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Improved Design of the Mixing-Pouring Truck(Machine) for Slurry of Aerated Concrete*

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Abstract: This paper presents an improved design of the mixing-pouring truck introduced from abroad. The improvements on design of bearing assembly of its mixing spindle, connection version of the spindle and lower hollow shaft fixed with mixing blade wheel, structure of bearing support and lubrication of the bearings are described in detail.

Key Words: aerated concrete; mixing-pouring truck(machine); improved design

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1 Introduction

Mixing-pouring truck(machine)for slurry of aerated concrete is a primary technological equipment which is used for preparing mixture of aerated concrete. When it is in operation, various constituents of aerated concrete which have been measured are put into its mixing tank in a definite sequence and in specified time, and mixed uniformly, then the well-prepared slurry is poured into a mould, Obviously, the mixing tank assembly is the most important part of the mixing-pouring truck. Whether structural design of the mixing spindle assembly is reasonable will have a great effect not only on its operating performance, but also on qualities of its key elements worked and assembled, service life and the costs of manufacture and maintenance. In order to make the design of the mixing-pouring truck more perfect, an attempt was made at improving the mixing tank assembly of the truck with $4m^3$ working volume, introduced from abroad. The new design is described as follows.

2 Improved design of bearing assembly of the mixing spindle

2.1 Problems existing in original design

According to the operating conditions of the unit, as the fluid materials heated to a certain temperature and put in mixing tank, such as sand slurry and slag slurry etc. have a direct influence on working temperature of the bearings and spindle, the version of bearing assembly known as having two-directional axial fix of spindle at one of two supporting points was used in the original design (Fig. 1 and Fig. 3). It's correct. In this case, the upper supporting point can bear both radial load and two-directional axial load, while the lower supporting point which uses an axially-floating bearing can only bear radial load. Its axial floating can compensate the changes in distance between the two supporting points due to temperature rise of the spindle.

As seen from Fig. 3, a double-row self-aligning ball bearing (1 314, the rated dynamic load c=

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58.30kN) was used as the upper bearing 1 to support radial load and two-directional axial load, while a single-row cylindrical roller bearing (32 314, c = 142kN) was chosen as the lower bearing 2 to support only radial force.

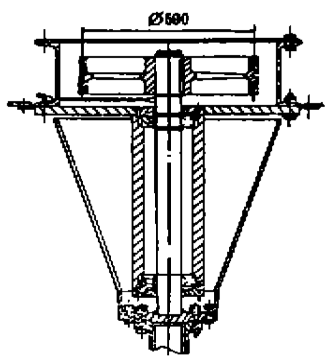

Fig. 1　Structure of the mixing spindle assembly in original design

Because of the limitation of welded structure composed of the spindle 3 and its end flange 4, the spindle 3 had to be designed with a non-shouldered shaft, the axial force could only be transmitted by means of the snap ring 8 which had been fitted into respective ring grooves of the spindle. Because the upper bearing was of self-aligning type, the axis of its inner race was allowed to be inclined to that of the outer race up to 2°～3°, and it could only bear a small axial force. In practice, the upper bearing 1 was subjected to a great down-axial force including the weights of big pulley 5(∅600×150mm or so), mixing spindle, blade wheel etc, and pressure of the slurry. As seen from these, the bearing assembly in original design would result in the following problems which influenced normal operation of the mixing spindle.

1) The double-row self-aligning ball bearing was not suitable for bearing so great axial force in original design, therefore its service life was reduced.

2) The thin snap ring 8 which transmitted so great axial force was less reliable, in particular, the ring grooves cut in the positions of greater bending moment of the spindle weakened its strength.

3) Belt tension resulted from belt drive exerted a pressure on upper end of the spindle, and made the spindle be elastically bent to some extent. Along with the bent axis, the inner race of the upper bearing deflected in respect to its outer race. But this sort of single-row cylindrical roller bearing used as lower bearing is particularly sensitive to the deflection of its axis, especially when radial clearance of the upper bearing was bigger, or when it had been subjected to wearing more seriously, the deflection of the spindle axis in respect to that of support hole of the lower bearing usually greatly exceeded the allowable limit 2′～4′ for the cylindrical roller bearing. As a result, the rollers of the bearing could not keep a good line contact with its raceways, load-carrying capacity and service life of the bearing were therefore reduced.

