

DEM Based Wear Analysis and Optimization of the Chute System in Transfer Stations

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Abstract. With the increasing application of bulk cargo transfer station in ports, it is one of key problems to effectively solve the wear problem of the chute system and to reduce the maintenance cost of port equipment and improve the production efficiency. Taking the actual wear of the chute as an example, this paper analyzed the causes of the wear of the chute system used in the bulk cargo transfer station based on the discrete element method (DEM), and the problems of the original chute design was revealed. On this basis, the optimization scheme of chute was put forward from two aspects of reducing the wear degree and facilitating the replacement of lining plate.

Keywords: DEM, the chute system, simulation, optimization.

1. Introduction

The bulk transfer station is the key equipment in the process of transfer in the port. The chute system in the transfer station plays an important role in the diversion of materials. For different materials, the chute design will be different. However, the chute is in direct contact with the material for a long time, and wear occurs from time to time. Generally speaking, the chute will be equipped with a wear-resistant lining plate inside, and the wear-resistant lining plate is installed on the chute theme through bolts. The advantage of installing wear-resistant lining is that once the wear-resistant lining is worn, the impact on the normal operation of the transfer station can be reduced by replacing the lining.

Ye Fangping [1] carried out simulations to find out the influence of granular materials on wear of the transfer chute. In the study, the Herz-Mindlin non-slip contact model and the Archard wear model was adopted to simulate wear and stress-strain of the transfer chute with different materials and under different working conditions. Ji Caiyuan [2] conducted discrete element simulation study on the flow behavior of coal particles in the transfer system. Orthogonal experiments were used to study the effect of the structure of the shroud and the blanking tube on the wear of the transfer pipe, the outlet speed of the material, and the impact strength of the material conveyor belt. Researchers at home and abroad have carried out related work in the field of DEM material flow simulation[3-6].

Therefore, through the simulation analysis of the wear state of the chute system, it is helpful to predict in advance and take effective control measures. In this paper, DEM was introduced to simulate the particle behavior in the chute system used in transfer stations. An example was analyzed and the problems of the original chute design was revealed. On this basis, the optimization scheme of chute was conducted via software packages EDEM.

2. wear zone analysis of the chute

The chute system of the transfer station is mainly composed of the conveyor head shield and the transfer chute as shown in figure 1.

