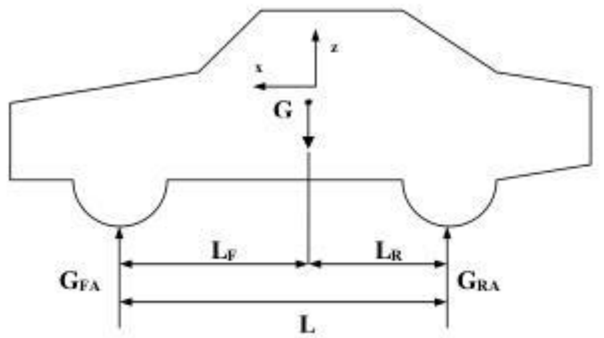
To understand the weight transfer we shall consider some cases of braking and cornering as most of the weight is transferred during these two cases only. But before I discuss those cases let me explain to you how weight is distributed in static conditions

STATIC CONDITION



Static axle loads on the vehicle

Consider a vehicle standing still as shown in above figure where

G= Center of gravity (where weight of vehicle is assumed to be concentrated)

L_F= Distance of centre of gravity from front wheel

L_R=Distance of centre of gravity from rear wheel

$L=L_F+L_R$= Wheelbase of the vehicle.

G_{FA}= Load on front axle

G_{RA}= Load on rear axle

Since every force is in equilibrium therefore on solving we get

$G_{FA}=G*L_R/L$

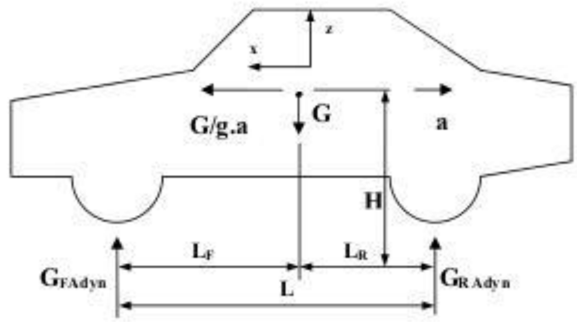
And $G_{RA}= G*L_F/L$.

Suppose our vehicle is of mass 600 kg and wheelbase of 2m and track width of 1.5 m with the centre of gravity at 60:40 position.

Therefore load on front axle= $600 * 10 * \frac{60}{40+60}$ = 3600 N

Similarly, load on rear axle = $600 * 10 * \frac{40}{40+60}$ = 2400 N

BRAKING ON LEVEL ROADS (LONGITUDINAL WEIGHT TRANSFER)



Forces acting on a vehicle during braking

When the vehicle is moving and you suddenly apply brakes the following forces are generated on the sprung mass and axle of the vehicle as shown in the figure. Here subscript "dyn" represents dynamics load on the axle. During braking as you are seeing in the figure due to retardation, a pseudo-force is developed which causes pitching action in the forward direction which equals Ga/g where a=braking retardation and H= height of the centre of gravity from the ground.

Considering the equilibrium of the vehicle the dynamic load on axle as found out by

$G_{FAdyn} = G_{FA} + \frac{maH}{L}$

$G_{RAdyn} = G_{RA} - \frac{maH}{L}$

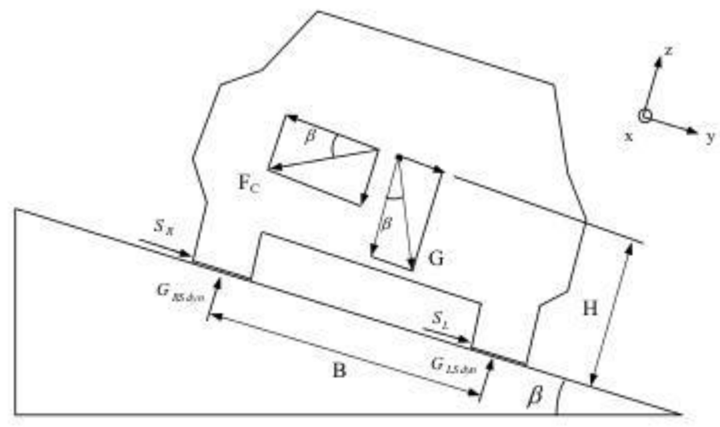
Here $\frac{maH}{L}$ represents part of weight that has been transfer for an instant form rear to front in case of braking and front to rear in case of accelerating.

Let braking retardation equals 6 m/s^2 and H=0.4 m

Therefore G_{FAdyn}= 3600 + 600*6*0.4/2 = 4320 N (22% weight transfer)

G_{RAdyn}= 2400 – 600*6*0.4/2= 1680 N

CORNERING ON BANKED ROAD (LATERAL LOAD TRANSFER)



Forces acting on a vehicle during cornering

During cornering, the force responsible for the weight transfer is the centrifugal force which is represented by F_c in the figure. The figure shows the rear view of the vehicle cornering on a banked road which is at angle β with the ground.

G_{RSdyn}= Dynamic load on right side wheel

G_{LSdyn}= Dynamic load on left side wheel

For given condition equations would be written as:

$G_{RSdyn}=\frac{G}{B}\left(\frac{v^2}{gR}\left\{Hcos\beta+\frac{B}{2}sin\beta\right\}+\frac{B}{2}cos\beta-Hsin\beta\right)$ where B= track width R= radius of cornering.

$G_{LSdyn}=\frac{G}{B}\left(\frac{v^2}{gR}\left\{Hcos\beta-\frac{B}{2}sin\beta\right\}+\frac{B}{2}cos\beta+Hsin\beta\right)$

Therefore weight transferred from left to right is given by

$G_C= G_{RSdyn} - G/2$

Here $\frac{v^2}{gR}$=μ where μ is dynamic coefficient of friction

If I assume $\beta=15^0$ and μ=0.65 for my vehicle then

G_{RSdyn}= $\frac{600*10}{1.5}\left(0.65\left\{0.4\cos 15+\frac{1.5}{2}\sin 15\right\}+\frac{1.5}{2}\cos 15-0.4\sin 15\right)$ = 3993 N

G_C = 3993 – 6000/2 = 993 N

In this way, you could find it out for different conditions and terrain the weight transfer occurring in the vehicle and thus suspension systems could be designed effectively considering it.

For more information on vehicle dynamics, visit my official website http://vehicledynamics.weebly.com or you can follow my blog on Quora http://vehicledynamics.quora.com