VLBA ACQUISITION MEMO #293

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Subject: The effect of the reel hub on tape pack

1] Interlayer pressure - sealing with reel size

The reel pack is complicated. As turns are wound on a rigid hub, the interlayer pressure builds until it is compensated by a reduction of tension due to the pressure of the outer layers. Computer solutions (see VLBA Acquisition Memos 129 and 134) show that the tension drops in the middle of the pack and turns can even go into compression. If the reel size, tape thickness, and tension are all reduced by the same factor, the same scaled radial dependence of interlayer pressure will result. In particular, the interlayer pressure at the hub will be the same for a 18,000′ 16 μm tape on our reel wound at 0.45 lbs tension as a 4500′ 4-μm tape wound on a VHS cassette at 0.1 lbs tension. Both reels having approximately the same 3:1 ratio of outer radius to hub radius.

2] Flexible hub

Sony 16-μm tape are received with an elastic band around the hub. We suppose the purpose of this band is to make the hub flexible to prevent the build-up of too great an interlayer pressure at the hub. However, the flexible hub can lead to another problem in large reels. When the assumption of a rigid hub is removed and replaced with a perfectly flexible hub, the inner turns of the pack are forced into compression (along the tape) like the arc of an arch or wall of a dam. For an interlayer pressure, P, the force of compression per unit width, T_c, needed to balance this pressure is given by

$$T_c = P\, R_h$$

P = interlayer pressure at hub (200 psi from rigid hub model of Figure 1)

R_h = hub radius (2.25")

The interlayer pressure at the hub for a full reel of 16-μm tape wound at 0.45 lb, under the conditions given in Figure 1) is about 200 *psi*. If this pressure is exerted on the inner tape layer, the resulting compression force is 450 lbs inducing a strain of over 50%, which is far greater than can be withstood, and the tape will deform and buckle. This has, in fact, been observed on several Sony tapes - see photo. Based on this observation, we conclude the flexible reel band is not desirable. However, we would very much like to find out if Sony knows more about this problem. Applying the tape pack computations to the cases of rigid and flexible hubs the difference between the two cases is clearly illustrated in Figure 1. For a given tape pack condition (winding tension, tape thickness, reel size) a hub with just the right amount of flexibility could be chosen to minimize

the radial compression without putting the tape into tangential compression. The finite difference algorithm used in the computation became singular in the case of a perfectly flexible hub.

3] Large vs small reels

Non-uniformities are the underlying cause of an unstable or "bumpy" pack. In VLBA Acquisition Memo 228, it was shown that thickened edges lead to a bumpy pack. The analysis shows that a more stringent uniformity is required for large reels in rough proportion to reel size (see VLBA Acquisition Memo #228, Equation 13). While the interlayer pressure in cassettes is not that different from our large reel. The problem of crushed turns (excessive compressive forces), and instability from non-uniformities are aggravated by the large reel. However, as industry goes to thinner tape, problems like those we have encountered, may well be experienced.

