

Improvement and Design of Road Construction Hoardings

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Abstract

Today, with the improvement of social productivity, the quality of life of our residents has been unprecedentedly improved, but the problems of uncoordinated, insufficient and unsustainable development still exist, such as the environmental problems closely related to people's lives. In recent years, sandstorms, automobile exhaust, industrial and agricultural smoke and dust, construction dust and other haze caused by the haze, has seriously affected the normal life of the people, the normal production of society, the health of residents; among them, construction dust, is gradually becoming the leading factor leading to air quality pollution, but as long as the right measures, construction work construction. The first convenient installation, saving time for installation and later disassembly, the second convenient device disassembly and handling effect, at the same time sealing snap post and sealing snap slot snap, complete the sealing fit of the two wind protection plate, increase the sealing of the device, so as to improve the device wind protection effect and improve the overall practicality of the device.

Keywords: road construction, dust, wind shield, spillage rate

1. Introduction

In recent years, with the rapid development of the national economy, road construction has become the main way to enhance the national economy, and with the accompanying dust pollution benefits are becoming more and more serious. Dust as one of the main sources of atmospheric pollutants, dust caused by the harm is multifaceted and serious: 1, pollution of atmospheric air quality, dust diffusion into the air China, will cause varying degrees of haze, acid rain, climate warming and other adverse to the protection of atmospheric ecological damage. 2, endanger the health of residents around the road, research shows that dust particles will improve the chances of respiratory disease, and atmospheric suspended particles per 100ug/m³ increase, the relative risk of chronic bronchitis, shortness of breath, cough and emphysema diseases are elevated by 29%, 13%, 20% and 59%, respectively. 3, affect the growth of plants, dust particles after covering the surface of plant leaves, will affect the photosynthesis and transpiration of plants, which is not conducive to the survival of plants.

Therefore, by combining the conclusions drawn from relevant studies, this paper seeks ways to improve and design the now existing road construction windbreaks, aiming to be able to design a new type of windbreaks with a focus on wind and dust reduction as the goal, and to study its dust reduction effect. This study focuses directly on dust reduction, which is of very positive significance in promoting green construction; at the same time, improving dust prevention and control helps construction companies to meet national health management standards when carrying out road construction, helping them to reduce the probability of being forced to stop work, thus saving economic costs and reducing the cost of environmental damage caused by road construction.

2. Current Status of Research

2.1 Related Research

There are many types of dust reduction techniques used in road construction project sites, such as dust spraying, dust covering, dust fencing, dust hardening, chemical dust reduction, dust sprinkling and so on. Among them, dust reduction by fencing is mandatory in the national construction standards, so the equipment is widely used.

But the fence is not only used for dust reduction, but also used for construction site safety separation, real estate advertising, etc. Therefore, the construction fence is very important in the construction engineering industry. At present, no matter abroad or at home, there are few studies on the dust reduction effect of construction hoardings, and no systematic results have been formed specifically for the dust reduction effect of hoardings in the foundation pit construction stage. However, over the years, many systematic studies have been conducted on wind fences and fences used to control open yards and sand, and many scientific and perfect research methods and dust reduction effect evaluation methods have been formed, with numerical simulation being the most popular research method, followed by wind tunnel experimental research, while actual measurement research is more often used for Theoretical studies are more often used for the analysis of auxiliary phenomena because of the difficulty of controlling the working variables and the difficulty of setting the desired parameters. Therefore, it is easy to see that in order to do a good job in the research of dust reduction effect of construction hoardings, we need to learn more from the research results on dust reduction effect of hoardings in research fields such as yard and sand.

2.2 Disadvantages of Using Existing Equipment

Road traffic construction process, in order to prevent dust and construction safety, the need to set up a wind screen, not only can warn drivers of road construction ahead, not pass, but also block the wind, to avoid high winds will be facilities blowing chaos, or blowing up sand and dust particles, damage to the environment, affecting the efficiency of workers construction, the existing wind screen in the use of the process or there are certain problems, so we redesign a road traffic construction with a wind screen.

Traditional road traffic construction safety with wind screen in the use of the following problems still exist.

- 1) in the event of strong winds and gales is not strong enough to resist, will cause damage to the wind screen, thus increasing the cost of dust reduction during construction.
- 2) It is difficult to dismantle when installing, and it takes a lot of manpower and time to dismantle later, and it will also waste too much time when installing, thus reducing the ease of installation.
- 3) In the actual use of the installation will appear unstable problems, the phenomenon of wind damage, reducing the actual windproof effect of the device, reducing the practicality of the device.

