

Simplifying the Pre-Simulation Set Up of Airbag Folding in LS-DYNA[®] Using ANSA

Thanassis Fokylidis
BETA CAE Systems S.A.
Stavros Porikis
BETA CAE Systems S.A.

1 Abstract

Crash and Safety simulations of virtual models hold a key role during the design process of a vehicle. Occupant protection analyses combined with laboratory tests ensure that models will offer the necessary safety to passengers. Airbags are one of the many protection systems that ensure this safety. During model set up for occupant safety simulations, significant time is consumed to fold the airbags properly and fit them in the respective cases.

Airbag folding in virtual models follows the exact specifications given for the real airbags. LS-DYNA, as a standard solution in Crash and Safety analysis supports the folding of an airbag. The loadcase set up, for preparing the respective pre-crash simulation, may include the definition of several LS-DYNA keywords. BETA CAE Systems has developed an assistant functionality, in the ANSA pre-processor, which streamlines all the necessary steps to set up properly a LS-DYNA pre-simulation for airbag models.

The current paper introduces this assistant and demonstrates the advantages of the procedure by ensuring a convenient LS-DYNA loadcase set up with the minimum effort.

2 Introduction

As a crucial safety system, the airbag ensures the protection of the driver and the passengers. As every safety system, there are certain protocols that should be followed in to guarantee its proper functionality. This increases the complexity of the system and therefore many labour-hours are required to complete its development. A part of the development process is the folding of the airbag and position it in the dedicated case. This procedure is of great importance considering that it has an impact in its deployment and its total efficiency during an accident.

CAE is definitely an integral part of the development of each system in modern industry. Simulation of airbags could not be an exception. Especially, the simulation of the airbag folding is a demanding and time consuming task. BETA CAE Systems introduces a new user-friendly plug-in tool, developed according to the needs of the industry in order to help the CAE engineers set-up an LS-DYNA simulation model for the folding of the airbag. The Airbag Folding tool combines the capabilities of the powerful pre-processor ANSA and the trust-worthy capabilities of the widely used in automotive industry LS-DYNA solver.

3 Folding Method

When it comes to CAE, there are two possible ways to perform the folding of the airbag. The first is the geometrical folding only by using the pre-processor. The second is the simulation of the folding process with the aid of a solver such as the LS-DYNA.

Geometrical folding is faster since only one software is needed. However, as more complex methods are required to provide us with more accurate results. Although simulation folding with the aid of the solver gives better results, the user has to deal with the loadcase setup of the folding process.

Based on that, ANSA offers a tool that makes the loadcase setup easier and simultaneously, LS-DYNA solver supports with the appropriate keywords the folding procedure. Therefore, the methodology in this paper offers the capability for an easy loadcase set-up of an airbag folding pre-crash simulation within LS-DYNA.

4 ANSA Airbag Folding Assistant

The tool enables the user to perform the loadcase setup by creating the appropriate LS-DYNA entities. The steps to be followed are adjusted to the folding type which has to be selected initially. Three folding types are available: the **Generic**, the **BPGF** and the **Tuck**.

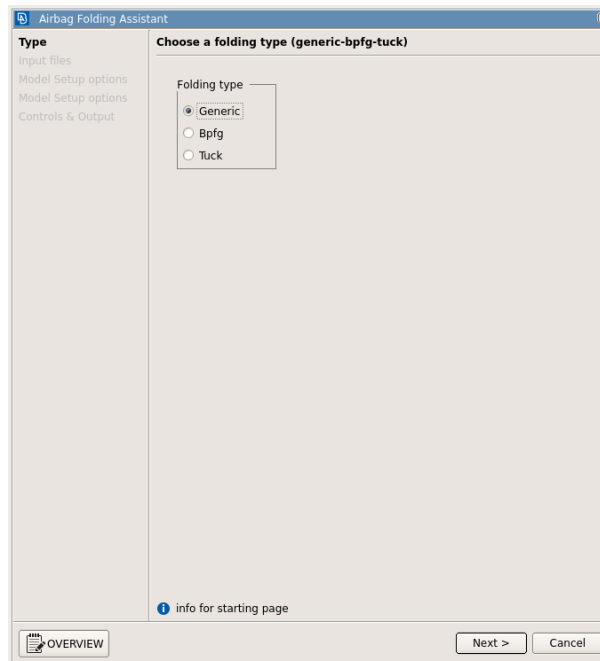


Fig. 1: Selection of folding type

4.1 Generic folding type

The **Generic** type contains all the necessary steps to create the entities needed to perform the folding with the aid of folding tools. A characteristic example of this type is the folding with rolling tools.

