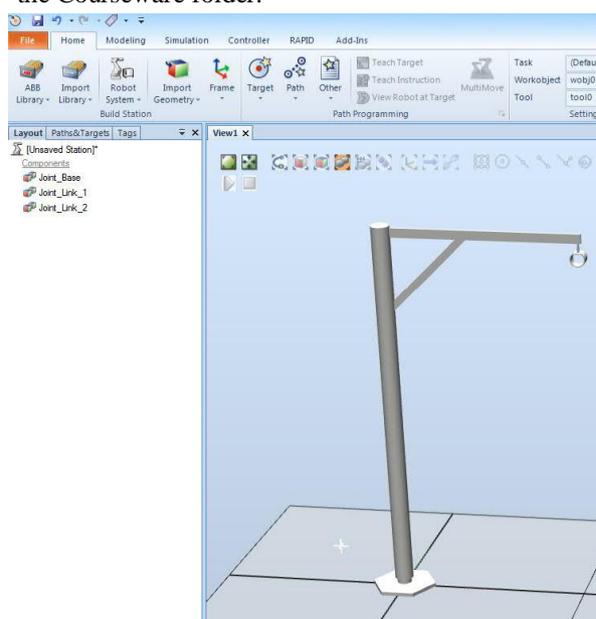


### 2.1.3. Create a Joint Mechanism

1. Create a new empty station.
2. Import the geometry models *Joint\_Base.sat*, *Joint\_Link1.sat* and *Joint\_Link2.sat* from the Courseware folder.

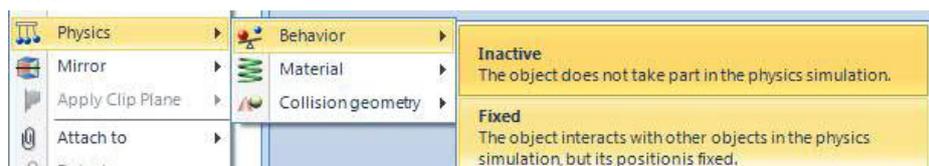


3. Turn off **Freehand Drag** and ensure that it **is not** selected as active.

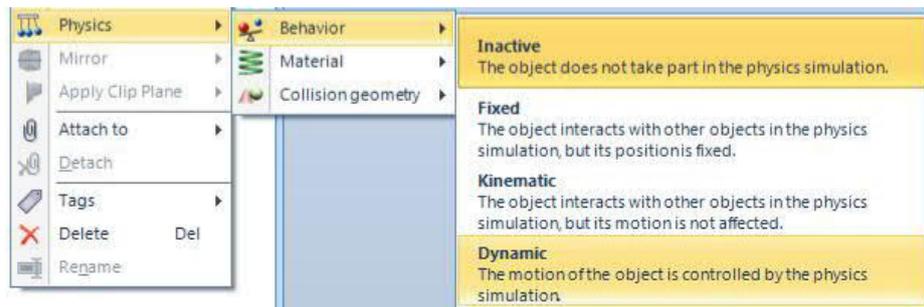


Before we define the joints in our mechanism we will start by defining how each component shall behave when interacting with physics in the simulation.

4. Right click on the *Joint\_Base* and change its behavior to **Fixed**. This will allow interaction with the other joints but will assume that this item is bolted down to the floor.



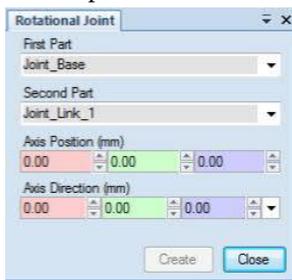
5. For both *Joint\_Link\_1* and *Joint\_Link\_2* change the behavior to **Dynamic**.



6. In the **Modeling** tab select **Physics Joint – Rotational Joint**.



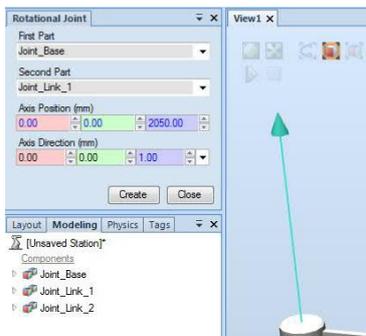
7. For the first part select *Joint\_Base* in the drop down menu and *Joint\_Link\_1* for the second part.



