

Building a Better Barrier

The original purpose of walls at race tracks was to keep the cars on the track and away from the spectators. While concrete works very well for preventing cars from getting into the grandstands, hitting a bare concrete wall is very hard on the driver, not to mention the car.

In 1998, Tony George, the President of Indianapolis Motor Speedway, realized that the walls surrounding the track could be made much safer. After a number of iterations, the SAFER (Steel and Foam Energy Reducing) barriers were produced via collaboration between the American IndyCar Series, NASCAR and researchers at the University of Nebraska–Lincoln. These barriers have been credited with greatly reducing the number and severity of injuries in motorsports at the tracks at which they have been installed.

This module challenges you to design a wall that makes collisions between the car and the wall safer. Like all real problems, you have to deal with some constraints. For example, you can't make the barrier so wide that there is no track left to race on. You can't make the barrier so expensive that tracks can't afford to install it. You also have to worry about the fact that there are multiple cars on the track, so the challenge is more than softening the impact: You also have to figure out how to make sure that your wall doesn't propel the car back into traffic where it might be hit by other cars.

Pre-Race

You will be testing barriers similar to those that are around race tracks. Your test setup is going to be similar to that shown to the right. Your 'wall' is a piece of wood. You will release your car from a spot at the top of the ramp that is between 15 (xx cm) and 18 inches (xx cm) from the floor .

Describe what you expect to see when you release the car.

Students should mention the car hitting the wall; some may predict that the car will bounce back. They also should mention that there will be a sound when the car hits the wall.



Your set up is going to look something like this, with a ramp on one side and a wall on the other.

How much force do you think your car will feel (in units of newtons). Explain why you are predicting that value of force.



STUDENTS: OBTAIN A CAR FROM YOUR INSTRUCTOR.

Start Your Engines...

Get your test equipment set up as shown in the pictures to the right. Make sure that the nose of the car hits the wall while the wheels of the car are still on the track.

Place a mark at the spot from which you will release the car and make sure that you release the car from the same height each time. Have one team member release the car from the mark while everyone watches as it hits the wall. Record your observations below.



The "wall" (right) is moved away from the setup so that you can see it more clearly. You should place your wall so that the nose of the car touches the wall while the car's wheels are still on the track, as shown in the picture below.



PIT STOP: Have your instructor check your answer before proceeding.

Did anything happen you didn't predict? Did anything not happen that you predicted would happen?

How would a scientist describe the interaction between the car and the wall? What kinds of science words would scientists use?

Engineers who study vehicle collisions use sensors to measure how hard each impact is. You have a force sensor to measure the force exerted by the car on the wall. Place the car at the same height you used for your first trial. This time, use the computer and force sensor to measure how the force on the wall changes with time. Paste the force vs. time graph below. What can you learn from this graph?

**What properties should a wall have to minimize injury to the driver and damage to the car?
How should the wall behave during and after the hit?**

What should the force vs. time graph look like if the wall you design does its job the way you want it to?



PIT STOP: Return your car to your instructor and wait for a class discussion of the force-vs-time curve. During the class discussion, make notes of any ideas you hear that your group didn't think about.

The track owner has asked you to make a preliminary study of a limited number of different types of barriers, and then present him with a report that summarizes the strengths and weaknesses of the different designs. The track owner tells you that your barrier cannot extend more than 6.4 cm (2.5 inches) from the front of the track wall. If the barrier is any wider, there won't be enough racing surface left.

Start Designing

Examine the materials available to you. What material do you think might be the best to use in constructing your first wall and why?

Your instructor will tell you how many wall designs the track owner's budget allows you to test. Fill out a separate wall evaluation form for each wall you test. You must get your instructor's approval of your design BEFORE you test the design.

Your Report to the Track Owner

What general principles have you learned about making walls safer for drivers and their cars?

Write a short paragraph summarizing the results of your tests that would be understandable to the track owner. Explain to the owner the science behind your design without using any technical terms, graphs or other diagrams. Include a recommendation for what type of wall you suggest he should fund further development.

Extension A: Selling your Wall

Write a few paragraphs suggesting that the owner invest in further research into the best type of wall you determined from your tests. Explain why you believe that this type of wall is the most promising type of wall to research and what additional experiments you would do if you had more time.

Extension B: A New Angle

You tested your wall using a head-on collision. In reality, a car usually hits the wall at an angle. Does hitting the wall at an angle increase or decrease the force felt by the driver?