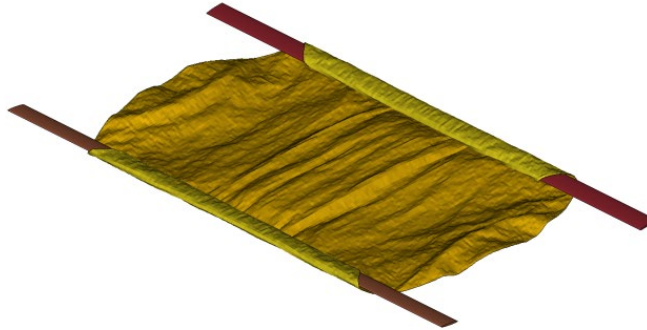


Fig. 2: Example of generic folding with tools

In the first step, the tool prompts the user to input the LS-DYNA files that contain the airbag and the folding tools. This step is common for all folding types.

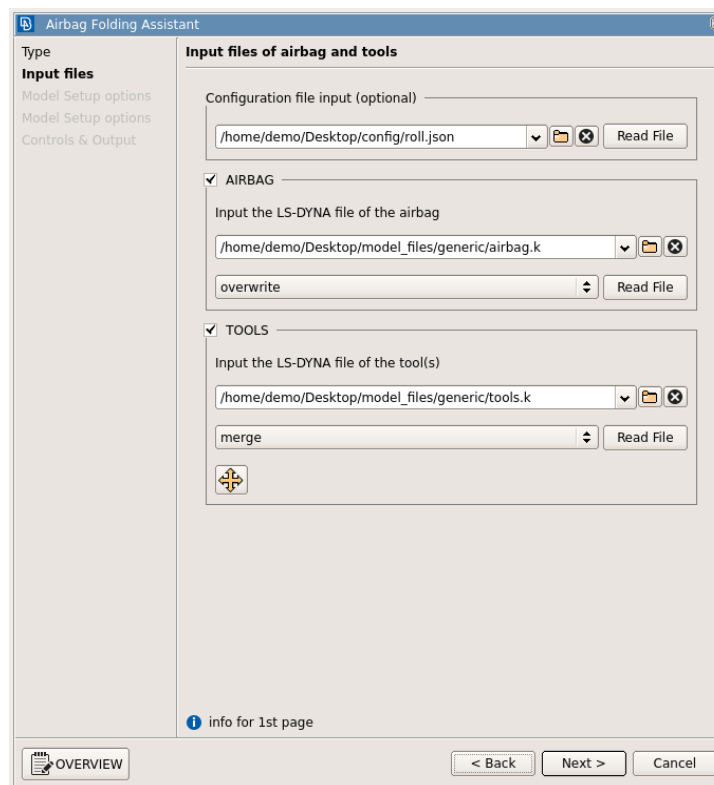


Fig. 3: Input of Files

Then, the loadcase setup is performed. Through the next steps of the wizard the user is guided to create only the entities required to perform the airbag folding. The minimum input is required and with the press of “Create” button, entities are created in the background. These are *CONSTRAINED_EXTRA_NODES for constraining the tools onto the airbag, *DAMPING_PART_MASS for the definition of the mass weighted damping and *BOUNDARY_PRESCRIBED_MOTION for the movement of the tools. Finally, *CONTACT are created, one between the tools and the airbag and one (self-contact) for the airbag properties. The *DEFINE_CURVEs that will be used by each entity can be automatically created by giving only the dimensions of the tool.

