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Design and realization of height-adjustable roadway height limiters

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Abstract: *As cities develop, urban construction becomes increasingly prosperous, leading to a rise in the use of various vehicles. However, due to various reasons, the city's roads often encounter issues with high or overweight vehicles passing through, posing significant safety risks to the road and surrounding environment. To address this issue, a new type of road height limiter was developed. The height-adjustable road height limiter consists of a support frame and chute. The support frame houses a sliding card with a lifting bar. At the bottom end of the support frame, there is a symmetrically placed sliding card with a fixed foot. The lifting bar incorporates reflective panels, cross-frames, buffer strips, gears, an outer cover, rack, the first slide key, wire rope, bellows, the second slide key, nuts and screws.*

Keywords: *height, adjustable, road, height limiters*

1. Introduction

With the development of cities, urban construction is becoming more and more prosperous, and the use of all kinds of vehicles is becoming more and more common. However, due to some reasons, the city's roads often encounter high, overweight vehicles and goods through the problem, which on the road and the surrounding environment have brought great security risks. In order to solve this problem, a new type of road height limiters came into being, it has the function of height adjustable, can adapt to different heights of vehicles through.

By installing the road height limiting pole in the forefront of the road, it can prohibit vehicles exceeding the standard height to move forward, so as to achieve the purpose of limiting the traffic, but sometimes out of special circumstances, need to let go of super-high vehicles, and the existing road height limiting pole can not be adjusted to the height of the road, making it impossible to complete the release of the special circumstances, and the existing road height limiting pole, in the frequent disassembling and installing, it may be damaged when the internal parts, thus Therefore, a device is needed to improve it. Our design concept is: safety, practicality and flexibility. Safety is the primary consideration of our design, we use high strength materials and advanced structural design to ensure the stability and safety of the height restrictor. Practicality is reflected in the height-adjustable function of the height limiters, which can be adjusted according to the height of different vehicles to adapt to different heights of vehicles through. Flexibility is reflected in our design can be adjusted according to different road conditions to meet the needs of different cities[1].

2. Content of the project

Our height limiters adopt adjustable design structure, mainly composed of bracket, lifting mechanism, height limiting device and other parts. The bracket is made of high-strength material, which can withstand the passage of vehicles of different heights. The lifting mechanism adopts electric drive mode, through the cooperation of motor and screw, it can realize the lifting of height-limiting device. The height-limiting device includes fixed crossbeam and movable crossbeam, and the movable crossbeam can slide along the fixed crossbeam to realize the height adjustment of the height-limiting device[2].

The purpose of this project is to provide a height-adjustable roadway height limiting pole to solve the problems raised in the above background technology[3].

In order to realize the above purpose, the project provides the following technical solution: a height-adjustable road height limiting pole, including a support frame and a slide groove, a lifting bar slidingly

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clamped to the inside of the support frame, a fixed foot slidingly clamped to the bottom end of the support frame symmetrically, a lifting bar including a reflective plate, a cross-frame, a buffer strip, a gear, an outer cover, a rack, a first slide key, a steel wire rope, a corrugated pipe, a second slide key, a nut, and a screw, a gear fixedly connected The gear is fixedly connected to the center of the side of the outer cover, the rack symmetrically gear meshing on the gear, the buffer strip symmetrically fixed welded to the end of the rack, the first slide key symmetrically fixed welded to the rack, the wire rope rotationally connected to the center of the end of the rack, the cross-frame is fixedly connected to the bottom end of the wire rope, the bellows symmetrically fixedly connected to the cross-frame, reflective panels symmetrically fixedly connected to the cross-frame on the side of the end of the second slide key symmetrically fixedly welded to the cross-frame at both ends of the interior, the screw fixedly welded to the cross-frame Inside, the screw is fixedly welded to the center of the side end of the second slide key, and the nut is threaded and inserted on the screw, the support frame includes a cover plate, a support rod, an insert rod, an auxiliary wheel, and a limiting pin, the cover plate is fixedly welded to the support rod, an auxiliary wheel is symmetrically fixedly connected to the inside of the support rod, a slide groove is opened at the top of the support rod and at the top of the inside of the cover plate, and the insert rods are symmetrically fixedly welded to the bottom of both ends of the support rod, the fixing feet include a limiting pin, a fastening screw, and a bottom foot, the fixing feet include a limiting pin, a fastening screw, and a bottom foot. Fixed feet include a limit pin, a fastening screw and a bottom plate, the limit pin is slidingly inserted in the side end of the bottom plate, and the fastening screw is symmetrically threaded and inserted in the bottom end of the bottom plate.