2.3 Analysis of the Effect of Enclosure Height on Particle Spillage

The final result of particle motion will end at the boundary of the calculation domain, and the statistical value of its ending situation often can reflect the movement characteristics and diffusion capacity of particles, and the spillage rate reflects the ability of dust particles to escape from the enclosure range and diffuse outward, and its formula is shown as follows.

$$R = \frac{\left(1 - \frac{i}{S}\right)}{S} \times 100\% \quad (1)$$

In the formula, R is the spill rate; i is the lag number; S is the total tracking number

In this paper, by assuming six common wind screen heights for construction, 0m, 1m, 1.8m, 2.5m, 3.5m, and 4.5m are asked, where 0m is the height without wind screen. And by collecting the data of dust particle movement trajectory of road construction, then the corresponding total number of particle tracking and pit retention number are simulated and the corresponding results are obtained. Then, according to the formula of spill rate, the particle spill rate and the reduction value of spill rate are calculated for 6 different heights of windscreen, where the reduction value of spill rate is relative to the case of 0m (no windscreen), and the calculated values are equal to the difference between the particle spill rate of scenario number 2, 3, 4, 5 and 6 and the particle spill rate of scenario number 1, respectively. The detailed statistical data, spill rate and spill rate reduction calculation results are shown in Table 1.

Table 1. Spill rate and spill rate reduction values

No.(N)	Height(m)	Total Tracking(N)	Detention(N)	Spillover rates (%)	Reduced value (%)
1	0	3563	130	96.35	0.00
2	1	4107	628	84.71	11.64
3	1.8	3611	808	77.63	18.72
4	2.5	3608	1180	67.30	29.05
5	3.5	3621	1722	52.44	43.91
6	4.5	3614	1742	51.80	45.27

From the above table, it can be seen that the spill rate and reduction value calculated by the six models are variable. In order to visually describe their change characteristics, the interrelationship between the spill rate, spill rate reduction value and enclosure height is described in the form of a line graph, as shown in Figure 1 below.

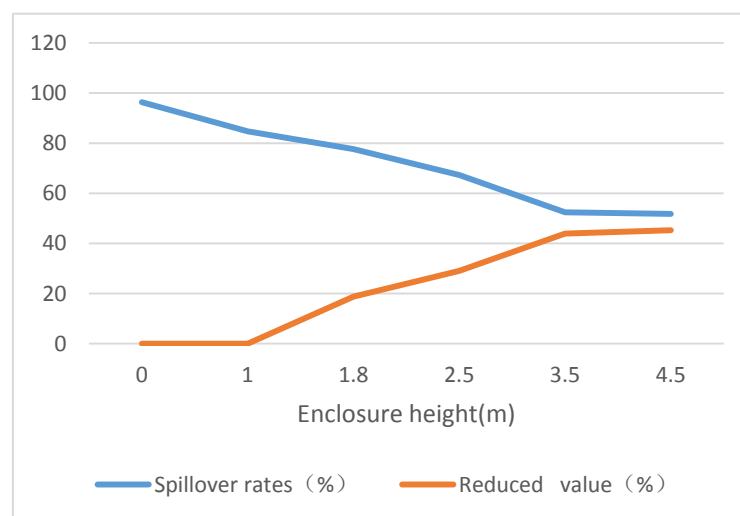


Figure 1. Spillover rate and reduced value fold chart

From the above calculation results and the line graph, it can be seen that the control effect of the fence to prevent particle spillage, with the increase of the fence height, the fence height reaches 3.5m when the particle spillage rate gradually tends to smooth out, the overall characteristics of the first increase and then tends to smooth out, from the economic as well as efficiency point of view to consider, 3.5m can be used as the upper limit of the fence to control particle spillage, if the excessive increase of the fence height, on the suppression of If the height of the fence is increased excessively, the efficiency of the fence is not high, but increases the material cost. In addition, the control effect of the fence on particle spillage is still very obvious, the fence height is only increased by 3.5m, the control rate of spillage has reached 43.91%. Therefore, it is appropriate to design the wind screen height at 3.5m when road construction is carried out.

2.4 Improvement and Design of New Road Construction Windscreen

According to the ideas derived from the above study, this paper improves and designs the existing road construction windscreen, aiming to make the new road construction windscreen can be better dust reduction, and not easy to damage, more convenient to install, more safe and reliable, and can significantly reduce the cost of

the construction side. The designed models are shown in Figure 2, Figure 3, Figure 4 and Figure 5 as follows.