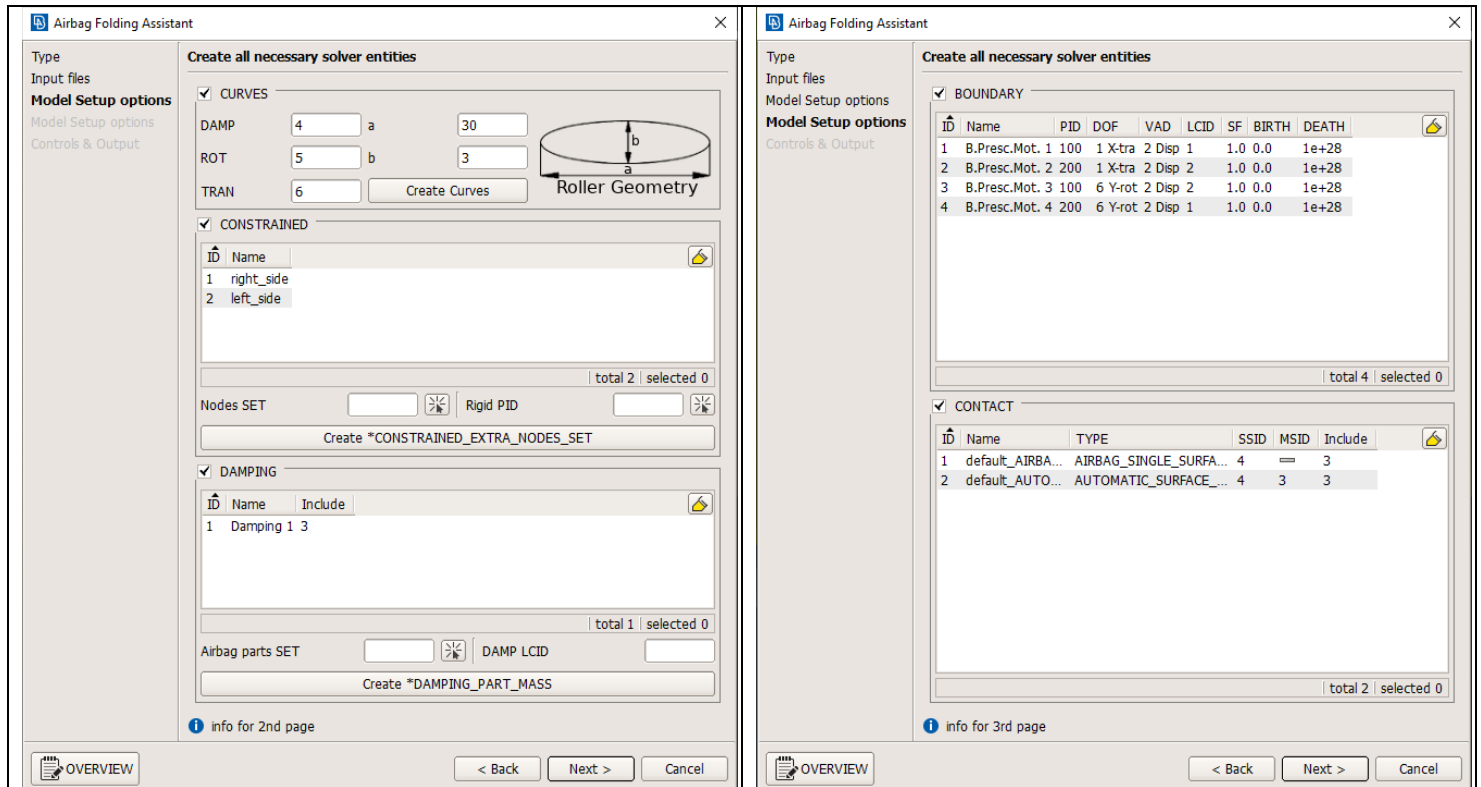


Fig. 4: Generic Type Model Setup

4.2 BPFPG Folding Type

The **BPFPG** type contains all the steps in order to create the entities needed to fit the airbag in its case.

