

Transmission of SAE Baja

Naveen Kumar
UG Student

Department of Mechanical Engineering
Chandigarh University Gharuan, Punjab

Nikhil Verma
UG Student

Department of Mechanical Engineering
Chandigarh University Gharuan, Punjab

Abstract

The automatic transmission is a unit which supplies the power from the Engine to the wheels. There are some types of gear transmission system which help to improve the economy and efficiency of the work transfer. Besides the traditional automatic transmission, there are also other types such as continuously variable transmission (CVT), dual clutch transmission (DCT) and automated manual transmission system. Gear shifting strategy is the core of intelligent control of any automatic transmission used in modern vehicles. It directly effects the vehicle performance, drivers comfort and fuel economy. The comparison between all types of transmission system, the gear shifting strategy in transmission systems and power transmitting drives are explained.

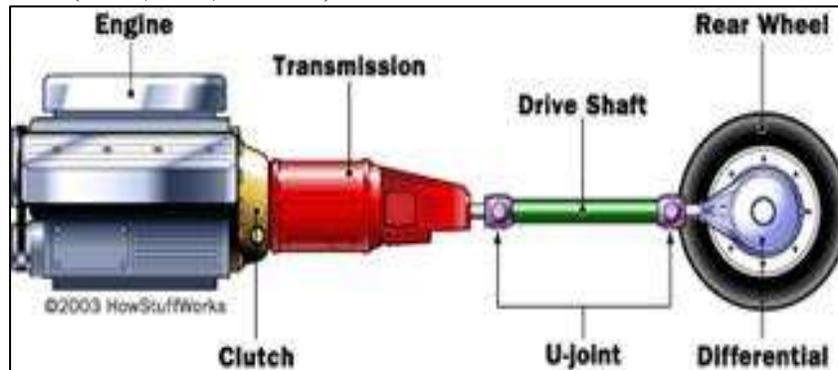
Keywords: Clutch, Sequential Gearbox, CVT, Differential & Its Types, Power Transmitting Drives, CV Shafts

I. INTRODUCTION

Transmission System is the next and final stage of the engine generated power before it hits the wheels. The whole system is responsible to connect engine and wheels, driving and alter the output shaft rotation to a desired speed/torque ratio, allowing a wide range of speed and better performance as the engine has its own RPM limit and maximum torque.

Transmission system consists of following major parts.

- Clutch (Dry/Wet).
- Gearbox/ CVT.
- Differential (Open, Torsen).
- Power transmitting drives (Chain, Belts, Cv shafts).



Each part has a specific role in transmitting power from the engine to the wheels ensuring correct rpm and torque. While studying about Transmission System, the common terms used are discussed as follows:-

A. Horsepower(hp):

1 hp is equivalent to power used by horse to lift 550 pound for 1ft per sec.

The constant “5252” used in formula is derived from above assumption. Mathematically

$$hp = \frac{\text{Torque} * \text{Rpm}}{5252}$$

B. Cubic Centimeters (CC):

It is the volume swept by the piston moving from TDC to BDC. For eg. If we have 150cc engine it means volume swept by piston during any stroke is equal to 150cubic centimeter.

C. Torque

It is the twisting force which tends to cause the rotation.

Now let us explore the Transmission.

II. CLUTCH

Clutch is a mechanical device which engages and disengages power transmission from driving shaft to driven shaft. It works on the principle of force of friction. It is classified into two types:

A. Dry Clutch:

Dry clutch is generally single plate clutch. Dry clutch is used in heavy automobiles where we can't compromise with Torque. The main disadvantage of dry clutch is heating problem due to which it has shorter life. Also it is bigger in size as compared to multi plate/wet clutch so it is not used in normal bikes.

B. WET Clutch:

Wet Clutch is also known as multi plate clutch. In this heat is dissipated through lubricant which also acts as coolant. It has different working as compared to dry clutch. In this alternate plates (friction & clutch plates) are used having teeth inward and outward respectively. Outward tooth plates are attached with driving shaft whereas inward are connected with driven shaft. Friction plate and clutch plate are locked by spring force which engages both shafts. When we press clutch pedal, these plates get apart from each other, disengages both shafts. The main advantage of wet clutch is its long life due to dissipation of heat by lubricant also it is more compact in size.

III. GEARBOX

It is the main component in transmission system which is responsible for alteration in rpm and torque according to the requirement. The most commonly used gearbox is H- Pattern Manual Gearbox. Earlier spur gears are used but due to noise problem these were replaced by Helical gears. Further helical gears are replaced by double helical gears as there is balancing problem which is removed by double helical gear (Herringbone Gear). During manufacturing gearbox the main factor to be considered is Progression ratio i.e the gear ratio should decrease or increase in proper manner so that there is no sudden loss of acceleration and power.