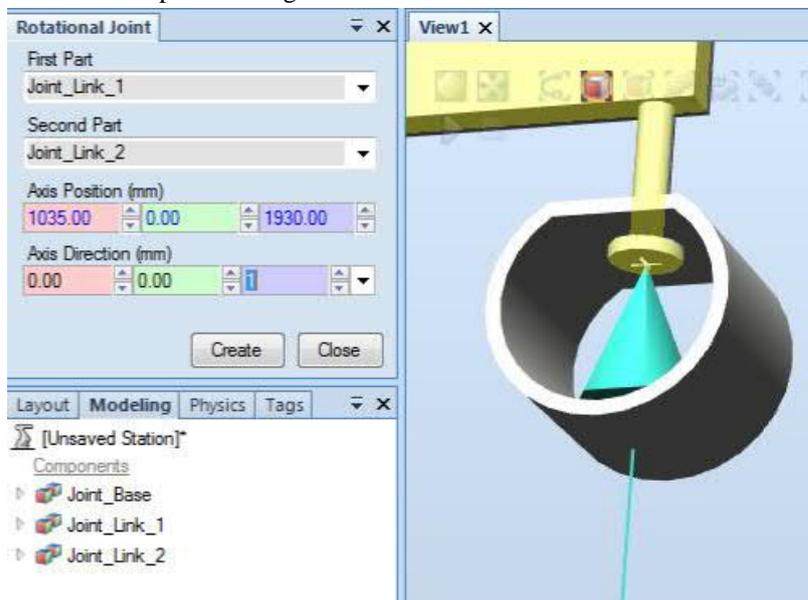
8. Select the **Axis Position** by placing the cursor in one of the coordinate boxes and then select the center of the top surface of the post.



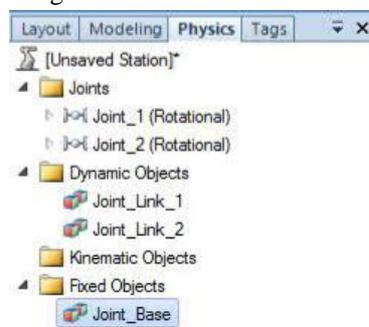
9. For the **Axis Direction** enter a value in the Z dialog box.



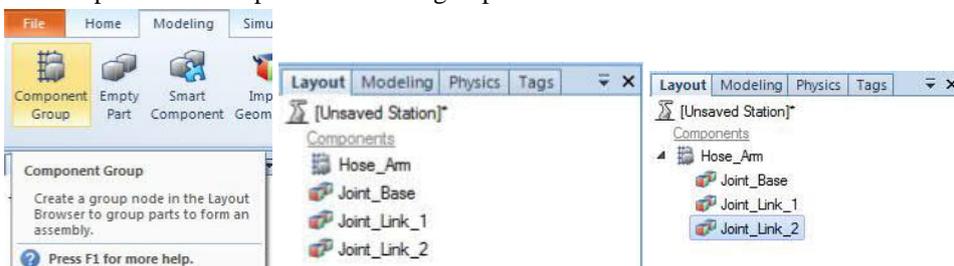
10. Click **Create**.
11. Create a second **Rotational Joint** using *Joint\_Link\_1* as the first part and *Joint\_Link\_2* as the second part defining its **Axis Position** and **Axis Direction** as shown below.



12. Click **Create** and **Close**.
13. In the **Physics** browser note the tree structure overview of the joints and behavior assigned to each item.



14. In the **Modeling Tab** create a **Component Group**, rename it to *Hose\_Arm*, then drag and drop all three components into the group.



15. Save the *Hose\_Arm* as a library item into the CourseWare Library folder.
16. Activate the **Freehand Drag** feature and see how the links can be moved in the graphics window.
17. Close the station without saving.

## 2.2. Gravity and Friction

### 2.2.1. Working With Gravity and Material Properties

#### Overview

In the following exercises we will work with boxes and some conveyors to see how gravity can have an effect on the simulated process.

