GID INTERFACE FOR DISCRETE ELEMENT SIMULATIONS - DEFPACK

O. Fruitos, R. Isanta, C. Labra, A. Maymó and R. Méndez

CIMNE - International Center for Numerical Methods in Engineering
Parque Tecnológico del Mediterráneo, Edificio C3 - Av. del Canal Olímpic, s/n
E-08860 Castelldefels (Barcelona, Spain)

e-mail: metalform@cimne.upc.edu, web page: http://www.cimne.com/

Key words: Discrete Element Method, Finite Element Method, Numerical analysis, GiD Graphical interface, Silo, TCL-TK.

1 INTRODUCTION

A specific graphical GiD interface which is adapted to combine the discrete element method (DEM) with the Finite Element Method (FEM) is presented. DEM problems have been specifically developed for granular material simulation [i]. Many problems can be studied in this field: silos, mills [ii], rock cutting [iii], fracture, etc. However, this paper will only focus in the silo specific interface and will also give a general overview of the different possibilities offered by this technology.

An oriented interface has been developed specifically for silo problems in 2D and 3D. Using this interface the end-user is able to simulate a complete silo problem. Amongst others, the user can define as many materials as needed, assign movement to the silo using point-to-point defined curves or analytic curves such as sinusoidal, define cohesion in the materials or define contact interactions between the material and other surfaces.

DEFPack interface lets the user choose a specific problem (silo 2D/3D, mill, rock cutting, amongst others) which has only available the necessary parameters and guides the end-user through a correct simulation. For advanced users there is also possible to use an open interface, where the user may exploit all the possibilities of the DEM-FEM simulation kernel. This option is oriented to the users who want to investigate in new processes which can not be simulated via the simulation guide.

2 OVERVIEW OF THE INTERFACE

DEFPack's new interfase has being programmed in Tool Command Language (Tcl) and Tool Kit (Tk) and it is fully integrated in the GiD environment. To do so, it is provided users with user-friendly windows to set the models for each case. DEFPack's new interfase has a main window with all the options included in the program (Figure 1). There are five wizard interfaces and one open interface (DEMFEM–Advanced user) in development at the moment.

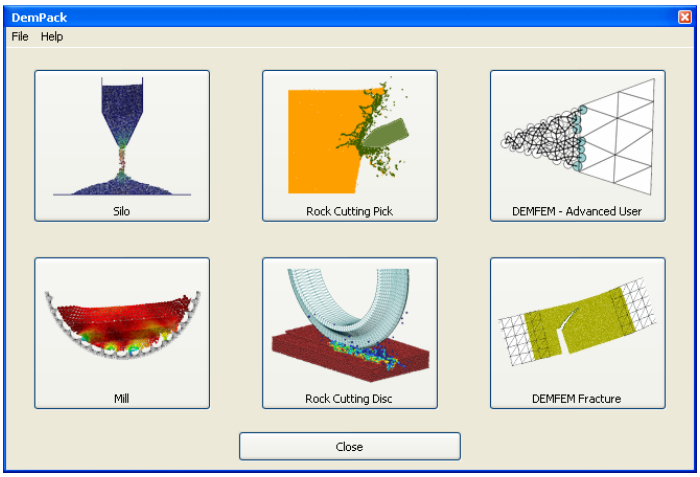

Figure 1: Main window with the interfase options

As regards the silo, once the user pushes the “Silo” button, another window appears. In it, there are the 2D and the 3D options for the silo. In this paper we are going to focus on the silo 2D option. It is designed to be as easy as possible for the users by having the main tools in only one window, by putting the steps in order and by guiding the user through the process with helping tools.

The first step in the silo simulation process is the “Create Geometry” menu. In it, the user can create using its six buttons the wanted geometry and also can view the normals of the lines (GiD performance), which must point at the the DEM material because of the contacts. The second step is to assign every geometry entity to the correct layer. The button opens the GiD layer manager.