The base plate is provided with slots that are adapted to the limit pins and support rods, and when the support rods are lowered to the limit position, the rods are slid into the interior of the base plate[3].

The top of the cover is provided with a running groove, and the side end of the support rod is engraved with a scale line.

The two ends of the support rod are provided with square grooves that are adapted to the second slide key and the screw, and the nut is screwed inward to the limit position and the cross frame is fastened to the support rod[4-5].

A motor is fixedly connected to the inside of the housing, and the gear rotates to the limit position in contact with the buffer strip.

The internal material of the buffer strip is rubber.

The ends of the cross frame are provided with moving slots adapted to the support bars.

3. Design Schematic

The lifting mechanism is the core part of the height limiter, its design is directly related to the height adjustment function of the height limiter. We adopt the electric drive mode, through the cooperation of motor and screw to realize the lifting and lowering of the height limiting device. The motor adopts low-noise, high-efficiency DC or AC motors, while the screw adopts precision ball screws to ensure the smoothness and accuracy of lifting and lowering. At the same time, we have added an anti-overload protection device to the lifting mechanism to prevent accidents[6-7].

In order to facilitate the operation of the user, our height limiters adopt two kinds of adjustment methods: manual and electric. Users can choose the appropriate adjustment mode according to the actual situation. In manual adjustment mode, users can manually pull the movable beam to realize the height adjustment of the height limiter. In the electric mode, the user only needs to press the button on the control panel to raise or lower the height limiter. In addition, we also equipped with a remote control for the height limiters, users can realize remote control of the height limiters through the remote control, more convenient and quick[8-9].

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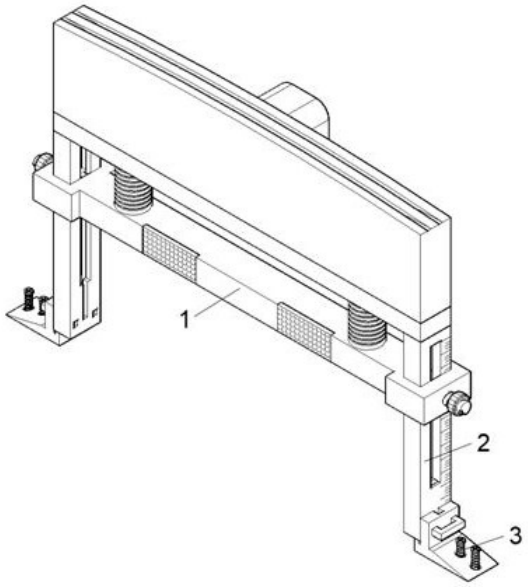