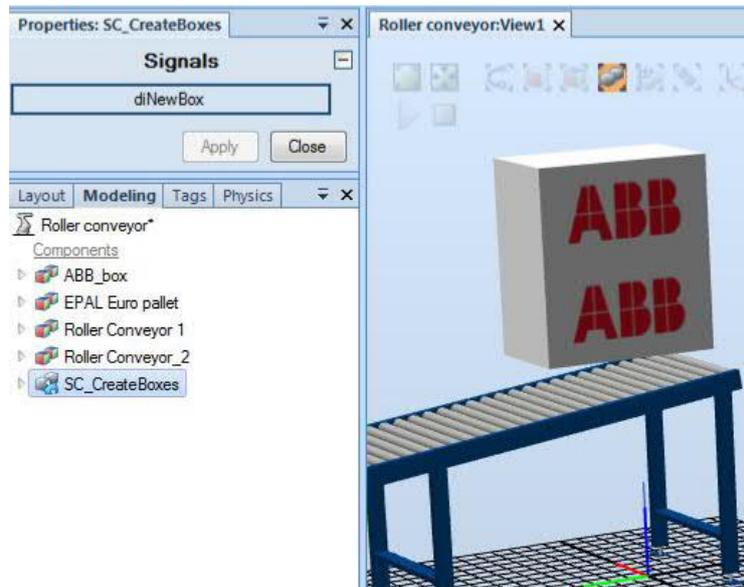
#### 2.2.2. Gravity

1. Open the station *Roller Conveyor*. This can be found in the CourseWare Stations folder.



2. Start the simulation in order to activate the Smart Component **SC\_CreateBoxes**. (Note that all items that consume time in RobotStudio need to have a “Simulation” running.)
3. Right click on **SC\_CreateBoxes**, select **Properties** then click on **diNewBox**.



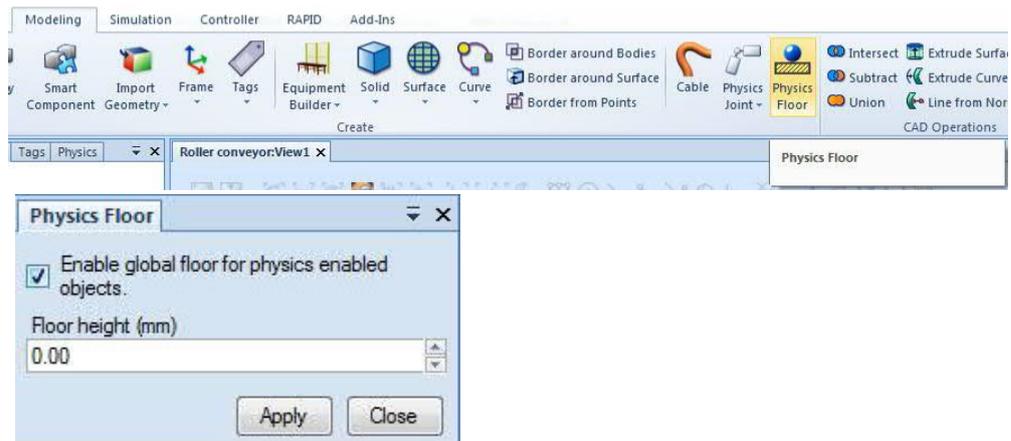


A new box will be created below the first one. In the next steps we will turn on some features so that gravity can affect the copy of the box.

4. Stop the simulation. Since the box copy is marked transient the copy will be removed from the station.

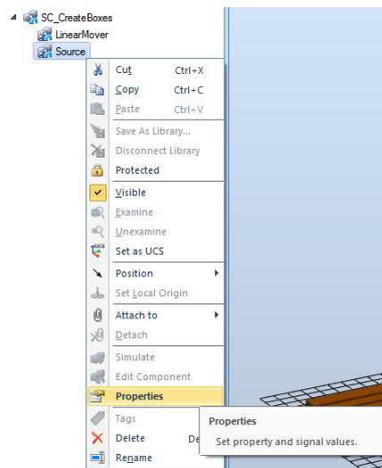
### Enable the Physics Floor

5. From the **Modeling Tab** select **Physics Floor**. Check the enable box and click **Apply** then **Close**.

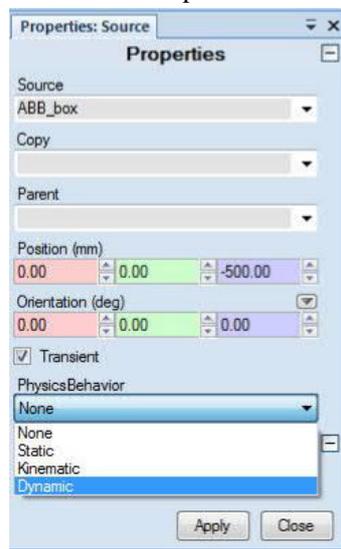


By enabling the Physics Floor we will ensure that any objects that are physics enabled land on the floor and do not continue to fall within the virtual environment.