The third link in the chain is the assignation of mesh element types. There are two main families, the DEM-type and the FEM-type elements. In this option (silo 2D), only circles, triangles and linear elements are available. Next step is about mesh properties, and some of the parameters could be automatic or also given by the user. The fifth step is where users can assign both DEM and FEM materials with their own features to the geometrical entities (surfaces in this case). A wide material data base has been implemented for every element type. Below the buttons to open each material window, there is a space (it is a treeview tk widget) where the interface shows the current materials assigned in the model and if they are FEM or DEM materials.

The sixth step is where users define the kinematics of the simulation. There are three types of curves which can be inputted in the model: Lineal, sinoidal and by points. Every curve type has its own window. These windows have the specific parameters to create the values of displacement, velocity and accelerations through time. The movement can be assigned to points, lines and surfaces in the silo 2D. There is also the possibility of load a curve from an external file (for example an acceleration vs. time input from an accelerometer). This way of work allows the program to read displacements, velocities and accelerations. Internally, there are a program which can convert the format of these inputs to de desired one.

The seventh link in the chain is the assignation of interactions between DEM materials and the rest of the model components (mainly silo walls and the ground). When the user pushes the “Create Contact” button, a window with the contact parameters appears. Once the contact is assigned, the tree is updated automatically and shows the current contacts of the model. The

eighth step is the “Damping” one. Users choose whether they use the numerical damping or not and its value. Damping should only be assigned to discrete and deformable finite elements. There are two types of damping: Viscous (velocity dependant) and non-viscous.

Next step is the “Problem data” option. In this step (notebook tool) there are three tabs with the minimum basic general parameters. There is a “+” button which lets users control all the problem data parameters used in the 2D silo. The step ten contains another notebook tk widget where one can select the necessary results. There are results available on nodes, on finite elements and on discrete elements. Some are common and others are genuine for each element.

In the “Mesh” option, users can choose all the parameters necessary to mesh [iv] correctly the model discrete elements by pushing the “Mesher options” button and working in the window that appear (it is a new GiD discrete element managing window). Then, users can generate the DEM-FEM mesh and then find out about the model mesh quality. Finally, in the “Calculate” option the user is able to begin the model calculation and see the calculus evolution. This button starts the calculation kernel and opens a window with the calculus evolution.

There are a new toolbar (on the left side of Figure 2) to work in the pre and the post process in all the study cases with some of the options used in the modelling work (especially to work as an advanced user).

3 NEW FEATURES

Nowadays a new user interface window for postprocess is being developed. This interface will be structured in steps as in the preprocess window. The development team is working on the creation of easier and DEM oriented options to load results for each kind of process described above. The user will be able to select the desired results, which is very useful for problems with a lot of information. This option will allow the user to select non-consecutive time steps data as well. This window will also have a special button that will select the most common results for the kind of model analyzed. In the silo model, some interesting results are the displacements and the cohesion forces between the DEM elements amongst others.

Other interesting development in which we are working on is the obtaining of graph results. This option is linked with the option given by GiD environment and adapted to the postprocess window to make the DEM analysis easier for the user.

4 REFERENCES

[i] Rojek, J.; Oñate, E.; Zarate, F. & Miquel, J. Modelling of rock, soil and granular materials using spherical elements. 2nd European Conference on Computational Mechanics ECCM-2001, 2001

[ii] Rojek, J.; Zarate, F.; de Saracibar, C. A.; Gilbourne, C. & Verdot, P. Discrete element modelling and simulation of sand mould manufacture for the lost foam process. Int. J. Numer. Meth. Engng., 2005, 62, 1421-1441

[iii] Labra, C.; Rojek, J.; Oñate, E. & Zarate, F. Advances in discrete element modelling of underground excavations. Acta Geotechnica, 2008, 3,317-322

[iv] Labra, C. & Oñate, E. High-density sphere packing for discrete element method simulations. Communications in Numerical Methods in Engineering, 2009, 25, 837 - 849

