The Design of Transmission Gear Based on the Dynamic Property

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Abstract:There are many factors can determine the module of gear. One of the most important is the strength of the gear noise and quality. Reduce the modulus, increase the tooth width can make the reduction of noise and can reduce the quality of the transmission conversely. This paper is based on the dynamic characteristics of transmission to design the car transmission gear.This paper discusses the design method of gear through the determination parameters of gears,the strength of the gear failure forms of analysis,the analysis of gear distribution of each gear.

Introduction

Variable speed for module of gear range is roughly as follows:Miniature and light car for 2.25～2.75，Intermediate car for 2.75～3.0，Medium-sized truck for 3.5～4.25，Heavy duty truck for 4.25～7. Chooses the module shall comply with the terms of GB1357-78. According to similar models module of gear, the primary modulus for m=3.5.The role of tooth surface under a concentrated load when in the process of meshing.We can regard gear teeth as a cantilever beam, the tooth root bending stress is very big,and the transition fillet with stress concentration, so the tooth root is very easy to break.There are two kinds of situations of tooth broken, one is a tooth impacted by the large enough sudden load, leading to tooth fracture.Another is by many times the effect of repeated load, maximum stress of tooth root by ramen area appear fatigue crack,when crack gradually extended to setting depth, tooth broken suddenly .

The determination of gear parameters

The calculation of pressure angle. The provisions of the state standard of gear pressure is 20^0, so the transmission gear pressure Angle is generally used to 20^0. There also has other pressure Angle, such as 14.5, 16.5 and 22.5 pressure Angle increases, the root circle of involute tooth thickness and the pitch circle radius of curvature is increased, the bending strength and contact strength are improved, and also reduce root cutting teeth at least. Mesh or joint of synchronizer gear pressure Angle- 20, 25, 30, 30 of the widely used pressure angle.

Gear helix Angle βselection. In order to reduce the working noise and improve the strength, most auto transmission gear with helical gear, only to reverse gear and a truck gear with straight teeth gear. General scope of transmission helical gear spiral Angle for 10 ~ 35. Spiral Angle increase the overlap coefficient of gear meshing, stable work, noise reduction, the strength of the gear also improved. But too much spiral Angle can make axial meshing and bearing load is too large. Car transmission gear rotational speed is high, with low noise, so the spiral angle of larger value. Finally, adjust the spiral angle of methods are available, and make each of meshing gear because of the module or the center of the tooth number and different causes such as ranging from phenomenon to

eliminate. Helical gear helix angle of car transmission can be provided in the following range to choose:

countershaft transmission:22 ^{0} ～ 34 ^{0} ,twin-shaft transmission:20 ^{0} ～ 25 ^{0} and truck transmission:18^0～26^0.

Tooth width selection. Tooth width should satisfy both can reduce the transmission quality, at the same time can meet the requirements of gear work smoothly. Often selected according to the size of the module of gear tooth width: b =（4.5～7.5） m_n =（4.5～7.5）×4.5=（20.25～33.25）mm.

The distribution of the gear teeth

To determine the transmission gears teeth.

①Try to conform to the power performance, economy and other requirements for the transmission ratio；

②The least number of teeth should not be undercut. Usually, one of intermediate shaft of the transmission gear is the least number of gears, the gear should not produce root cutting, and the root circle diameter should be greater than the intermediate shaft diameter；

③Meshing of the gears, each other should not have common factor between teeth, high speed gear more should pay attention to this；

④Number of teeth can reduce the transmission of gear noise.The transmission ratio and thetransmission schemeto be assigned to the gear according to the predetermined number of transmission gears

Calculation and analysis of center distance. According to the empirical formula: a =（15～19） $\sqrt[3]{M_{e\max}}$ =17×$\sqrt[3]{477}$ =133.6 mm.Confirm the number of teeth on the gear of the first gear ration.

$i_1=\frac{z_3 z_2}{z_1 z_4}$, In order to seek z_2、z_3 number of tooth，it demands number of tooth and z_h straight tooth $z_h=\frac{2A}{m}$.

If calculation result is not the integer, it must take the z to integer values according to the z values for the distribution of large and small gear teeth. Like the one on the intermediate shaft pinion gear ratio less as far as possible, so that z/z ratio larger, z/z transmission ratio can be allocated, so often meshing gears can be assigned to the first axis more teeth, so that the inside cavity set before the second shaft bearings. If the first axis constant mesh gear teeth is too little, after processing of bearing hole, it can make the wheel is too thin to affect the gear strength. If teeth too much and make gear wheel diameter increases, more than the transmission housing, the first shaft bearing on the size of holes can't assembly.

