Modelling of Air Bag System

4.4. Multi-airbag Modeling

With a validated single airbag impact model established, a multi-airbag impact model was developed to facilitate the design of the personal airbag system. This model exploits the non-linear stiffness of airbags by employing a structural dynamics framework, based on Lagrange's equation. This is given by

$$\frac{d}{dt}\left(\frac{\partial K}{\partial \dot{q}}\right) - \frac{\partial K}{\partial q} + \frac{\partial V}{\partial q} + \frac{\partial D}{\partial \dot{q}} = \frac{\partial W}{\partial q} \qquad (5)$$

Using Lagrange's equation, the resulting system equations for this particular three airbag system are found to be

$$m\ddot{u} + k_1 u_1 + k_2 u_2 + k_3 u_3 = mg$$

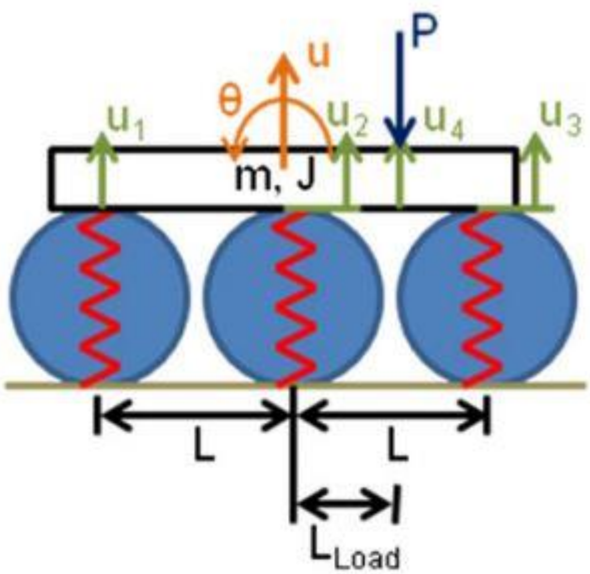
$$J\ddot{\theta} - L\cos\theta(k_1 u_1 - k_3 u_3) = mg\, L_{Load} \cos\theta \qquad (6)$$

where u is the system vertical displacement, θ is its pitch angle, u_i and k_i are respectively the vertical displacement and non-linear stiffnesses of airbag i, P is the system weight force located at its center of gravity, L is the distance between adjacent airbags, L_{Load} is the distance between the center of gravity and the system geometric center, m is the system mass, and J is its mass moment of inertia.

<u>Equation of motion:</u>

$$m\ddot{u} + k_1 u_1 + k_2 u_2 + k_3 u_3 = mg$$

$$J\ddot{\theta} - L\cos\theta(k_1 u_1 - k_3 u_3) = mg\, L_{Load} \cos\theta$$



$$\ddot{\theta} = \frac{1}{j}\{p - k_1 u_1 \cos\theta\,(-L - L_{load}) - k_3 u_3 \cos\theta\,(L - L_{load}) + k_2 u_2 \cos\theta\; L_{load}\}$$