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Analysis and Simulation of Scraper Configuration on Roughcast Mechanism

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Abstract

To roughcast processing in construction is a complicated and inefficient working procedure，and now the equipment is defective in market. A new type of semi-automatic roughcast scraper mechanism was design in this paper, and the scraper board which is the key components been carried on the structure analysis and calculation, and to determine the formation of the scraper movement and the best installation angle; to analyzed the force of the scraper and provided theory basis for the optimal design.

Keywords*: Institutional design; Roughcast; Scraper mechanism; Scraper board*

1. Introduction

In building decoration engineering, currently for the roughcast putty (calcium carbonate) processing working procedure on wall, mainly adopt manual mode operation, workers labor intensity, multiple operation, the need for scaffolding and high stool for higher roughcast construction , etc, which brings to inconvenience and causes production efficiency low[1]. According to this situation, there are many scholars did a lot of work in this field, to study the different functions of scraper mechanism, the scraper mechanism can be divided into two categories: one kind is sprayer, another kind is porcelain scraper. At present, for scraping putty this procedure, sprayer is adopted to the most of the construction, the efficiency is high by the way, but it needs artificial leveling after spraying which brings to inconvenience; Adopting porcelain scraper for wall decoration doesn't need manual, and can get a good quality, operation conveniently, so it has a good development trend, but existing porcelain machine mainly adopts double pillar support, poor stability, and scraper place cannot achieve inching, poor accuracy[2-3].

In view of the above situation, in this paper, a kind of semi-automatic scraper mechanism was designed, and carried on design and analysis of the scraper mechanism, make the scraper can rotate at work, plastering wall distance adjustment, work smooth, simple structure, convenient operation, and can realize the secondary calendering operation[4].

2. Structure Design and Working Principle

According to the actual movement of scraper mechanism work, the scraper mechanism adopts the gantry structure, the structure is shown in figure 1.Scraper mechanism is supported by five parts including chassis, plunger parts, transmission lifting, conveying material parts and scraper putty part [5-6]. Setting a distance locator in the front of the machine chassis to keep a certain distance from the wall when it works, which facilitate the machine running.

Began to work, drive elevator component drives the scraping board on the wall to scrape putty, when it reaches the highest position of the wall, scraper stops, then it forward rotates 90 degrees and moves downward to finish secondary calendering

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operation of the wall. Stop when it reaches the lowest position of the wall, and a job completes [7]. Then, the scraper machine was pushed to left or rights a machine distance and locked; to repeat the above action can implement other scraper movement. In terms of working process, scraper putty part is an important part of the five parts, and the structure is shown in figure 2, the running stability determines the quality of scraping.

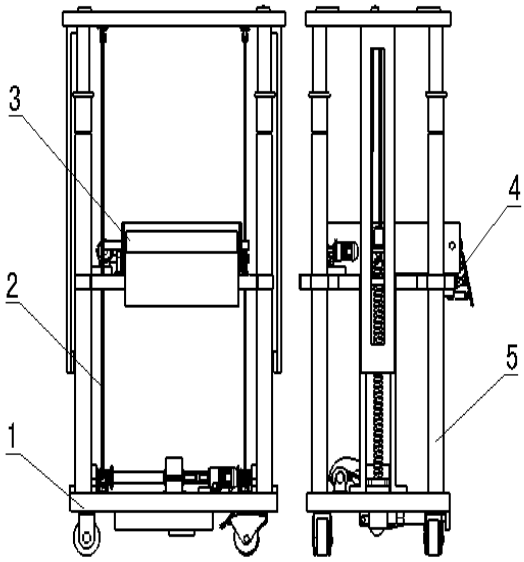

Figure 1. Scraper Machine Mechanical Structure

1-chassis part; 2-transmission lifting part; 3-convey material part; 4-scraper putty part; 5-plunger part

