Computational Dynamics Inc. (CDI)

CDI Tutorial
Creating an Air Brake Model in ATTIF

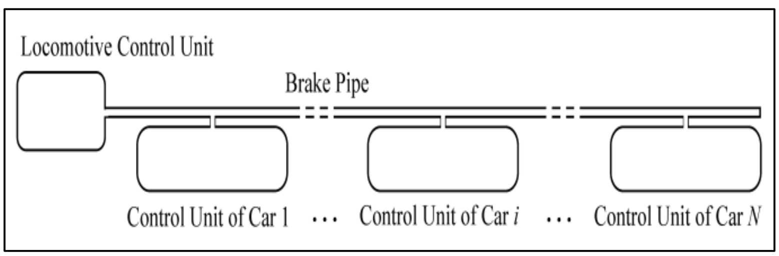
1 Overview

The full application of pneumatic brakes in a very long train can take several minutes, and the recharging of such a system will generally take even more time. This delayed process requires the engineers to model the pneumatic braking system of a long train using computer simulations. ATTIF (**A**nalysis of **T**rain/**T**rack **I**nteraction **F**orces) allows for such modeling through the integration of a pneumatic brake formulation that makes use of efficient longitudinal train force algorithms.

The air brake formulation used in ATTIF is briefly described and the procedure for creating an ATTIF model that makes use of the available air brake formulation is outlined in this document. The example given in this document can assist ATTIF users in developing their own detailed air brake models for investigations.

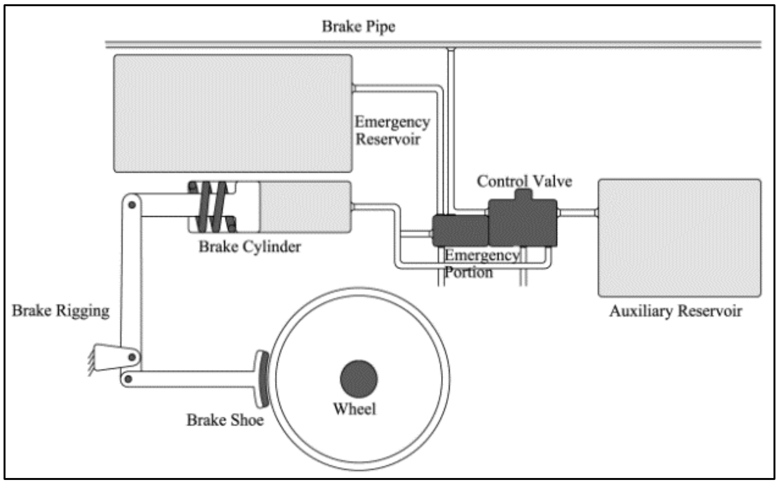
2 Air Brake Outline

The air brake formulation developed in ATTIF consists of the locomotive automatic brake valve, air brake pipe, and car control unit (CCU), as shown here:



