ISSN: 2414-1895 DOI: 10.6919/ICJE.202310_9(10).0010

Design of Mechanical Gripper for Insulating Glass Production Line

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Abstract

According to the position and process requirements of the manipulator in the insulating glass production line, a mechanical gripper for insulating glass production line is proposed. The mechanical gripper is composed of 14 vacuum suckers symmetrically distributed on the "cross" frame. Taking the glass deformation as an index to evaluate the rationality of the vacuum sucker distribution of the mechanical gripper, the rationality of the vacuum sucker distribution is analyzed and verified.

Keywords

Insulating Glass; Mechanical Gripper; Design.

1. Introduction

Various robots have been widely used in the manufacturing industry[1-3], such as ABB's development of a 6-axis robot IRB6660-100/3.3 for automatic press line[4]. Chen Ruihong et al. have designed a loading and unloading manipulator for gearbox gear meshing testing machines, significantly improving work efficiency[5]. Fu Tie et al. have developed a loading and unloading manipulator for laser marking machine operations[6]. However, some insulating glass production lines still rely on manual loading and unloading, resulting in low production efficiency and easy damage to the glass during operation, which affects product quality.

According to the workstation and process requirements of the robotic arm in the insulating glass production line, a mechanical gripper is proposed. The mechanical gripper is composed of 14 vacuum suckers symmetrically distributed on the "cross" frame. It can reach the designated position to suck and release glass according to instructions.

2. Structural Design of Mechanical Gripper

The mechanical gripper is an important component of the manipulator in the insulating glass production line. It reaches the designated position to suck and release glass according to instructions, and is composed of a vacuum suction cup and a vacuum generator installed on its frame. The frame of the mechanical gripper is composed of two hollow tubes made of 45 steel, The mechanical gripper is composed of 14 vacuum suckers symmetrically distributed on the "cross" frame, as shown in Fig. 1.

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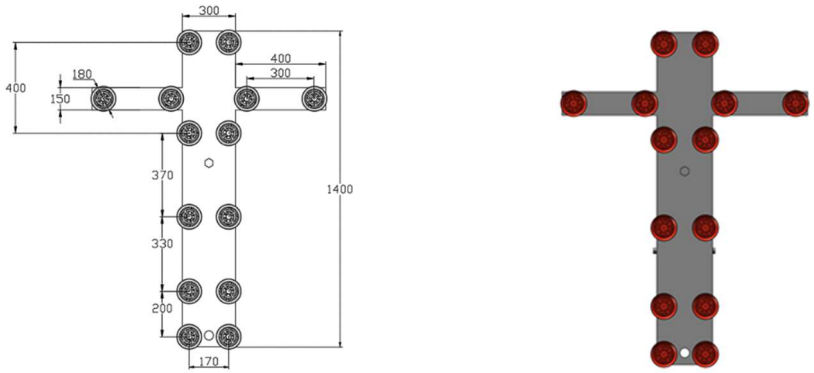
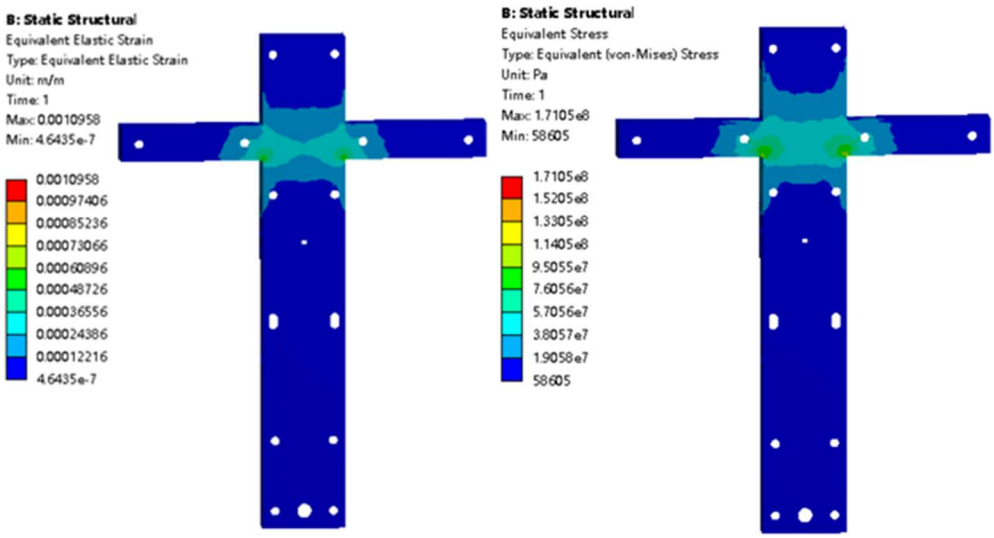


(a) End effector size (b) CAD drawing of end effector

Fig.1 End effector

3. Static Analysis of Mechanical Gripper Frame

The 3D model of the mechanical gripper frame is imported into ANSYS and material property parameters are set [7-8]. The tetrahedral method is used to divide the grid for static analysis, and the stress-strain cloud diagram is shown in Fig. 2. The maximum deformation is 0.076mm, and the maximum stress is 15.375Mpa, which is far less than the material yield strength. Therefore, the design of the mechanical gripper frame is reasonable.



