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HyperWorks


HM-4630: Interfacing for Arbitrary - Lagrangian - Eulerian Capability using DYNA

In this tutorial, you will learn how to:

- Use the **ALE setup** panel
- Define *ALE cards and other cards related to the LS-DYNA Arbitrary-Lagrangian-Eulerian (ALE) capability
- Update the *SECTION card used by the ALE components INK and AIR to *SECTION_SOLID_ALE.
- Define *EOS_LINEAR_POLYNOMIAL for the ALE components.
- Define *INITIAL_VOID_PART to define the AIR component as the void in the fluid interaction.
- Define *ALE_REFERENCE_SYSTEM_NODE to control the motion of the ALE mesh.
- Define *ALE_REFERENCE_SYSTEM_GROUP to specify the reference system type for the fluid interaction of the ALE components.

Tools

The **ALE setup** panel can be accessed from the **Analysis** page. Use the **ALE setup** panel to create and modify input data pertaining to the Arbitrary-Lagrangian Eulerian LS-DYNA capability.

The **Card Edit** feature can be accessed by clicking  on the **Collectors** toolbar. Use the **Card Edit** panel to select the entities that are viewed in the **card image** subpanel. The card images are defined in the template file.

To access the control cards feature do one of the following:

- From the menu bar, click **Setup > Create > Control Cards**.
- From the **Analysis** page, click **control cards**

Use the **Control Cards** panel to set up job-level, solver specific data. The available control cards are defined in the template file.

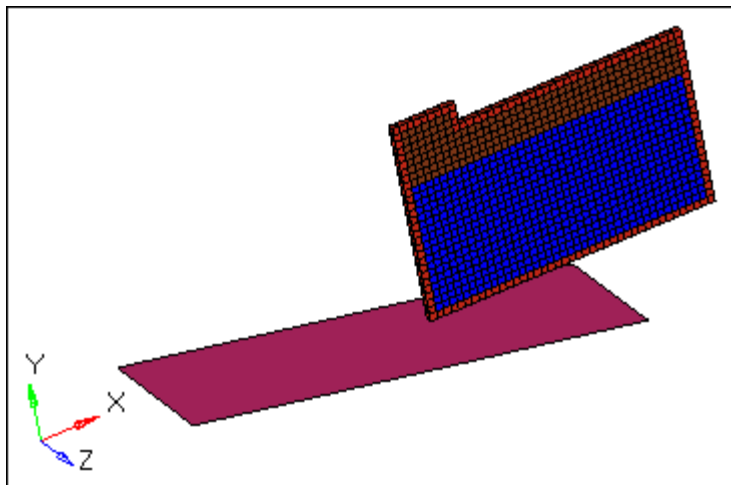
README	CONTROL_ADAPTIVE	delete
KEYWORD	CONTROL_ADAPTIVE_CURVE	disable
Title Card	CONTROL_ALE	enable
unsupp_cards	CONTROL_BULK_VISCOSITY	
unsupp_mechanism_cards	CONTROL_CHECK	next
CONTROL_ACCURACY	CONTROL_COARSEN	
CONTROL_ADAPSTEP	CONTROL_CONTACT	return

Model Files

This tutorial uses the `cartridge.hm` file, which can be found in `<hm.zip>/interfaces/lsdyna/`. Copy the file(s) from this directory to your working directory.

Exercise: Define Model Data for the Ink Cartridge Drop Analysis

The purpose of this exercise is to help you become familiar with defining LS-DYNA cards related to the ALE capability. In this exercise you will set up the model data for an LS-DYNA analysis of an ink cartridge falling through air and onto the ground. The ink and ground model is shown in the image below.



Ink cartridge model

Loads and contacts are already defined in the model as follows.


- A velocity along the negative Y-axis is applied to every node of the ink cartridge using the card `*INITIAL_VELOCITY`.
- The interaction between the cartridge and the platform is defined using the card `*CONTACT_AUTOMATIC_NODES_TO_SURFACE`. All of the nodes of the `CARTRIDGE` are slave to the master `PLATFORM` component.
- Single point constraints are applied throughout the model. The `PLATFORM` component has all of its DOFs fully locked, while the parts in the ink cartridge have the Z translation (DOF 3) constrained. This last constraint is necessary for symmetry reasons since the model has been simplified.
- A gravity load along the negative Y direction is applied to the entire model. A curve defining the force versus time function is defined to fully create a gravity load.