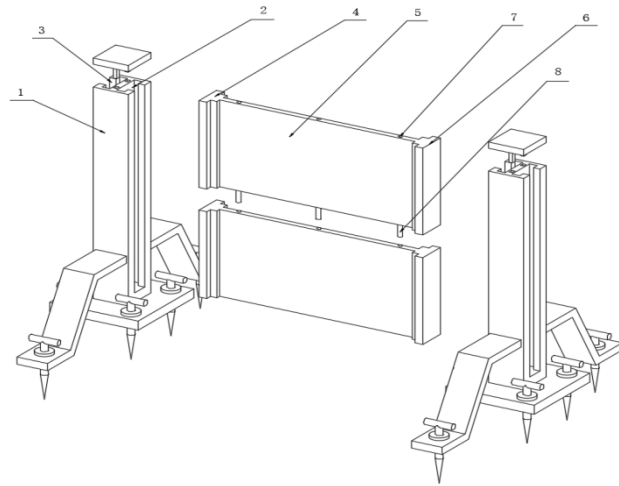


Figure 2. Schematic diagram of three-dimensional structure

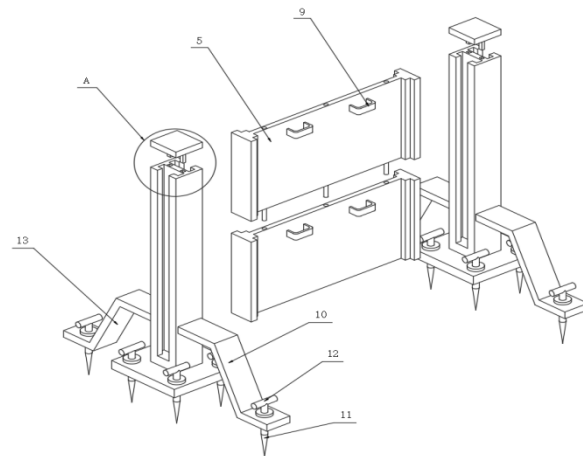


Figure 3. Schematic diagram of the overall side view structure of the device

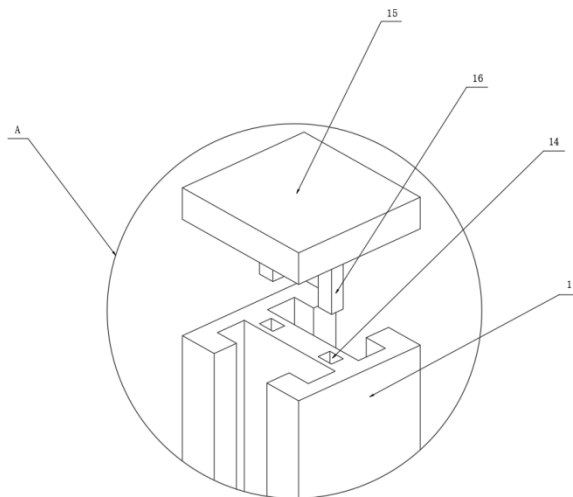


Figure 4. The A enlarged structure schematic diagram of Figure 2

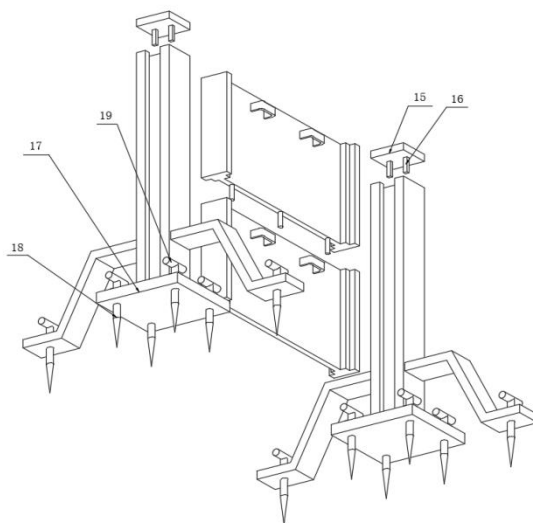


Figure 5. Schematic structure of the overall elevation view of the device

(1, mounting support post; 2, first mounting slot; 3, second mounting slot; 4, first mounting rod; 5, wind shield disc; 6, second mounting rod; 7, sealing snap slot; 8, sealing snap post; 9, mounting aid handle; 10, first aid support foot; 11, first fixing cone; 12, rotating handle; 13, second aid support foot; 14, capping slot; 15, capping disc; 16, capping rod; 17, fixing disc; 18, second fixing cone; 19, fixing handle)