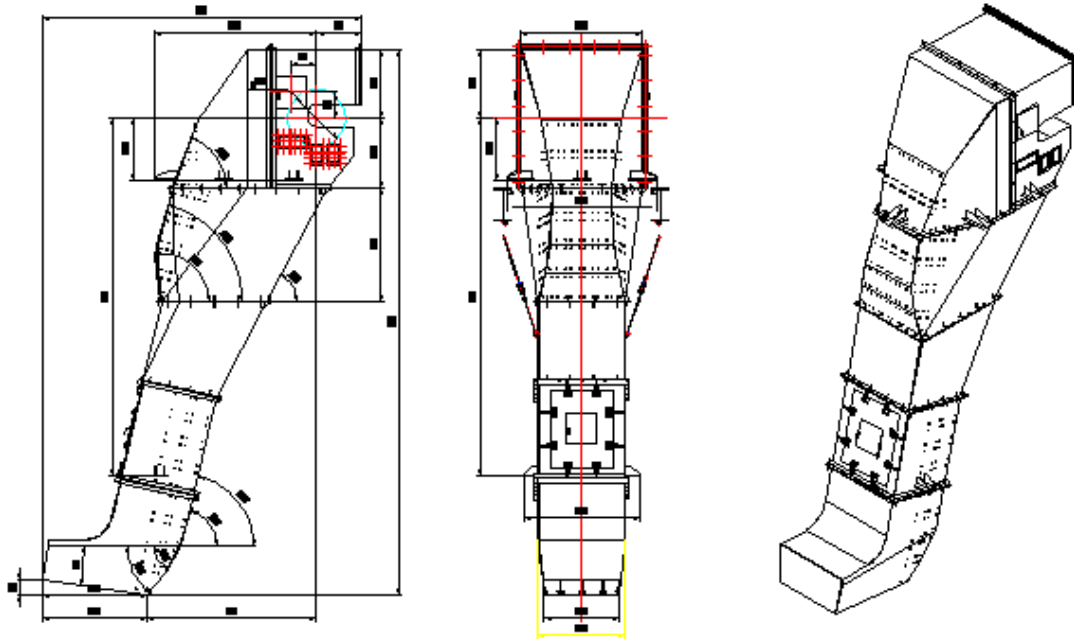


Figure 1. the design of a typical chute

According to the actual situation of the site, the chute impact wear was serious as shown in Figure 2. And the head shield was ideal. According to the discrete element simulation analysis, the matching degree between the simulation results and the real results were verified, which provided a simulation foundation for the model optimization design.



Figure 2. internal wear zone of the chute used in ports

In order to investigate the original problem of the chute, the 3D model was built in Figure 3 as follows.

