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Wave propagation and localisation in stratified rocks with sliding layers

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It is well known that elastic deformation of stratified rock with sliding layers and layered rock masses is strongly anisotropic and in the simplest 2D case is represented by a 2D orthotropic continuum. Somewhat less appreciated that in the process of deformation the layers can bend representing an additional, rotational degree of freedom. It is represented by the average gradient of layer deflection. The rotations make the stress tensor non-symmetrical. On top of that the rotation gradient creates moment stresses, which represent bending moments over the unit area in the layer cross-section.

We model such a stratified rock by an orthotropic Cosserat continuum. (We consider the simplest case 2D). We show the appearance of shear-bending waves. As the resistance to sliding reduces, the waves tend to localise. In the limiting case of fee sliding the waves localise in two directions: normal and parallel to the layers. The strongest is the p-wave. The tendency to the localisation can lead to the concentration of the wave energy in certain direction and initiation of damage and failures. This can serve as a mechanism of failure in stratified rocks.