Energy balance in a particle system

Arno Mayrhofer, Alice Hager and Christoph Kloss

DCS Computing GmbH, Linz, Austria

When simulating particle systems, a quantity often of interest is the energy inside the system or, more precisely, the energy balance. This balance can give insight into the physical processes inside the bulk. Additionally, quantities, such as the dissipated energy, can be used as model input, e.g. in a heat conduction model.

In this presentation, the theoretical basis behind energies in a particulate system are discussed. The different energy components in a typical discrete element model (DEM) are analysed and explicit formulae are given for Euler and Verlet time integration schemes. Besides investigating particle – particle systems, a part of the presentation will be dedicated to the interaction between particles and walls. Several DEM models, including a bond and a lubrication model, will be analysed together with the respective damping terms.

In order to verify the proposed equations, several small test cases are presented which allow the investigation of different energy components. It will be shown that the energies in these systems are analytically conserved. Finally, two cases are used to show the relevancy of the presented developments. The first demonstrates the impact of a spherical object (e.g. a stone) onto the sea bed. The second one will demonstrate the energy balance during grab dredging in the sea bed with different tool geometries. This will allow the study of the energies required for the removal of sediment in this common form of sea bed management.

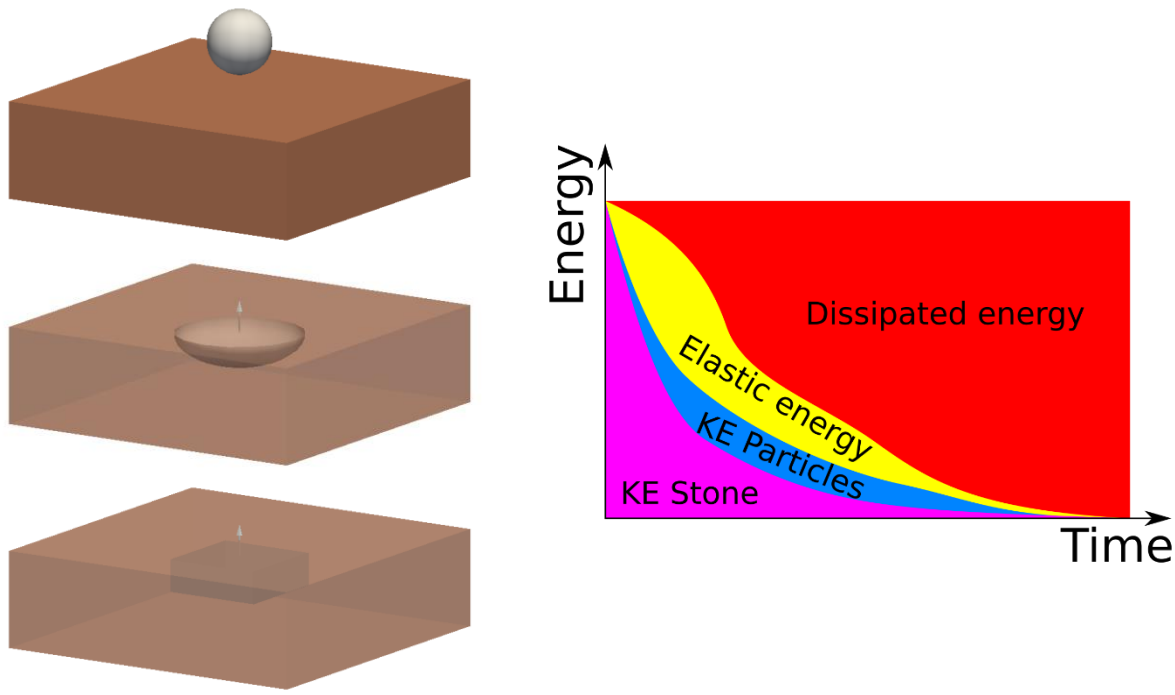

Figure 1: a) Setup of stone impact on sea bed; Setup of grab dredging with spherical (b) and cubic (c) tool; d) Schematics of the cumulative energies during the stone impact.