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Differential Gearbox-A Review

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ABSTRACT: ***When the vehicle is moving on a road and when it takes a turn both the surface and inside wheel got to travel different distance so here the differential gearbox comes into role. The transmission utilized in the vehicle contain a component which is employed to transfer power from propeller shaft to both the wheels is named as differential. It's an assembly of drugs in an epicyclical gear train which enable the rotation of two shaft at two different speed, used at the rear side of the vehicle to rotate the wheel faster than the opposite. This study deals with the differential problems during various situations and solutions to each problem by modifying the content, configuration and using a different method. Any researcher's view in this paper is to increase performance by increasing the power of its weight by adjusting its shape by changing either the chain differential or the gear differential. This differential development increases its performance by cracking as the load works.***

KEYWORDS: ***chain differential, design, development, efficiency, spur gear differential.***

1. INTRODUCTION

The differential is employed in two ways, one is that it receives an input and creates two outputs whereas other is that It receives two inputs combined it and provides one output. The differential is found in between the two-rear wheel of the vehicle to rotate one wheel faster than the opposite. In automobiles and other wheeled vehicles, the differential allows the outer drive wheel to rotate faster than the inner drive wheel during a turn. This is necessary when the vehicle turns, making the wheel that is traveling around the outside of the turning curve roll farther and faster than the other. The average of the rotational speed of the two driving wheels equals the input rotational speed of the drive shaft. An increase in the speed of one wheel is balanced by a decrease in the speed of the other.

When used in this way, a differential couples the longitudinal input propeller shaft to the pinion, which in turn drives the transverse ring gear of the differential. This also usually works as reduction gearing. On rear wheel drive vehicles the differential may connect to half-shafts inside an axle housing, or drive shafts that connect to the rear driving wheels. Front wheel drive vehicles tend to have the engine crankshaft and the gearbox shafts transverse, and with the pinion on the end of the counter-shaft of the gearbox and the differential enclosed in the same housing as the gearbox. There are individual drive-shafts to each wheel. A differential consists of one input (the drive shaft) and two outputs, which are connected to the two drive wheels; however the rotations of the drive wheels are coupled to each other by their connection to the roadway. Under normal conditions, with small tyre slip, the ratio of the speeds of the two driving wheels is defined by the ratio of the radii of the paths around which the two wheels are rolling, which in turn is determined by the track-width of the vehicle (the distance between the driving wheels) and the radius of the turn.

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A gear train is a mechanical system formed by mounting gears on a frame so the teeth of the gears engage. Gear teeth are designed to ensure the pitch circles of engaging gears roll on each other without slipping, providing a smooth transmission of rotation from one gear to the next.[1] Features of gears and gear trains include:

- The ratio of the pitch circles of mating gears defines the speed ratio and the mechanical advantage of the gear set.
- A planetary gear train provides high gear reduction in a compact package.
- It is possible to design gear teeth for gears that are non-circular, yet still transmit torque smoothly.
- The speed ratios of chain and belt drives are computed in the same way as gear ratios. See bicycle gearing.

An Agricola illustration from 1580 showing a toothed wheel that engages a slotted cylinder to form a gear train that transmits power from a human-powered treadmill to mining pump. The transmission of rotation between contacting toothed wheels can be traced back to the Antikythera mechanism of Greece and the south-pointing chariot of China. Illustrations by the Renaissance scientist Georgius Agricola show gear trains with cylindrical teeth. The implementation of the involute tooth yielded a standard gear design that provides a constant speed ratio.

Non-automotive uses of differentials include performing analog arithmetic. Two of the differential's three shafts are made to rotate through angles that represent (are proportional to) two numbers, and the angle of the third shaft's rotation represents the sum or difference of the two input numbers. The earliest known use of a differential gear is in the Antikythera mechanism, circa 80 BCE, which used a differential gear to control a small sphere representing the moon from the difference between the sun and moon position pointers. The ball was painted black and white in hemispheres, and graphically showed the phase of the moon at a particular point in time. An equation clock that used a differential for addition was made in 1720. In the 20th Century, large assemblies of many differentials were used as analog computers, calculating, for example, the direction in which a gun should be aimed.

An epicyclic differential can use epicyclic gearing to split and apportion torque asymmetrically between the front and rear axles. An epicyclic differential is at the heart of the Toyota Prius automotive drive train, where it interconnects the engine, motor-generators, and the drive wheels (which have a second differential for splitting torque as usual). It has the advantage of being relatively compact along the length of its axis (that is, the sun gear shaft). Epicyclic gears are also called planetary gears because the axes of the planet gears revolve around the common axis of the sun and ring gears that they mesh with and roll between. In the image, the yellow shaft carries the sun gear which is almost hidden. The blue gears are called planet gears and the pink gear is the ring gear or annulus. Ring gears are also used in starter motors.

