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Model set-up for Abaqus/Standard - /Explicit Co-Simulation with ANSA

Many CAE models represent complex systems comprised of numerous different sub models. These sub models could be subjected to different load types, i.e. long duration or short duration, which would be better treated using a different type of discretization techniques and solution algorithms [1]. This problem can be addressed by Co-simulation which is the coupling of different simulation systems that exchange data during the integration time [2]. ANSA v14.x makes it possible to prepare a model for such a Co-simulation analysis.

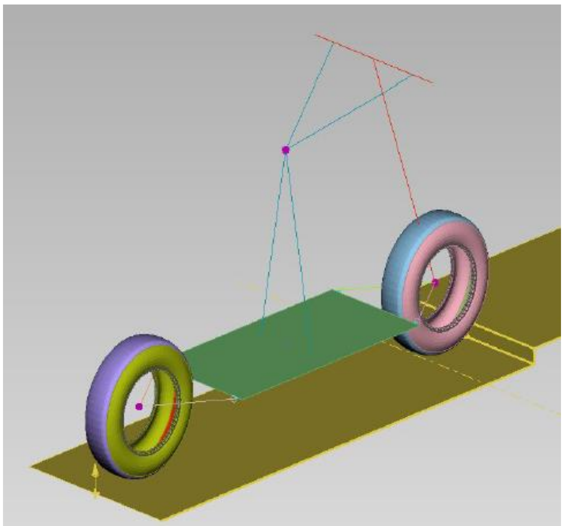
The ABAQUS Standard and ABAQUS/explicit coupling case.

As an example, the case of ABAQUS Standard and ABAQUS/Explicit coupling is presented using a scooter and rider model. Then the steps for the preparation of this model in ANSA are illustrated. These steps are the following:

- Definition of the areas of interest
- Definition of the Co-Simulation analysis
- Output for the Co-Simulation analysis

The Scooter and Rider model

The case consists of an assembly modeling a scooter with the rider. The body of the scooter is modeled by a plate (consisted of SHELL elements), and serves as a mounting base for the front and rear forks which are modeled by connector elements. The handle is modeled by beams, while the rider by a point mass mounted on the scooter using a coupling constraint. This model assembly is shown below.

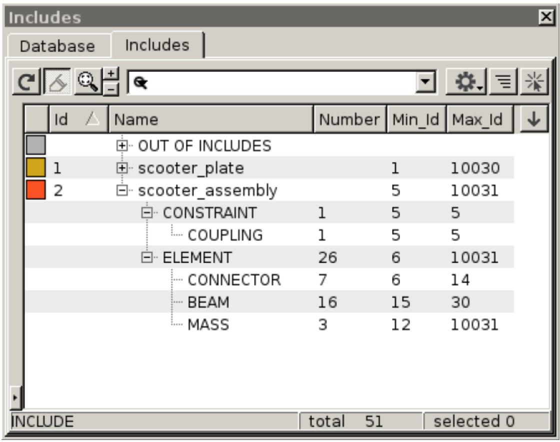


1: Scooter and rider model

Although this model is simplified, it is ideal for the illustration of the basic features and advantages of performing a Co-simulation analysis due to the difference in the loads that different areas are subjected to. For example, the front tire crashes on the bump and is subjected to dynamic loading, while the scooter plate, the handle, and the rider, are subjected to slower mode dynamics. The front tire would be better treated by an explicit solver while the other sub models by an implicit.

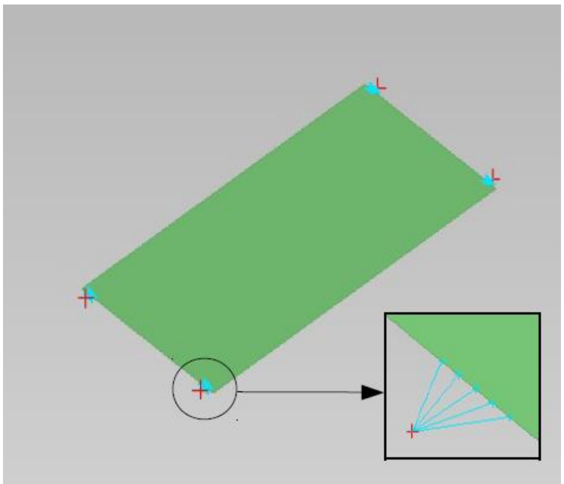
Definition of the areas of interest

Using ANSA Includes Manager the model can be separated into the areas which are subjected to different load types.