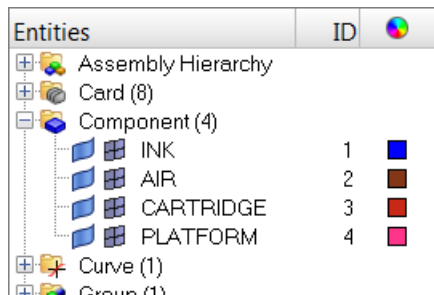
Step 1: Load the LS-DYNA profile

1. Start HyperMesh Desktop.

2. In the **User Profile** dialog, set the user profile to **LsDyna**.

Step 2: Retrieve the model file and review it's contents

1. Open a model file by clicking **File > Open > Model** from the menu bar, or clicking  on the **Standard** toolbar.
2. In the **Open Model** dialog, open the `cartridge.hm` file. The model appears in the graphics area.
3. In the **Model** browser, expand the **Component** folder. Notice the model is broken up into four component collectors: AIR, CARTRIDGE, INK, and PLATFORM.

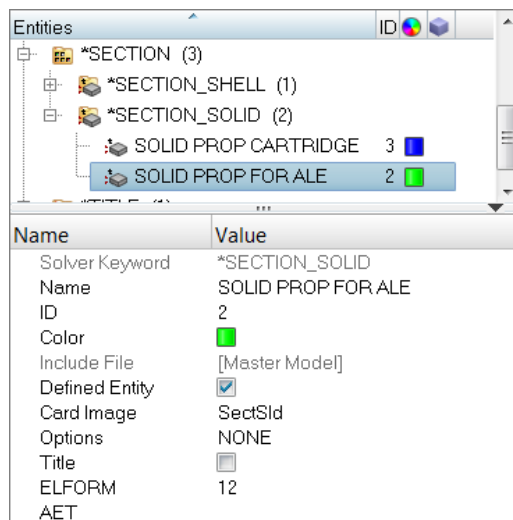


4. Use the **Model** browser or the **Solver** browser to review the defined materials and properties.

Step 3: Update the *SECTION_SOLID card used by the ALE components INK and AIR to *SECTION_SOLID_ALE

Method 1 - Using the Solver Browser

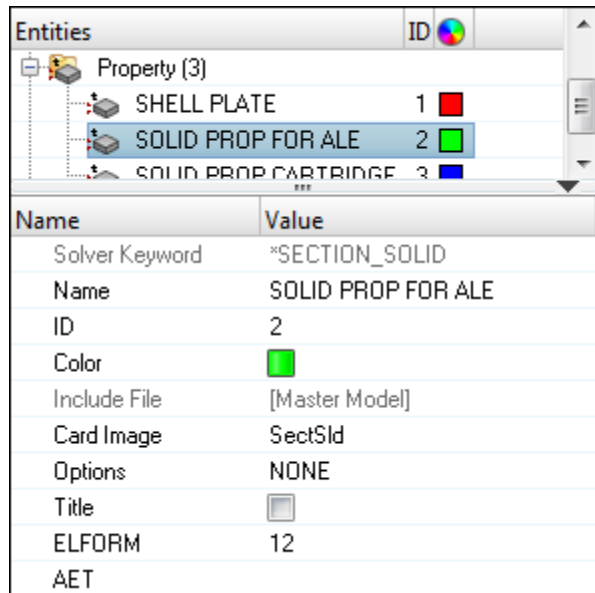
1. Open the **Solver** browser by clicking **View > Browsers > HyperMesh > Solver** from the menu bar.
2. In the ***SECTION > *SECTION_SOLID** folder, click **SOLID PROP FOR ALE**. The **Entity Editor** opens, and displays the property's corresponding data.