Figure 1. Main structure of the project

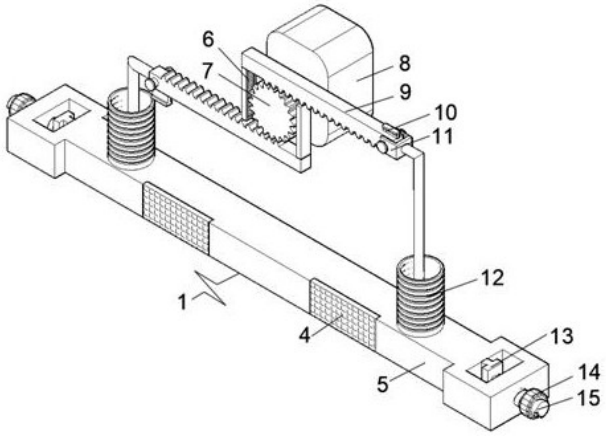
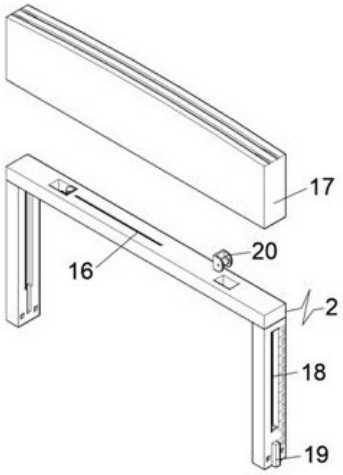


Figure 2. Schematic diagram of lifting rod structure



Frame 3. Bracket structure diagram

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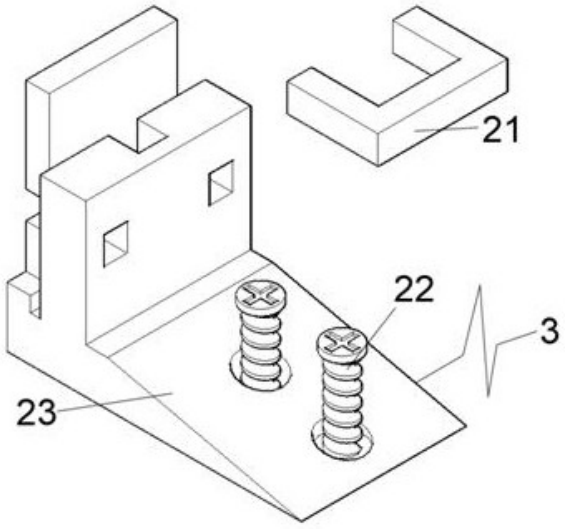

Figure 4. Structure of the fixed foot of this project

In the figure: 1-lifting rod, 2-support frame, 3-fixed foot, 4-reflector, 5-transverse frame, 6-buffer strip, 7-gear, 8-cover, 9-rack, 10-first sliding key, 11-wire rope, 12-bellows, 13-second sliding key, 14-nut, 15-screw, 16-chute, 17-cover plate, 18-support rod, 19-plug-in, 20-auxiliary wheel, 21-limit bolt, 22-fastening screw, 23-bottom plate.

4. Specific modalities of realization

Please refer to Figs. 1-4, an embodiment provided by this project: a height-adjustable road height limiting bar, including a support frame and a slide groove, a lifting bar slidingly attached to the inside of the support frame, a fixed foot slidingly attached to the bottom end of the support frame symmetrically, a lifting bar including a reflector, a cross frame, a buffer strip, a gear, an outer cover, a rack, a first slide key, a steel wire rope, a corrugated pipe, a second slide key, a nut, and a screw, a gear fixedly attached In the center of the side of the outer cover, rack symmetrical gear meshing in the gear, buffer strip symmetrical fixed welding in the rack at one end, the first slide key symmetrically fixed welding in the rack, wire rope rotating connection in the center of the rack at one end, the cross-frame is fixedly connected to the bottom end of the wire rope, corrugated pipe symmetrically fixed connection in the cross-frame, reflective plate symmetrically fixed connection in the cross-frame at the side of the end of the second slide key symmetrically fixed welded to the cross-frame at the ends of the interior, screw fixed welding in the cross-frame Inside, the screw is fixedly welded in the center of the side end of the second slide key, and the nut is threaded and inserted in the screw, the support frame includes cover plate, support rod, insert rod, auxiliary wheel and limit pin, the cover plate is fixedly welded on the support rod, the auxiliary wheel is symmetrically fixedly connected to the inside of the support rod, and the slide groove is opened in the top end of the support rod and the top end of the inside of the cover plate, and the insert rod is symmetrically fixedly welded in the bottom of both ends of the support rod, and the fixing feet include limit pin, fastening screw and bottom pin, and the fixing feet include limit pin, fastening screw and bottom pin, and the fixing feet are fixedly welded in the bottom of both ends. Fixed feet include a limit pin, a fastening screw and a bottom plate, the limit pin is slidingly inserted in the side end of the bottom plate, and the fastening screw is symmetrically threaded and inserted in the bottom end of the bottom plate[10].