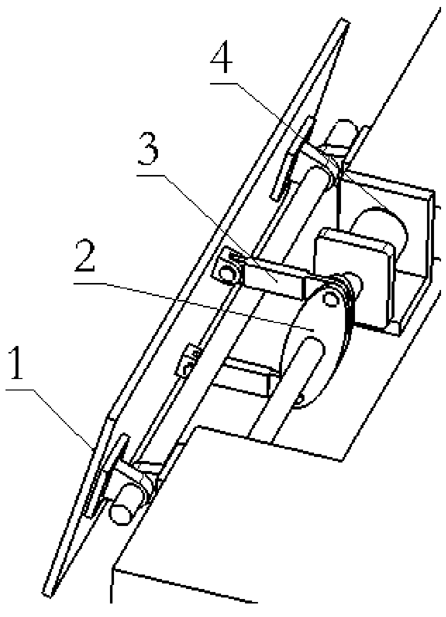

Figure 2. Scraper Putty Part Structure

1-scraper blade; 2-cam; 3-strut; 4-step motor

3. The Structure Analysis of the Scraper Mechanism in Scraper Putty Part

3.1 Calculate the Degrees of Freedom of the Scraper Mechanism

Number of degrees of freedom F shall be the activity component degree, subtracting the total number of the restricted sum, the calculation such as equation 1.

$$F = 3n - 2P_L - P_H \tag{1}$$

Where P_L is number of the revolute pair; P_H is number of the higher pair.

According to the analysis and calculation, the scraper mechanism can be simplified as the figure 3, the figure 3 illustrates the active component has four of the event, in which component 1 and component 3 make up the redundant constraint, it was ignored when calculate. The activity numeral calculated at three and revolute pair number calculated at four. Take the above data into equation 1; the freedom degree of scraper mechanism is 1. This component has a moving part. The number of moving parts is equal to the freedom degrees.

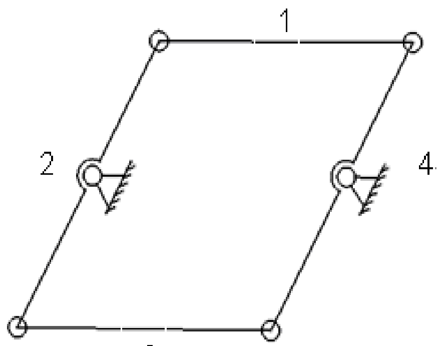

Figure 3. The Scraper Mechanism Motion Diagram

3.2 The Installation Angle Analysis of Scraper Blade

The angle between scraper blade and the wall has a direct impact on the scraper quality, the figure 4 is a diagram for the cross section view of the wall and scraper. In the figure, the wall on the left side, on the right side there is a quarter circle with a radius R, the beeline of R position shows the scraper. And there is a certain distance between scraper bottom and the wall, the distance is the thickness of putty, and the angle between scraper blade and the wall is θ. From the figure 4, a right triangle is made up of b, h and R. According to the above data and trigonometric function relationship can get equation 2.

$$\begin{cases} b = R\sin\theta \\ h = R\cos\theta \\ s = \frac{1}{2}bh = \frac{1}{4}R^2 \sin 2\theta \end{cases} \tag{2}$$

Where R is the width of the scraper, and b is the horizontal distance from scraper top to the bottom when it works, and h is the vertical distance, and s is the triangle area which is made up of b, h and R.

Assuming that the length of scraper is l, the volume of a cube between scraper and wall is V. Due to the thickness of the putty is small, the volume can be ignored. Combined with the equation 1, the scraper volume can be obtained by equation 3.

$$V = sl = \frac{1}{4} R^2 l \sin 2\theta \quad (3)$$

In the process of work, the consumption of putty was 0.6 ~ 0.8 kg/m. The thickness of the putty is 1*mm*, so the consumption per cubic meter is (0.6 ~ 0.8) $\times 10^3$ kg$/m^3$. The consumption of putty takes $0.8 \times 10\, \mathrm{kg}/m^3$, $R = 20cm$, $l = 1m$, $g = 9.8N/\mathrm{kg}$, then the mass of the putty can be calculated by equation 4, the gravity of the putty can be calculated by equation 5.

$$m_{总} = 0.8 \times 10^3 \times \frac{1}{4} R^2 l \sin 2\theta = 8 \sin 2\theta \quad (4)$$

$$G = m_{总} g = 78.4 \sin 2\theta \quad (5)$$

Integral analysis can be used to analyze the stress of putty, when scraper works, the stress diagram is shown as figure 5, in the figure, F is putty support from scraper blade, N is putty support from wall, f_1 is friction force of putty from scraper blade and f_2 is friction force of scraper blade from wall, according to the figure 5 equation 6 is as followed.

$$\begin{cases} F \cos\theta = N + f_1 \sin\theta \\ F \sin\theta + f_2 + f_1 \cos\theta = mg \end{cases} \quad (6)$$

Where $f_1 = u_1 F$; $f_2 = u_2 N$; the μ_1 and μ_2 for the frictional coefficient.