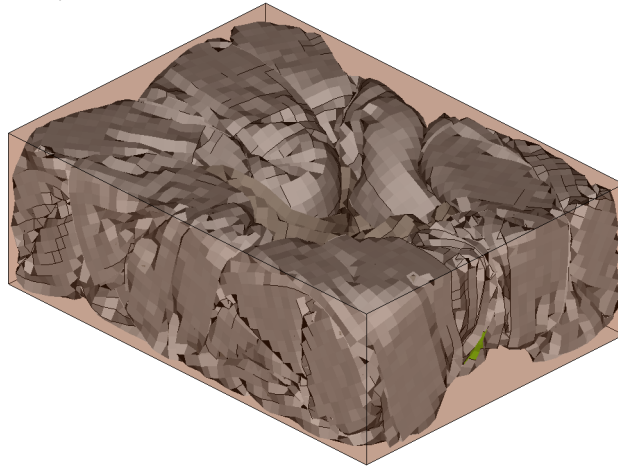


Fig. 5: Example of BPFPG folding

Likewise, the Generic folding type, the input of the files is done in the first step and the loadcase setup is following. For this folding type ***BOUNDARY_PRESCRIBED_FINAL_GEOMETRY**, ***DAMPING** and ***CONTACT** keywords are created.

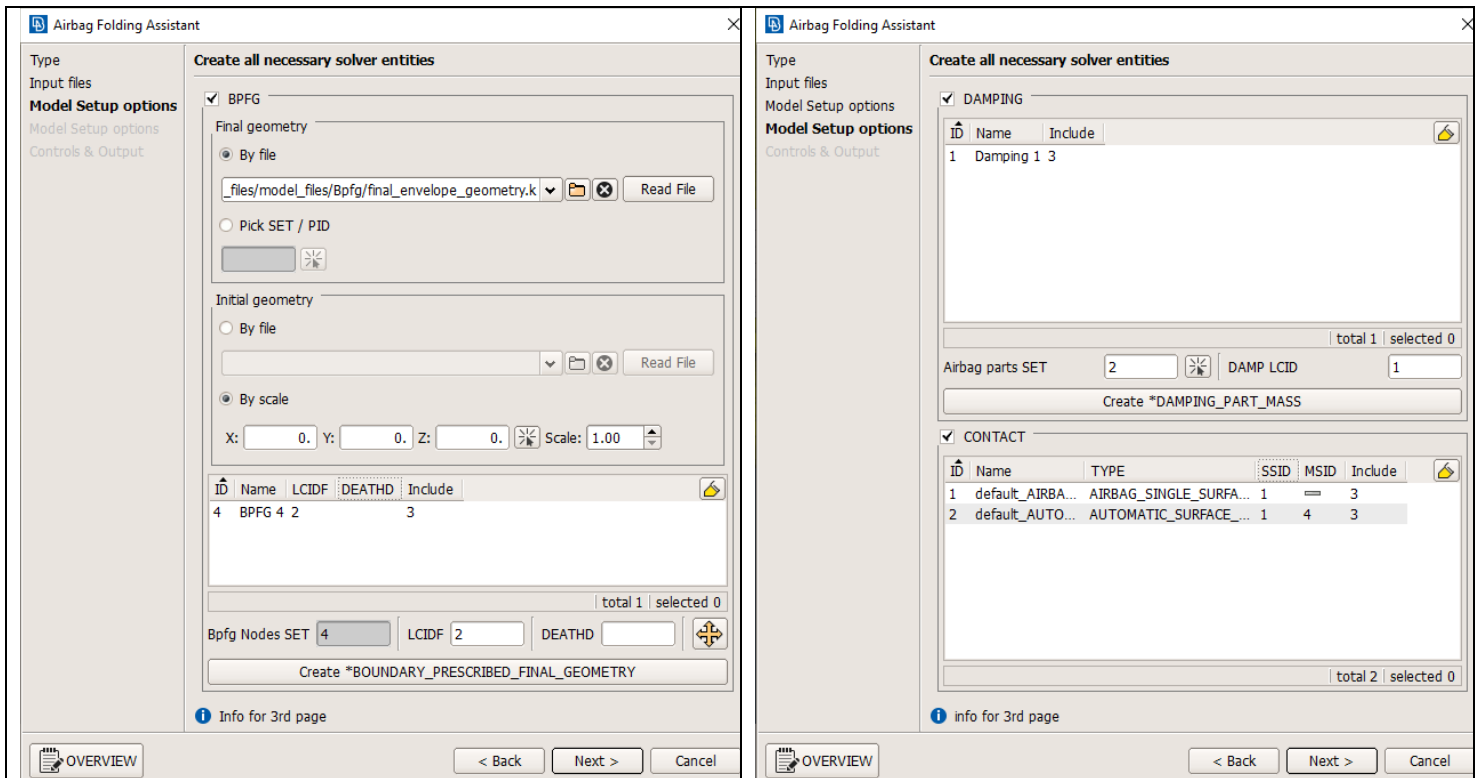


Fig. 6: BPFPG Type Model Setup

4.3 Tuck Folding Type

The **Tuck** folding type contains all the steps for preparing the tucking of airbag areas in LS-DYNA.