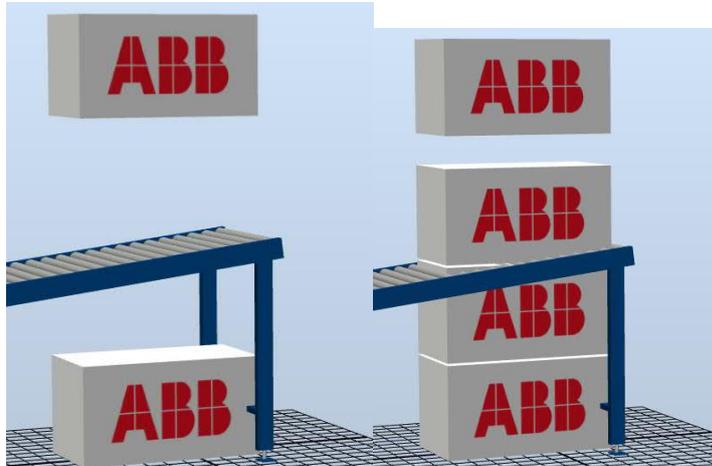
6. Expand the node of **SC\_CreateBoxes**, right click on the **Source** and select **Properties**.



7. Click on the drop down menu under **Physics Behavior** to change the copy to **Dynamic**.



8. Click **Apply** and **Close**.
9. Start the simulation again and trigger the creation of a new box with **diNewBox**. A new box will be created and it will fall and land on the floor. Note that if additional copies are created they will stack on top of one another.



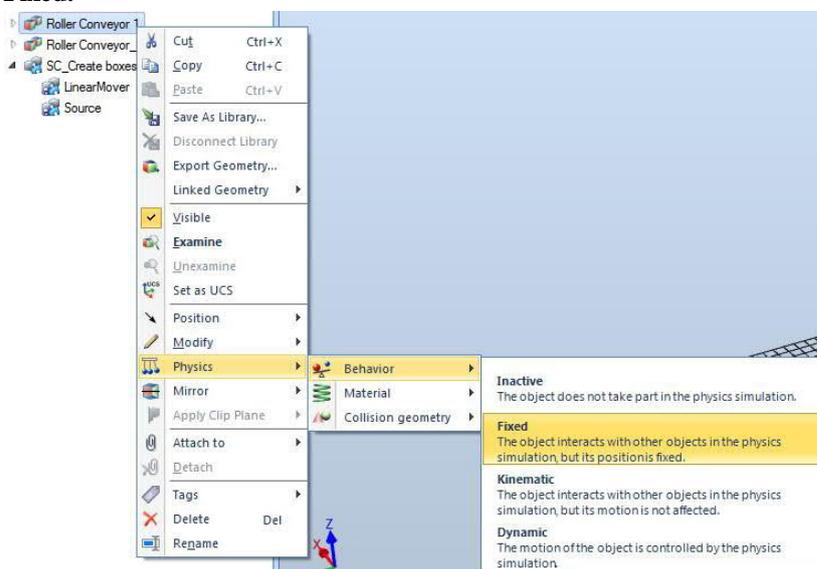
10. Stop the simulation.
11. Save the station as *RollerConveyor\_Gravity*.