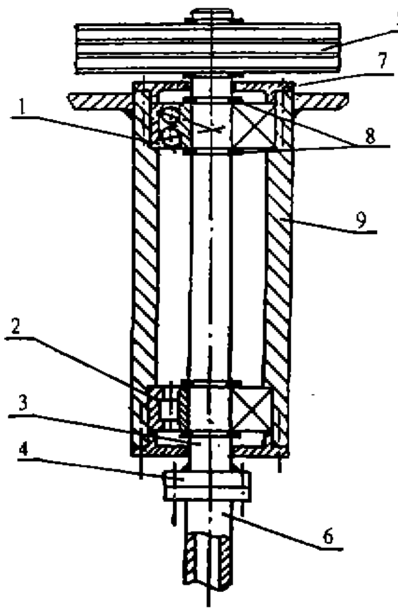

Fig. 3　The mixing spindle assembly before the innovation

2.2　Advantages of the improved bearing assembly

In view of above mentioned problems, the improved design is shown in Fig. 2. Under the prerequisite condition of the spindle 8 and its end flange 10 splined (the working principle will be described in part 3), two taper roller bearings (7 214, the rated dynamic load c=77.80kN) or two angular contact ball bearings are used for upper supporting point to bear radial force, and up-and down-axial

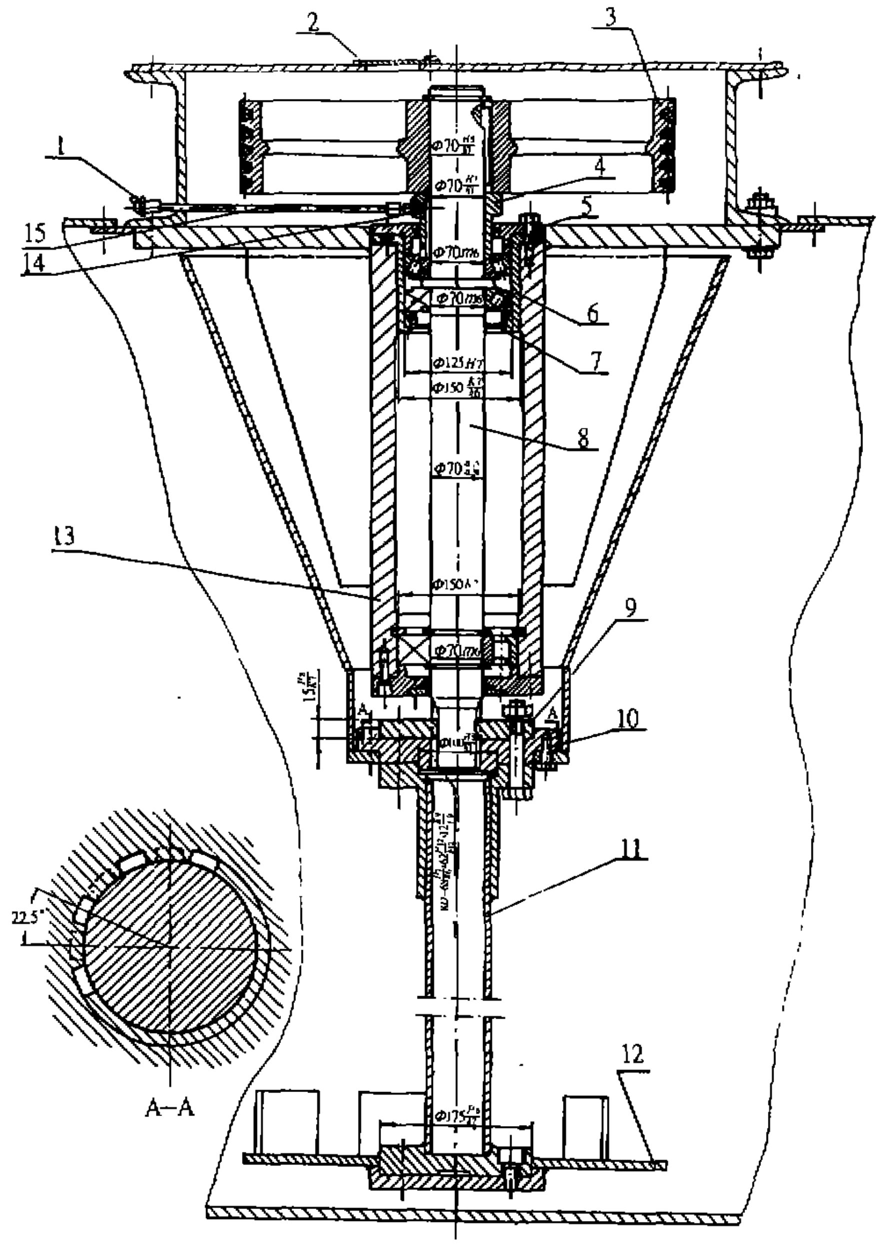

Fig. 2 Innovated design of the mixing tank unit

forces respectively. By means of this arrangement, for upper supporting point, its radial load-carrying, in particular, axial load-carrying capacities are significantly increased, meanwhile deflection of the axis between the two supporting points, resulted from belt pressure on the spindle end, and its adverse effects on the cylindrical roller bearing used for lower supporting point are avoided . Furthermore, since such a great axial force is transmitted by the use of shoulder instead of previous snap ring, the force transmission is completely reliable. Therefore, after the innovation, operation of the mixing spindle is smoother, and service life of the bearings is extended.

3 Innovated connection version of the spindle and lower hollow shaft

For original design, welded bond of the spindle and its end flange not only limited the designs of the spindle structure and its bearing assembly to a great extent, but also made the main elements be worked, assembled, dismantled and maintained more inconveniently.

3. 1 Problems existing in original design

1) Since the flange 4 was welded on lower end of the spindle 3, the elements fitting with the spindle could only be installed in corresponding sequence from its upper end downwards, and the designed spindle had to be of non-shoulder. Consequently, axial fix position and axial force transmission of the elements had to use the snap rings, then the disadvantages presented in 2. 1(2) were inevitable.

2) Obviously, because of the welded structure composed of the non-shoulder spindle and its end flange, the design of its bearing assembly was largely limited and could not use the version shown in fig. 2.

3) The manufacturing process of the welded structure is more complicated. If it was improperly planned, it would exert an adverse influence on its machining accuracy and accuracy maintenance of the mixing spindle.

4) Because the elements fitting with the spindle could only be installed in corresponding sequence from its upper end downwards (if dismantled, just in the opposite sequence and direction), their installation and dismantlement were inconvenient.