3. For **ELFORM** (Element formulation options), verify that it is set to 12.
4. Set **Options** to **ALE**.

Method 2 - Using the Model Browser

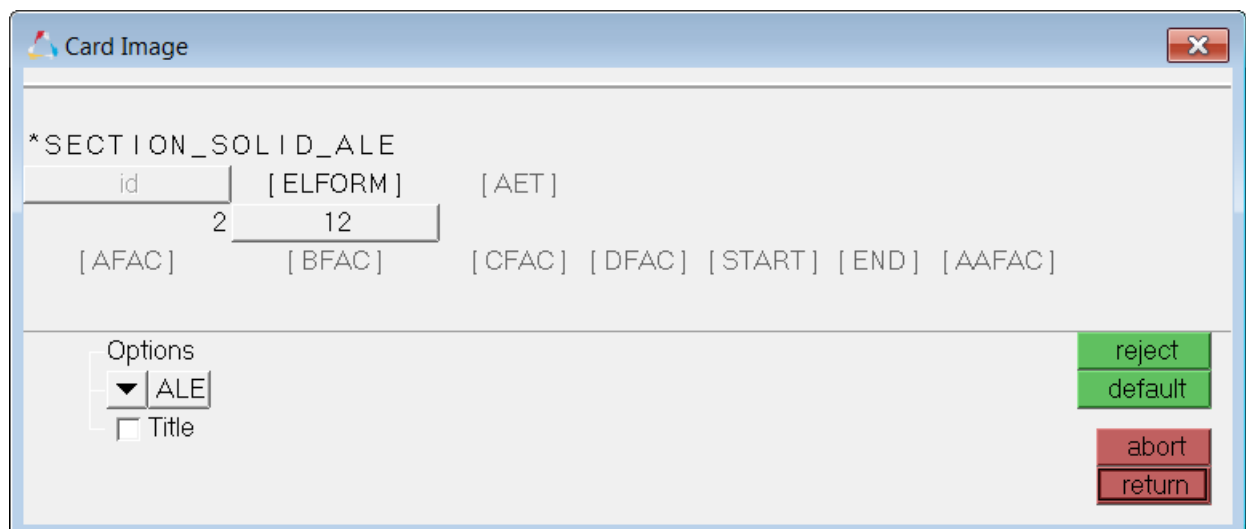
5. In the **Model** browser, **Property** folder, click **SOLID PROP FOR ALE**. The **Entity Editor** opens, and displays the property's corresponding data.



6. For **ELFORM** (Element formulation options), verify that it is set to 12.
7. For **Options**, select **ALE**.

Method 3 - Using the Card Editor

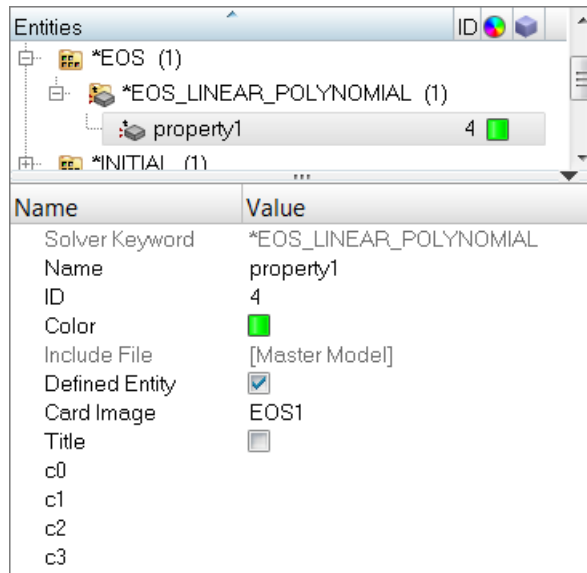
8. In the **Model** or **Solver** browser, right-click on the property **SOLID PROP FOR ALE** and select **Card Edit** from the context menu. The **Card Image** dialog opens.



9. For **ELFORM** (Element formulation options), verify that it is set to 12.
10. For **Options**, select **ALE**.
11. Click **return**.

Step 4: Define *EOS_LINEAR_POLYNOMIAL for the ALE components

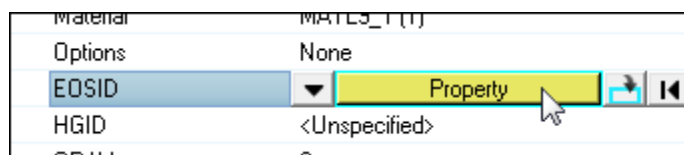
1. In the **Solver** browser, right-click and select **Create** > ***EOS** > ***EOS_LINEAR_POLYNOMIAL** from the context menu. A new property opens in the **Entity Editor**.



