Report Center of Gravity (COG)

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Introduction

In this short report, we provide bounds for the semi-optimal location of the COG for a racing motorcycle as function of the wheelbase. The values are found in the literature by Cossalter[1]. Influences of the total wheelbase are not considered in this report.

Coefficients:

a = distance COG to front wheel [m]
b = distance COG to rear wheel [m]
h = height COG of total wheelbase [m]
p = wheelbase [m]

Influences of COG:

The location of the COG mainly influences the three aspects of the motorcycle:

1. Maximum acceleration (assuming limitation by wheelie and not engine power)
   COG more to the front -> Higher acceleration
   Lower COG -> Higher acceleration
2. Maximum deceleration (assuming limitation by stoppie and not braking power)
   COG more to the rear -> Higher deceleration
   Lower COG -> Higher deceleration
3. Handling in the corners
   Higher COG results in larger instability of the bike making it easier to roll inside the corners. However a high COG makes it more difficult to roll from one side to the other side.

Forward COG	The motorcycle tends to over-steer (in curves the rear wheel slips laterally to a greater extent).
Rear COG	The motorcycle tends to under-steer (in curves the front wheel slips laterally to a greater extent).
High COG	The front wheel tends to lift in acceleration. The rear wheel may lift in braking.
Low COG	The rear wheel tends to slip in acceleration. The front wheel tends to slip in braking.

Table 1. Influences of COG on steering, braking and acceleration.[1]

Constraints:

From Cossalter[1] the following constraints can be found for the COG (without the rider[2]):

$0.43*p < a < 0.50*p$
$0.50*p < b < 0.53*p$
$0.30*p < h < 0.40*p$ (For racing motorcycles close to 0.4 is preferred[1])

[1] Motorcycle dynamics, Cossalter, 2006, 2nd edition
[2] Note here that the rider in general moves the COG up and slightly towards the rear.
[3] …..

Important note:
Note that it is assumed that the acceleration is not limited by engine power. In case a wheelie or skidding of the wheel will not occur due to power limit, the optimal COG position is based on the braking maneuver. In this case it will be better to place the COG more to the rear and higher to increase the traction on the rear wheel as well as the achievable braking force. [4]

[4] Cossalter, Tavernini, Lot, Optimization of the centre of mass position of a racing motorc
and wet track by means of the “Optimal Maneuver Method”, (2013).