A vehicle with two drive wheels has the problem that when it turns a corner the drive wheels must rotate at different speeds to maintain traction. The automotive differential is designed to drive a pair of wheels while allowing them to rotate at different speeds. In vehicles without a differential, such as karts, both driving wheels are forced to rotate at the same speed, usually on a common axle

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driven by a simple chain-drive mechanism. When cornering, the inner wheel travels a shorter distance than the outer wheel, so without a differential either the inner wheel rotates too quickly or the outer wheel rotates too slowly, which results in difficult and unpredictable handling, damage to tires and roads, and strain on (or possible failure of) the drivetrain. In rear-wheel drive automobiles the central drive shaft (or prop shaft) engages the differential through a hypoid gear (ring and pinion). The ring gear is mounted on the carrier of the planetary chain that forms the differential. This hypoid gear is a bevel gear that changes the direction of the drive rotation.

When the vehicle takes a turn, the inner wheel covers less distance than the outer wheel, so it means the speed of inner wheel has got to be but the outer wheel. But when the vehicle goes straight both the wheel rotate at an equivalent speed. To supply both the condition differential gearbox is employed. When the vehicles one wheel is in mud, snow, slippery, potholes or stucked to the obstacle the 2 problem is that the wheel which is stucked rotates twice the traditional speed while the opposite wheel is stationary. This is often thanks to the wheel which is stucked does have enough traction force acting to the paved surface. To avoid this problem the event in the gearbox is to be done and therefore the solution to possess differential locking system which give engagement or disengagement. The planning of the differential effect on the failure of the differential. Because it makes with the assembly of the pinion and crown wheel it's good for taking load of the vehicle.

So, to enhance the general differential and to avoid failure thanks to loading. The planning of such differential is given to the present paper. Some development of differential is to decrease the weight of the differential by replacing pinion and crown wheel with spur gear. So overall design and development to scale back the limitations and to extend the efficiency of differential is administered during this paper. The four-wheel drive was discussed by the author. It won't work until there's a center differential. They looked at the phenomena of windup, which occurs when there is a tiny discrepancy in front and rear wheel speeds. Torque is applied to the transmission as a whole[1]–[5]. This is a case study for Maruti Suzuki Zypsy is a car manufactured by Maruti Suzuki. It distributes torque in a 50:50 ratio for the front and rear wheels yet the torque developed by the engine should ratio.The recommended ratio for improved handling is 60:40. As a result, it must Replace the gearbox with a central differential that has been modified to have two axles.

For analysis, the FEM approach is utilized. Creo-2 is a program that calculates design. They came to the conclusion that the central differential has been change. A differential may be a gear train with three shafts that has the property that the angular velocity of 1 shaft is that the average of the angular velocities of the others, or a hard and fast multiple of that average. A gear box provides speed and torque conversions from a rotating power source to a different device using gear ratios. In automobiles and other wheeled vehicles, the differential allows the outer drive wheel to rotate faster than the inner drive wheel during a turn. This is often necessary when the vehicle turns, making the wheel that's traveling round the outside of the turning curve roll farther and faster than the opposite.

The typical of the rotational speed of the 2 driving wheels equals the input rotational speed of the drive shaft. A rise within the speed of 1 wheel is balanced by a decrease within the speed of the opposite. When utilized in this manner, a differential couples the input shaft (or prop shaft) to the

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pinion, which successively runs on the ring gear of the differential. This also works as reduction gearing. On rear wheel drive vehicles, the differential may hook up with half-shafts inside an axle housing, or drive shafts that hook up with the rear driving wheels. Front wheel drive vehicles tend to possess the pinion on the top of the main-shaft of the gearbox and therefore the differential is enclosed within the same housing because the gearbox. There are individual drive-shafts to every wheel.

ANSYS is useful for mechanical engineering concept research applications. For those who want to hear more about ANSYS, that's an introduction. ANSYS is a fully optimized ProEngineer concept analytics automation programme. In order to model the work conditions for your design and forecast its actions this programme uses the Finite Element Approach (FEM). FEM calls for the solution of large equation schemes. With fast solvers, ANSYS helps designers to verify the integrity of their designs and to look for the optimal solution easily. Usually, the following phases are part of a software creation cycle.