2.5 Working Principle

By rotating the fixing handle 19 to drive the second fixing cone 18 to install the support column 1, and then use the rotating handle 12 on the first fixing cone 11 to install the first auxiliary support foot 10 and the second auxiliary support foot 13, through the first installation rod 4 snap into the first installation slot 2, and then through the second installation rod 6 snap into the second installation slot 3 of another installation support column 1 inside Finish the installation, continue to install another wind shield plate 5, using the sealing snap post 8 and sealing snap slot 7 snap, complete the installation of two wind shield plate 5 splicing, increase its sealing effect, improve the wind protection of the device, and then insert the capping rod 16 into the interior of the capping slot 14, complete the final installation of the capping plate 15, to avoid the accumulation of dust or rain inside the first installation slot 2 and the second installation slot 3, increase the device's wind protection. The final installation of the capping plate 15 is completed by inserting the capping rod 16 into the interior of the

capping slot 14 to avoid the accumulation of dust or rainwater inside the first and second installation slots 3 and increase the service life of the device.

2.6 Comparative Analysis With Existing Equipment

Compared with related technologies, the present improved wind shield model provides a wind shield for road construction with the following beneficial effects.

1) the improved wind screen model for road construction herein, through the first installation slot, the second installation slot, the first installation rod, wind screen protection plate, the second installation rod, sealing snap slot and sealing snap post together, played a direct use of the first installation rod into the interior of the first installation slot, while using the second installation rod stuck into the second installation slot of another installation support column inside, to complete the installation can be, first convenient installation, the Save the time of installation and later disassembly, the second convenient device disassembly and handling effect, while the sealing clasp column and sealing clasp slot clasp, complete the sealing of the two pieces of wind protection plate fit, increase the sealing of the device, so as to improve the device wind protection effect, improve the overall practicality of the device.

2) this paper improves the road construction wind shield model, using the first auxiliary support foot, the first fixed cone, rotating handle and the second auxiliary support foot together, played the use of the first auxiliary support foot and the second auxiliary support foot to play a certain auxiliary support effect, improve the stability of the device later installation, to avoid the problem of tipping or wind leading to device damage, improve the safety of the device, thereby improving the device Practicality.

3) this paper changed into the road construction with wind shield model, the use of capping slot, capping plate and capping rod with, played the use of capping plate on the first installation slot and the second installation slot for a certain sealing operation, the first to avoid the entry of dust, the second can avoid the accumulation of rainwater, so as to avoid dust affect the first installation rod and the second installation rod installation and removal problems, while avoiding rainwater on the first installation rod and the second installation The phenomenon of corrosion caused by the first installation pole and the second installation pole, improve the service life of the device, thus improving the practicality of the device.

4) The improved wind screen model for road construction in this paper adopts a design height of 3.5 m. The overflow rate of dust particles can be controlled at 43.9% under this height, thus significantly reducing the spread of high concentration of dust to the outside caused by high winds, while protecting the environment around the road construction, thus reducing the cost required for dust reduction in construction.

3. Conclusion

In this paper, by analyzing the existing road construction wind screen device assembly inconvenience, not strong enough and other problems, combined with the spillage rate calculation formula, and looking for relevant data, the spillage rate of dust particles of different heights of wind screen is calculated, and draw a line graph, and conclude that: with the increase of the height of the enclosure, the spillage of particles is the first to reduce, and then tends to a fixed value. When the enclosure height is less than 3.5m, the spill rate of dust particles decreases rapidly with the increase of enclosure height, and the relationship between the spill rate and the enclosure height is close to a primary function with a slope of -12.55. When the enclosure height reaches 3.5m, and then increase the enclosure height, the change of the spill rate is minimal, showing almost a horizontal straight line trend. 4.5m enclosure condition spill rate The spillage rate under 3.5m enclosure is only 1.36% lower than the spillage rate under 3.5m enclosure. Therefore, the optimal height of the fence is 3.5m, which is not only effective in preventing wind and dust, but also uses less material and lower cost compared with the fence above 3.5m.

Therefore, the new road construction wind screen designed in this paper is not only stronger and less susceptible to damage by high winds compared with existing equipment, but also its height can minimize the negative impact of dust particles spreading outward, which not only reduces the cost of dust reduction operation by construction units, but also better protects the atmospheric environment.

References

- Jiang, W.-M., et al.. (2003). *Air pollution meteorology*. Nanjing: Nanjing University Press.
- Kan, H., Chen, B. H. (2002). A 10-year review of the health effects of air pollution in some cities in China. *Chinese Journal of Preventive Medicine*, (1), 60-62.
- Li, Q.-Q. (2020). Numerical simulation study on the effect of dust reduction in fences during the construction stage of foundation pits of building projects. *Chongqing University*.

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