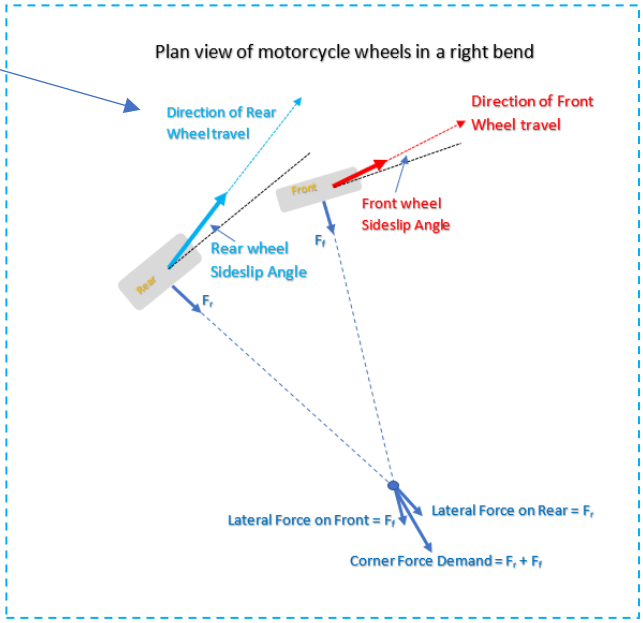
Explanation of why placing the upper torso on to the tank of a motorcycle in a bend, helps it to negotiate the bend.

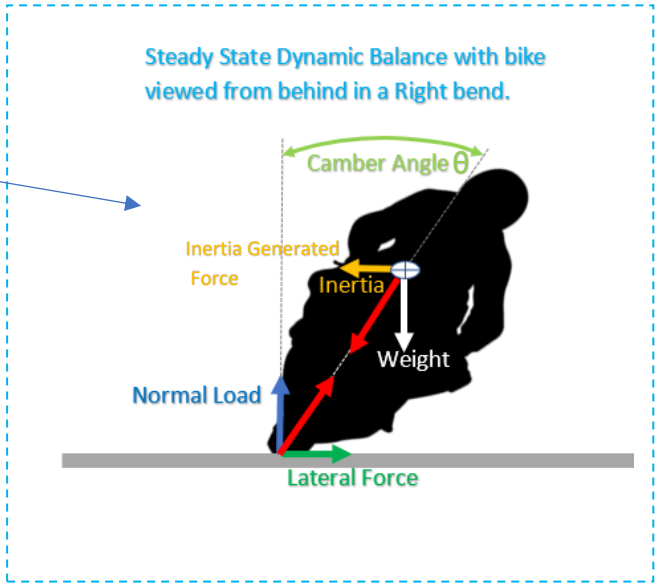
To negotiate a bend a motorcycle must meet the demand of Corner Force, which acts towards the centre of the bend. The main force responsible for meeting this demand is Camber Thrust, a Lateral Force caused by deformation of the tyre carcass when the bike leans off the vertical. Note that a 'Lateral Force' is one that acts at right angles to the plane of the wheel. Camber Thrust therefore acts towards the centre of the bend, like a compressed spring resisting tyre deformation.



At speed the bike also slips sideways in the bend and in doing so, Lateral Slip Generated Friction Forces are produced at each contact patch. When added together, Camber Thrust and 'Lateral Force' meet the Corner Force demand.

Lateral Force therefore contributes to 'grip' and it is proportional to the Normal Load on the Contact Patch and the Camber Angle (I.E. the angle that the bike leans off the vertical in a bend). The relationship between them for the front wheel is: $F_f = N_f \, Tan\theta$

I.E. The Lateral Force on the Front Contact Patch is equal to the Normal Load on the Front, times the Tangent of the angle of lean off the vertical (θ).



This is the crux of the matter!

