Contributions To Rod Tip Speed

The speed of the rod tip derives from three major effects: 1) the *translation* of the rod by the caster's hand, 2) the *rotation* of the rod by the caster's hand, and 3) the *rebound* (flexing) of the fly rod. The largest effects are rod rotation and rebound.

Here is a simple way to estimate the relative importance of each of these effects. Assume for simplicity that the caster's hand moves horizontally (no vertical motion) and that the rod is linearly elastic and rebounds in its fundamental mode of (bending) vibration. Moreover, we'll assume that the rod rebounds at the same time the caster's hand reaches its highest rotation speed.[1] Let V_{tip} be the speed of the rod tip, V_{hand} be the (horizontal) speed of the caster's hand, ω be the angular speed of the caster's hand (units are degrees/second), and L be the rod length. Also, let f_n be the natural frequency of the fundamental bending mode (units are Hertz or cycles/second), and let D be the largest lateral tip deflection achieved while loading the rod. Then the speed of the rod tip is approximately

$$V_{tip} = V_{hand} + \omega L(\pi/180) + f_n D(2\pi)$$

This estimate summarizes the effects due to *translation* (first term on right side of equation), *rotation* (second term), and *rebound* (third term). Note that the second term is proportional to the length of the rod, hence the magnifying effect of rod length. Also, the third term depends on the rod stiffness, mass and length (in arriving at the natural frequency) as well as the maximum loading of the fly rod.

Here's a specific example. Consider the cast Bruce made with a 9 foot rod casting 43' of line. The figure below shows the angular speed (ω) of the fly rod during two back casts and one forward cast. The power during the forward cast is applied for about half a second as seen below and the peak angular speed is about 300 degrees/second. Let's assume that Bruce translates his hand about 3 feet (he probably did far less than this for just a 43' cast) over this half second. Let's also assume that the rod tip deflects about 2.5 feet from its undeflected position when it is maximally loaded, and that the rod has a fundamental natural frequency of 3 Hz[2]. Then, an estimate of the translation speed of his hand is $V_{hand} \approx 3/(1/2) = 6\ ft/\sec$. The rotation of his hand contributes $\omega L(2\pi/180) = 300*9(\pi/180) = 47\ ft/\sec$ in rod tip speed. The rebound contributes $f_n D(2\pi) = 3(2.5)(2\pi) = 47\ ft/\sec$.Thus the total rod tip speed of 100 ft/sec (about 30 m/s) is composed of translation (6%), rotation (47%) and rebound (47%).

[1] Our measurements have already shown that rebound occurs after the stop and therefore there would be a time delay between the maximum rotational speed of the casters hand and the maximum speed due to rebound. We're just going to ignore this time delay in the approximations used here.

[2] This is an average value based on the published results that I've read.

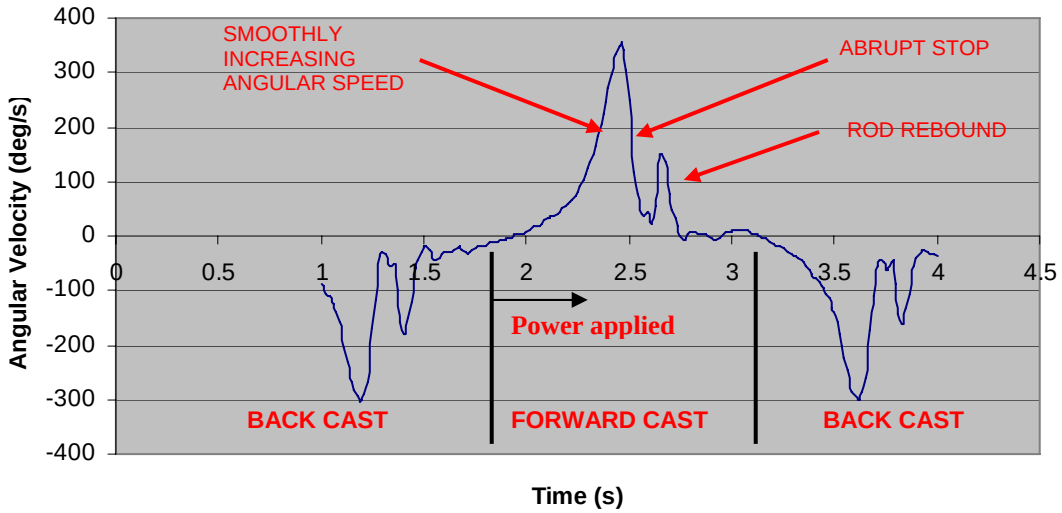

Figure shows the recorded angular speed of the rod measured at the reel seat for a cast of 43 feet using a 9 foot 6 weight. Cast by Bruce Richards.