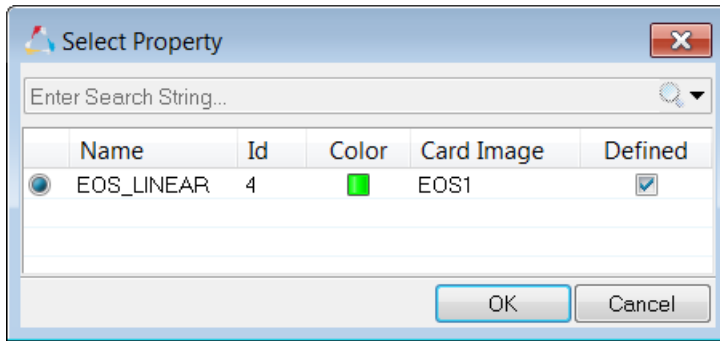
2. For **Name**, enter `EOS_LINEAR`.
3. For **c1** (1st polynomial equation coefficient), enter `1.5E+9`.
4. For **V0** (Initial relative volume), enter `1`.

Step 5: Assign *EOS_LINEAR_POLYNOMIAL for the ALE components

1. In the **Solver** browser, ***PART** > ***PART** folder, and click **INK**. The **Entity Editor** opens, and displays the component's corresponding data.
2. For **EOSID**, click **Unspecified** >> **Property**.



3. In the **Select Property** dialog, select **EOS_LINEAR** and then click **OK**.



- Repeat steps 1-3 for the **AIR** component.

Step 6: Define *INITIAL_VOID_PART to define the AIR component as the void in the fluid interaction

- In the **Solver** browser, right-click and select **Create** > ***INITIAL** > ***INITIAL_VOID** from the context menu. A new group opens in the **Entity Editor**.
- For **Name**, enter `VOID`.
- For **PSID/PID**, click **0 Components** >> **Components**.
- In the **Select Components** dialog, select **AIR** and then click **OK**.

Step 7: Define *ALE_REFERENCE_SYSTEM_NODE to control the motion of the ALE mesh

- In the **Solver** browser, select **Create** > **ALE** > **Reference System** > **Node** from the context menu. A new ***ALE_REFERENCE_SYSTEM_NODE** opens in the **Entity Editor**.
- For **Name**, enter `ALE_NODE`.
- For **NID1**, click **Unspecified** >> **Node**.
- In the panel area, click **node**.
- In the **id=** field, enter 5 and then press **ENTER**.
- Click **proceed**.
- Repeat steps 7.3 through 7.6 for **NID2** and **NID3**.
For **NID2**, select node 6; for **NID3**, select node 7.

Step 8: Define *ALE_REFERENCE_SYSTEM_GROUP to specify the reference system type for the fluid interaction of the ALE components

- In the **Solver** browser, select **Create** > **ALE** > **Reference System** > **Group** from the context menu. A new ***ALE_REFERENCE_SYSTEM_GROUP** opens in the **Entity Editor**.
- For **Name**, enter `SYSTEM_GROUP`.
- Click **SID**.

4. Set the entity selector to **Sets**.
5. Assign a set.
 - a. Right-click on SID and select **Create Sets** from the context menu.
 - b. For part set **Name**, enter `Set_ALE_Components`.
 - c. For Card Image, select **Part**.
 - d. For Entity IDs, click **Unspecified >> Components**.
 - e. In the **Select Components** dialog, select **INK** and **AIR**.
 - f. Click **OK**.
 - g. Click **Close**.
6. Set **PRTYPE** to 5.
7. Click **PRID >> Alereferencesystemnode**.
8. In the **Select Alereferencesystemnode** dialog, select **ALE_NODE** and then click **OK**.

Step 9: Review the pre-defined *CONTROL_ALE card and export the model to an LS-DYNA 971 formatted input file

1. In the **Solver** browser, ***CONTROL > *CONTROL_ALE** folder, click ***ALE1**. The **Entity Editor** opens, and displays the control card's corresponding data.
2. Review the ***CONTROL_ALE** parameters.
3. From the menu bar, click **File > Export > Solver Deck**.
4. In the **Import - Solver Deck** tab, set **Template** to **Keyword971**.
5. In the **File** field, navigate to your working directory and save the file as `cartridge_complete.key`
6. Click **Export**.

Step 10 (Optional): Submit the LS-DYNA input file to LS-DYNA 971

1. From the desktop's **Start** menu, open the LS-DYNA Manager program.
2. From the **solvers** menu, select **Start LS-DYNA analysis**.
3. Load the file `cartridge_complete.key`.
4. Start the analysis by clicking **OK**.

Step 11 (Optional): View the results in HyperView

The results for ALE data are stored as **Extra Solid History Variable** in HyperView.

Step 12 (Optional): Save your work

The exercise is complete. Save your work as a HyperMesh file.