A. H-Pattern Type Gear Box:

These gearboxes are generally Constant Mesh type. In this all gears are always in mesh, the required gear is achieved by locking the gear by dog clutch. In case of reverse gear we use idler gear which results in counter rotation of driven shaft. Earlier there was irritating noise produced during shifting of gears due to which material loss occurs which is improved by introducing synchronizer rings. These are generally brass rings which help in maintaining equal speeds of both gears by use of friction.

B. Sequential Type GearBox:

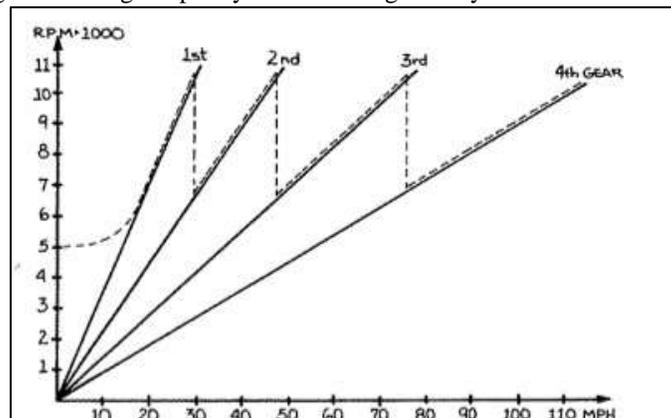
These Gearboxes are generally used in bikes. In this gears are shifted in sequential manner which reduces time lapse and speed drop in shifting gear. Its main advantage is that in this there is no confusion as there is only single gear up or down which avoids the problem of Engine Blown Off.

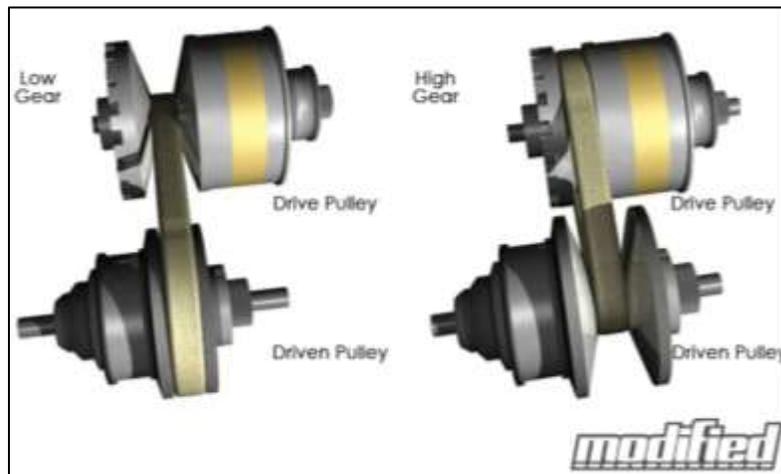
C. CVT:

CVT stands for Continuously Variable Transmission. As the name suggests, it is stepless transmission that can change seamlessly through the continuous range of effective gear ratio.

1) Working:

It consists of two inward tapered pulleys so that belt can adjust itself according to the gear ratio. These pulleys consist of rotating masses when we throttle, rpm increases which results in centrifugal force due to which masses tend to move outward which leads to alter the gear ratio by opening and closing the pulleys. CVTs are generally used in Honda Activa and other gearless bikes.





2) *Advantages of CVT:*

- There is no headache of shifting gears and power loss during shifting of gears is minimized in cvt.
- Compact in size.
- No need of clutch
- Better fuel consumption
- Improved acceleration
- Better emission control results in less greenhouse effect
- Smoother ride

3) *Disadvantages:*

- Higher cost
- Limited amount of torque
- Heating problem due to slip of belt
- High wear and tear
- Require special oil
- Less life than manual gearbox
- Requires experienced driver

IV. DIFFERENTIAL

The main function of Differential is to slow down the inner wheel while taking turn, as the outer wheel has to cover more distance Spider gear is used for this purpose. The main types of differential are:-

- 1) Open differential.
- 2) Limited Slip differential.

Open Differential is common differential used in buses and trucks. It provides 50-50 torque to both wheels weather the wheel is in traction or not.

Limited slip differential (LSD) is helps in providing 100% torque to the wheel which is on traction when one wheel loses traction with road. For eg:- Torsen Differential.

Torsen Differential works on Worm gear-Worm Wheel Principle i.e Worm gear can rotate worm wheel but worm wheel can't rotate worm gear.

