Workshop # 4 **Nov. 2011**

Ventilated Rotor Brake Temperature – Constant Heat Flux

The purpose of WS4 is to review detailed applications of the finite difference method and to do parameter evaluations and brake temperature sensitivity studies. Disc brake details see webinar at: http://www.mcicoach.com/service-support/webinars.htm "Getting to know your disc brakes". **PC-BRAKE TEMPERATURE – "Constant Heat Flux"** is available from the website.

See Section 3.1.10.3 of 3rd edition of ***Brake Design and Safety***/SAE International 2011. The rotor and bearing geometry is illustrated in Fig. 3-14. The temperature response of Fig. 3-15 is for 30 cycles of varying braking severity (70 mph). The convective heat coefficients were reduced to account for the rust buildup in the cooling vanes (node 2, Fig. 3-8) and tight packaging of the brake limiting effective cooling air flow.

Eq. 3-58 shows the temperature of the inboard node #3. The number of nodes used (Fig. 3-14) is sufficient to study the temperature response for repeated braking. All nodal equations are available in the formula bar of the spread sheet. The computer program attached applies to constant downhill braking followed by cooling. The speed underlying WS4 example is 40 ft/sec (27.3 mph) constant for 300 seconds, followed by cooling. See other input data on Tab NsCC.

Step 1. Use Eq. (3-40) or (3-41) to calculate/estimate convective heat transfer coefficient h_1 for friction/cooling surface of nodes #1 and 3 at 40 ft/sec.

Step 2. Use Eq.(3-42) or (3-43) to calculate/estimate convective heat transfer coefficient h_2 at 40 ft/sec. If needed, choose a truck tire size for wheel revolutions at 40 ft/sec. See Eq. (3-35).

Step 3. Use attached software/spread sheet to study thermal problem. Evaluate temperature chart. Which nodes store most of the thermal energy/heat?

Step 4. Carefully review Section 3.1.7.1 Lumped Formulation. Use PC-BRAKE Temperature 2.3, Continued (Down Hill) Braking. The underlying thermal analysis of 2.3 software program uses a lumped formulation. Input the same braking data. Based upon Step 3, "adjust" critical brake rotor data until brake temperature after 300 sec (0.0833 h) is approximately 1250 deg. F. Would it be more accurate to use the average temperature of the three highest temperatures of node #1, #2, and #3? What h-value should be used for the lumped temperature analysis?

Step 5. What is the effective volume of the rotor that stores most of the thermal energy? (Step4). What is the effective cooling area of the rotor? Under what conditions is a lumped formulation [Eq.(3-35)] sufficient for a continued braking analysis? What approximate surface area and volume should be used for a lumped temperature analysis (Fig. 3-14)? (v_r = 0.145 ft^3, A_c = 3.4 ft^2 may work, but you check!). Review Section 3.3.1.2.