(a) Strain (b) Stress

Fig.2 Stress-strain nephogram of End effector rack

4. Reasonability Analysis of the Distribution of Mechanical Gripper Sucker

The distribution of vacuum suckers affect the stress situation of glass, and glass deformation is used as an indicator to evaluate the rationality of vacuum suckers distribution. Glass model is imported into ANSYS, the force point at the sucker position is set as shown in Fig. 1, the tetrahedral method is used to divide the grid, Grid size is 0.01mm, and the constraints and force is added, the suction force of each sucker is set to 1298N, the glass strain cloud diagram is shown in Fig. 3. The maximum deformation of glass is 0.67mm, and the deformation can be ignored. This indicates that the arrangement of suckers is reasonable.

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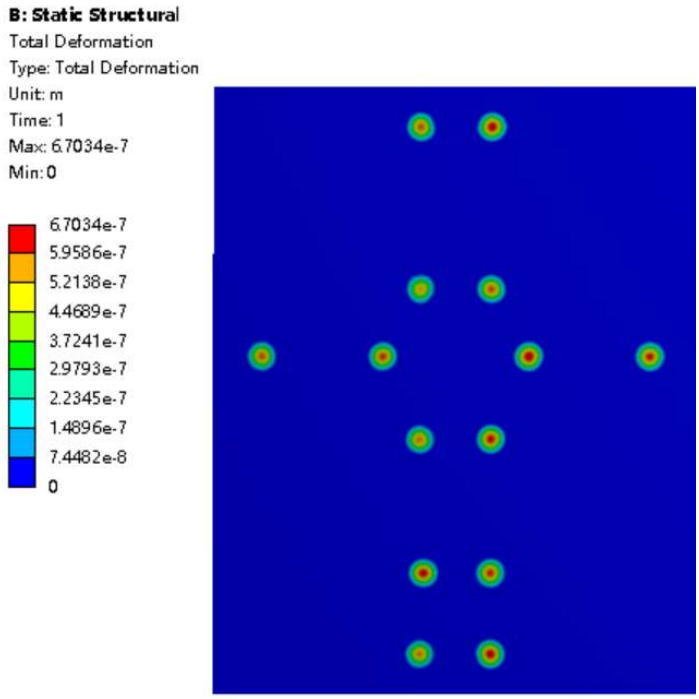

Fig.3 Glass strain nephogram

5. Conclusion

In order to improve the automation level of the insulating glass production line and meet the needs of the production line, a mechanical gripper for the insulating glass production line has been designed. Glass deformation as an indicator is used to evaluate the rationality of the distribution of vacuum suckers in the end effector of the manipulator, the rationality of the distribution of vacuum chucks is analyzed and verified.

References

[1] ZHAO Xu. Research status and industrialization development strategy of Chinese industrial robot[J]. Scientific and Technological Innovation, 2019(36): 72-73.

[2] FENG Xu, SONG Mingxing, NI Xiaoyu, et al. Overview of the development of industrial robots[J]. Technology Innovation and Application, 2019(24):52-54.

[3] ZHANG Yuefu. Research on the current situation and industrialization development of industrial robot technology in China [J]. China High-Tech Enterprises, 2017(03): 3-4.

[4] ZHOU Hao, XIONG Junyin, SHAO Ning. Current Situation and Reflection on the Development of Industrial Robot Industry in China[J]. Technology Wind, 2020(11): 1-2.

[5] CHEN Ruihong, TAN Zhaozhan. Design of loading and unloading manipulator for gearbox gear meshing tester[J]. Machine Tool & Hydraulics, 2020, 48(3): 41-46.

[6] FU Tie, WANG Sheng, LI Chunyang, et al. Design and realization of loading and unloading manipulator for laser marking machine[J]. Experimental Technology and Management, 2021, 38(3): 103-106+112.

[7] LIU Xinjun, YU Jinjun, KONG Xianwen. Rototic Mechanisms[M]. Beijing: China machine press, 2021.

[8] ZHANG Qiang. Robotics mechanism, kinematics, dynamics and motion planning[M]. Beijing: Tsinghua university press, 2019.