There is a slot inside the base plate which is compatible with the limit pin and the support rod, and when the support rod is lowered to the limit position, the rod is slidingly inserted in the inside of the base plate, there is a running groove at the top of the cover plate, and there is a scale line engraved on the side end of the support rod, there is a square groove inside the two ends of the support rod which is compatible with the second slide key and the screw, and the nut is screwed inwardly to the limit position and the cross frame is fastened to the support rod, there is an electric motor fixedly connected to the cover, and the gear is in contact with the buffer strip when rotated to the limit position, the buffer strip is made of rubber, and there is a moving groove at both ends of the cross frame which is compatible with the support rod, the gear is rotated to the limit position and it contacts with the buffer strip. The motor is fixedly connected to the outer cover, and the gear rotates to the limit position and contacts with the buffer strip,

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the internal material of the buffer strip is rubber, the two ends of the cross frame are opened and the support bar is adapted to the moving slot, the motor is installed inside the outer cover, and the gear is fixedly connected to the motor, the motor can be energized to start, so that it can lead to the gear to rotate, when the gear is rotating, it can lead to the movement of the rack that is meshed with the gear, and the buffer strip is made from rubber, so it can be used as a buffer strip, so that it can be used as a buffer strip, and it is used as a buffer strip. The internal material of the cushion strip is rubber, so as to avoid steel collision with the gear when the gear moves to the limit position. The wire rope is rotated and connected to one end of the rack, and the cross frame is fixedly connected to the bottom end of the wire rope, so that when the rack is moving, it can be driven by the wire rope to drag the cross frame upward, and thus the height of the cross frame can be adjusted flexibly, and the screw is fixedly connected to the side end of the second sliding key, and the nut can be turned inward until it meets the cross frame, and then it can be screwed inward. The screw is fixedly connected to the side end of the second slide key, and the nut can be screwed inward until it is tightened with the side end of the cross frame, which can drive the cross frame to be tightened with the support rod, and thus can share part of the gravity of the cross frame. When the wire rope is ascending or descending, it can pass through the inner end of the auxiliary wheel, so that the wire rope can complete the work more smoothly. There is a running groove at the top of the cover plate, so that the rain water will not be accumulated at the top of the cover plate to avoid the moisture of the internal parts, and there is a scale line engraved on the side end of the support rod, so that the descending distance can be accurately controlled, and there is a slot at the side end of the base plate that is adapted to the limiting pins and support rod, so that the limiting pin can be inserted into the base plate and support rod in sequence. With the slots at the side of the base plate that are compatible with the limit pins and support rods, the limit pins can be inserted into the base plate and the side ends of the support rods in sequence, so that the support rods can be fixed on the base plate, and thus the support rods can be quickly removed and installed.