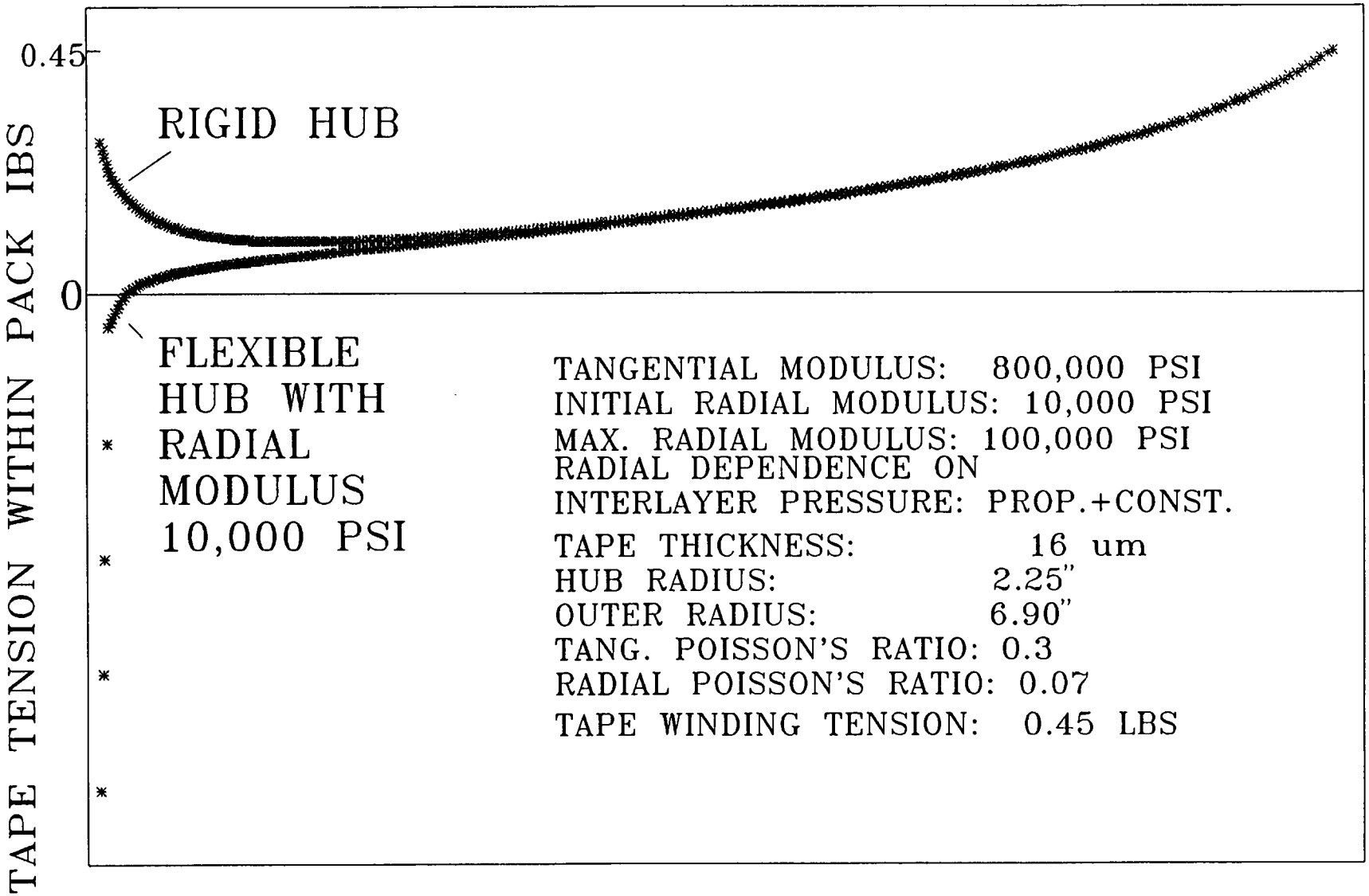
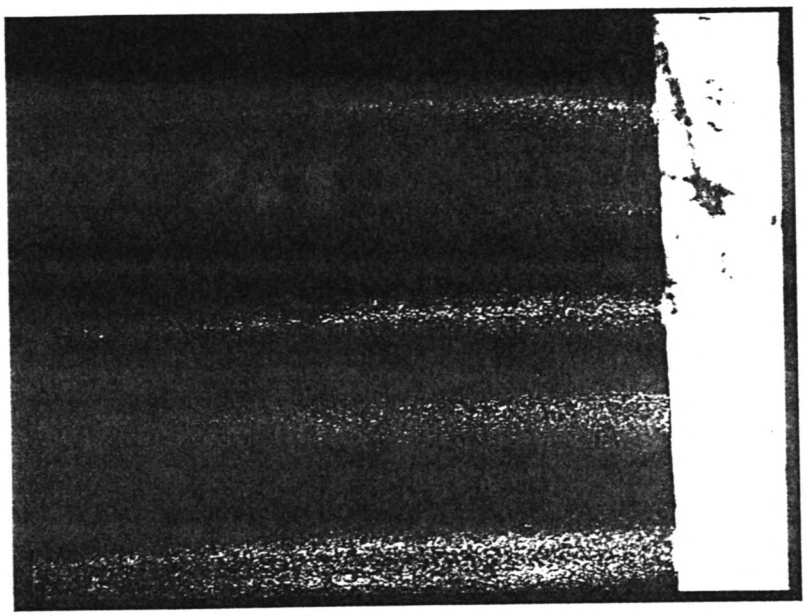
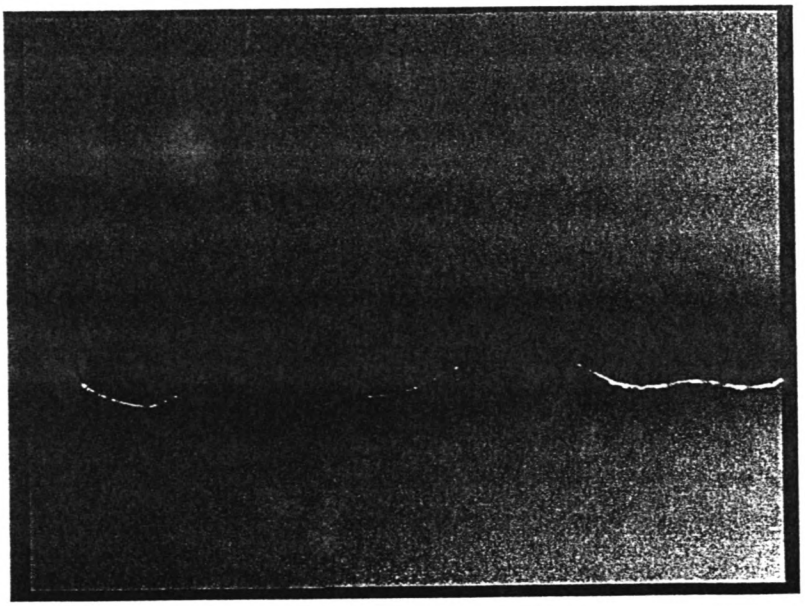


FIG. 1 TAPE PACK CALCULATION WITH RIGID AND FLEXIBLE HUB



Top View x40



Side View x40

Photographs of Sony Dl-K - buckled by pressure at the hub