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DELIVERING QUALITY SCIENCE TO THE WORLD

A Design of New Type of Bulldozer Shovel

Hui Wang [a], Xinwei Gan [b], Liangchen Shao [c]

School of Mechanical and Electronic Engineering, Shan Dong University of Science and Technology,

Qing dao 266590, China

[a]2575429605@qq.com, [b]923597420@qq.com, [c]620780102@qq.com

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Abstract: Bulldozer is blocked because of adhere between the soil and the shovel wall surface when bulldozers work, in order to reduce the adhere resistance, bionics and engineering mechanics were studied and explored. Dray of bulldozer was affected by the design of cutting angle and shove wall surface when the bulldozers working in the same environment. The bulldozing designed could be reduced partial resistance by improving bulldozer blade angle. The non-surface were designed instead of smooth surfaces by using the bionics principles in surface design of shovels. Flows along the surface of the soil cutting and the destroyed soil could be reduced by using non-smooth shovel. The contact area of the shovel and soil was lowered. And the resistance could be reduced.
Keywords: bionics, bulldozer shovel, non-smooth surface.

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1. INTRODUCTION

1.1 Research status at home and abroad

Today, the ground-contacting parts of pavement construction machinery are mostly smooth surface structures. When the soil moisture content increases, the earth-moving parts of the road machinery such as a bulldozer adhere to the soil, resulting in a significant increase in the resistance and affecting the working efficiency of the machine during normal operation. In recent years, bionics has been widely used in the construction machinery industry and has made some progress. Using bionics to improve the structure of the construction machinery, it has the characteristics of good performance, simple and light overall, and high work efficiency. The structural parameters of the blade determine the resistance of the blade and soil. The efficiency of the bulldozer at work is closely related to the design level of the blade. People also simulated the relationship between blade adhesion and work efficiency. Therefore, the blade is combined with bionics to improve the design of a highly efficient blade.

1.2 Direction of research

Studies on animals living in moist soils, such as pangolins, loach, pupa, etc., have found that many sticky wet soil animals have unique features of appearance and structure. Using bio-bionics to improve the angle of the bulldozer can reduce the problem of bulldozing resistance to a certain extent.

On the design of the shovel wall surface, the bionic principle was used to change the conventional smooth surface into a non-smooth surface. Non-smooth bulldozing plates have significant desorption and drag reduction capabilities during soil cutting. To improve the bionics of the blade's cutting angle and the surface of the shovel's wall. To a certain extent, the adhesion resistance of the soil to the blade is reduced, and the working efficiency of the blade is improved.

2. BULLDOZER BUCKET

Fig. 2.1 shows the bulldozer when the bulldozer is working, and 6 is the push beam, which is fixed on the frame of the chassis by means of a hinge connection. The bulldozer and can be adjusted by lifting and lowering by tilting the cylinder. Blade 3 Dozer blade 1, tie rod 4, cylinder 5, and support frame form a rigid frame that can withstand the load of the bulldozer during operation.

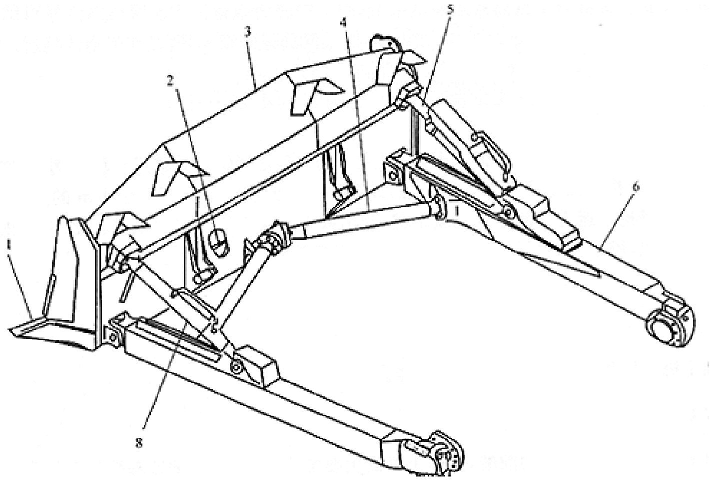

Figure 2.1 bulldozer dozer device diagram

3. BULLDOZER BUCKET RAW DATA

The bulldozer designed in this paper is a Ty220 type bulldozer blade that is produced by a company. The blade is a compound curved surface composed of a straight line segment and an arc segment. The cutting angle is 52°, the blade width is 3725mm, the blade height is 1316mm, and the radius of the compound wall of the shovel wall surface is 1404mm. The detailed parameters of the blade are shown in Table3.1.

Table 3.1 Dozer blade parameter table

structural parameters	numerical value	structural parameters	numerical value
cutting angle	55°	blade height	3725mm
rear corner	30°	arc radius	1404mm
diagonal corner	75°	blade wall thickness	15mm
front corner	75°		
blade width	1316mm		

4. BULLDOZER BUCKET CUTTING BIONIC

Dung beetle survives in sticky soil and is a typical dig and dozing animal. Dung beetle the overall shape is oblong, body black, and shiny on the body surface. In the middle of the head, there is a big bump similar to a bulldozer structure.