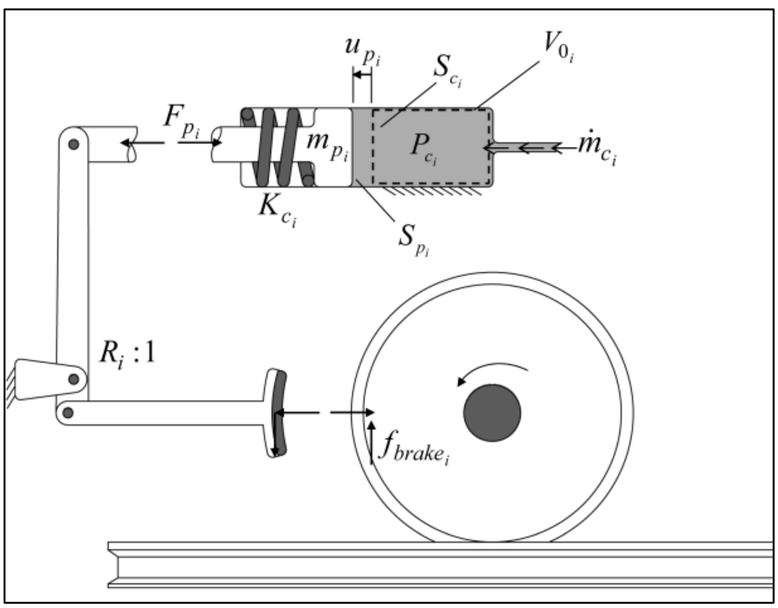
Main Air Brake Components

The brake force model implemented in ATTIF accounts for the effects generated by the flow of air through long train pipes as well as the effect of leakage and branch pipe flows. This formulation can be used to study the dynamic behavior of the air flow in the train pipe and its effect on the longitudinal train forces during brake application and release. The ATTIF implementation also includes a detailed model of the locomotive automatic brake valve that can be used to define the inputs to the air brake pipe during the simulation. In addition, a detailed CCU, as shown here, is considered:



Car Control Unit Components

The coupling between the equations that detail the air brake, locomotive automatic brake valve, car control units, and train formulations is considered in ATTIF. The car brake forces, which depend on the locomotive automatic brake valve handle position, are applied to the wheels using the CCU located along the brake pipe, as shown here:



Brake Force on a Car Wheel

ATTIF has been used in different simulation scenarios in order to investigate the effect of the air brake forces on the train longitudinal dynamics. The numerical results of ATTIF have additionally been validated using experimental data.

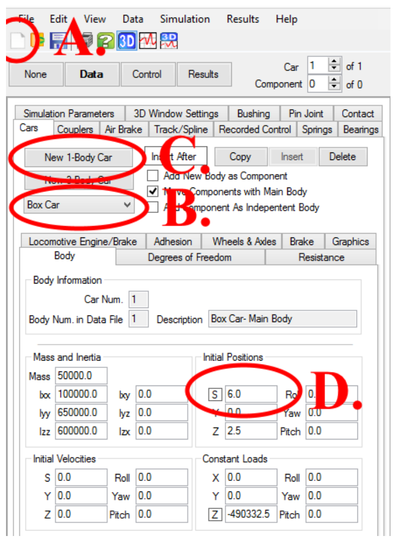
3 MODEL CREATION & ADDING CARS

A.) Select the "New" button from the interface toolbar in order to begin a creating a new model.

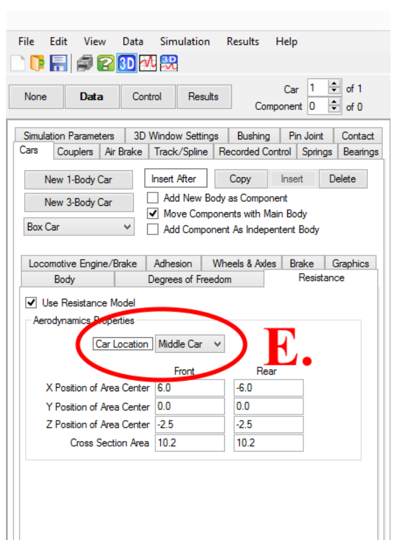
B.) In the "Cars" page of the sidebar, select the type of car to add. For this example, the first car will be a "Box Car".

C.) Click the "New 1-Body Car" button to add the car to the model.

D.) Specify the position of the car along the length of the track in the "Initial Positions" box. For the first car, the default value does not need to be changed.



E.) Under the "Resistance" sub-page of the sidebar, specify the "Car Location". For the first car of the model, the car location should be set to "Last Car".



F.) The remaining cars of the model can be added using the same procedure, with the data below:

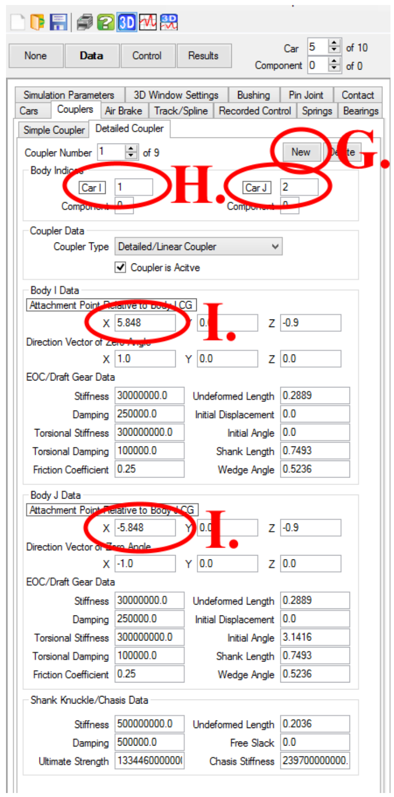
Car Number	Car Type	Initial Positions	Car Location
1	Box Car	6.000	Last Car
2	Box Car	19.976	Middle Car
3	Box Car	33.952	Middle Car
4	Box Car	47.928	Middle Car
5	Box Car	65.904	Middle Car
6	Box Car	83.880	Middle Car
7	Box Car	97.856	Middle Car
8	Box Car	111.832	Middle Car
9	Box Car	125.808	Middle Car
10	Box Car	143.784	First Car