### 2.2.3. Material Properties

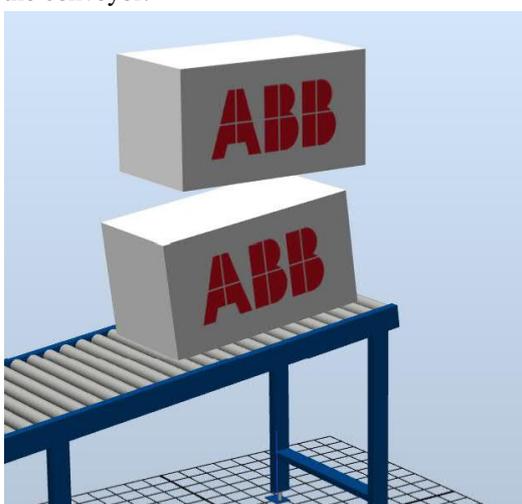
In the next section will enable physics properties on the conveyor and then manipulate the material properties to allow the box to interact with the conveyor.

#### Change the Conveyor Properties

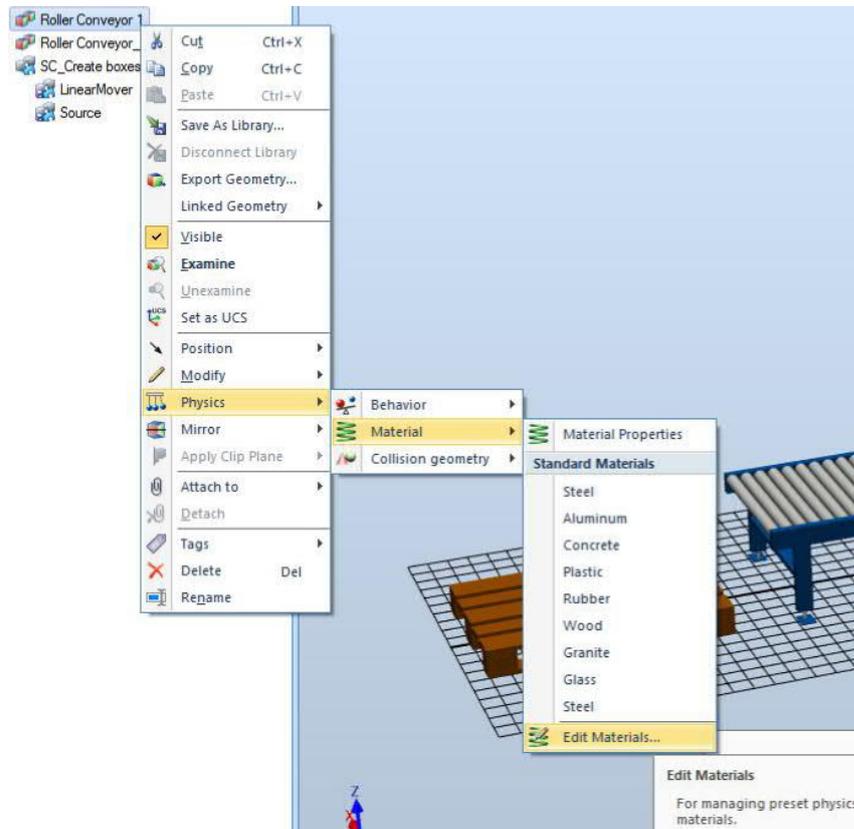
1. Open the station *RollerConveyor\_Gravity*.
2. Right click on **Roller conveyor 1** and change the **Physics Behavior** from **Inactive** to **Fixed**.



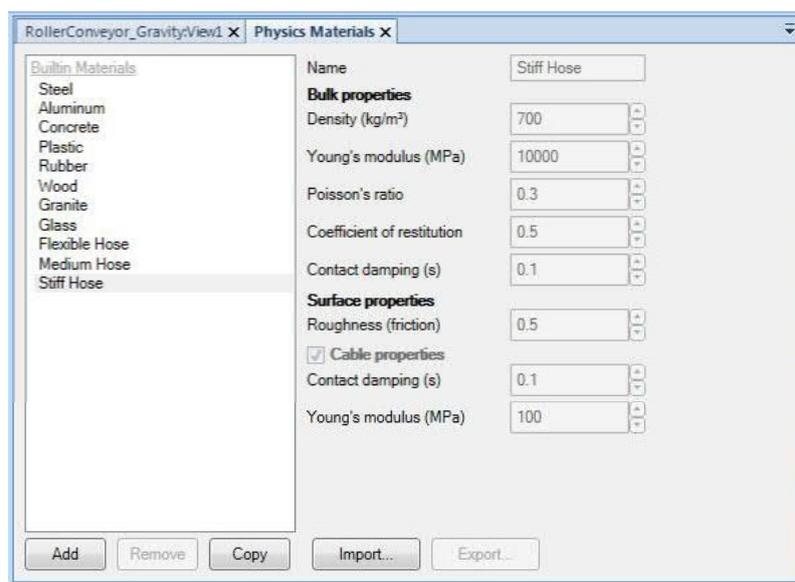
3. Run the simulation and create a new box. Note that the new box falls onto and stays on the conveyor.



