Maximum brake force calculations for Drum Brakes

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The maximum brake force that can be generated on application of drum brakes are a compound of the force applied on the lever, the mechanical advantage offered by the connecting linkages and a function of the shoe efficiency.

The schematic below shows the setup of drum brakes in motorcycles.

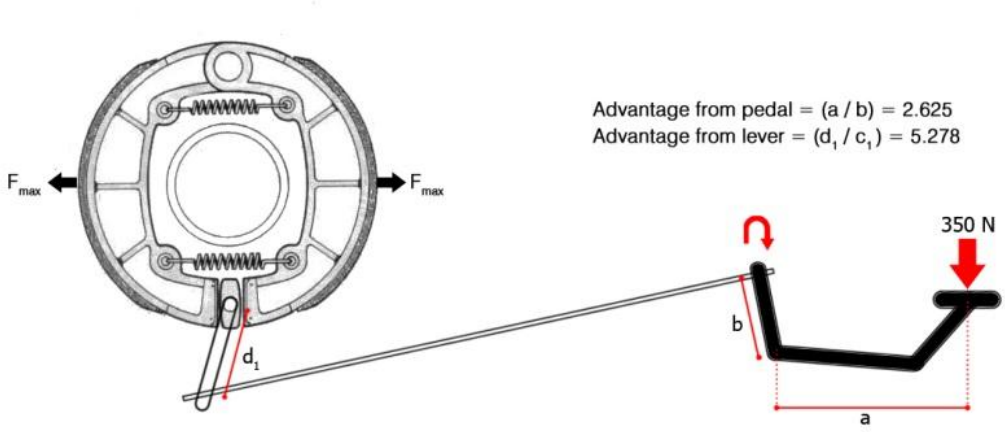

Figure (1) Rear Braking System

The rear braking system for standard drum brakes consist of a pedal, rod and lever at the drum. To calculate the brake force at the brake shoe we have to consider the force at the pedal and the force multipliers such as the linkages. The mechanical advantage provided by each linkage is calculated independently and then compounded to obtain the total brake force at the shoe.

Force applied on the pedal, F_{pedal} = 350 N [1]

Advantage offered by the pedal, $Adv_{pedal} = (a/b) = 2.625$

Advantage offered by the drum lever, $Adv_{lever} = (d_1/c_1) = 5.278$

Force applied at the cam, $F_{cam} = F_{pedal} \times Adv_{pedal} \times Adv_{lever} = 494.465$ kgf

Coefficient of friction between brake shoe and brake drum, $\mu = 0.4$

Maximum force applied by the brake shoes, $F_{max} = 2 \times F_{cam} \times \mu = 395.565$ kgf

Maximum brake torque, T_{max} = Drum Diameter $\times F_{max} = 0.13 \times 395.565 = 51.42$ kgf-m

Revision 1

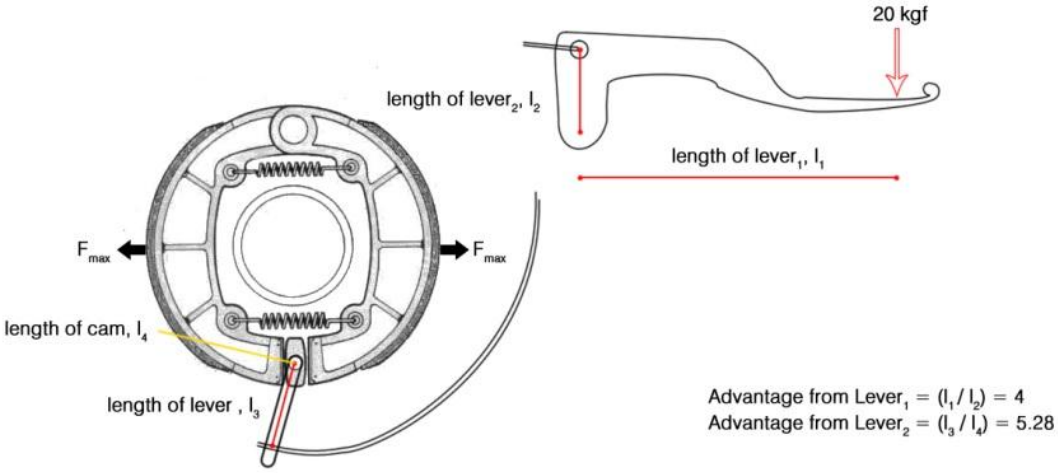

Figure (2) Front Braking System

The braking system at the front of the motorcycle is set up as shown in the above figure. The initial braking force is applied via the hand lever. The mechanical advantage of the hand lever and the drum brake lever are compounded to arrive at the force on the cam. It is assumed that the maximum force that can be applied by the rider at the hand lever is 20 kgf.

Force applied on the lever, F_{lever} = 20 kgf [2]

Advantage offered by the hand lever, $Adv_{lever1} = (l_2/l_1) = 4$

Advantage offered by the drum lever, $Adv_{lever2} = (l_3/l_4) = 5.278$

Cable efficiency, $\eta = 0.8$

Force applied at the cam, $F_{cam} = F_{lever} \times Adv_{lever1} \times Adv_{lever2} = 337.792$ kgf

Coefficient of friction between shoe and drum, $\mu = 0.4$

Maximum force achieved by the brake, $F_{max} = 2 \times F_{cam} \times \mu = 270.234$ kgf

Maximum brake torque, T_{max} = Drum Diameter × F_{max} = 0.13 × 270.234 = 35.13 kgf-m

RESULT:

Maximum brake force for a rear drum brake = 395.565 kgf

Maximum brake force for a front drum brake = 270.234 kgf

Maximum brake torque for a rear drum brake = 51.42 kgf-m

Maximum brake torque for a front drum brake = 35.13 kgf-m

Revision 1

References:

[1] & [2] - IS 14664 (2010): AUTOMOTIVE VEHICLES — PERFORMANCE REQUIREMENTS AND TESTING PROCEDURE FOR BRAKING SYSTEM OF TWO AND THREE WHEELED MOTOR VEHICLES [TED 4: Automotive Braking Systems] – Bureau of Indian Standards

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