Lateral Force contributes to 'grip' and it increases as the Normal Load on the Contact Patch increases and as the lean angle off the vertical increases in a bend. However, it can only increase to some maximum value, after which the tyre lets go and the front wheel slips out from under the bike, even though at a theoretical lean angle of 90^0, Tan θ would be infinity, suggesting that grip is infinite, if you had a 90^0 lean: clearly an impossibility.

By placing your upper torso on to the tank you reduce the Centre of Gravity of the bike / rider combination and in doing so, you transfer less Normal Load to the rear wheel under acceleration; leaving that un-transferred Normal Load acting on the front Contact Patch, where it contributes to the Lateral Force and hence to the amount of 'grip' available.

Why is this?

It is explained by considering the Load Transfer formulae, which are easily derived from the diagram below, taken from the excellent reference book 'Motorcycle Dynamics' by Professor Vittorie Cossalter.

From a consideration of the Moments and Forces shown in this diagram, we can derive formulae for Normal Load on the front and rear Contact Patches.

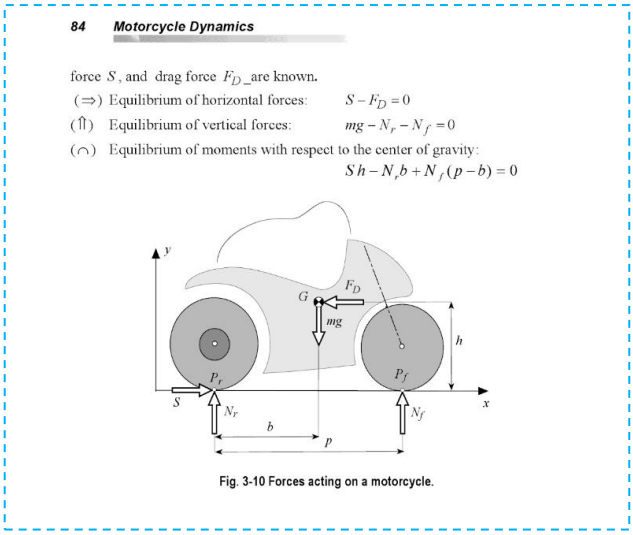
This shows that under acceleration, the Normal Load on the front Patch reduces by an amount S $\frac{h}{p}$ whilst the Normal Load on the rear patch increases by the same amount S $\frac{h}{p}$

I.E. this is the amount of Load transferred from front to back under acceleration.

$$N_r = mg\frac{p-b}{p} + S\frac{h}{p}$$

$$N_f = mg\frac{b}{p} - S\frac{h}{p}$$

This term is the Load Transfer Factor and you can see that it depends on the Drive (S) to the rear wheel, which increases when you go on gas; it also alters with the height (h) of the Centre of Gravity above the road surface and the length of the wheelbase (P) of the bike, which is the distance between the front and back Contact Patches.


84 Motorcycle Dynamics

force S, and drag force F_D are known.

($\Rightarrow$) Equilibrium of horizontal forces: $S - F_D = 0$

($\Uparrow$) Equilibrium of vertical forces: $mg - N_r - N_f = 0$

($\curvearrowright$) Equilibrium of moments with respect to the center of gravity: $Sh - N_r b + N_f(p-b) = 0$

Fig. 3-10 Forces acting on a motorcycle.

By lowering your torso on to the tank, the height of the combined bike / rider Centre of Gravity is reduced (I.E. h gets smaller).

This in turn reduces the Load Transfer Factor $S\frac{h}{p}$

The amount of Normal Load transferred under acceleration therefore reduces, leaving more Normal Load on the front Contact Patch. I.E. the front has a bigger share of supporting the weight of the bike and rider, than it would if you sat upright in the saddle, with the same amount of acceleration in the bend.

It was stated above that the increased Normal Load on the front Contact Patch, increases 'grip':

$$F_f = N_f\, Tan\theta$$

Hence, by leaning over the tank in a bend, you increase the 'grip' available to the front tyre, which makes the bike corner better.

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