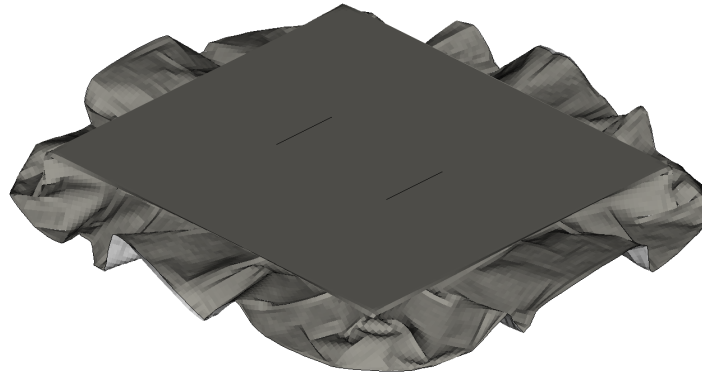


Fig. 7: Example of Tuck folding

As in the previous folding types, the input of the files is done and then the loadcase setup is following. For this folding type the ***DAMPING**, ***BOUNDARY_SPC**, ***LOAD**, ***CONTACT** and ***RIGIDWALL** entities are created.

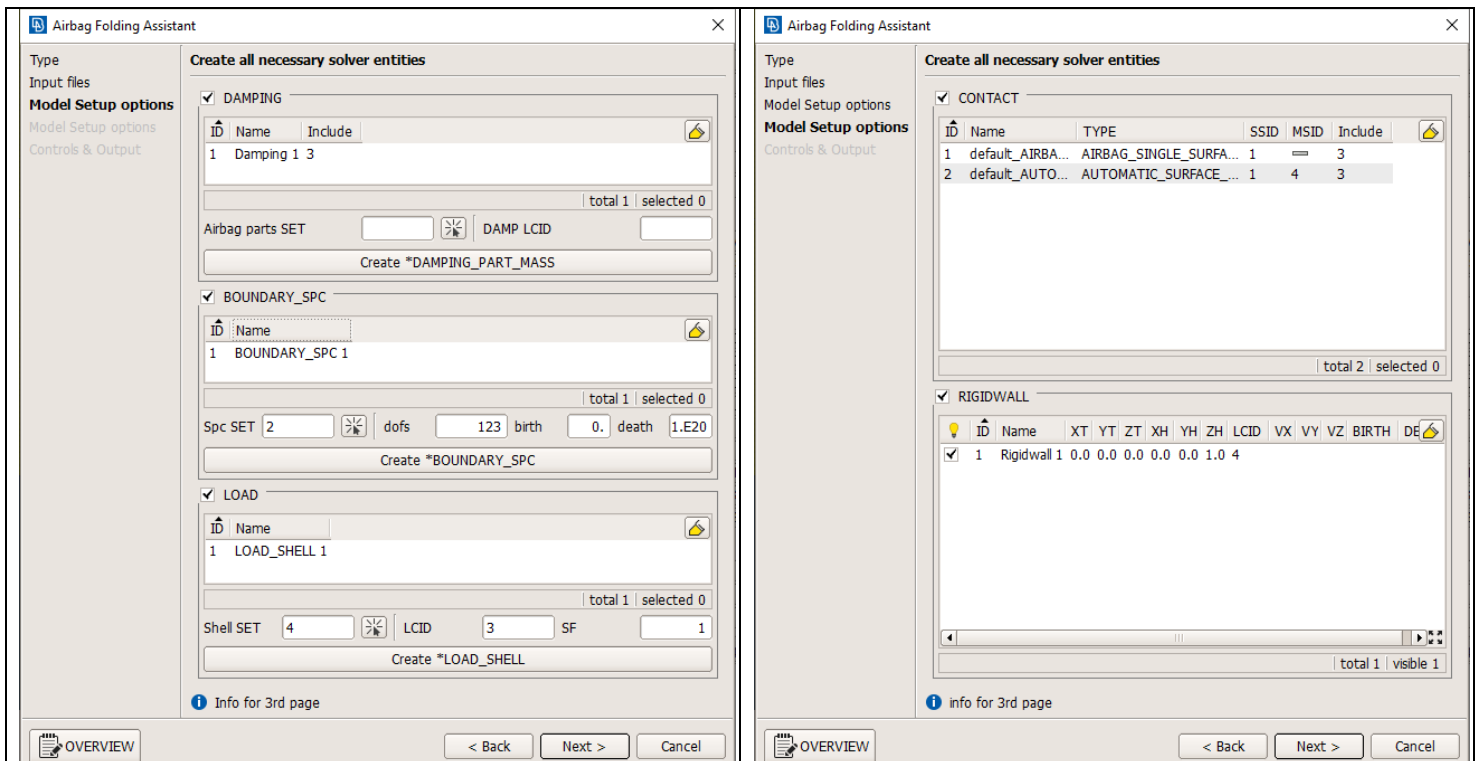


Fig. 7: Tuck Type Model Setup

4.4 LS-DYNA Output Files

After the loadcase setup is completed, the selection of the CONTROLS card and the output of the LS-DYNA file is the last required action. This step is common for all the folding types described above.

