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Design and Fabrication of Multi Drive Pulley Transmission using CVT

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***Abstract*: Continuously Variable Transmission (CVT) offers a continuum of gear ratios between desired limits. This allows the engine to operate more time in the optimum range. In contrast, traditional automatic and manual transmissions have several fixed transmission ratios forcing the engine to operate outside the optimum range. The need for a transmission system and the working principle of CVT has been discussed in depth. An attempt has been made to understand the contribution of Hydraulic Actuators, which is an integral part of a CVT. Furthermore, the question of how and why a Torque Converter has effectively replaced a conventional clutch has been answered.**

The materials used, constructional aspects and stress analysis of the belt has been discussed in detail. A comparison between manual transmission and CVT has been done. Recent developments in clamping force control for the push belt Continuously Variable Transmission (CVT) have resulted in increased efficiency in combination with improved robustness. By using CVT, we can obtain multi drive operations. Current control strategies attempt to prevent macro slip between elements and pulleys at all times for maximum robustness.

***Keywords*: multi drive pulley, continuously variable transmission**

1. Introduction

A Continuously Variable Transmission (CVT) has been around for more than a 100 years, but has only recently found its way into automotive applications. However, alternative designs exist that can transmit power and simultaneously give a step less change of ratio; in other words a Continuously Variable Transmission.

Continuously Variable Transmission is a type of automatic transmission that provides an uninterrupted range of speed ratios, unlike a normal transmission that provides only a few discrete ratios.

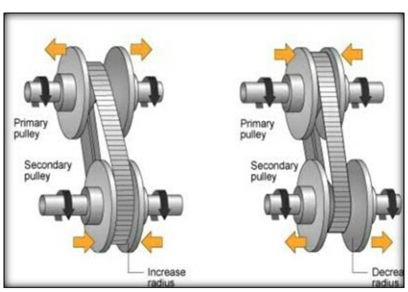

Fig. 1. Continuously variable transmission (CVT)

A Continuously Variable Transmission (CVT) is a transmission that can change stepless through an infinite number of effective gear ratios between maximum and minimum values. On the other hand, the conventional mechanical transmissions offer only a fixed set of gear ratios. The unique feature of a CVT allows the driving shaft to maintain a constant angular velocity over a range of output velocities. This property produces better fuel efficiency compared to other transmissions by allowing the engine to run at its most efficient revolutions per minute (RPM) for a range of automobile speeds. Another possibility is that a CVT can be used to achieve the best automobile performance by permitting the engine to revolve at the RPM at which it produces the peak power. This is normally higher than the RPM that achieves peak efficiency. The use of CVT makes the engine to go from an idle to a pre-programmed rpm immediately, so the engine input is constant and then varies the output speed for smooth, seamless acceleration. CVTs enable power application without any jerk. The continuously variable transmission (CVT) has been around as long as the automobile. Engineers have always recognized its theoretical advantage over the multi ratio gearbox. A CVT enables the engine to run at its most fuel-efficient or most power-efficient speed while driving the vehicle at any speed desired. With a CVT, engine speed and vehicle speed are no longer connected by a series of discrete ratios. Instead, they can function independently across a wide and step less band according to engine characteristics and performance requirements. The advantages of this infinite ratio selectivity are enormous. Most obvious in the IC engine application is that the engine can be loaded into its most fuel efficient region at cruising speeds, then allowed to accelerate into its region of greatest output when peak power is needed, regardless of vehicle speed. Practical problems have consistently plagued the design, but the CVT is now coming of age.

2. Components

1. CVT Setup
2. Pulley
3. Frame
4. Motor
5. Belt
6. Pillow block Bearing
7. Wheel

3. Calculation for CVT flat belt

Torque of flat belt

Input speed = 1440 RPM

1.Transmission ratio:

$i = N_2/N_1$

1400 / 400 = 3.5

2. Torque= $60\times P/2\pi N_1$

(Power = 186.425 Watts.)

$= 60\times186.425 / 2\times\pi\times1400$

$T= 1.2715\times10^3$ N-mm

Length of flat belt:

1. Design power= Rated power ×Service factor(Ks)× Arc of contact(Ka)
2. Arc of contact= 180- (D-d) / c × 60°
   = 180- (165-60) / 1220 ×60°
   (Ks)= 174.8°→ 1.
   (from P.S.G design data book)
3. Correction factor(Ka)= 1
   (from P.S.G design data book)
4. Design power= 186.425×1×1.2
   = 223.71 Watts.
5. Length of the belt $L= 2C+\pi /2\ (D+d) + (D-d)^2 / 4C$
   $=2\times1500+\pi / 2\ (165+60) + (165-60)^2 /4\times1500$
   L=2797mm

Dimension of the flat belt:

Thickness of fla t belt=5mm

Width of flat belt=50mm

Torque of CVT:

1.Torque of motor $T=60 \times P/ 2\pi N$

$T=60\times186.42/2\times\pi\times1440$

T=1.236 N.m

2.Torque of inner CVT pully:

$T_1=60 \times 186.42/2\times\pi\times500$

$T_1=3.56$ N.m

3.torque of outer CVT pulley:

$T_2=60\times186.42/2\times\pi\times630$

$T_2=2.82$ N.m

Output torque of CVT:

INNER:

$T/T_1=N_1/N$

$1.236/T_1=900/1440$

$T_1=1.97$N.m

OUTER:

$T_1/T_2=N_2/N_1$

$1.97/T_2=750/900$

$T_2=2.36$N.m

4. Modeling

Cad tek Systems is a fully authorised and approved training provider for all of the SOLIDWORKS products available. With different training locations across the UK we are able to offer regular classroom based training courses with a fully qualified instructor, to suit all needs. Our flexible training course structure is designed to allow customers to build an appropriate learning and development path that addresses individual specific industry needs.