Dung beetle has a unique ability to dig and push soil. It pushes the hole more than 1,000 times more than the body's body weight. When excavating, the soil on the front wall is cut with a head similar to a bulldozer, acting as a shovel-type excavator. The soil cut off from the head plate structure is continuous and uninterrupted. The soil rises along the curved surface of the head plate structure. After being turned over the curved surface structure, it loosely spreads on the back wing of the chest below the head and finally falls off. To the ground. The curved panel structure of the head is similar to that of a bulldozer bulldozer. Under normal circumstances, the head angle of the head is 48°-52°51′ and the post-cut angle is 27°40′-35°30′. The forefeous forefoot has evolved into the excavation of the foot. The outer edge of the foot has a hard dentate structure that is shaped like a shovel and is easy to dig. The neck is wide and flat.

This angle structure facilitates the cutting and pushing of the soil in the excavation of the cave. According to the scorpion head plate structure, the blade shape and cutting angle can be designed in conjunction with the bionic principle, so that the soil can easily fall forward on the blade's upper edge during operation, and the soil cannot cross the back of the blade. Scattered behind, there must be more soil before the blade, and the soil becomes smaller as the height of the blade surface rises, so that the cutting resistance of the soil will become smaller, the surface will not be easily bonded to the wet soil, and the shovel will also unload the soil. Will be clean. When designing a blade, the blade cutting resistance becomes smaller as the blade angle becomes smaller within a certain range of angles.

As the blade is to ensure the use of strength, the blade rake angle is 45° to 60°, and its adjustment range is approximately ±10°. The blade angle ranges from 30° to 35°. When the relief angle is less than 30°, terrain undulation will lead to grounding behind the blade, which will increase the frictional resistance of the shovel and reduce the cutting ability of the blade.

5. BLADE BIONIC SURFACE BIONIC DESIGN AND IMPROVEMENT OF SOME PARAMETERS

5.1 Calculation of curved surface curvature radius

When calculating the R value, calculate and select the cutting angle, rake angle, front turning angle, shoveling wall height H, and the length of composite straight line a according to the performance requirements. Use surface plotting methods to make the best surface shape.

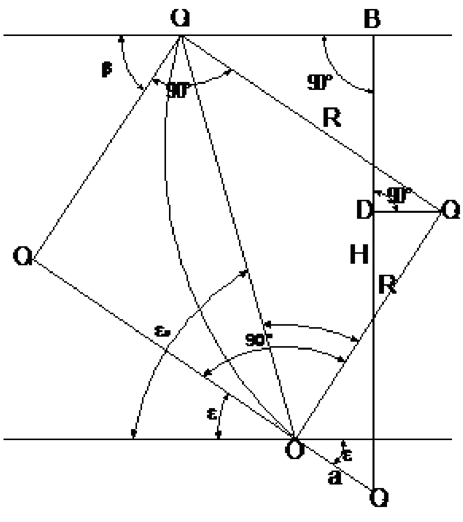

Figure5.1 Surface geometry of shovel wall

From Figure 5.1 we can see:

$$\angle O_2O_3O_4 = \angle O_2OO_4 = 90^\circ$$

$$O_2O_3 = O_2O_3 = R\,;\, O_1B \perp CB\,;$$

$$O_1B = H = BF + O_1F\,;\, OO_1 = a \text{ (Take arbitrary value)}$$

$$\angle\; O_1OF = \varepsilon \;\; O_1F = a\sin\varepsilon$$

$$BF = R(\cos\beta + \cos\varepsilon)$$

$$H = R(\cos\beta + \cos\varepsilon) + a\sin\varepsilon$$

$$R = \frac{H - a\sin\varepsilon}{\cos\varepsilon + \cos\beta}$$

Using surface scale features and surface irregularities of the pangolin to improve the blade surface. The blade angle is changed from 55° to 52° through the bionic head structure. The blade surface of the bulldozer blade is designed to resemble a scale structure with uneven surface. The arched corrugated surface bulldozing blade with regular longitudinal shape is used as the shovel blade. Thickness range 14-15.5mm, blade other parameters unchanged. $\varepsilon_0 75^{\circ}$, $\varepsilon 52^{\circ}$, $\beta 75^{\circ}$, $H 1316\text{mm}$, $\text{a}180\text{mm}$.

$$R = \frac{H - \text{a}\sin\varepsilon}{\cos\varepsilon + \cos\beta} = \frac{1316 - 180\sin 52^{\circ}}{\cos 52^{\circ} + \cos 75^{\circ}} \approx 1342\text{mm}$$

5.2 Dozer blade parameter improvement

The improved cutting angle becomes 52 degrees. If the cutting angle is too large, the strength of the blade will be reduced. When the cutting angle is too small, the soil debris will directly adhere to the bulldozing plate, and the soil will not easily fall. The relief angle is 30 degrees. When the relief angle is too small, the ground will cause the blade to be grounded, increasing the frictional resistance of the contact. Both the oblique and front flip angles are 75 degrees, and the oblique angle determines the volume of the bulldozing soil. When the value is too small, the soil will fall over the edge of the shovel blade and fall behind the blade. And the volume of the soil is too large, increasing the lifting resistance of the blade. The tipping angle determines the ease with which the blade cuts the soil and falls to the bulldozer. Being too small is not easy to fall, excessive increase in level and vertical bulldozing resistance. The arc of the curved surface is a composite section. The straight section is increased from 160mm to 180mm. The curved section is calculated from the curved surface geometry and the curvature from the new configuration. The radius of the new curved section is 1342mm.

