4WD Systems

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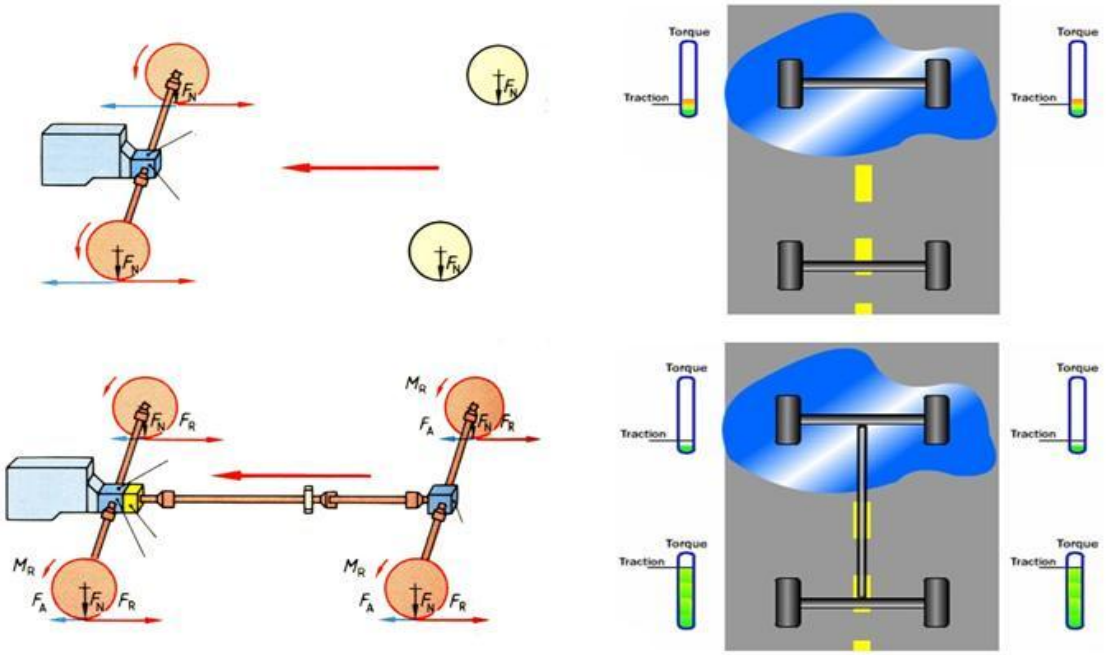
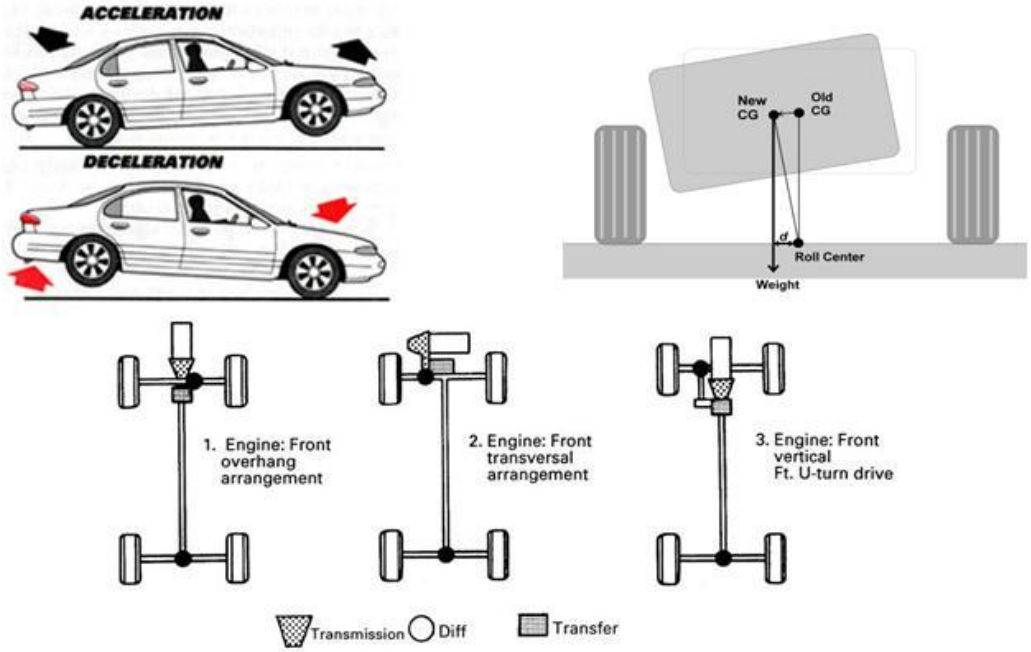
Advantage of 4WD



The main reason for the usage of 4 WD system is to improve the overall traction of the vehicle.
For easy understanding we define traction as the maximum amount of driving force the tire can apply against the ground. The major benefit of a four-wheel drive is the potential to double the amount of longitudinal force the tires can apply to the ground. This helps in a variety of situations, such as low friction road (e.g. snow covered road). In the example on the right side a road with a partly slippery surface is given. In the case of a 2 WD vehicle the required torque to move the vehicle is higher than the available traction. As a result the wheels start spinning and the vehicle gets stuck. A 4 WD vehicle on the same spot will transfer more torque to the rear wheels on the not slippery part, so that the torque acting at the front wheels and rear wheels is below the available traction: the vehicle will move forward. (simplified general sample :the exact condition of torque transfer depends on the actual system layout). The following factors affect traction in general: the weight on the tire - The more weight acts on a tire, the more traction is available.
The coefficient of friction relates the amount of friction force between two surfaces to the force holding the two surfaces together: it is a function of the kind of tires on the vehicle and the type of surface the vehicle is driving on. Important the coefficient of friction for static contact is higher than for dynamic contact (wheel slip), therefore static contact provides better traction than dynamic contact. Wheel slip : it occurs when the force applied to a tire exceeds the traction available to that tire. The possible traction force is reduced in this case, as explained before. The weight transfer due to vehicle acceleration and cornering influences the possible traction of the tires, as the weight acting on the individual tire changes.
FN = weight force on tire, FR = max traction force, FA = driving force , MR = driving torque on tire

Weight transfer and different 4WD systems



The layout of the power train influences the behavior of the car in terms of weight transfer

Weight transfer changes the available traction at the wheels as it reduces/ increases the weight acting on the tires. Weight Transfer occurs in longitudinal direction due to deceleration and acceleration of the vehicle and in lateral direction due to cornering. When a car is cornering at speed, the car's weight is transferred from the inside wheel to the outside wheel. When it accelerates, weight shifts to the rear wheels. The rate of change is proportional to the height of center of gravity (CG), the lateral acceleration (in g) and inversely proportional to the track width.
Weight transfer = (Lateral acceleration x Weight x Height of CG) / Track width. For example, a car is cornering at 0.85 g. Assuming its track width is 1600 mm, height of CG is 500 mm and it weighs 1250 kg, then we can calculate the weight transfer is 332 kg. A car (track width 1600 mm, height of CG 500 mm, weight 1250 kg), rolls 10 degrees when cornering, d will be 500 x sin10° = 86.8 mm. Then the load of the outside wheels can be calculated as: Weight x [(Track width/2)+degrees when cornering] / track width (1250 x (800 + 86.8)) / 1600 = 693 kg While the inside wheels take 557 kg (1250kg – 693kg). So there is 68 kg weight transfer. The amount of weight transfer depends not only on the on the vehicle weight or the G force, but also on the general construction of the vehicle, such as power train layout etc. The picture shows some typical 4 WD layouts for Hyundai vehicles. There are also others as indicated below.