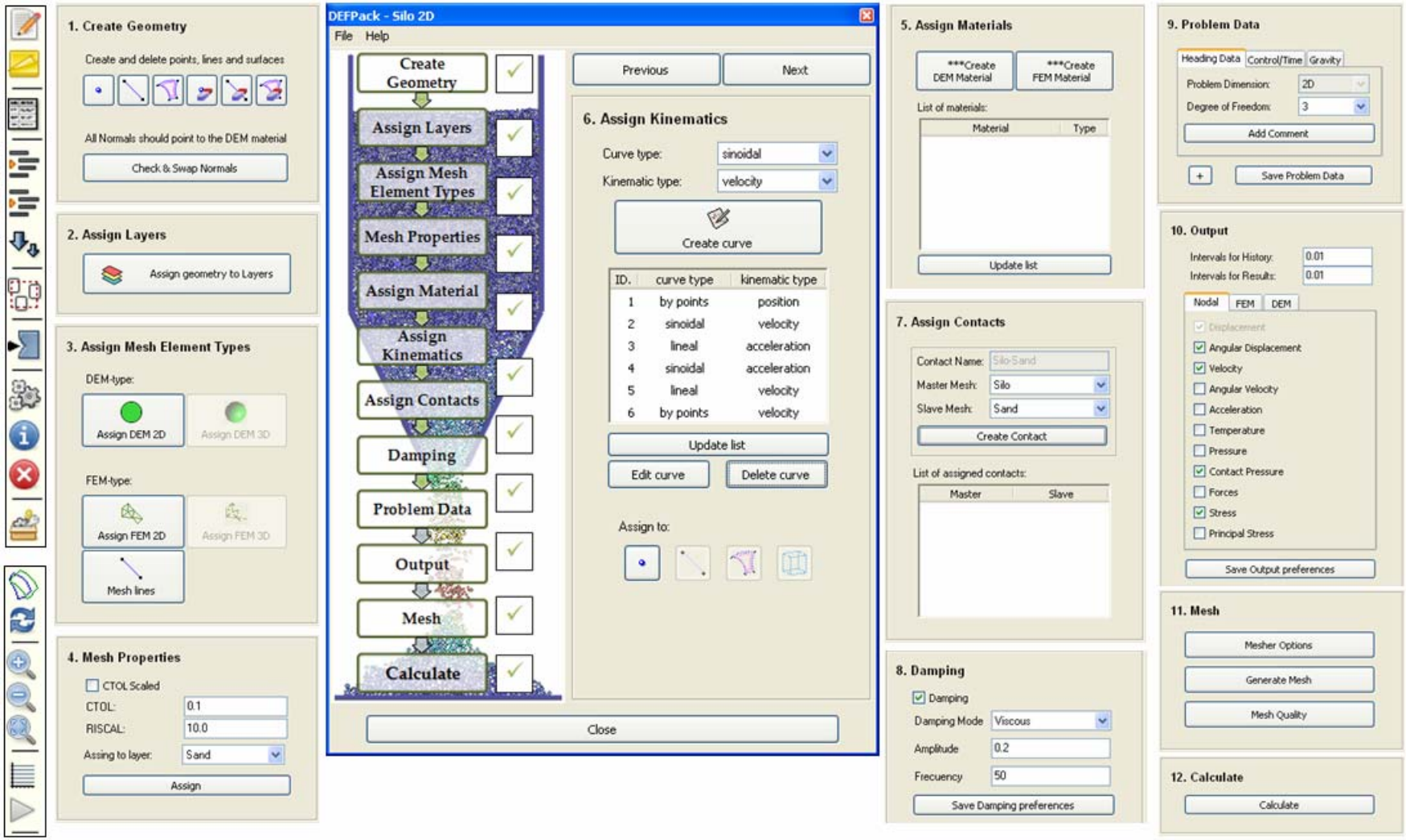

Figure 2: Overview of the silo 2D wizard interface (preprocess and postprocess toolbar and all the menus)