6. DOZER BLADE SIMULATION

Figure 6.1 below shows an improved three-dimensional model of the bulldozing shovel with an improved surface curvature of 1342mm and a cutting angle of 52° and a composite straight line length of 180mm. The overall curved surface resembles a scale structure with irregularities on the surface, a regular, arched corrugated shape in the longitudinal direction, and a regular strip-shaped surface dozer blade in the transverse direction. The thickness of the shovel wall ranges from 14 to 15.5 mm. In that design does not change the articulated devices, support rods, cylinders and other components, and the blade length and height does not change, so the normal assembly and use can be carried out. Figure 6.2below shows the three-dimensional structure of bulldozer dozer. Create two-dimensional assembly drawings and parts drawings using three-dimensional models. Complete assembly of dozer blades and dozers.

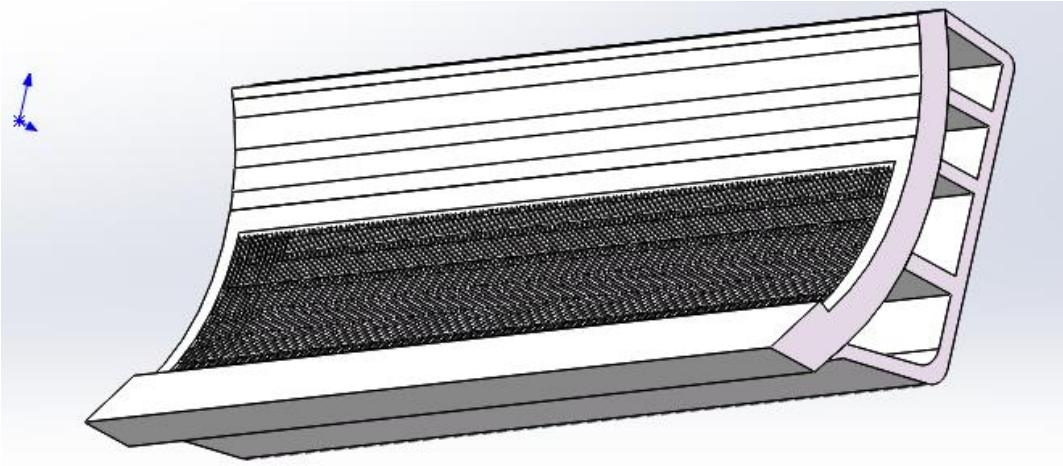

Figure 6.1 Dome shovel profile simulation

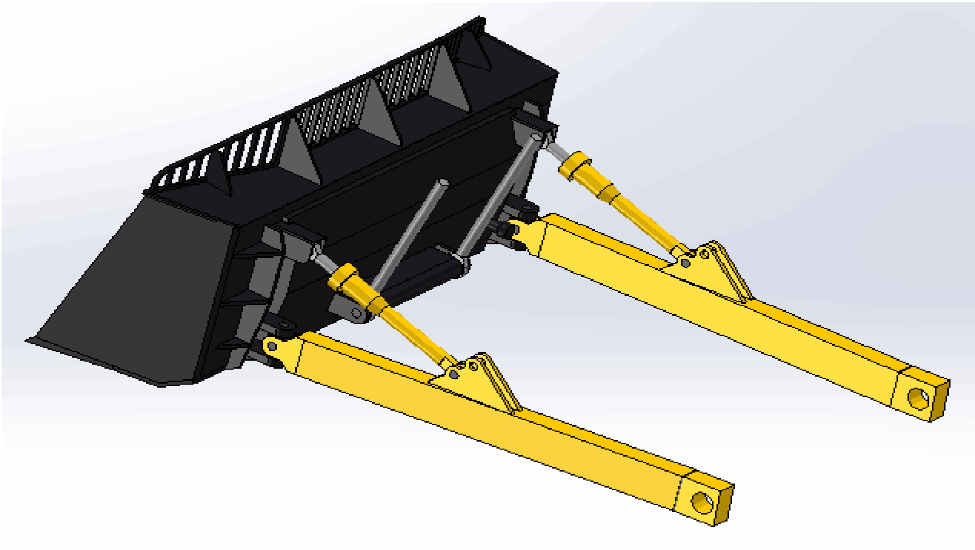

Figure 6.2 Three-dimensional structure diagram of a bulldozer

7. SUMMARY

The bionic design of the blade changes only at the cutting angle and the shape of the curved structure. In practical applications, the bulldozer can be normally assembled and used for the blade, and has feasibility and practicality. The bionic study of the bulldozer provides a new method for the problem of soil adhesion and resistance to the earth-contacting parts of ground machinery.

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