Summary

Many engineering applications can be described as axially moving continua. These include, among others, conveyor belts, magnetic tapes and drive belts. Transverse vibrations are present in all of these systems and may cause excessive wear or severely damage the entire system in case of resonance. If these vibrations can be predicted accurately, resonance-free systems can be designed.

Equations of motion describing vibrations of static elements such as strings and beams are well understood and the natural frequencies can be predicted easily. When string-like elements have a bending stiffness which is not negligible, the beam model should be used. For higher order modes of vibration, the bending stiffness becomes increasingly important.

Many different models are used to describe axially moving materials. Less complex models simplify the real world applications greatly by neglecting damping and bending stiffness and assuming a constant transport velocity. String models are studied most extensively, yet beam models are required to take bending stiffness into account. A method was developed to combine both the string and beam equations to describe the full range of modes of vibration. Boundary conditions and damping are not studied extensively and are commonly simplified.

The equations of motion describing the vibrations can be solved in different ways, analytically, asymptotically and numerical. While analytical solutions are preferred, due to non-linearities these are often not possible. Different techniques exist to solve the equations asymptotically and numerical.

Experimental studies have proven that mathematical models can accurately describe the dynamic behaviour of belt systems. The effect of non-linearity is seen in these experiments as simplified asymptotical solutions become less accurate at higher transport velocities [1]. An experimental study discovered a second source of transverse perturbation other than eccentricity of the pulley. Misalignment of the sheaves in a V-belt system causes the belt to periodically rise and snap back, resulting in additional vibration and noise [2].

Vibrations are an important design aspect of drive belts. Increasing reliability and decreasing noise are the most important goals of the automotive industry. Because of improper installation or improper use of belt systems, relatively many fail prematurely. Under or overtensioning or contamination are common causes for premature belt failure.

The mathematical models are able to describe transverse and longitudinal vibrations of simple belt systems with reasonable accuracy. Using this theoretical knowledge, resonance-free systems can be designed. Besides resonance, other important issues exist which may cause damage to the mechanism.