DESIGN AND ANALYSIS OF GEAR BOX

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ABSTRACT:

Angular resampling of the acceleration signal of a gearbox submitted to limited speed fluctuation. The previous algorithm estimates the shaft angular position by narrow-band demodulation of one harmonic of the mesh frequency. The harmonic was chosen by trial and error. This paper proposes a solution to select automatically the mesh harmonic used for the shaft angular position estimation. To do so it evaluates the local signal to noise ratio associated to the mesh harmonic and deduces the associated low-pass filtering effect on the time synchronous average of the signal. Results are compared with the obtained when using a tachometer on industrial gearbox used for waste water treatment.

Key words:- Catia, Ansys, Analysis of gear

1.INTRODUCTION

A machine consists of a power source and a power transmission system, which provides controlled application of the power. Merriam-Webster defines transmission as an assembly of parts including the speed-changing gears and the propeller shaft by which the power is transmitted from an engine toa live axle. Often transmission refers simply to the gear box tha tuses gears and geartrains to provide speed and torque conversions from a rotating power source to another device.

In British English, the term transmission refers to the whole drive train, including clutch, gearbox, prop shaft (for rear-wheel drive), differential, and final drive shafts. In American English, however, the distinction is made that a gearbox is any device which converts speed and torque, whereas a transmission is a type of gearbox that can be "shifted" to dynamically change the speed-torque ratio such as in a vehicle.

Tractor transmission with 16 forward and 8 backward gears A diagram comparing the power and torque bands of a "torquey" engine versus a "peaky" one

The dynamics of a car vary with speed: at low speeds, acceleration is limited by the inertia of vehicular gross mass; while at cruising or maximum speeds wind resistance is the dominant barrier.

Many transmissions and gears used in automotive and truck applications are contained in a cast iron case, though more frequently aluminum is used for lower weight especially in cars. There are usually three shafts: a mainshaft, a countershaft, and an idler shaft.

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-5, ISSUE-1, 2018
DOI: 10.21276/ijcesr.2018.5.1.3

The mainshaft extends outside the case in both directions: the input shaft towards the engine, and the output shaft towards the rear axle (on rear wheel drive cars- front wheel drives generally have the engine and transmission mounted transversely, the differential being part of the transmission assembly.) The shaft is suspended by the main bearings, and is split towards the input end. At the point of the split, a pilot bearing holds the shafts together. The gears and clutches ride on the mainshaft, the gears being free to turn relative to the mainshaft except when engaged by the clutches.

1.2 Hydrostatic

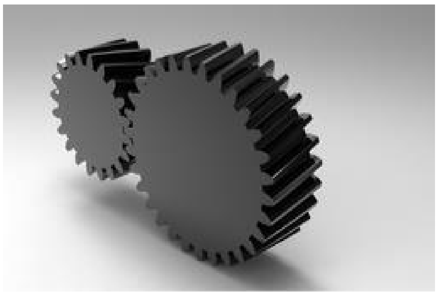
Hydrostatic transmissions transmit all power hydraulically, using the components of hydraulic machinery. They are similar to electrical transmissions, but hydraulic fluid as the power distribution system rather than electricity.

The transmission input drive is a central hydraulic pump and final drive unit(s) is/are a hydraulic motor, or hydraulic cylinder (see: swashplate). Both components can be placed physically far apart on the machine, being connected only by flexible hoses. Hydrostatic drive systems are used on excavators, lawn tractors, forklifts, winch drive systems, heavy lift equipment, agricultural machinery, earth-moving equipment, etc. An arrangement for motor-vehicle transmission was probably used on the Ferguson F-1 P99 racing car in about 1961.

1.3Hydrodynamic

If the hydraulic pump and/or hydraulic motor make use of the hydrodynamic effects of the fluid flow, i.e. pressure due to a change in the fluid's momentum as it flows through vanes in a turbine. The pump and motor usually consist of rotating vanes without seals and are typically placed in close proximity. The transmission ratio can be made to vary by means of additional rotating vanes, an effect similar to varying the pitch of an airplane propeller.

The torque converter in most automotive automatic transmissions is, in itself, a hydrodynamic transmission. Hydrodynamic transmissions are used in many passenger rail vehicles, those that are not using electrical transmissions. In this application the advantage of smooth power delivery may outweigh the reduced efficiency caused by turbulence energy losses in the fluid.