3. 2 Splined structure of the spindle and lower hollow shaft

In the innovated design(Fig. 2), the spindle 8 is connected with its end flange 10 by means of a rectangular spline. The end flange which can be conveniently installed or dismantled not only provides a possibility for the structural design shown in Fig. 2, but also makes other elements fitting with the spindle be conveniently installed or dismantled. The main features of the splined structure are expounded as follows.

Close to the spline tail of lower end of the spindle 8, its convex teeth have been turned off up to a length of 15mm in the axial direction. An axial-fix plate 9 has thickness of 15mm and the splined hole corresponding to the splined spindle. During the installation, the plate 9 is moved up from the end of the splined spindle to the annular slot of 15mm in width along the axis, then rotated about the axis up to 22. 5°or so (as shown in Fig. 2, A-A, for example here is a 8-tooth spline), and finally clipped in the slot to form the transition fit $15\frac{H_8}{k_7}$. The plate is therefore axially fastened in respect to the spindle. Then the end flange 10 with corresponding splined hole is fitted with the splined spindle and makes the lower hollow shaft 11 be centered depending on its fit ($\varnothing 100\frac{H_8}{h_7}$) with the joint flange welded at upper end of the shaft. At last, the two end flanges and the axial-fix plate 9 are fastened together by the use of reamed bolts or ordinary bolts. Thus by means of the axial-fix plate and bolted connection, the hollow shaft fixed with the blade wheel 12 is axially fastened in respect to the spindle, and the driving torque of the spindle 8 is transmitted to the blade wheel 12 through the splined connection and bolted connection.

3. 3 Advantages of the splined structure

1) In the improved version, the spindle and its end flange are individual parts and are connected by spline, thus providing the possibility for the structural design shown in Fig. 2.

2) The spindle and its end flange are separately worked more easily and will have a good accuracy maintenance. When one of them is failed, the another can be retained to continue working, thus saving the repair cost.

3) After the innovation, the elements fitting with the spindle can be installed in corresponding sequence simultaneously from both ends of the spindle (if dismantled, just in the opposite sequence and direction). It should be noted that there are two threaded holes symmetrically distributed on the upper end face of sleeve 6 for dismantling the assembly including the bearings and the spindle etc. It can be seen that the installation and dismantlement of the mixing tank assembly are far more convenient.