5. Working Principle

Users will be placed in the designated location of the base plate 23, and then fastening screws 22 symmetrical thread through the base plate 23 and the ground fastening, through the base plate 23 of the internal opening of the slot with the limit pin 21 and the support rod 18 compatible, can be sliding inserted in the base plate 23 support rod 18, and then limit pin 21 through the bottom of the plate 23 and the support rod 18, so that can be fixed position of support rod 18, and at the same time, through the cover 8 of the internal installation of a motor, the motor can be energized to start, so that can drive the gear 7 rotation, when the gear 7 in the rotation, can drive the rack 9 movement, and when the gear 7 in the rotation, can drive the rack 9 movement. At the same time, through the outer cover 8 of the internal installation of the motor, the motor can be energized to start, so that can drive the gear 7 rotation, when the gear 7 in the rotation, can drive the rack 9 movement, and rack 9 in the movement, can drive the wire rope 11 and the cross-frame 5 up and down, so that can be flexible adjustment of the height of the cross-frame 5, and through the first sliding key 10 symmetrically connected to the rack 9, the slide groove 16 symmetrically opened at the top of the support bar 18 and the cover of the cover, the support bar 18 can be fixed position, and through the first slide key 10 symmetrically connected to the rack 9, slide slot 16 symmetrically opened at the top and the support bar 18. The top of the support bar 18 and the top of the inside of the cover plate 17, the first slide key 10 can be slid and stuck in the inside of the slide 16, so as to ensure that the rack 9 moves in a straight line, thus avoiding the tilt of the steel wire rope 11 in the pulling up, through the support bar 18 has a scale line engraved on the side end, so that it can accurately control the cross-frame 5 to move to the distance, when the cross-frame 5 is moved to the specified position, and then turn the nut 14 symmetrically inward, until it drives the cross-frame 5 to move up and down with the support bar, and the nut 14 is screwed symmetrically inward, until it drives the cross-frame 5 to move up and down with the support bar, and then it can be adjusted flexibly. Until drive cross frame 5 and support bar 18 phase fastening, so that the cross frame 5 can be fixed at a specified height, through the bellows 12 fixed connection between the cross frame 5 and support bar 18, and the bellows 12 is located in the outer ring of the wire rope 11, so that the wire rope 11 can be prevented from being wet by the rain, so that the service life of the wire rope 11 can be greatly enhanced.

6. Pioneer Point

The project through the outer cover of the internal installation of the motor, and gears are fixed connected to the motor, the motor can be energized to start, so that the gear can be driven to rotate, when the gear is rotating, can be driven with the gear meshing rack movement, through the buffer strip of the

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internal material for the rubber, so as to avoid the gear driven rack to move to the limit of the position and the gear of the steel collision, through the steel wire rope rotating connected to the end of the rack, the cross frame is fixed at the bottom of the wire rope, so that the wire rope can be driven to pull the cross frame to move up, so that the height of the cross frame can be adjusted flexibly. The cross frame is fixedly connected to the bottom end of the wire rope, so when the rack is moving, it can drive the wire rope to pull the cross frame upward, so that the height of the cross frame can be adjusted flexibly. The screw is fixedly connected to the side end of the second slide key, and the nut can be screwed inward until it is tightened with the side end of the cross frame, so that the cross frame and the support bar are tightly fixed, and the cross frame can be shared with a part of its gravity. The bellows is fixedly connected between the cross frame and the support bar, and the bellows is located on the outer ring of the wire rope, so it can protect the wire rope from rain, thus avoiding corrosion and fracture, the auxiliary wheel is symmetrically fixedly connected to the inside of the support bar, when the wire rope rises or falls, it can be passed through from the inner end of the auxiliary wheel, so the wire rope can be smoother to complete the work of the wire rope, and the water flow groove is opened at the top of the cover, so that the rain water will not accumulate in the top of the cover, so that the rain water will not accumulate in the cover, so that the wire rope will be more smooth and smooth. The top of the cover plate is equipped with a running groove, so that the rainwater will not accumulate at the top of the cover plate, thus avoiding the moisture of the internal parts. The scale line engraved on the side end of the support rod makes it possible to precisely control the descending distance, and the slots opened at the side end of the base plate are compatible with the limit pins and the support rods, so that the limit pins are inserted into the side end of the base plate and the support rod in sequence, so that the support rods can be fixed on the base plate, and the support rod can be dismantled and installed quickly.

7. Air suspension height adjustment with dual loop control

The electronically controlled air suspension collects signals from the external environment and vehicle systems through sensors, which can adjust the stiffness, damping, and body height of the suspension system to improve passenger comfort, driving safety, and vehicle passability. Body height adjustment is one of the characteristics of electronic air suspension, which controls the opening and closing of the solenoid valve to charge and deflate the air spring by judging the external environment, thereby achieving changes in body height. Therefore, electronic control air suspension has become a common configuration in high-end cars.

