

## Combination of finite and discrete element methods in underground structures simulation

**Author:** Carolina Álvarez Caparrós      **Tutores:** Benjamín Suarez Arroyo; José Manuel González López

The development of this minor thesis is focused on “The Multidimensional City” Project. The aim of this dissertation, in which CIMNE is working nowadays, is based on the idea of transforming our actual cities into more sustainable ones, by leading our current transport system to a new underground system one. In an attempt to pursue this goal, new numerical methods techniques are being developed. One of these new methods, which consist of combining both finite (soil modelling) and discrete (tunnel modelling) elements, is the one we introduce in this dissertation.

According to the newness of this method as a geo-structural modelling application, the aim of this minor thesis is just to introduce the method and apply it to a geo-structural example, in an attempt to find out the pros and cons of the method, so that they can be used as a starting point for new studies.

To begin with, the second chapter of the minor thesis is an introduction to the State of the Art of Combination of discrete element and finite element methods for dynamic analysis of geomechanics problems.

As a result of it, and once the contact model in which the discrete elements modelling is based is introduced, the aim of the third chapter of this dissertation is to verify that SIMPACT’s algorithm (the one that is going to be used in every computational work of this minor thesis) reproduces in a reliable way the expected behaviour of discrete elements, according to what is explained in the chapter above of State of the Art. After modelling four spheres to which all the different states of stress are applied, it is concluded that the algorithm reproduces in a reliable way the behaviour expected on the State of the Art.

The next step on the thesis consists on modelling different samples of soil and submits them to an uniaxial compression test. Some microscopical parameters are required to proceed with the computational procedure. As this micro parameters cannot be drawn from geotechnical studies or tests, a relationship between macroscopical and microscopical parameters is needed. In the absence of reliable information about this field, tests were need to be done in order to achieve reliable relationships between the needed parameters. Once these relationships were established, some inverse analysis were done in order both to show the parameters’ estimation method and to confirm that the recovering of macro parameters was working properly.

Once being verified that the parameters’ estimation process was working properly, it is proceed to apply the new methodology to a complete geomechanical problem. This problem consists on modelling the behaviour of a geo-structural tandem of tunnel and soil located on La sierra de Pajares, between Folledo and Viadongos. For this simulation, the all length of the tunnel is reduced to two unique tunnel sections, considered especially unfavourable due to the load they have to carry with, and the strength of the material along the tunnel is built itself. After applying different hypotheses and boundary conditions in order to simulate a tunnel boring machine process, it is concluded that: although this new method provides results in the range of what it was expected, it is needed to contrast the results with real cases. Moreover, leaving apart the reliability of the method, it will be necessary in future studies to pay special attention to hypotheses related to simulate the building process in order to achieve more reliable results.