Intermediate shaft pinion on the minimum number of teeth z is restricted by intermediate shaft neck size when the shaft and gear teeth are unified. In order to avoid the root cutting and enhance the strength of the pinion modified gear must be used. Intermediate shaft type transmission gear ratio i_1

$=3.3\sim3.9$，Intermediate shaft on a gear teeth can choose between z = 13 ~ 19 for truck.When gear ratio and gear modulus is larger, the number of tooth of Z should value small. After choose z_3. Use $z_2=z_h-z_3$ can figure out the large teeth number of the first gear.

Adjust the center distance. When figure the teeth number of the first gear, if the z_h is not integer, we have to round it, so the center distance must be changed, at this moment, we should figure the center distance A from z_h and the gear modification coefficient, at last we use this distance to distribute all the gears,$z_h=\frac{2A}{m}=\frac{2\times133.6}{4.5}$=59.4,so it will be adjusted to 59.In order to refrain from undercut and enhance the strength of gears,Choose 13 for z_2, So:$z_2=z_h-z_3$=59－13=46.

And the center distance will be adjusted to the following: A= z_h×m/2=59×4.5/2=132.8mm.

Confirm the teeth number of the constant mesh gear. Figure out the transmission ratio of the constant mesh gear: $\frac{z_{33}}{z_{22}}=i_1\frac{z_3}{z_2}$.The center distance of the constant mesh gear is equal to the first gear: A=$\frac{m_n(z_{33}+z_2)}{2}$. Then recount the value between the transmission ratio of the first gear and the transmission ratio which is given, if it has so much difference, make a teeth number adjustment. We can also meet the requirements of the center distance if b is confirmed. Substitute the number: A=$\frac{m_n(z_{33}+z_2)}{2}=\frac{4.5\times(z_{33}+z_2)}{2}$=132.8, $\frac{z_{33}}{z_2}=i_1\frac{z_3}{z_2}$ =7.64×12/46.We make an adjustment of the teeth number because the transmission ratio which I figured is far away from the transmission ratio which is given.z_1=46，z_2=13，z_3=24，z_{33}=45.

The damage of the gear forms.

The tooth broken. In order to avoid the gear tooth broken, we need to reduce the bending stress of tooth and improve the tooth bending strength.We can improve the teeth bending strength by adopting the following measures:increasing the thickness of the tooth root;increasing the tooth root transition radius;using long tooth gear transmission;improving the coincidence degree;increasing the meshing teeth in logarithmic at the same time;making the tooth surface and tooth root transition fillet in smooth as far as possible;improving the allowable stress of material.

The tooth pastry erosion. Tooth pastry erosion is closed gear drive often appear a form of damage.Because of closed gear working in lubricating oil, tooth surface contact stress by pulsating

effect for a long time, will gradually produce large and tooth surface into a small crack angle.And cracks filled with lubrication, meshing, tooth surface due to squeeze each other, higher in hydraulic fracture, make the cracks continue to expand, resulting in tooth surface surface patches flake, tooth surface appear a large number of small pitting sector, this is tooth surface corrosion phenomenon.Efforts to improve the contact strength: on the one hand, is a reasonable choice of gear parameters, reduce contact stress;On the other hand is to improve the tooth surface hardness, such as big steel using allowable stress.

The tooth surface glue. Axis high-speed heavy-load gear transmission, unparallel helical gear transmission and hypoid gear transmission, due to the tooth surface relative sliding velocity, the contact stress is large, the lubricant film between tooth surfaces, direct contact between tooth surfaces of metal materials, local temperature is too high, each other fusion welding adhesion, form tearing trace tooth surface along the sliding direction, the damage form called agglutination.

There are many measures to prevent glue. On the one hand, it has pressure additives of lubricating oil viscosity, increasing the oil film strength.Making the oil film not to undermine can not produce local temperature rise.On the other hand it can improve the tooth surface hardness, or meshing gear with different materials, etc.

Conclusion

In order to offset the axial force of the jackshaft, the teeth number has to satisfy the formula.We can know from the formula from above.We can use the same way to confirm the teeth number of the other gears. It needs to explain that the center distance, helical angle, modification coefficient, and the distribution of the tooth are interaction.It is meaningful to reduce the noise of cars,and reduce the quality of truck is more important. For the gear strength, each gear should have their own module, and from a process point of view, all the gear to choose a module is reasonable.

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