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Tapered Roller Bearings Cage to Improvement Design

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Abstract

In order to improve the utilization of materials, improving stamping cage processing methods, the single row tapered roller bearing cage is improved from structural strength, puts forward whole stamping cage a type of structure. Use ANSYS finite element analysis to the different structure and the thickness cage. Get the stress contours of the cage, based on equal strength design principles. Get sheet metal stamping manufacturing cage, improving the process and precision manufacturing. Change the traditional increase cage strength only by increasing the thickness of the method. Improve production efficiency and reduce the input device.

Keywords: *cage, improving structural design*

1. Introduction

Bearing basket-shaped cage by sheet metal stamping, through cut metal forming - cut the bottom - punch fenestrae - press slope - side of the car - expansion process sheet processed into the bearing cage, Which cut metal forming, cut the bottom, punch fenestrae, press slope and expansion processes are complete stamping presses (punch), while in the car side process will have dedicated lathe turning. For example, 32216 tapered roller bearings cage, a selection of sheet metal manufacturing cage, full-stamping process, to improve the stamping performance and the accuracy of product manufacturing. Change the past thick plate retainer stamping, end turning to ensure dimensional accuracy characteristics.

2. Improving a Cage Design

Figure 1 is a tapered roller bearing assembly drawing, cage's role is to separate the roller as a unit assembly, keep it on the outer and inner ring raceway [1]. The movement of the cage is guided and driven by the roller, and inner and outer ring have not interact. Figure 2, cage's structure is the basket-shaped, by the steel plate stamping molding, end side need to go through the turning. Figure 3, cage's structure is the basket-shaped too, but side edge is the form of outer flange, all-stamping method machining annular body, the annular outer flange of the end edge of the annular body at the same time stamping molding, eliminating the need for the original car edge technology, making the processing of the entire cage full of stamping process, improve production efficiency and reduce the input device. And compared in terms of turning process, the use of full-stamping process to process the cage, improving manufacture precision of the bearing cage, and improve product quality. The same time, eliminating the need for turning process, improve the production environment of the bearing cage.

Shown in Figure 4, Changes the cross-sectional area of the cage C (Ic2 × H), larger impact on the overall structural strength, Cross-sectional area D (Ic1 × h), Cb and t are parameters of the structural strength, during the design, these parameters should pay attention to the difference between them, the structural strength of the cross-sectional area C reflects the radial anti-deformation ability, the structural strength of the cross-sectional area D reflects the tensile force of resistance to the circumferential direction of the tangent, resist the cage pocket deformation capacity, pursuant to the cage failure analysis and simulation of tensile test [1], cage pocket the transition connection location is the position of the first failure occurs, it is the most important place in the design, in this transition structure the design process, add a small

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arc transition, or to avoid quality defects during the processing, the transition structure can effectively guarantee the structural strength of the cage [1].

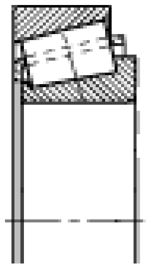

Figure 1. Tapered Roller Bearing Assembly Drawing

Figure 2. Tapered Roller Bearing Cage

Figure 3. Improved Tapered Roller Bearing Cage

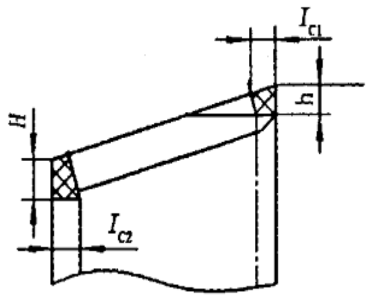

Figure 4. Cage Dimensions

Explanation of symbols: Ic1 for a cage big end tendon width; Ic2 for a cage small end tendon width; t for cage beam thickness; Cb for cage beam width; Arc surface of the cage pocket, act on the roller, used to guide the roller rotation. Circular surface of the cage form act on the roller, used to guide the roller rotation, the circular arc and roller contacts of effective area, the position of the roller center, is the key of design parameters for the roller contact force and reaction force. The width of the cage and cage pocket numbers is relevant, bearing for 20 rollers. Cage beam corner part is the whole to cage weak links, so t must be guaranteed not less than meet the limits of the cage strength. Repeating design more than one product, testing and using, t value of experience: $t = D_w \cdot K_s$

Where: t - plate thickness;D_W - roller big end diameter.

Bearing series is narrow, middle and width, corresponding Ks value is 0.18, 0.15, 0.14. General, in the specific design, the t values determined by the formula, t values based on the size of the appropriate adjustments in the load carrying capacity. In principle, the carrying capacity of the bearing is small, the cage increase appropriately the value of t, in order to improve the use intensity; the contrary, the carrying capacity of bearing is big, strength to meet the premise, the cage may reduce appropriately t value.

3. Cage Model by Finite Element Analysis

The structure of cage is completely periodic symmetrical, ANSYS can take advantage of the structure symmetry of the cycle, only one sector of the cycle symmetrical structure is modeled and analyzed, this can reduce the size of the analysis, saving analysis computation time. Therefore, we analyze only a sector of the cage, when bearing solid model is created, just take the whole cage model 1/20. Respectively, to establish a solid model of the cage before and after improvement, by Pro / E.

Cage model using the free meshing, the grid length of the contact area takes half of contact minor axis, based on the Hertz theory, so to be able to get the correct results. Meshing cage model based on this principle, as shown in Figure 5, for the meshing of the model before improvement, shown in Figure 6, the meshing of the model after improvement.

