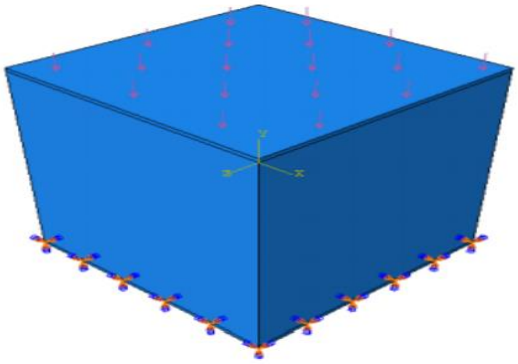
Verification

1. Quantities
   Displacements and stresses will be checked with a simplified verification. That is results of FEM algorithm such as displacement and stresses will be compared with analytical solution of displacements and stresses
2. Method
   a. Compression



<Figure 1. Compression at cubic>

First, maximum displacement will be checked with following equation:

$$\delta = \frac{pL}{EA}$$

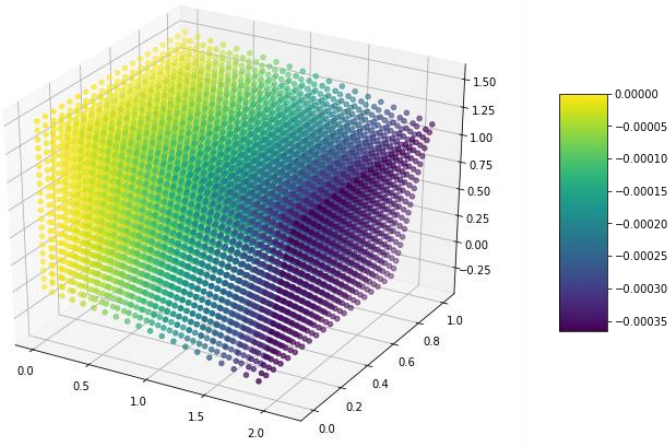
$$where, \delta: displacement, E: Young's\ modulus, A: Area,$$
$$p: pressure, L: length\ of\ material$$

Second, maximum stress will be compared with following equation:

$$\sigma = \frac{p}{A}$$

$$where, \sigma: Stress$$

   b. Bending



<Figure 2. Bending at 3D beam>

First, maximum displacement will be checked with following equation:

$$\delta = \frac{pL^3}{3EI} \; or \; \delta = \frac{wL^2}{8EI}$$

Where, I: moment of inertial around the neutral axis
p: point load, w: distributed load

Second, maximum stress will be checked with following equation:

$$\sigma = \frac{My}{I}$$

$$where, \sigma: Stress$$

Where, M: calculated bending moment, y: vertical distance from neutral axis

Validation

1. Quantities
   FEM algorithm's displacements and stresses will be compared with those of experiment result.
2. Model/method
   Real model is cubic mortar with cement, graded sand and water. Almo is on the way to measure displacement and stress at cubic mortar. And he will share his result. In addition, I will find experimental data at online such as google. Currently, we are struggling to find best material properties such as Young's modulus and Poisson's ratio.

Uncertainty quantification

Material parameters such as Young's modulus and Poisson ratio strongly affect the result of FEM algorithm. I will do simulations about a composite material consisting of cement, graded sand and water. It will be very difficult to find correct effective material properties. Thus, I expect there would be a difference between experimental and computational result. In addition, boundary condition also affects the computed result. For example, I will define no displacements at bottom surface, but very small displacements can be measured in experiment because of various reasons such as lab environment and individual mistakes.

Reference:

Mechanics of materials; James M. Gere, Barry J. Goodno