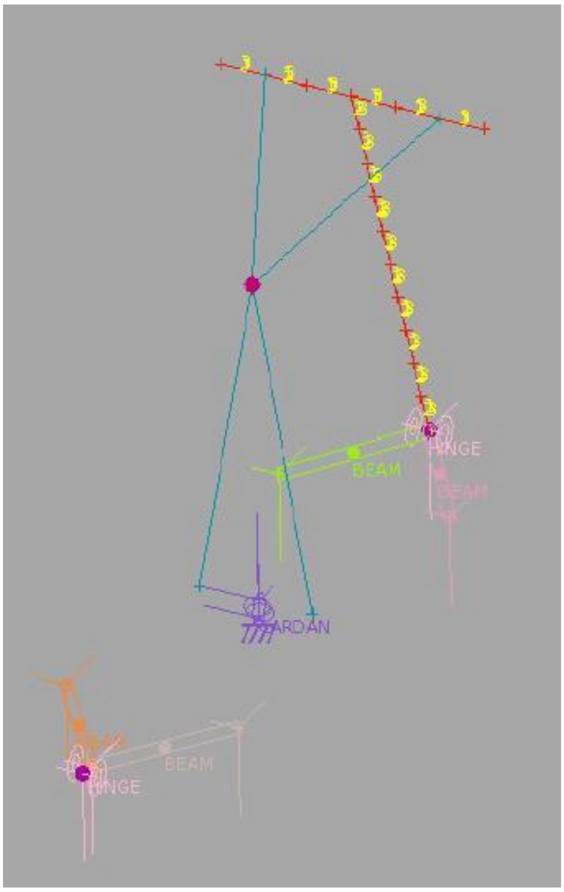


2: ANSA Includes manager

These areas will be later selected to be treated by a different simulation system. In this case, the selection will be made between ABAQUS Standard and ABAQUS explicit suits.



3: Scooter plate include

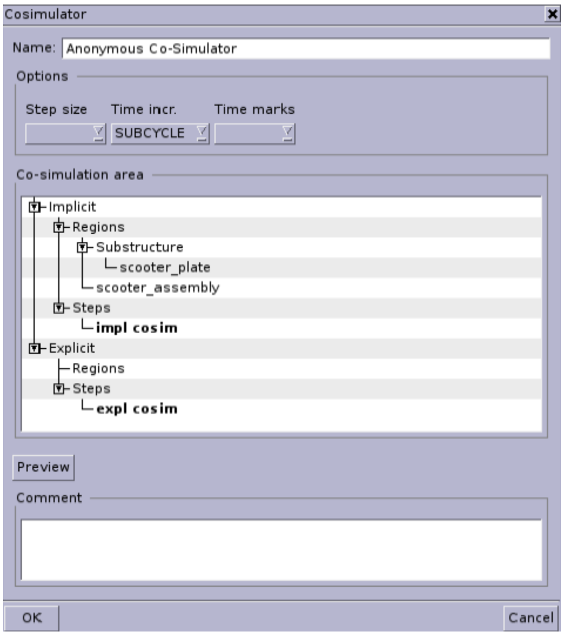


4: Scooter assembly include

It is not needed to add any boundary conditions or loads to the includes. These entities are appropriately handled by ANSA for the creation of a valid model.