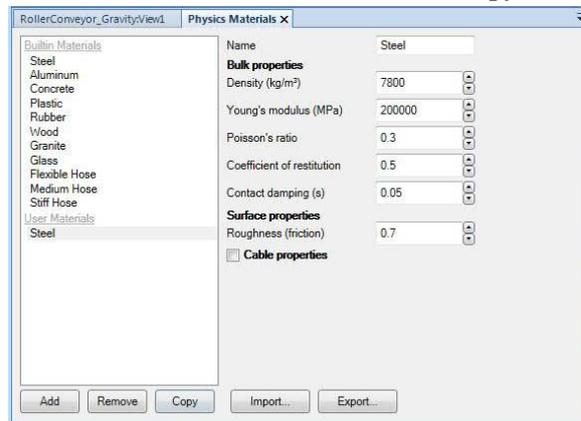
- Right click again on the **Roller Conveyor 1** and select **Physics > Material > Edit Materials**.



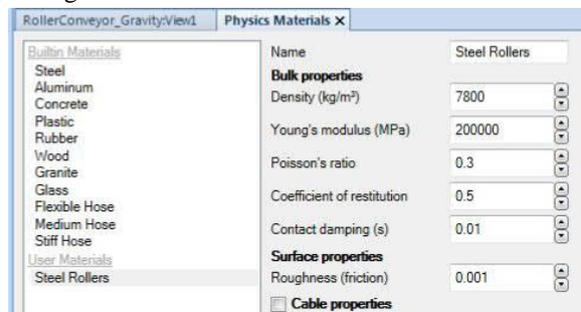
RobotStudio includes a number of “Built In” materials. From this interface we can create a copy of one of the default materials and then manipulate its properties in order to influence the behavior of the items in the simulation.



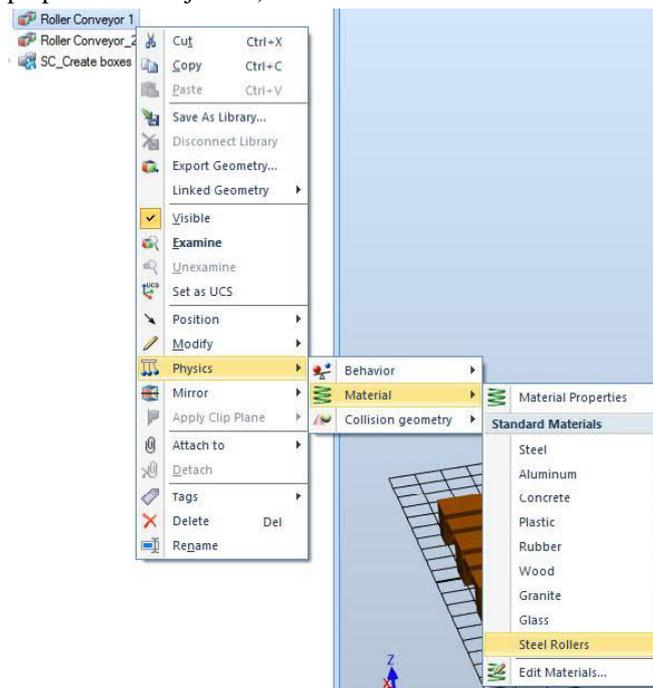
5. Select **Steel** as the material and then click **copy**.