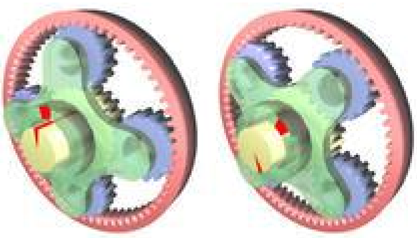


Non-synchronous: There are commercial applications engineered with designs taking into account that the gear shifting will be done by an experienced operator. They are a manual transmission, but are known as non-synchronized transmissions. Dependent on country of operation, many local, regional, and national laws govern the operation of these types of vehicles (seeCommercial Driver's License). This class may include commercial, military, agricultural, or engineering vehicles. Some of these may use combinations of types for multi-purpose functions. An example would be a power take-off (PTO) gear. The non-synchronous transmission type requires an understanding of gear range, torque, engine power, and multi-functional clutch and shifter functions.

Also see Double-clutching, and Clutch-brake sections of the main article

1.4 Automatic

Automatic transmission



Epicyclic gearing or planetary gearing as used in an automatic transmission. Most modern North American and Australian and some European and Japanese cars have an automatic transmission that will select an appropriate gear ratio without any operator intervention. They primarily use hydraulics to select gears, depending on pressure exerted by fluid within the transmission assembly. Rather than using a clutch to engage the transmission, a fluid flywheel, or torque converter is placed in between the engine and transmission. It is possible for the driver to control the number of gears in use or select reverse, though precise control of which gear is in use may or may not be possible.

1.5 Synchromesh

If the teeth, the so-called dog teeth, make contact with the gear, but the two parts are spinning at different speeds, the teeth will fail to engage and a loud grinding sound will be heard as they clatter together. For this reason, a modern dog clutch in an automobile has a synchronizer mechanism or synchromesh, which consists of a cone clutch and blocking ring. Before the teeth can engage, the cone clutch engages first, which brings the selector and gear to the same speed using friction. Moreover, until synchronization occurs, the teeth are prevented from making contact, because further motion of the selector is prevented by a blocker (or baulk) ring. When synchronization occurs, friction on the blocker ring is relieved and it twists slightly, bringing into alignment certain grooves and notches that allow further passage of the selector which brings the teeth together. Of course, the exact design of the synchronizer varies from manufacturer to manufacturer.

1.6 Design variations

Ratio count

Until the mid-1970s, cars were generally equipped with 3-speed transmissions as standard equipment. 4-speed units began to appear on volume-production models in the 1950s and gained popularity in the 1960s; some exotics had 5-speeds. In the 1970s, as fuel prices rose and fuel economy became an

important selling feature, 4-speed transmissions with an overdrive 4th gear or 5-speeds were offered in mass market automobiles and even compact pickup trucks, pioneered by Toyota (who advertised the fact by giving each model the suffix SR5 as it acquired the fifth speed). 6-speed transmissions started to emerge in high-performance vehicles in the early 1990s.

1.7 Gear ratios

The slowest gears (designated '1' or low gear) in most automotive applications allow for three to four engine rotations for each output revolution (3:1). "High" gear in a three or four speed manual transmission allows the output shaft to spin at the same speed as the engine (1:1). Five and six speeds are often 'overdrive' with the engine turning less than a full turn for each revolution of the output shaft (0.8:1, for example).

1.8 Lubrication

Most manual transmissions rely on splash lubrication although some five speed Rover gearboxes did incorporate an oil pump. The problem with splash lubrication is that it is speed dependent. There are centrifugal effects, hydrodynamic effects and effects from the gears working as pumps. If a gearbox is fitted with Perspex windows and run on a test rig these effects can be observed. As the gearbox is run through its rev range, the oil jets will switch over and move around. Research on the Austin Maxi 1500 gearbox showed that one of the ball races was running dry at 80 miles per hour (130 km/h), the speed that much of the United Kingdom's motorway traffic runs at. The solution was to alter the casting to include a small projection that would intercept the main oil jet that was present at 80 mph and disperse it. This small modification enabled the later Maxi 1750 gearbox to be relatively trouble free. Four speed gearboxes seldom show these problems because at top speed (and maximum power) they are basically a solid shaft and the gears are not transmitting power.

1.9 Performance and control

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-5, ISSUE-1, 2018
DOI: 10.21276/ijcesr.2018.5.1.3

Manual transmissions generally offer a wider selection of gear ratios. Many vehicles offer a 5-speed or 6-speed manual, whereas the automatic option would typically be a 4-speed. This is generally due to the increased space available inside a manual transmission compared with an automatic, since the latter requires extra components for self-shifting, such as torque converters and pumps. However, automatic transmissions are now adding more speeds as the technology matures. ZF currently makes 7- and 8-speed automatic transmissions. The increased number gears allows for better use of the engine's power band, allowing increased fuel economy, by staying in the most fuel-efficient part of the power band, or higher performance, by staying closer to the engine's peak power. However, a manual transmission has more space to put in more speeds, as the 991 Generation of thePorsche 911 has a 7- speed manual transmission, which is a first for a production vehicle.