4 An improvement on the bearing support and its advantages

According to the original design, both end holes of the bearing support could only be bored individually from both ends at a distance of 450mm or so (Fig. 4,a). Therefore, it was more difficult to reach a high coaxality of both end holes. In the new design shown in Fig. 2, the sleeve 6 added between the taper roller bearings and their support 13 makes the diameters of both end holes reach the same design dimension $\varnothing 150K_7$. Since the cylindrical roller bearing used for the lower supporting point is unable to bear any axial froce, the inner and outer races of the bearing may be axially fixed by means of snap rings. Then the both end holes designed actually are non-shoulder through-holes with the same diameter (Fig. 4,b). In the course of boring the holes of the support, both end holes ($\varnothing 150K_7$) can be finish-cut out under the conditions of one-time fastening of the workpiece and one-time feed, a high coaxality of the two holes being easily achieved. In addition, as the precision control of axial dimensions is more difficult during the machineworks of the spindle and support, errors of the associated axial dimensions synthetically manifest themselves as a greater axial dislocation of inner race of the lower bearing in respect to its outer race during the assembling. In original structure, it was very difficult to correct the dislocation. After the innovation, the thickness of the spacer added between the sleeve 6 and upper end face of the support 13 can be conveniently adjusted in order to correct it. Furthermore, the clearances of the upper bearings can also be adjusted by increasing or reducing thickness of the spacer between the end cap 5 and upper end face of sleeve 6. Obviously, for the innovated structure, its assembling and adjustment are quite convenient.

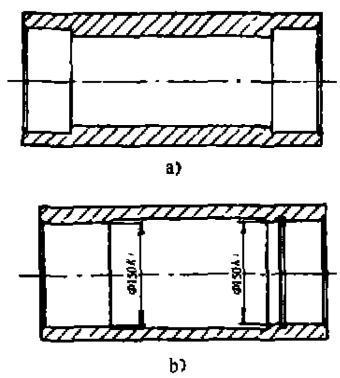

Fig. 4 Structure of the bearing support before (a) and after the innovation (b)

5 Improved lubrication

The upper and lower bearings in the mixing tank are lubricated by grease. Because the mixing spindle is vertical and working temperature of the bearings is influenced by that of the slurry in the tank, grease filled in the upper bearings at a time can flow down the spindle, so that, not long after, the upper bearings will have lack of grease, while excessive grease will gather at the lower bearing. In order to mitigate the grease flowing down, a grease-trapping ring 7 is fitted into bottom of the sleeve 6 and keeps a certain clearance with the spindle. During the course of assembling, the ring is filled with clean grease. Although grease in the ring, to some extent, hinders grease passing through upper bearings from flowing down, it is allowed to pass very slowly through the proper radial clearance between the ring and the spindle, so as to supplement a suitable quantity of grease for the lower bearing. After the mixer works for a definite time, in order to supplement a suitable quantity of grease for the unit conveniently, the cap 2 of observation hole is horizontally turned away, the big pulley 3 is slowly rotated by hand, so that the grease cup 14 fitted in the periphery of the muff 4 is aimed against the orifice of horizontal grease tube 15, and then by means of a grease gun grease is pumped into joint-grease cup 1, via the tube 15, the cup 14, axial grease channel on the inner surface of sleeve 6 and its end gap, flowing into the upper bearing. Consequently, without the need to dismantle any element, grease can be conveniently added in the bearings.

6 Conclusion

It can be seen from the above comparisons and analyses that because the innovated connection version composed of the axial-fix plate, spline fitting of the spindle and its end flange and bolts etc. is used to replace their conventional welded structure, the structural design of the mixing tank unit acting as heart of the mixing-pouring truck(machine) is more reasonable and perfect. The use of the improved design not only gets rid of the outstanding problems in the original design, bu also makes working of its key elements easier, and assembling, adjustment and maintenance of the mixing tank unit more convenient. As a result, availability factor of the mixing-pouring truck(machine) is significantly increased. By the way, it should be pointed out that the innovated connection version can also have wide application in the similar structures of machines of different kinds.

加气混凝土搅拌浇注车(机)的改进设计

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摘要：介绍了对从国外*引进的加气混凝土搅拌浇注车的改进设计。在文中，就其搅拌轴的轴承组合设计、主轴与其装有搅拌叶轮的空心下轴的联接方式、轴承支架的结构以及轴承的润滑等几个方面的改进作了详细的论述。

关 键 词：加气混凝土；搅拌浇注车(机)；改进设计

* 瑞典