In this step, the user defines the CONTROL card that will be used in the solution. One can either use an existing one in the working model or input a file which contains one. Moreover, the wizard offers access to the selected CONTROL card but also the START and TERMINATION time can be modified directly.

During this process, an Include is automatically created depending on the folding type and every entity created by the wizard is moved inside it. In addition, each of the files that were input in the first step, are moved to separate “read-only” includes.

Based on the existing includes hierarchy, one can output either a file with Includes structure (main file with nested Includes) or a single monolithic file.

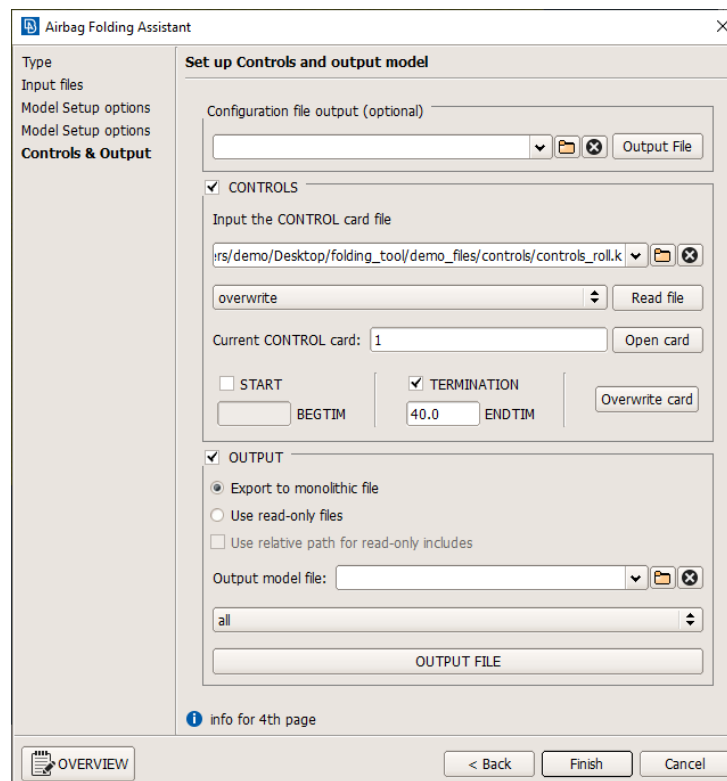
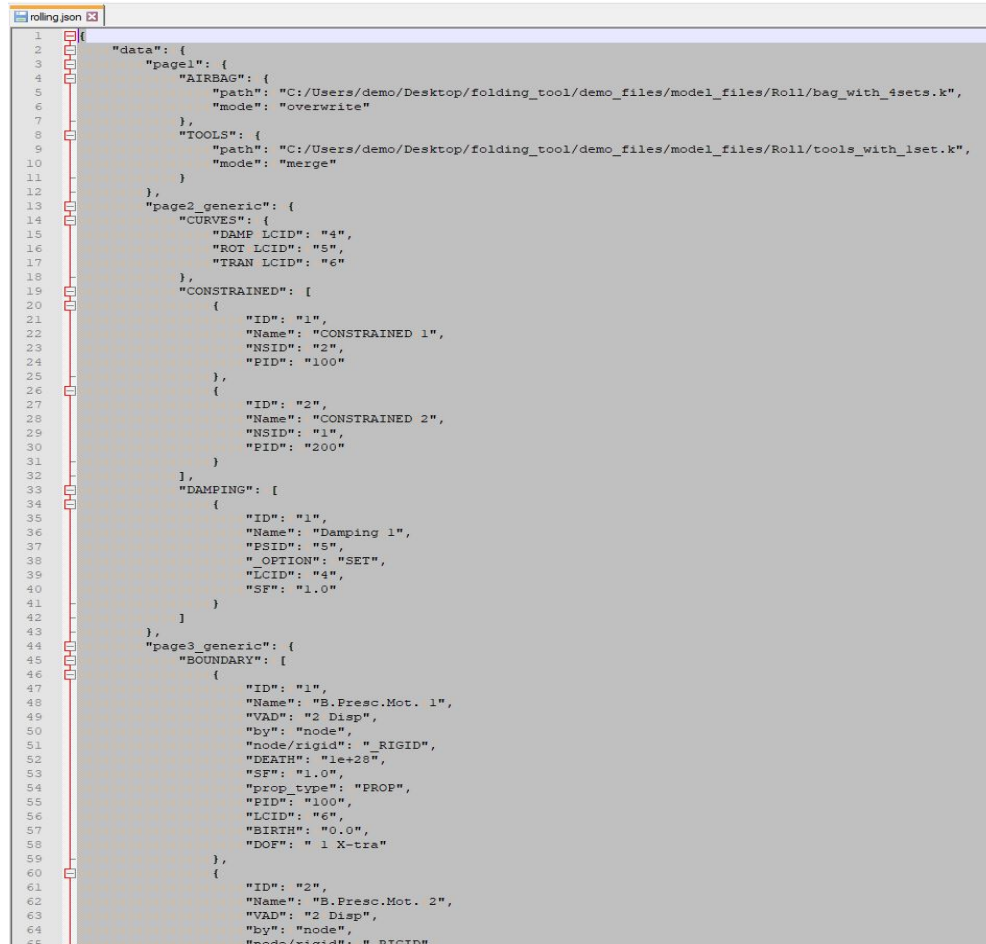