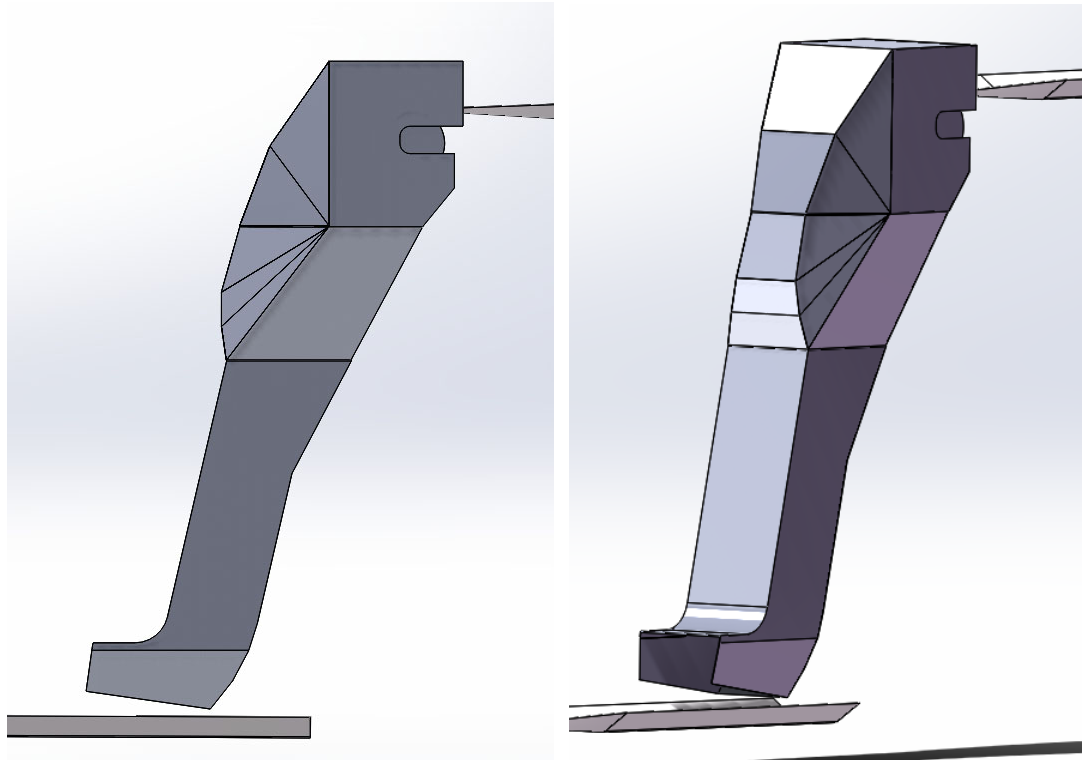


Figure 3. The 3D model of the chute

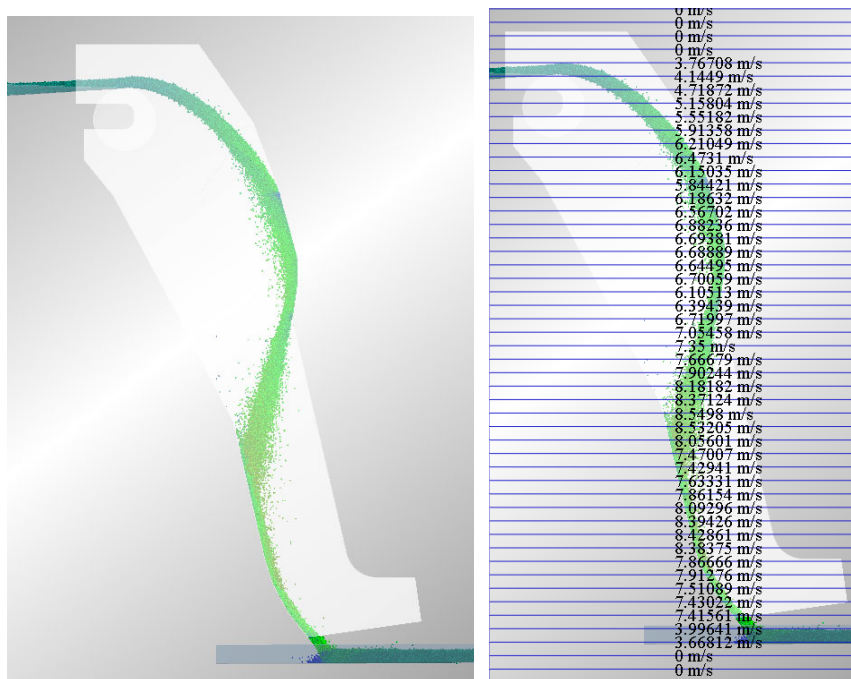


Figure 4. speed analysis of materials through the chute

As shown in the above diagram, the layout angle of the head shield was reasonable, and the material approaching angle was about 20 degrees. In the chute part, there was a long vertical acceleration space, where the material accelerates and falls, and the wear at the impact point was more serious, which should be optimized. The discrete element analysis of the original model was shown in Figure 4.

From the Figure 4 it can be seen that the material was in the head shield position, and the running state was ideal. The material approaching angle was minor, and the wear of the head position was

lighter, and speed control of the material was better. As the material was thrown away from the head position, the material accelerated backward and collided with the left position of the chute, and the material speed increased to 8.5 m/s before the collision. The impact wear was serious in this area and the replacement cycle of the lining plate was short, which affected the online time of the belt conveyor system.