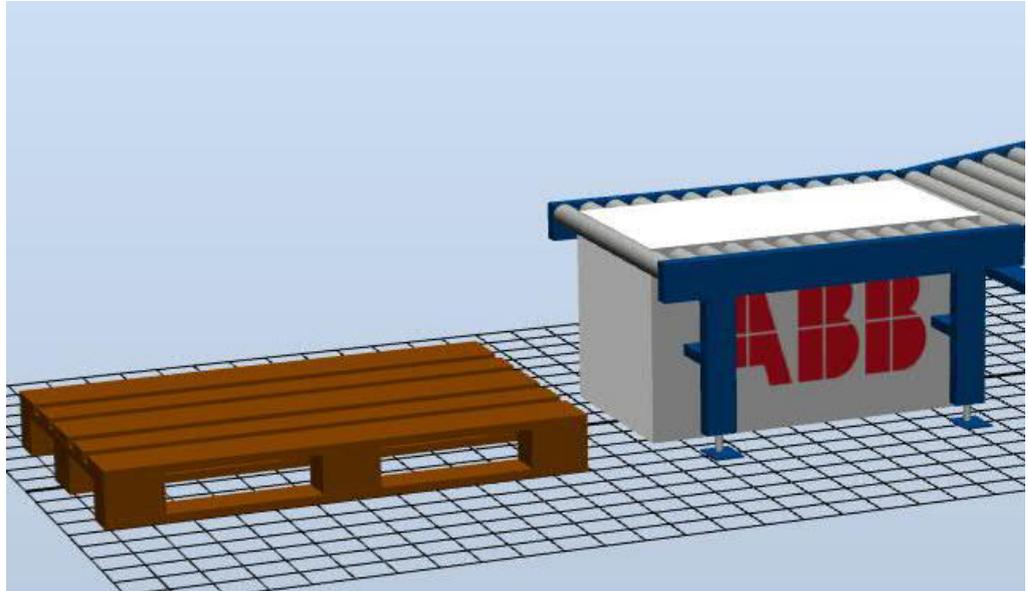
6. Change the name of the material to *Steel Rollers*.



7. Reduce the **Roughness** value (friction) to **0.01**.
8. Close the Physics Materials window.
9. Right click again on the **Roller Conveyor 1** and select the **Steel Rollers** property so that it is in effect. (Note that this needs to be done each time the material is changed or the properties are adjusted.)



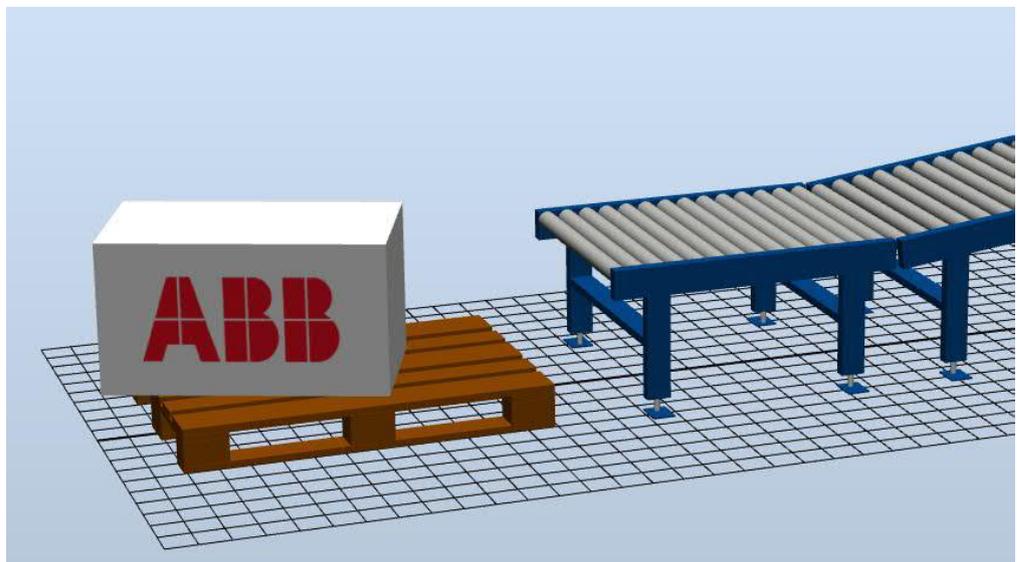
10. Run the simulation again and view the behavior. The copied box should slide down the conveyor and end up on the floor under the second conveyor.



11. Save the station as *RollerConveyor\_Properties*.

**Challenge**

Adjust the properties for the pallet and both conveyors so that the box rolls down the first conveyor, over the second conveyor and then lands on the pallet.



Hint! What material is the box made of?

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