Fig. 8: Output of LS-DYNA files

4.5 Configuration File

A highlight of the folding assistant is the capability to create and read a configuration file in “.json” format. This option facilitates even more the usage of the tool and the time needed to setup a folding simulation by saving all the created entities of the folding scenario in an ASCII file. Accordingly, by reading the configuration file, all the entities that are described inside it are instantly created.



```
1 {
2   "data": {
3     "page1": {
4       "AIRBAG": {
5         "path": "C:/Users/demo/Desktop/folding_tool/demo_files/model_files/Roll/bag_with_4sets.k",
6         "mode": "overwrite"
7       },
8       "TOOLS": {
9         "path": "C:/Users/demo/Desktop/folding_tool/demo_files/model_files/Roll/tools_with_1set.k",
10        "mode": "merge"
11      }
12    },
13    "page2_generic": {
14      "CURVES": {
15        "DAMP LCID": "4",
16        "ROT LCID": "5",
17        "TRAN LCID": "6"
18      },
19      "CONSTRAINED": [
20        {
21          "ID": "1",
22          "Name": "CONSTRAINED 1",
23          "NSID": "2",
24          "PID": "100"
25        },
26        {
27          "ID": "2",
28          "Name": "CONSTRAINED 2",
29          "NSID": "1",
30          "PID": "200"
31        }
32      ],
33      "DAMPING": [
34        {
35          "ID": "1",
36          "Name": "Damping 1",
37          "PSID": "5",
38          "OPTION": "SET",
39          "LCID": "4",
40          "SF": "1.0"
41        }
42      ],
43    },
44    "page3_generic": {
45      "BOUNDARY": [
46        {
47          "ID": "1",
48          "Name": "B.Presc.Mot. 1",
49          "VAD": "2 Disp",
50          "by": "node",
51          "node/rigid": "_RIGID",
52          "DEATH": "1e+28",
53          "SF": "1.0",
54          "prop_type": "PROP",
55          "PID": "100",
56          "LCID": "6",
57          "BIRTH": "0.0",
58          "DOF": "1 X-tra"
59        },
60        {
61          "ID": "2",
62          "Name": "B.Presc.Mot. 2",
63          "VAD": "2 Disp",
64          "by": "node",
65          "node/rigid": "_RIGID",
```

Fig. 9: Example of json configuration file

4.6 Single/Multiple Step Folding

The user has the capability to setup a model for either a “single” step or a “multiple” steps folding.