To balance stability and comfort, cars equipped with electronic air suspension generally adopt a double wishbone suspension structure. However, in the height adjustment model of a double wishbone air suspension vehicle, the suspension dynamics model often uses the classic two degree of freedom model. Although this model can better reflect the motion of the suspension system, it ignores the influence of the geometric structure and kinematics of the double wishbone suspension, resulting in significant errors between the height adjustment model of the double wishbone air suspension vehicle and the actual situation.

Due to the complexity of the model and susceptibility to road surface interference, the vehicle height adjustment system often experiences oscillations. Therefore, the design of its control algorithm needs to handle the nonlinearity of the model and suppress road surface interference in order to improve the accuracy and speed of vehicle height adjustment. The hybrid predictive model control algorithm is used to control the linearized vehicle height adjustment model. However, there are problems with the linearization of the air spring inflation and deflation mechanism model, as well as the algorithm's computational complexity being greater than the susceptibility to road interference. The fuzzy PID algorithm was used for vehicle height control, but the impact of road interference on the vehicle height adjustment system was not considered. For complex nonlinear systems, a dual loop control structure can effectively handle them, which is generally divided into a main controller and an auxiliary controller. The model predictive control algorithm has various forms and has good performance in handling nonlinear models and suppressing interference. It has a wide range of applications and is therefore suitable as a main controller. The fuzzy PID control algorithm has a simple structure and high robustness, making it suitable as an auxiliary controller. In response to the problems in the design of the model and control algorithm for the height adjustment system of the double wishbone air suspension vehicle mentioned above, a new type of height adjustment model for the double wishbone air suspension vehicle was first established. Then a dual loop control structure was designed for the vehicle height adjustment system. The main controller adopts a model predictive controller based on an extended state observer. By utilizing the observation and feedback of road surface interference, model linearization error, and unmodeled dynamic terms from the extended state observer, equivalent compensation of air mass flow

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is made in rolling optimization to suppress road surface interference and handle model nonlinearity. The auxiliary controller adopts a fuzzy PID controller. When the supervision mechanism finds that the height error of the main control target is large, the auxiliary controller intervenes to avoid the influence of the main control target caused by road interference and the use of fixed weight coefficients in model predictive control.

8. Conclusion

In conclusion, the height-adjustable road height limiter is an innovative and practical design product. It adopts the adjustable structure design, which can adapt to the passage of vehicles of different heights, providing a strong guarantee for the safety of urban roads. At the same time, our design also takes into account the convenience and safety of the user, adopting electric drive and a variety of adjustment methods, as well as multiple safety protection measures to ensure the safety and reliability of the product. We believe that this design will bring more protection and convenience to urban road safety.

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References

[1] Li Jinguang, Yan Xingpei. Study on optimizing the management of road height limiters[J]. Road traffic management. 2021(02).
[2] Zhao Feng. Big Business behind the Forest of Road Limit Poles [J]. Business Watch. 2021(08).
[3] Man Xingpei. Crack the height limit and safety contradictions to avoid the height limit pole into a "life-threatening pole" [J]. China highway. 2021(10).
[4] Du Yonggang. Talking about the design of urban high-pole lamp renovation [J]. Shanxi construction. 2012(11).
[5] Zou Aoqing. Analysis of intelligent control system for high mast lamps in marina [J]. Communication World. 2015(12).
[6] Wu Peng. Retrofitting of high-pole light system in coal yard [J]. Port Science and Technology. 2011(03).
[7] Zhang Lei. Driving without observing and knocking down the height limit bar[J]. Driving Garden. 2012(07).
[8] Yin G. Retrofitting of high-pole lights in coal terminal yards[J]. Port Science and Technology. 2015(05).
[9] Tang Li. Intelligent control of harbor highbay lights [J]. Port Handling. 2013(05).
[10] Chen Zhuo, Li Ping. Design points and application based on the height of roadway height limiters[J]. Low carbon world. 2019(07).