3. Optimization of the chute

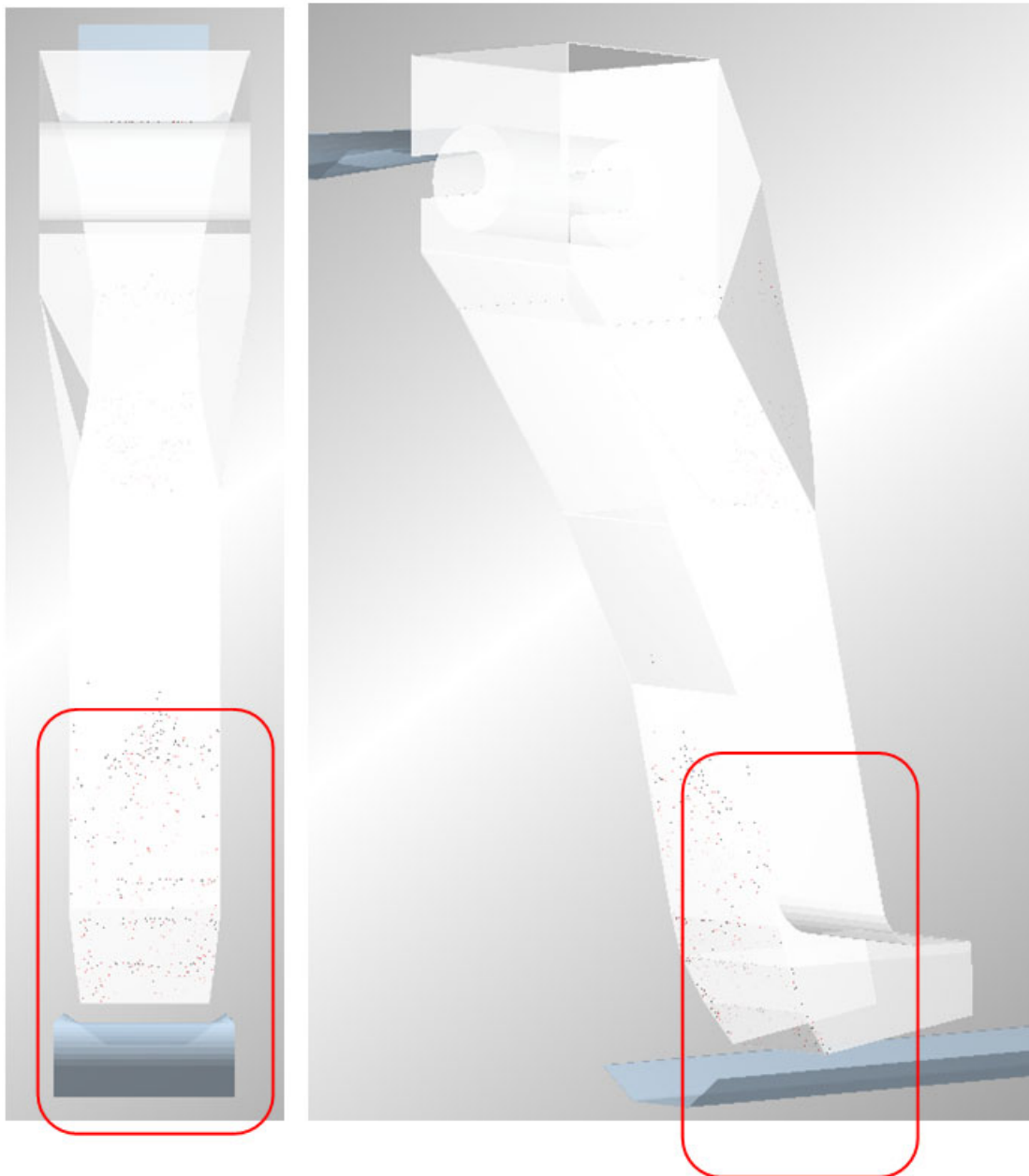


Figure 5. analysis of the wear area

It can be seen from Figure 5 that the wear area of the chute system was mainly concentrated at the lower end of the chute. After the material accelerates, it collides with the area at a large angle and at a high speed. This resulted in severe wear of the lining plates here and a short replacement period as shown in Figure 5. In order to ensure the overall optimization effect, the chute should be fully optimized and the conveyor head position should be replaced together. When optimization was

carried, the material speed and the collision angle of the equipment was emphasized to reduce the wear of the equipment and prolong the service life of the equipment.

According to the impact points of the original design, the radian of the chute in the impact area was optimized, and the impact angle and impact speed were controlled. Figure 6 showed differences of geometric equipment shape and material flow before and after model optimization