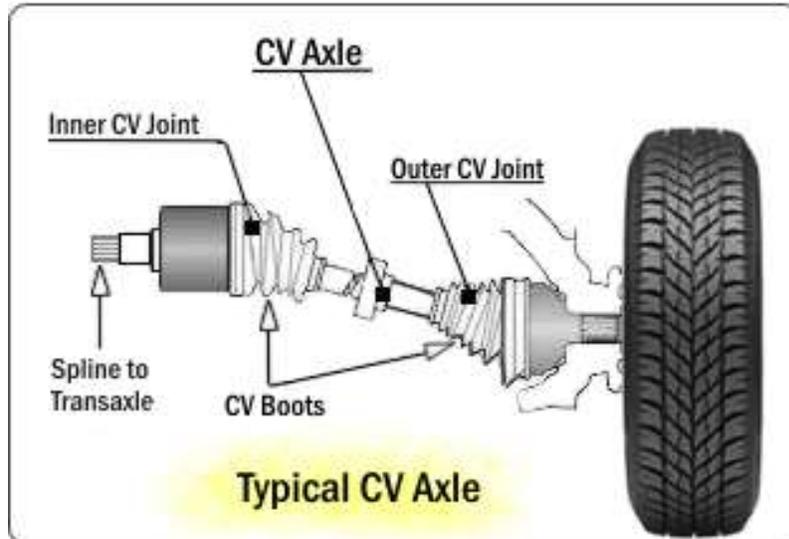
V. POWER TRANSMITTING DRIVES

	<i>GEARS</i>	<i>BELT</i>	<i>CHAIN</i>	<i>SHAFT</i>
<i>COST</i>	<i>Medium</i>	<i>Medium</i>	<i>Low</i>	<i>High</i>
<i>Life</i>	<i>Medium</i>	<i>Low</i>	<i>Medium</i>	<i>long</i>
<i>Efficiency (%)</i>	<i>Above 95</i>	<i>80-85</i>	<i>95-97</i>	<i>98</i>
<i>Use</i>	<i>Shorter distance</i>	<i>Medium</i>	<i>Medium</i>	<i>Larger Distance</i>
<i>Space Requires</i>	<i>Less</i>	<i>Large</i>	<i>Medium</i>	<i>Very Large</i>
<i>Slip</i>	<i>No slip</i>	<i>Yes</i>	<i>No slip</i>	<i>No slip</i>
<i>Noise</i>	<i>Medium</i>	<i>Medium</i>	<i>High</i>	<i>Less</i>

VI. CV SHAFTS

CV shafts consists of cv joints which enables the shaft to transmit constant power at at constant rotational speed at different angles. CV joints provides a allowance of angle. We have various types of cv joints with different allowance.

- Rzeppa joint
- Tripod joint
- Double cardan joint
- Ball type joint



A. Calculations

Some assumptions are made according to requirements which may change.

Assumptions

→ Engine Briggs & Stratton 305cc, 10HP,
Torque (engine) : 14.5, Idle R.P.M = 1750.

$$H.P = \frac{T \times N}{5252} \quad \left(\begin{array}{l} T - \text{torque} \\ N - \text{R.P.M} \end{array} \right)$$

$$N = 3620$$

To calculate gear ratio we have to assume velocity of vehicle.

As $T \propto \frac{1}{N}$

for offroad purpose we need torque.

Let us consider low speed at 1st gear for greater torque.

at 1st gear. $v = 2.7 \text{ m/s}$

$$N_w \rightarrow \text{R.P.M of wheels (22 inches dia)} \Rightarrow v = \frac{\pi D N_w}{60}$$

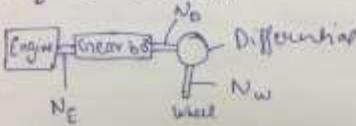
$$N_w = 92.3$$

G.R - Gear Ratio.

If we are using differential of G.R 4:3

$$\therefore \frac{N_D}{N_w} = 4:3 \quad [N_D \text{ is shaft transmitting Power to differential}]$$

$$N_D = 396.89$$



$\frac{N_E}{N_D}$ = gear ratio at 1st gear

If R.P.M of engine is 2300 according to throttle.

gear ratio at 1st gear = 5.54

* Net reduction is $G.R_w \times G.R_o$

$$5.54 \times 4.3$$

$$= \underline{23.8}$$

Similarly for other gears

assume speed according to requirement

To find acceleration.

$$\text{Traction force (wheels)} = \frac{\text{Engine Torque} \times \text{Gear Ratio}}{\text{transmission efficiency} \times R}$$

$$\eta_t = 0.95 \text{ (gears)}$$

$$0.8 \text{ (belt in CVT)}$$

for 1st gear = 23.8

$$\text{Traction force} = 1170 \text{ N} \quad 0.5 \text{ (constant)}$$

$$\text{Aerodynamic resistance} = \frac{R A V^2}{\text{area} \quad \text{vel.}}$$

$$\text{weight [in case of inclined]} = mg \sin \theta$$

$$\text{Rolling resistance} = R_w \sin \theta$$

$$\text{Net resistance} = 380 \text{ N}$$

$$\text{mass of car } 300$$

$$\text{Net force} = \text{Traction} - \text{resistance}$$

$$f = 1170 - 380 = 790 \text{ N}$$

$$\text{acceleration} = \frac{f}{M} = \frac{790}{300} = \underline{2.63 \text{ m/s}^2}$$