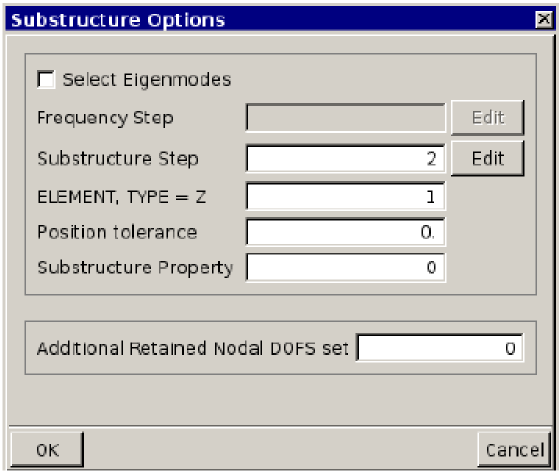
Defining of the Co-simulation analysis

In order to define the Co-simulation analysis, the ANSA Cosimulator is used.

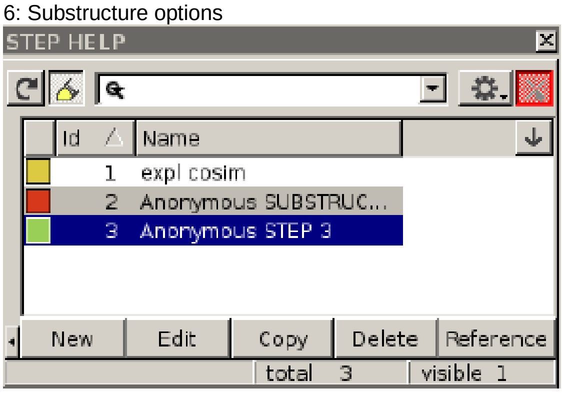


5: ANSA Cosimulator

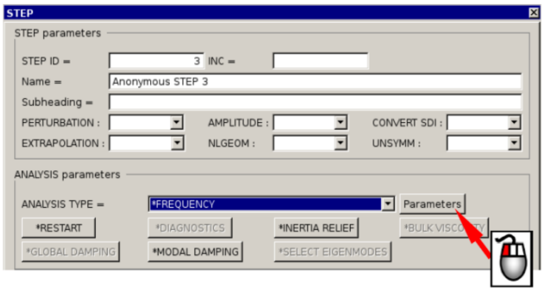
Using the Cosimulator, the engineer can define which areas will be treated by which solver. Additionally, using the Substructure Options manager, other parameters such as the frequency step, the substructure step, the element type and the position tolerance can be defined.



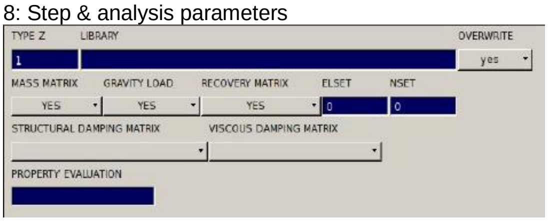
6: Substructure options



7: Step Help manager



8: Step & analysis parameters



9: substructure step parameters

Output for the Co-simulation analysis

Once the Cosimulator has been set up, the Co-Simulation analysis can be exported. The output process creates the necessary files for the Co-simulation, and any additional file that is needed for the substructure generation that is defined in the Cosimulator.

Benefits from using the Co-Simulation process

Co-simulation allows for the coupling of different simulation systems for different substructures of a model. It offers a number of advantages such as:

- It allows combining heterogeneous solvers (using discretization techniques and solution algorithms that are best suited for a model subsystem) [2].
- It facilitates collaborative model design and development process, i.e. models developed by different design teams or subcontractors [2]
- It can be proven to be less time consuming when different load and model cases require different amount of time for the solution between two different solvers [3].

ANSA v14.x offers the unique capability to prepare such a model in a fast and comprehensive way, aligned with the concept of Co-simulation for accurate and fast results even in complicated models.

References

[1] F. J. Harewood and P. E. McHugh, "Comparison of the implicit and explicit finite element methods using crystal plasticity," *ScienceDirect,* vol. 39, pp. 481-494, 2007.
[2] M. Trcka, J. L. Hensen and M. Wetter, *Co-simulation of innovative integrated HVAC systems in buildings,* 2010.
[3] SIMULIA, "Full vehicle Durability Usng Abaqus/Standard to Abaqus/Explicit Co-simulation," *Abaqus Technology Brief,* November 2011.

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