4 COUPLING THE CARS

G.) In the “Couplers” page of the sidebar, in the “Detailed Coupler” subpage, click the “New” button.

H.) The numbers of the cars connected by the coupler can be specified in the “Body Indices” box, under “Car I” and “Car J”. The first coupler connects car numbers 1 and 2.

I.) The attachment points of the coupler on the i*th* and j*th* cars can be defined under the “Attachment Point Relative to Body I CG” and “Attachment Point Relative to Body J CG” headings. The default values for the first coupler do not need to be changed.

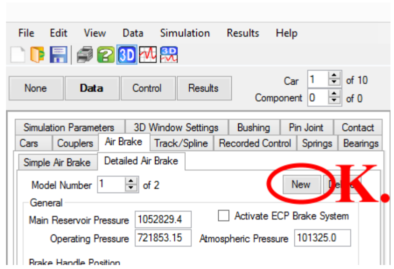


J.) The remaining couplers can be added in a similar manner using the following data:

Coupler Number	Car I	Car J	X-Attachment Point Relative to Body I CG	X-Attachment Point Relative to Body J CG
1	1	2	5.848	-5.848
2	2	3	5.848	-5.848
3	3	4	5.848	-5.848
4	4	5	5.848	-9.848
5	5	6	9.848	-5.848
6	6	7	5.848	-5.848
7	7	8	5.848	-5.848
8	8	9	5.848	-5.848
9	9	10	5.848	-9.848

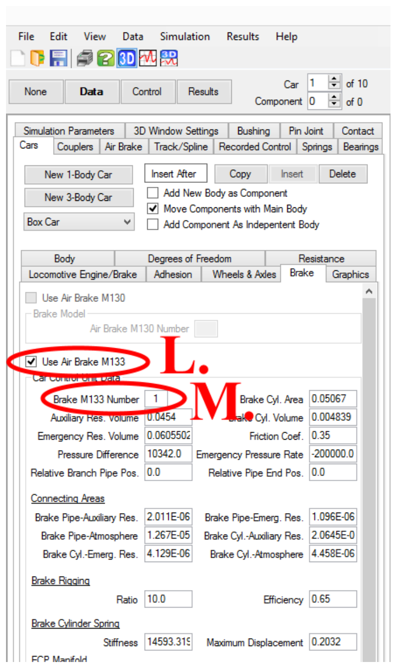
5 Defining The Air Brake System

K.) In the “Air Brake” page of the sidebar, in the “Detailed Air Brake” subpage, click “New” twice in order to add two new air brake models.



L.) In the "Cars" page of the sidebar, in the "Brake" subpage, select the "Use Air Brake M133" checkbox for the first car.

M.) The brake model number may be specified under "Brake M133 Number". The default value for the first car does not need to be changed.



N.) The brake system may be defined for the remaining cars using a similar procedure and the data below:

Car Number	Brake M133 Number
1	1
2	1
3	1
4	1
5	-
6	2
7	2
8	2
9	2
10	-

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6 Loading a Track

O.) In the "Track/Spline" Page, select "Open Default Track File".

P.) Select "Load Track Data".

7 Final Remarks

The proper braking procedure of a railroad vehicle system is crucial for stability and safety. The ability to numerically model and simulate a vehicle as the pneumatic brakes are applied and released can assist in the design and analysis of a proper braking method. This tutorial is intended to guide the user through some of the features of air brake modeling in ATTIF.

CDI will continue to develop ATTIF in order to provide users with an up-to-date tool for the simulation of detailed longitudinal train dynamics.