Benchmark 2 - OLD

Benchmark 2

Various tests on the implementation of gravity in viscoelastic finite element models. All analyses are 2D plane strain and assume uniaxial strain boundary conditions.

Benchmark 2a: Relaxation of deviatoric stresses following application of body forces in a viscoelastic block. Lateral and vertical density homogeneity is assumed (? = $?_1$).

Benchmark 2b: Relaxation of deviatoric stresses following application of body forces in a viscoelastic block. Lateral variations in density are included with a region of lower density located in the upper, +x-direction quadrant of the model (see Figure 1; low density material in x > 12 km, d z > -8 km). The block has uniform viscosity.

Benchmark 2c: Relaxation of deviatoric stresses following application and removal of a surface load in a block containing an elastic layer overlying a viscoelastic layer (see Figure 1). Lateral and vertical density homogeneity assumed (? = $?_1$).

GOALS

- All benchmarks: Test the implementation of gravity and confirm an approach toward an isostatic response.
- All benchmarks: Test the effects of different meshes, e.g., optimizing the mesh based on expected strain energy distributions, the effect of free form meshes, etc.
- Benchmark 2c: Test the viscoelastic gravitational response to surface loads during both loading and unloading.

DETAILED DESCRIPTION

- Model size: 24 km by 24 km (0 km ? x ? 24 km; -24 km ? z ? 0 km)
- Top layer: -12 km ? z ? 0 km; Bottom layer: -24 ? z ? -12 km
- (Note: Top and bottom layers only necessary in benchmarks 2b and 2c)
- Elastic material properties: Poisson solid, G = 30 GPa
- Maxwell viscoelastic material properties: Top layer (if elastic): ? = 10^{25} Pa-s
- Rest of model: ? = 10^{18} Pa-s
- Power-law material properties: $?_{ref}$ = 10^{18} Pa-s and $?_{ref}$ = 10^{8} Pa. (Note: This value is chosen because the maximum initial elastic stress is of order 10^{9} Pa, only a fraction of that is deviatoric, and the deviatoric stress decreases with time.)
- Density and Gravity: $?_1$ = 3000 kg/m^3; $?_2$ = 2700 kg/m^3; g = 10 m/s^2
- Boundary conditions: Bottom pinned
- Sides pinned in x and y; free in z
- Top free (except 2c)
- Coarse mesh node spacing: dx = dz = 2 km

- Surface loading (Benchmark 2c only): Sinusoidal surface load defined by TBD.

REQUESTED OUTPUT AND RESULTS

Mesh Variations: As memory, time, and patience allow, run models at 1/2, 1/4, and 1/8, etc. the original coarse mesh spacing, investigate variable mesh spacing, and/or employ a variety of element types.

For All Benchmark Variations:

- Stresses along a path through (0,0,-24) and (24,24,0) at t = 0, 1, 5, and 10 years.
- Displacements along a path through (0,0,-24) and (24,24,0) at t = 0, 1, 5, and 10 years.
- CPU time, wallclock time, memory usage info, compiler info, and platform info

TRUTH

Analytical solutions for each benchmark will be posted at geoweb.mit.edu/fe

ADDITIONAL NOTES

None.