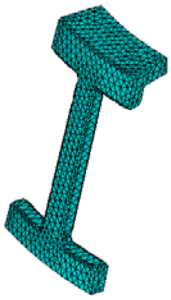

Figure 5. Before Improvement Cage Model Meshing

Figure 6. After Improvement Cage Model Meshing

According to the motion characteristics of the cage, it can be assumed zero displacement of the cage surface in the three coordinate directions, so the top and bottom surface is set to zero displacement constraints. In ANSYS Main Menu> Preprocessor> Loads> Define Loads> Apply> Structural> Displacement> On Areas. Since the cage is taken according to the period symmetric structure one sector modeling, the symmetry constraints imposed in the symmetry plane. In ANSYS Main Menu> Preprocessor> Loads> Define Loads> Apply> Structural> Displacement> Anti-symmB.C. > On Areas.

The contact point of roller and cage is in the central position of the cage pocket hole pressure slope, also is roller to cage force point. Lintel load, is bearings in the normal operation of the process, roller guide cage, the generated load is considered to be acting on the lintel beam midpoint, all roller and the contact point of the cage pocket hole are on the festival park, roller end and cage pocket holes both sides of the interaction is negligible.

Experience has shown that the lintel pressure slope contact surface friction much smaller with compared to the normal force, and therefore negligible. Therefore, we consider only lintel pressure slope contact surface to normal force. The force calculation formula (1) is described as follows [2]:

$$F = K \cdot Z_c \tag{1}$$

Roller bearings on where K is as follows:

$$F = \frac{67}{C_p} \tag{2}$$

(2) substitute into (1) $F = \frac{67}{C_p} \cdot Z_c$

The article is that the cage strength analysis, considering only the roller and cage lintel contact limiting case, so we chose $F = 67(N)$ [2].

Operation execution Main Menu> Solution> Define Loads> Apply> Structural>Force Moment>On Nodes.

Database files should be saved before solving, in order to reenter the ANSYS, using RESUME command to restore the model, and then through the menu path Main Menu>

Solution> solve> current LS to solve calculation. After the calculation, you can view the stress cloud in the post-processor. Path through the menu operation General postproc> Plot Results> the contour the Plot> Mouse Nodal Solu> Stress> von Mises stress.

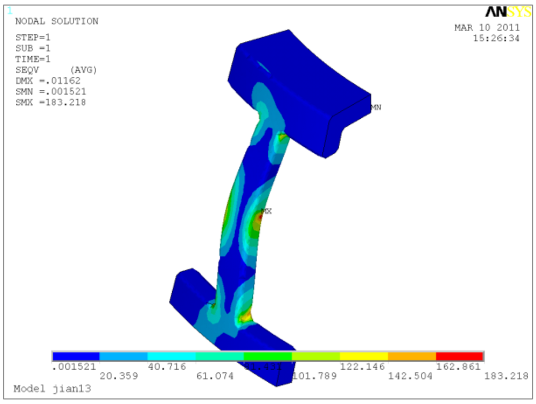

Figure 7. 2.5mm Thick Before Improvements Cage Stress Cloud

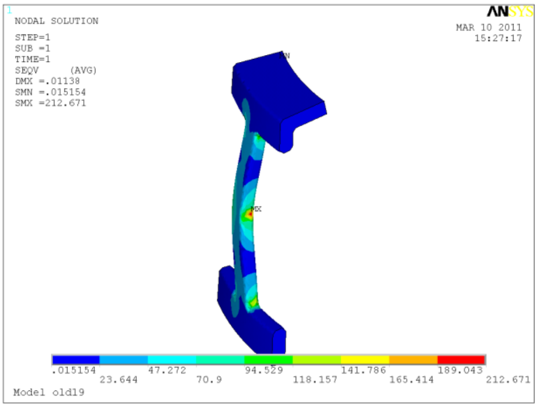

Figure 8. 1.9mm Thick Before Improvements Cage Stress Cloud

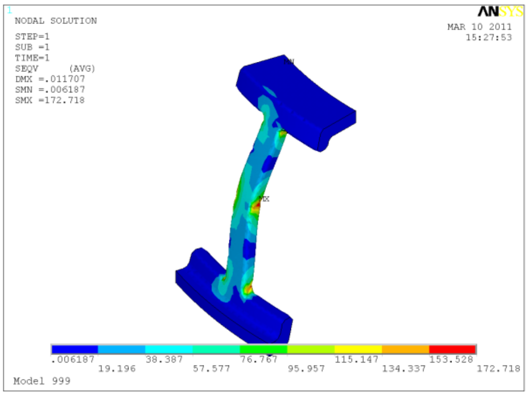

Figure 9. 1.9mm Thick After Improvements Cage Stress Cloud

4. ANSYS Finite Element Analysis Results

Seeing the results in the post-processor, get the stress contours of the analysis model. Figure 7, Figure 8 and Figure 9 are respectively before and after improvement cage the stress distribution. Cage plate thickness is 1.9mm, the maximum stress for 212.671Mpa. Cage plate thickness is 2.5mm, the maximum stress is 183.218MPa. Change the structure of the cage, the cage plate thickness is 1.9mm, the maximum stress is 172.718MPa. Based on the equal strength design principles, 32216 tapered roller bearing cage, choose the manufacture of sheet, improved manufacturing processes and reduce material costs.

Found by the stress distribution at the same time, the point of maximum stress occurs in the holder over the contact portions of the beams and upper and lower annular surface. This result with cage actual fatigue damaged parts is the same, is one of the factors that cause the cage fatigue failure. Completely avoided by improving the structure of the cage, to increase the thickness of the beam in order to improve the strength of the cage in the past, the new cage design increases strength and material savings.

5. Conclusion

Full-stamping flanged cone cage using reliability theory, according to with the original structure the principles of equal strength, using finite element analysis get a new plate thickness value, realize the thickness of the optimization value, replace the traditional increase cage strength a only by increasing the thickness of the method.

References

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