2.Introduction to CATIA

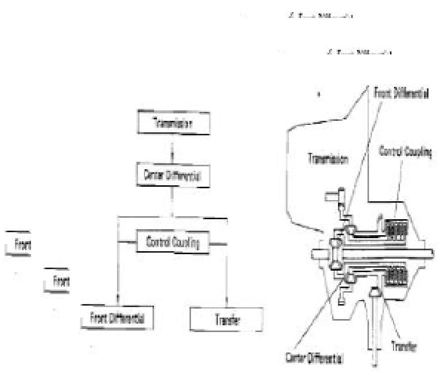
CATIA is a robust application that enables you to create rich and complex designs. The goalsof the CATIA course are to teach you how to build parts and assemblies in CATIA, and how to make simple drawings of those parts and assemblies. This course focuses on the fundamental skills and concepts that enable you to create a solid foundation for your design

2.1 What is CATIA.

CATIA is mechanical design software. It is a feature-based, parametric solid modeling design tool that takes advantage of the easy-to-learn Windows graphical user interface. You can create fully associative 3-D solid models with or without constraints while utilizing automatic or user-defined relations to capture design intent. To further clarify this definition, the italic terms above will be further defined

3. GEAR BOX OPERATION:

Here is a basic explanation of how the gearbox works. The top picture shows the actual cross section of the gearbox, while the second below is diagrammatic showing the main physical components. I spent several hours sitting down with the manual and a stripped gearbox working this out!



4. ANSYS- It is software which provides finite element analysis (FEA), in this methodology any component under consideration is discredited into small geometric shapes and the material properties are analyzed over these small elements.

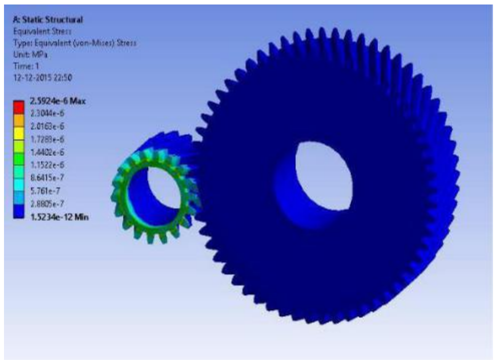


Fig.49 Equivalent stress

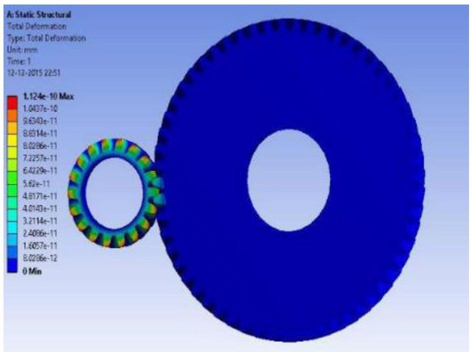


Fig.50 Total deformation

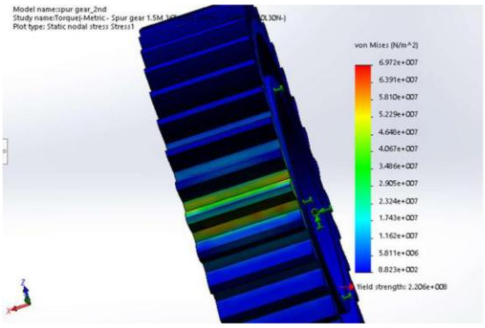


Figure 6.2: Static Structural Analysis on Gear 2

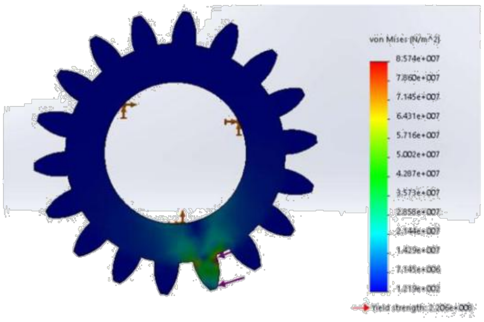


Figure 6.3: Static Structural Analysis on Gear 3

CONCLUSION

The stress analysis of the gearbox was carried out and it was observed that the stresses induced on the gear tooth were higher than the permissible/safe limit. After modifying the design of the existing gearbox, again the stress analysis was carried out and the results were found tobe well within allowable/safe limit. It was further observed that the stresses induced on the gear tooth were reduced considerably by making hole at the root of the gear tooth.

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