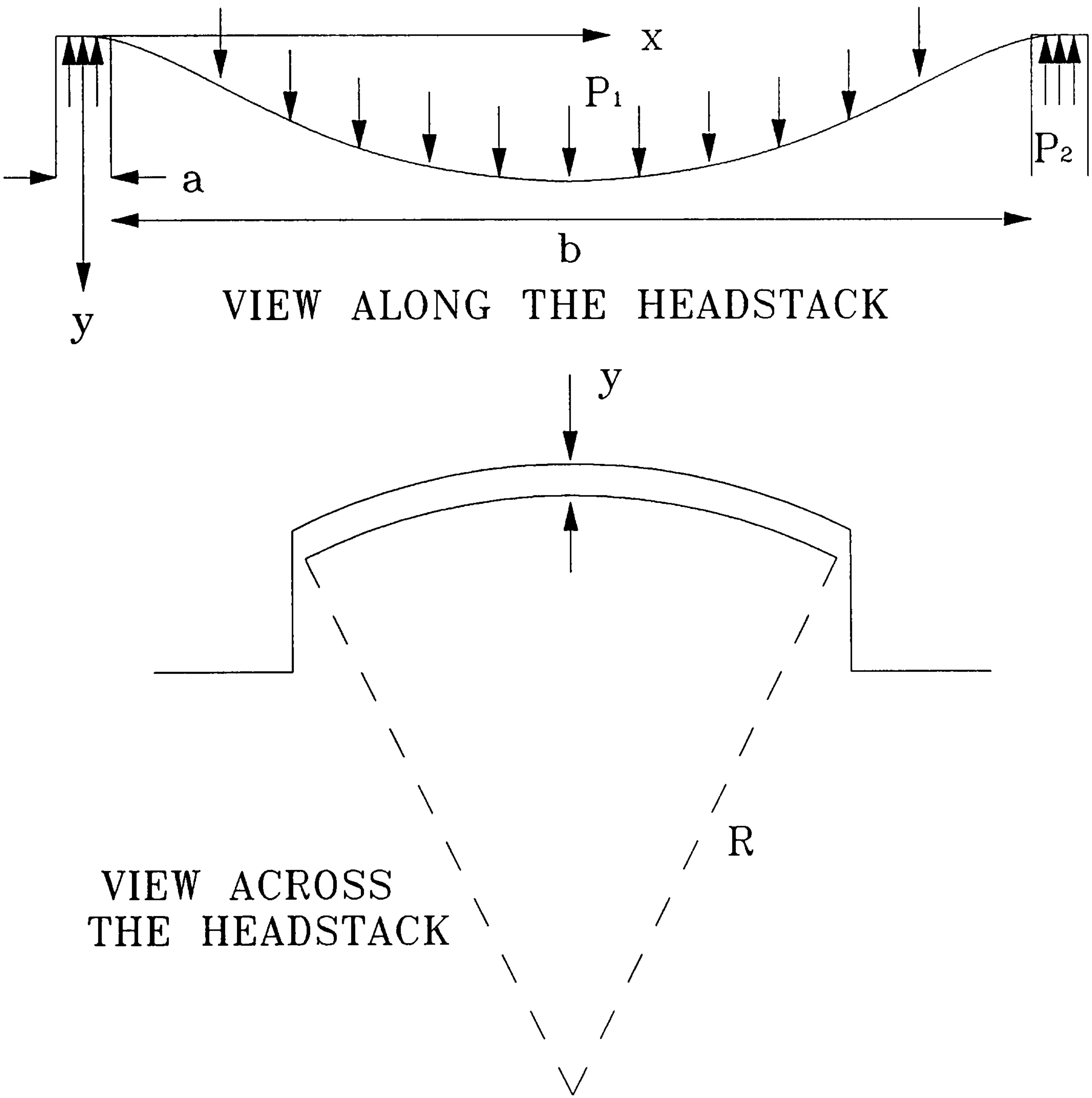

FIG. EFFECTS OF UNEVEN WEAR ON HEAD PROFILE