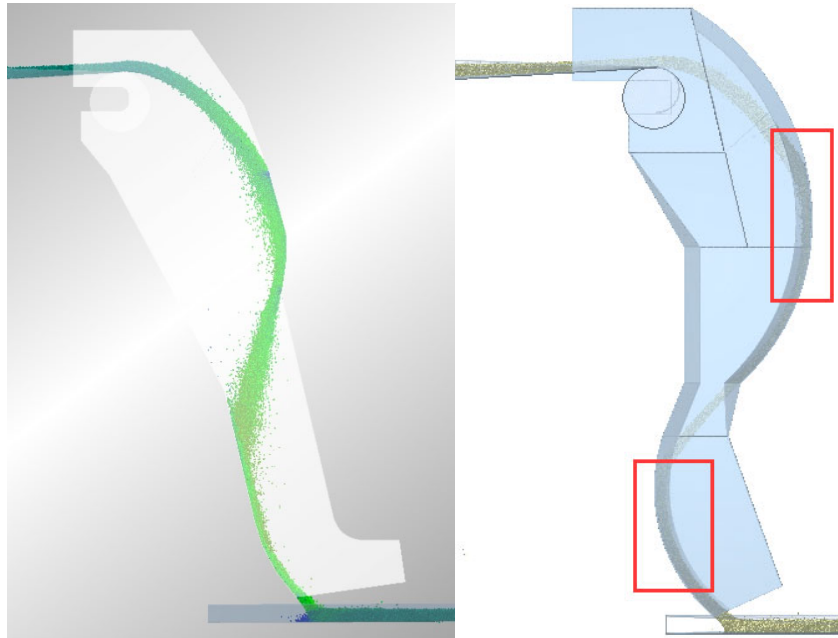


Figure 6. the comparison of the different chutes

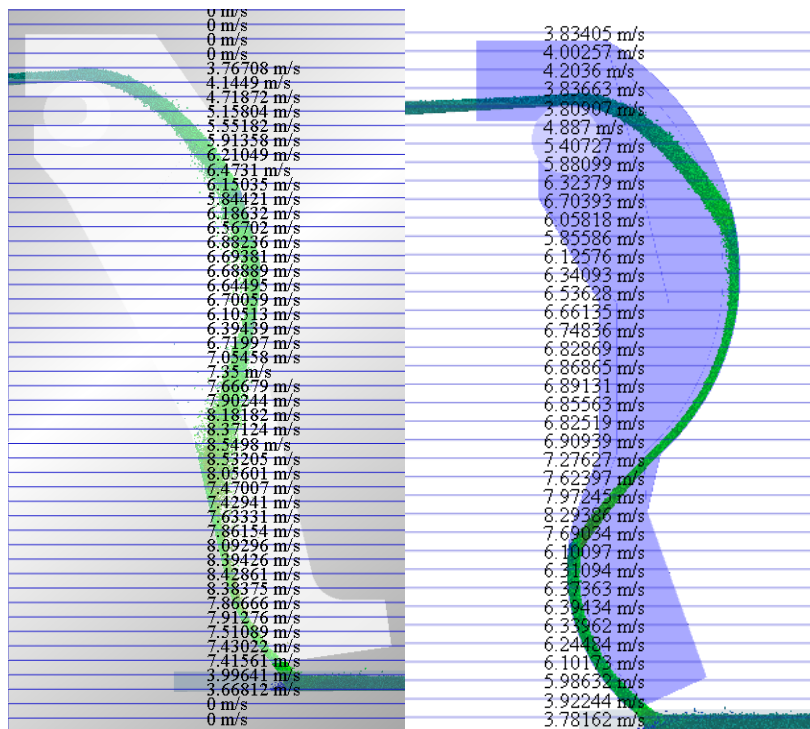


Figure 7. shows the comparison of material velocity distribution before and after model optimization. After optimization, the bottom impact velocity was reduced from 8.5m /s to 7m /s which was good to reduce the wear of the chute.

4. Conclusion

The transfer station is one of key equipment in ports. The chute system plays an important role in the cargo conveying process. the discrete element method (DEM) was used to simulate and analyze the wear state of the chute system of the transfer station. In this paper the causes of the wear of the chute system used in the transfer station were analyzed. Under the guidance of the simulation results, strategies of the wear control for different working conditions are proposed. On this basis, the optimization scheme of chute was put forward. The research results provide a theoretical basis for the optimal design of the chute system and the formulation of maintenance measures, which will help to improve handling efficiency and reduce equipment maintenance cost.

References

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