**Report Wheelbase**  
By: Marianne Schaaphok  
Date: 17-12-2018

**Introduction:**In this small report we provide an analysis of the wheelbase and the effects/influences of the wheelbase on the dynamics of the motorcycle. The analysis is mainly based on information from the book Motorcycle Dynamics by Cossalter [1].

**Definitions:**  
p = wheelbase [m]  
= friction coefficient tire (assuming 1.1)   
g = gravitational constant (9.81 m/s2)

**Influences:**An increase in the wheelbase will result in the following positive (+) and negative (-) effects:

**(-)** **Increase in flexional and torsional deformability of the frame.** Here note that more deformable   
 frames result in less maneuverability. Difficult to find any concrete notes on the precise effect of  
 the deformability on the maneuverability.

**(--)** **Increase in minimum curvature radius**   
 Minimum curvature for straight up bike increases at low speeds. However since this is straight up  
 and at low speeds, it is therefore not important for race bikes.

**Note** that the actual turning radius is only defined by the (constant) lean angle and the speed   
 and is not dependent on the wheelbase.

The longer wheelbase does however increase the time taken by the bike to reach that certain lean  
 angle, thereby decreasing the maneuverability.

[At Assen the sharpest corner has curvature radius R ≈ 23 m.   
 Using it can be computed that the maximal velocity for this turn is 15.8 m/s. ]  
  
**(-)** **Increase in the necessary steering torque**   
 Since the wheelbase is longer, a larger steering torque is necessary from the driver to receive the   
 same response by the motorcycle. Achieve concrete numbers on how much this is affected is   
 difficult. However we note that in general the driver only has to race the bike for about 20 min,   
 making it less important if he has to put slightly more power into steering, as long as it does not  
 affect his driving style.   
  
 **(-)** **More space in between to cover, increasing weight.**   
 If done efficiently, the space can be covered without adding too much extra weight to the bike.   
 The gain in acceleration/deceleration will be more than the loss due to extra weight.   
  
**(++)** **Decrease in load transfer**, which results in more stability during acceleration/braking and   
 decreases the pitch.  
 Due to the larger wheelbase, a wheelie and stoppie occur less fast, increasing the maximum   
 acceleration and deceleration (assuming that the wheelie/stoppie are the main limiting factors   
 and not engine/brake power or slipping).   
  
**(+)** **Reduction of pitching due to road unevenness**   
 It should be considered that the racetrack has small unevenness and the pitching due to this factor   
 is relatively small. Therefore the positive effect of the increased wheelbase is in   
 reality small and can largely be ignored.   
  
**(+/-)** **Increase in directional stability**   
 Directional stable is when a motorcycle tends towards its equilibrium in rectilinear motion.   
 The wheelbase influences the value of the trail and long trails lead to high directional stability at   
 high velocities. However directional stability is also influenced by other factors, such as steering   
 geometry, forward speed, gyroscopic effects, inertial factors and tire properties.

However a high directional stability also implies more difficulty in handling in the corner, also  
 named in the increased steering torque. The bike will roll slower into corners and takes more   
 work for the driver.

**(+) More room for the other components**  
 A larger wheelbase will provide more room to place batteries and give more space to shift with   
 the locations of different parts.   
  
 Also a longer wheelbase will allow the rider to have a more aerodynamic position.

**Empirical values:**From literature it is found that the wheelbase of racing motorcycles are in the following range:

In table 1, the wheelbase values for current racing motorcycles can be found.

|  |  |
| --- | --- |
| MOTORCYCLE | WHEELBASE(mm) |
| Yamaha YZF-R6 | 1380 |
| Honda CBR600RR | 1370 |
| Kawasaki Ninja ZX-6R | 1390 |
| Suzuki GSX R600 | 1390 |
| Ducati 749 | 1420 |
| Energica Ego(Electric) | 1465 |

Table 1. Wheelbases for 6 different brands of motorcycles

**Consideration**In comparison to conventional bikes, electric motors can give maximal torque and acceleration continuously. It can be assumed that the acceleration is therefore sooner limited by the wheelie. The continuous torque will result in a larger advantage when the wheelbase is slightly longer.   
  
Agility can be affected by many different parameters and can for example be improved by:

Also take into mind that the wanted agility also depends on the preferences of the rider and should therefore be slightly flexible.

**Conclusion and discussion:**

In conclusion we can say that a larger wheelbase will improve the acceleration and braking since it will reduce the load shift and increase the conditions for the wheelie/stoppie. Further it increases the directional stability, decreasing its agility and responsiveness for cornering.

Looking at the advantages and disadvantages we would want to increase the wheelbase, such that we can make full use of acceleration, under the constraint that the bike is still agile enough for the track it needs to race.

Since it is hard (for now) to place any concrete numbers on the values, it might be a good idea to make the wheelbase a bit flexible, e.g. by giving room to shift the connection of the swingarm or the value of the trail.

We would **advise** a starting wheelbase of 1450 mm.

**References:**