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New finite element with variable young's modulus

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Image of local tissue stiffness variation in one bone area is available through Computer Tomography. There is the relation between Young's modulus and radiographic density (expressed in Hounsfield's units) using an intermediate relation of mineral density ρ and radiological HU. Creating FEM bone model we assign one finite element to one pixel on the tomographic image. In FEM models created with this relation occur major stress concentrations areas that have no reflection in reality. Stress concentrations are caused by notches that create between elements with different Young's Modulus (in fact bone's density changes smoothly, in digital CT image changes stepwise). We can prevent it by making CT scans with better resolution but it entails higher radiation dose for the patient and provide no additional medical information. Our propose is to modify FEM calculations by adding to them formula describing various material properties so we get a better model with even less image resolution. This method gives very good results both in plane and solid elements.

From the left, we can see high resolution (61x61 mesh) calculations results of the sample (varying properties in its volume) loaded by compressive force acting on its upper edge and supported on the opposite edge. The middle figure is FEM calculations without any changes (3x3 mesh) while on the right figure there are results of calculations with proposed changes made with the same low mesh. In a speech, we will present the results of similar calculations for solid FEM models i.e. those that have not only study but also medical use.

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