5. 3D modeling

The assembly solid model of the device. The above model was drawn by the use of the solid works.

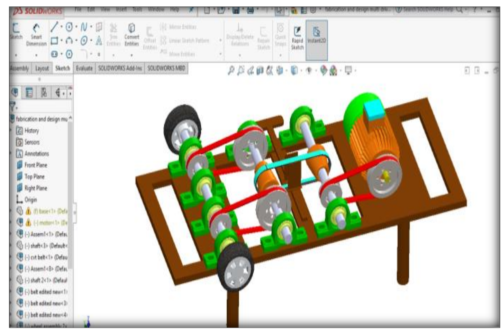

Fig. 2. 3D modelling

6. Working method

1. We are switching on the motor; it starts to run.
2. Rotor is connected with pulley 1 it is inserted in shaft 1. In shaft 1 speed is transmitted to pulley 1 big end and continuously variable transmission pulley.
3. By adjusting the shifting lever, the speed can be varied. In continuously variable transmission the belt is adjusted to big end and smaller end then the speed will be increased.
4. If the belt is adjusted to small end to big end the speed will be reduced. After in shaft 2 pulley 2 & 3 big end and continuously variable transmission pulley transmits the power to shaft 3.
5. In shaft 3 pulley 2&3 are small end then the output speed is increased.by following this power transmission we can achieve requirement of speed quickly.
6. Then the speed can be varied by using shifting lever.

7. Analysis

Analysis is done using an analysis software called ANSIS. He structural analysis is done for the frame made of AS1010.

The cutting force required to chamfer the tooth is calculated. Here the stress and deformation of the components are calculated using finite element method.

Stress analysis:

- VON: von Misses Stress=133887 N/m^2
- Node: 284068.7596e+009 N/m^2
- Node: 20981

1. The young's modulus of plain steel is 190 Gpa.
2. The maximum principle stress acting in plain steel is 26.87 Mpa.
3. As the (1) in higher than the (2) the shaft is designed for its safety.

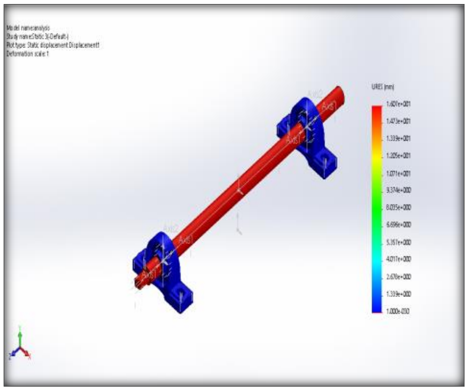

Fig. 3. Stress Analysis

Strain analysis:

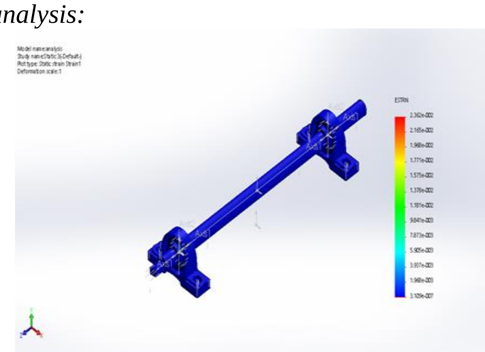

Fig. 4. Strain analysis

Stain analysis:

1. ESTRN: Equivalent Strain=3.10919e-007
2. Element: 166710.0236181
3. Element: 94847

Due to the maximum principle stress the maximum strain 23.27, Which is within the allowable limit.

Fig. 5. Hardware setup

Table 1
Manual transmission

S. No.	Parameters	Manual Transmission
1.	Shifting gears	clutch and pedals shifting is easy
2.	Control and drive	Effective control of the car but it is not always convenient to drive a manual cars
3.	Maintenance	High cost
4.	Initial cost	Low

Table 2
CVT transmission

S. No.	Parameters	CVT Transmission
1.	Shifting gears	CVT shifting is easy
2.	Control and drive	Less control of the car but it is always convenient and comfort to drive cars
3.	Maintenance	Low cost
4.	Initial cost	High

8. Advantages of CVT

1. CVTs provide unlimited gear ratios and improved performance.
2. Pulleys and a belt inside the CVT seamlessly change the gear ratios without any “shift shock” or delay.
3. The infinite ratios help in maintaining a steady cruising speed, reducing the fuel emissions and thus improve fuel economy.
4. Due to its ability to change the ratios continuously, a CVT helps to keep the engine in its optimum rpm range, thereby increasing the fuel efficiency.
5. The 2012 model of the Honda Jazz sold in the UK actually claims marginally better fuel consumption for the CVT version than the manual version.

9. Conclusion

This paper presented design and fabrication of multi drive pulley transmission using CVT.

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