Appendix B

Kinematics Calculation

Vehicle Motion

- Initial velocity =160 km/h

$$u = 160\frac{km}{h}(\frac{1h}{3600s})(\frac{1000m}{1km})$$
$$u = 44.4444m/s$$

- Time taken to fully stop the vehicle

$$v = u + at$$
$$t = \frac{v-u}{a}$$
$$t = \frac{0-(44.4444m/s)}{-(0.7)(9.81)m/s^2}$$
$$t = 6.47s$$

Drum Brake Equation

- Shoe contact area (A)

$$A = s_{1-2} * W$$
$$= \frac{d_i \theta \pi}{180^o} * W$$
$$= \frac{(0.25m)(100^o)\pi}{180^o}(0.185)$$
$$= 0.0807m^2$$

- Initial angular velocity of drum (ω)

$$\omega_{tire} = \omega_{drum}$$
$$v_{tire} = r_{tire} * \omega_{tire}$$
$$\omega_{tire} = (44.4444 m/s) / {(0.57m)}/{2}$$
$$\omega_{tire} = 155.9454 rad/s$$

- Disc initial angular acceleration

$$\alpha_t = \alpha_d$$
$$a_t = r_t * \alpha_t$$
$$\alpha_t = (6.867 m/s)/(0.285 m)$$
$$\alpha_t = 24.09 rad/s^2$$

- Angular velocity of the next shoe movement

$$\omega_1^2 = \omega_0^2 + 2\alpha\theta$$
$$\theta = 100°$$
$$= 1.745 rad$$
$$\omega_1 = \sqrt{\omega_0^2 + 2\alpha\theta}$$
$$\omega_1 = \sqrt{(155.9454 rad/s)^2 + 2(-24.09 rad/s^2)(1.745 rad)}$$
$$\omega_1 = 155.6756 \, {rad}/{s}$$

- Time interval between shoe movements

$$\Delta t = \frac{\omega_1 - \omega_0}{\alpha}$$
$$\Delta t = \frac{155.6756 - 155.9454}{-24.09}$$
$$\Delta t = 0.01112$$

- Velocity of vehicle during next shoe movement

$$v_2 = (0.285m)(155.6756rad/s)$$
$$v_2 = 44.3676m/s = 159.7232km/h$$

Thermal Calculation

Energy loss during braking

$$E_{1-2} = 0.95\left\langle\left[\frac{1}{2}m(V_{t1}^2 - V_{t2}^2)\right]\right\rangle$$
$$E_{1-2} = 0.95\left\langle(0.5)(172.5kg)\left[\left(44.4444\frac{m}{s}\right)^2 - \left(44.3676\frac{m}{s}\right)^2\right]\right\rangle$$
$$E_{1-2} = 559.655J$$

Heat flux at contact area

$$q = \frac{Q}{A} = \frac{\Delta Q}{At} = \frac{7503.46J}{(0.0112s)(0.0807m^2)}$$

$$q = 619224\ W/m^2$$

Note: Calculation is continued until value of ω becomes zero.