Chapter 13 Problem 39 [†]

Given
$f = 0.45\ Hz$
$L = 40\ m$

Solution
Find the speed at which the car shakes violently.

The bumps act as the driving force of the oscillations for the car. Therefore, the speed of the car must be such that the bumps are hit with a frequency matching the natural frequency of the car. Frequency is related to the inverse of the time period.

$$T = 1/f$$

Average velocity is defined as

$$v = \frac{\Delta x}{\Delta t}$$

The change in x is the distance between bumps and the change in time is the time period of the oscillation. Therefore, the velocity for violent shaking is

$$v = \frac{L}{T} = \frac{L}{\frac{1}{f}} = Lf = (40\ m)(0.45\ Hz)$$

$$v = 18\ m/s$$

This speed corresponds to about 40 miles per hour.

[†] Problem from Essential University Physics, Wolfson