VLBA ACQUISITION MEMO #322

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To: VLBA Data Acquisition Group

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Subject: The effect of debris on tape packing

In VLBA Acquisition Memo #228 the effect of non-uniformity was studied in a model for pack stability. It was estimated that edge thickening of 6% would lead to instability. In some cases, an edge thickening of 1-2 microns (6-13%) by melting was seen. I now estimate the effective edge thickness increase due to the presence of a small amount of debris on the edge of the tape. Consider the infrequent deposit of a particle of thickness h on the edge of the tape. If the particle is assumed to be incompressible it will force the layer of tape over the particle to traverse an added distance d of

$$d = 2r\,(\tan\theta - \theta) \approx 2r\,\theta^3/3$$

where

r	=	radius of pack
θ	=	angle to tangent (see Figure 1)

since from the geometry

$$\theta = (2h/r)^{1/2}$$

we get

$$d = \frac{2^{5/2}}{3}\,h^{3/2}\,r^{-1/2}$$

If the particles are separated by a distance L the added distance for one turn is $(d2\pi\,r/L)$ for the case when $L > r\theta$ and $2\pi h$ when $L \le r\theta$. The equivalent fractional thickening of a tape with thickness t is

$$\begin{aligned}\mu &= \textit{added distance}/(2\pi t)\\ &= \left(\frac{2^{5/2}}{3}\right) h^{3/2}\,r^{1/2}\,L^{-1}\,t^{-1} \quad \textit{for } L > r\theta\\ &= h/t \quad \textit{for } L \le r\theta\end{aligned}$$

thus scattered debris of thickness h acts like a solid layer when distributed with mean separation of

$$L \leq (2hr)^{1/2} \leq 600\ \mu m\ (for\ h = 1\,\mu m,\ r = 7")$$

Evaluating μ for
more sparsely distributed debris

$$\mu \sim 6\%$$

when

$h = 5\ \mu m$
$r = 7"$
$L = 1\ cm$
$t = 16\ \mu m$

These estimates emphasize the importance of maintaining tape edges free of debris.

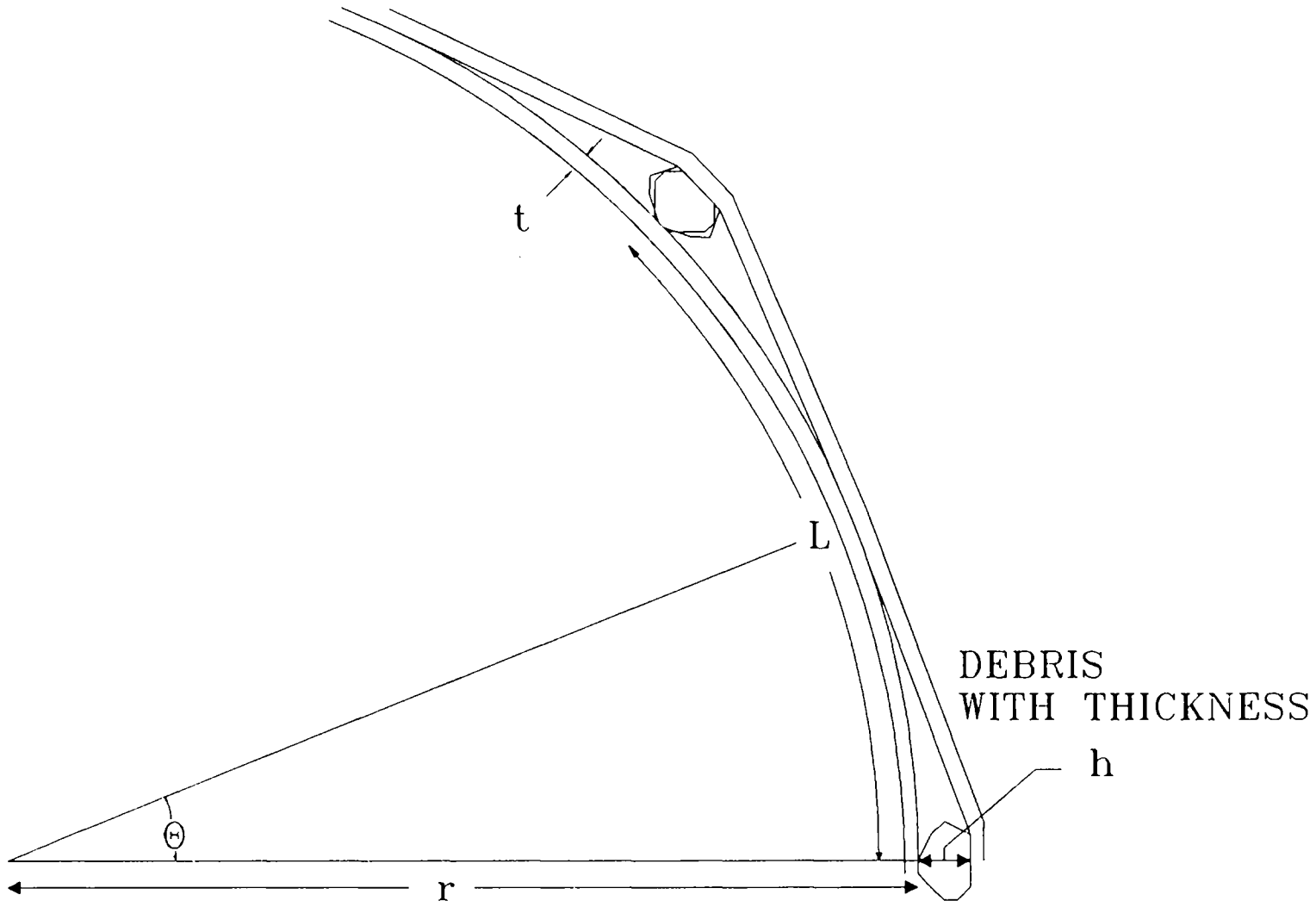

Figure 1. Debris between layers of tape