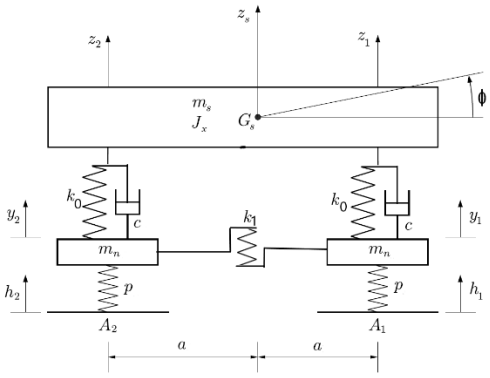
1. Comfort with roll motion

(a)

(b)



(c)

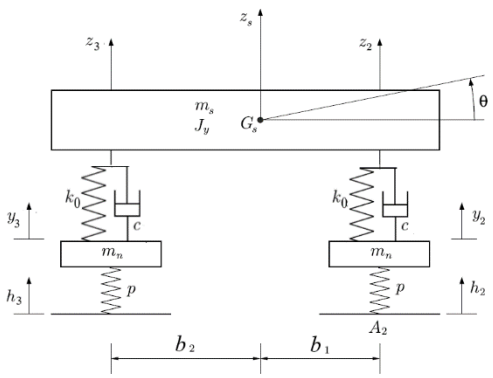


Fig. 1-(a) vehicle on a test track, (b) model front view, (c) right side

An urban vehicle is traveling on a test track. At x_0, the car encounters a series of triangular bumps. At x_1, the track becomes flat again. The multiple bumps can be assumed to be a periodic triangular pulse function of the horizontal variable x, with a phase shift between the forcing acting on A_1 and A_2.

Consider the following test procedure:

- Test 1. Constant acceleration staring from $v(0) = v_0$.

The vehicle must be modeled as a 7 degrees-of-freedom system with the following parameters: sprung mass m_s , roll moment of inertia J_x, pitch moment of inertia J_y, center of gravity G_s, unsprung mass m_n, suspension stiffness k_0, viscous damping coefficient c, tire stiffness p, front anti-roll bar stiffness k_1. Tires are always in contact with the ground.

i) Derive the equation of motion of the system, find the natural frequencies and the mode shapes.
ii) Plot the full transient response of the masses.
iii) Remove the anti-roll bar and repeat (i) and (ii).
iv) Compare and discuss the results obtained with and without the front anti-roll bar.