When a four-wheeler (car) takes a turn, the outer wheel turns faster than the inner wheel. Thus, there is relative movement between the inner and outer wheel. The function of the differential is to permit the relative movement between inner and outer wheels when vehicle negotiates (takes) a turn. The torque transmitted to each rear wheel is equal in this case, although their speed is different. The differential is made up of a system of gears that connect the propeller shaft and rear axles. It is a part of inner axle housing assembly. The assembly consists of differential, rear axles, wheels, and bearings.

When a vehicle travels in a straight line, the two rear wheels turn on the road exactly at the same speed and there is no relative movement between two rear wheels. But when vehicle takes a turn the outer wheel travels on a longer radius than the inner wheel. The outer wheel turns faster than inner wheel i.e. there is relative movement between two rear wheels. If two rear wheels are rigidly fixed to a rear axle, the inner wheel will slip, which will cause rapid tire wear, steering difficulties and poor road holding. Therefore there must be some device, which will divide the input torque of the transmission system between two rear axles. Differential serves this purpose.

They analyse using different material such as cast iron, cast steel and aluminium alloy. The design is done with help of the cosmos software which is used for the finite element method to stimulate the working condition of design of design and it also predict the behaviour of the material. From this paper he concluded that aluminium alloy has the stress value within the permissible limit[6]–[14]. So aluminium alloy is safe for differential gearbox. After comparing stress value for speed, they concluded that the value of permissible stress of aluminium alloy is less than the other material. They also observed the frequency analysis of the material. The vibrations are less in the aluminium allow.

Principle of Differential:

If a vehicle travels in a straight line, the two rear wheels turn exactly at the same speed, and there is no relative movement between them. But when the vehicle takes a turn the outer wheel travels a longer radius than the inner wheel i.e. there is relative movement between the two rear wheels. The outer wheel turns faster and covers a larger distance than the inner wheel. The inner wheel

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makes a larger angle than the outer wheel.

Construction of Differential:

The following main components are used in the differential assembly.

- Drive pinion or Bevel pinion
- Ring gear or Crown wheel
- Differential case
- Differential side gear or Sun gears
- Differential pinions (or) Planet gears
- Axle shafts or Half shafts
- Pinion shaft or Cross pin (or) spider.

On the inner ends of each axle a smaller bevel gear called differential side gear is mounted. Two bevel gears are put together to mesh both driving and driven shafts at an angle of 90°. The differential case is mounted with two-wheel axles and differential side gears. The differential case has bearings that rotate two axle shafts. Then, the two pinion gears and their supporting shaft, called pinion shafts, are fitted into the differential case. Then, the pinion shaft meshes with the two differential side gears connected to the inner ends of the axle shafts.

The ring gear is bolted to a flange on the differential case. The' ring gear rotates the differential case. Finally, the drive pinion is mounted. The drive pinion is assembled with the differential housing called differential case or carrier. The driver shaft is connected with the drive pinion by a universal joint and it meshes with the ring gear. So, the drive pinion is rotated when the drive shaft turns. Thus, the ring gear is rotated.

When the vehicle takes a turn, the inner wheel covers less distance than the outer wheel, so it means the speed of inner wheel has got to be but the outer wheel. But when the vehicle goes straight both the wheel rotate at an equivalent speed. To supply both the condition differential gearbox is employed. A gear box provides speed and torque conversions from a rotating power source to a different device using gear ratios. In automobiles and other wheeled vehicles, the differential allows the outer drive wheel to rotate faster than the inner drive wheel during a turn. This is often necessary when the vehicle turns, making the wheel that's traveling round the outside of the turning curve roll farther and faster than the opposite.

2. DISCUSSION

The material used for body of differential gearbox should be Aluminium alloy because it reduces the load and therefore the gear should be made from steel thanks to its strength. Within the development of modified differential gearbox different system are often used. Till now the differential wont to take one input and two outputs but by modifying and adding one extra pinion and crown wheel adjustment on crown wheel we will take one input and three outputs. And by analyzing using different materials we will modify differential gearbox having three outputs. Also, there are various special purpose differential gearbox but individually they can't overcome all the

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restrictions so we will use the combinations of those special purpose differential gearboxes and reduce the restrictions to some extent.

3. CONCLUSION

Using Aluminium alloy for a differential gearbox body as the weight is low and the stress value strongly enabled is in competition with other materials. Using the differential spur gear instead of spindle gears, since this differential reduces costs and boosts performance 30% lighter than the spindle gap. Space releases the difference up to 70 per cent. This incorporates the Go Green idea. A higher tensile strength, recycled ability, decreased stress and low costs improves mechanical performance using lightweight materials like the glass filled polyamide. The daily parking issues can be triggered with the combination of different differential gearboxes, sensors and different steering mechanisms be solved too.

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