In “single” step, one folding type is selected, then the corresponding entities are created in the next steps and the ready-to-run LS-DYNA file is output. After running the solution, the deformed airbag can be input again in the tool to setup a second folding scenario. As a result, the final desired airbag shape comes from separate folding scenarios that are performed in a sequence.

The Folding Assistant offers one more option for the folding of the airbag to the desired shape. In “multiple” step process, the setup of the loadcase is done as described in the “single” step process but instead of output the file after each folding case, the user is able to move back to the initial step and add another folding type. The setup of the step that follows is done as usual. After finishing with the setup of all the folding steps, one output file is produced and sent to the solver. With this option, the final desired airbag shape is a result of one single LS-DYNA solution that contains all the steps required.

4.7 Overview Button

At any point inside the wizard, the “OVERVIEW” button pops up a separate window that gives a quick overview of all the entities created by the wizard. Different tabs exist for each folding type and entities created during each step are showed under the corresponding list. Each listed entity can be quickly edited by double clicking on it.

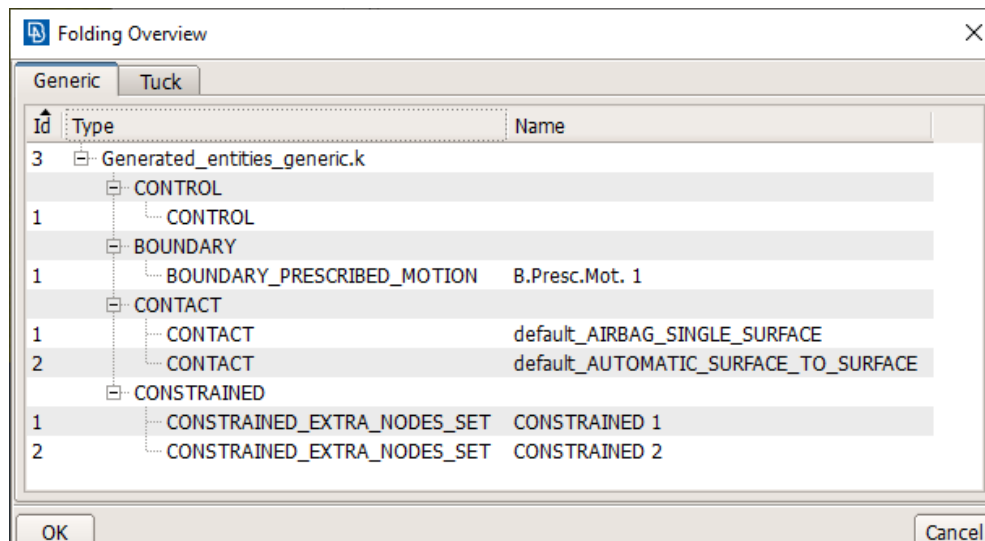


Fig.10: OVERVIEW button pop-up window

5 Summary

This methodology streamlines all the steps for creating airbag folding loadcases that will be solved by LS-DYNA through a wizard-like functionality and leads the analyst from the input of the airbags in ANSA to the ready-to-run LS-DYNA file.

By selecting the desired folding type, the tool is automatically adjusted to the setup of the appropriate entities. Moreover, it is possible to setup either a single or a multiple step folding process. A complete control over the process is provided with the “overview” button that pops-up a window which contains all the created entities according to the folding type they belong to. Last but not least, configuration files can be created that offer the ability to control the folding process through a text editor.

References

- [1] ANSA version 20.1.0 User’s Guide, BETA CAE Systems International AG, November 2019
- [2] LS-DYNA Keyword Users’ Manual Version R11, Livermore Software Technology Corporation, Livermore 2019