According to actual work, assuming that $u_1 = u_2$ = 0.7, $mg = 78.4 \sin 2\theta$, make it into the equation 6 and the equation 7 is followed.

$$\begin{cases} F = \dfrac{78.4 \sin 2\theta}{1.4\cos\theta + 0.51\sin\theta} \\ N = \dfrac{78.4 \sin 2\theta}{1.4\cos\theta + 0.51\sin\theta} \times (\cos\theta - 0.7\sin\theta) \\ f_1 = \dfrac{54.88 \sin 2\theta}{1.4\cos\theta + 0.51\sin\theta} \\ f_2 = \dfrac{54.88 \sin 2\theta}{1.4\cos\theta + 0.51\sin\theta} \times (\cos\theta - 0.7\sin\theta) \end{cases} \quad (7)$$

According to the equation 7, the θ is used as the abscissa, respectively, the N, f_2 as the ordinate, so the scraper force with radian- change curve is shown in figure 6, the maximum support and the maximum friction from the curve is visible.

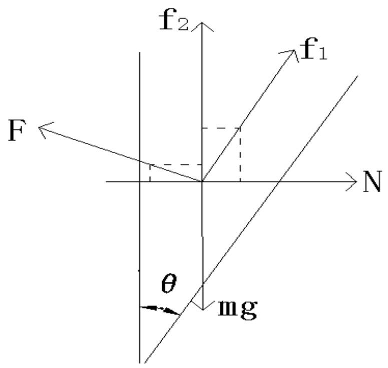

Figure 5. Stress Diagram

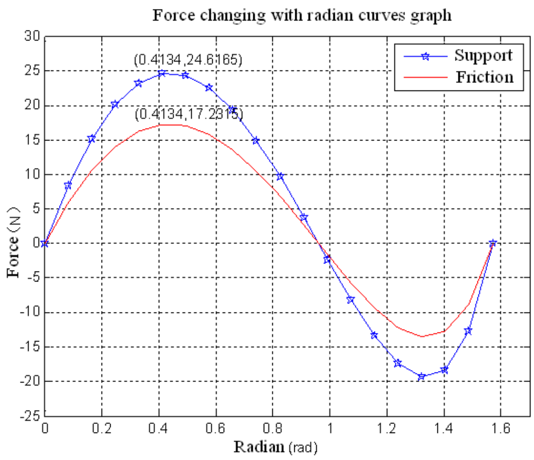

Figure 6. Force Changing with Radian Curves Graph

In the experiment, when the putty support and friction force from wall achieve the maximum, the quality of scraping putty is best. In the diagram the maximum of abscissa is 0.4134, it is the radian in the diagram. The equation 8 can be used to convert it to the angle, get $\theta = 24^{\circ}$ **,** so when the angle is 24^0, the quality is the best.

$$\theta = 0.4134 \times \frac{180}{\pi} = 23.69^{\circ} \tag{8}$$

3.3 Scraper Static Analysis

According to the best angle of scraper and the equation, the pressure of the scraper is 39.2 N , then finite-element static analysis was carried out on the scraper, the result of the analysis are shown as figure 7.

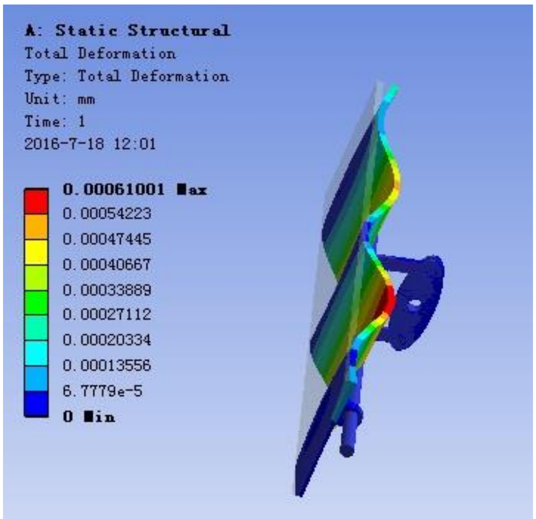

Figure 7. Scraper Deformation Image

Deformation degree each position is visible when the scraper works from the diagram, a maximum of deformation of scraper is 0.00061001*mm*. Look from the overall deformation, and the deformation is too small, so meets the requirement.

4. Conclusion

The new scraper movement form and the best installation angle is determined by the above structure analysis, and carry out finite-element static analysis on the scraper, gain the overall mechanical parameters of the scraper, and lay a theoretical foundation for further research design.

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