

A new type of foldable expansion stair lift

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Abstract. Stairs are very important in dealing with various complex Spaces in construction projects. However, the application space of stairs is limited, and it is necessary to connect two separate parts in sufficient space. In order to solve this problem, a telescopic ladder based on scissor unit and expansion is proposed. In this study, the retractable and expandable basic unit and optimization and ordinary retractable stairs cannot transport large and heavy objects or over the service life and structural instability and other problems were improved and optimized.

Keywords: Stair lift, foldable expansion, expandable structure, maximum bearing limit.

1. Introduction

The stair is to undertake the structure of the upper part of the building space and the lower part of the space, through the stair can go upstairs or downstairs, in order to achieve the effect of personnel evacuation and travel to the destination. According to the structure of the stairs can be divided into plate stairs, beam stairs, overhanging stairs, spiral stairs, etc. According to the layout of walking can be divided into straight running stairs, double running stairs, single running stairs, etc. According to the construction process can be divided into cast-in-place integral stairs, prefabricated stairs, etc. according to the composition of the material can be divided into wooden stairs, reinforced concrete Yellowstone latest bus line table [1].

Earth stairs, steel stairs, etc. Stair by step, ladder section, ladder beam, ladder column or bearing column, baluster, armrest, rest the composition such as resting platform. The technical problem is to overcome the existing shortcomings [2]. This chapter first introduces the structural design of telescopic stairs in practical application, which is applied to the basic operation principle of double fork arm acceptance and pulley folding structure, and finally puts forward a new type of new expansion structure design which can be used in the actual scene application.

Traditional telescopic stairs can be used for practical application very wide, occupy little space. Traditional stairs fixed in a location occupied by the floor space area needs a lot but retractable stairs can be done to completely occupy any space downstairs, and upstairs only occupy less than 1 square space, since the retractable staircase was designed specifically for the attic, its load-bearing capacity will be relatively small compared to the traditional staircase. About 200kg or less [3], when using more than this weight will affect the service life of telescopic stairs. In terms of floor height, the general indoor attic telescopic staircase design is suitable for the height between 2m and 3.2m[4], retractable staircase volume and flexibility considerations the size of the hole installed is generally within the range of 0.7 m × 1.2 m [5], as shown in the figure 1. Which is not suitable for the passage of large items.

Based on the above problems, this design develops a loft lifting telescopic stair platform, the structure design is safe and reliable, the installation position is flexible, without installing guide rails, not subject to the condition of whether close to the wall, saving the space of the wall, but also to solve the problem of carrying less items, moving items inconvenient. After the platform is put up, it can be level with the bottom ceiling, which does not occupy the interior space, improves the interior beauty, and can effectively solve the problems in the background technology.

In order to achieve the above purposes, the utility model is designed as follows technical scheme. The utility model relates to a lifting telescopic stair platform. The platform is a component used for vertical communication between floors in a building. It is used for communication between floors and can realize lifting and transportation of people and goods between floors. Telescopic stair

platform is widely used in industrial plants, public places, families and other scenes for manufacturing and assembly, maintenance, cleaning and maintenance, temporary construction and other operations. The existing indoor telescopic stairs need to install guide rails on the wall. Limited by the conditions of the wall, the installation is not flexible enough, and occupies the indoor space, affects the appearance, and the production cost is high, in order to solve the above problems.



Figure 1. Attic retractable staircase

2. Methods

2.1. Structure of Foldable Expansion Stair Lift

The institution is mainly concerned with the components Chassis; And the bottom frame is arranged opposite the top of the bottom frame; Two side plates, each side plate comprises an upper half and a lower half, the upper half of the side plate can be connected to one side of the top plate, and the lower half of the side plate can be connected to one side of the bottom frame; The front end plate is inversely connected to one end of the base frame; And a rear end plate that is inversely connected to the other end of the base frame. The foldable container also includes at least two docking structures, each docking structure includes an upper connection that can be detached from each other. The closing part and the lower connecting part, and at least one bendable connecting part arranged between the upper and lower connecting parts, the distance between the upper and lower connecting parts. Wherein, the upper junction part has a first official bearing surface, and the lower junction part has there is a second supporting surface corresponding to the first supporting surface. There is a docking structure between the upper and lower parts of each side plate. The upper part of the side plate is fixed with the upper joint part of the docking structure, and the lower part is fixed with the lower connection of the docking structure or department. One of the upper and lower joint parts is a convex joint part, and the other is a concave joint part corresponding to the convex joint part. The two ends of each side plate are respectively provided with a corner post, each corner post comprises a removable upper half and a lower half, where the upper half is fixed to the upper half of the corresponding side plate, and the lower half is fixed to the lower half of the corresponding side plate. The front-end plate is detachably connected with the two corner columns located on the front end side of the two side plates; The rear end plate and the rear end of the two side plates are detachably connected with the two corner column, the top surface of the roof is provided with a double arm structure for connection.

2.2. Working Principle of Foldable Expansion Stair Lift

The bottom of the fold frame is used to pull the ring when contracting, and the ring is pulled out when contracting. We will cut the fork arm is set between the upper frame and take the container, symmetric shear fork arm set in the staircase of two sides, take the bottom corners of setting a roller

frame, wheel rack setup guide wheel, drum set in passenger load center, at the bottom of fixed connected with one end of the traction rope on the drum, the other end of the traction rope around guide wheel fixed connection with the top frame, Drum can drive traction rope contraction at the same time, to avoid unilateral force, to ensure the smooth and reliable by container lifting, reduce the shaking, carry on the bottom face set by load box set on bearing plate, through the bearing plate to take a container for segmentation, separating the people or things with the driving mechanism, u-shaped frame set between the upper frame and take the container, u-shaped frame setting on the lateral side of the chute, One joint of the cutting fork arm is rotationally connected with one end of the U-shaped frame, and the other is connected with the cutting fork arm. Ensure in safe and reliable lifting the staircase structure, floor stairs are installed on the fixed frame, stair fixator can accommodate the stairs when folding, the safe and reliable design, flexible installation position, not affected by whether the constraints of clingy metope, saves the space of metope, the platform can with the underlying the ceiling level after fold, do not take up interior space, improve indoor beautiful sex, as shown in the figure 2.

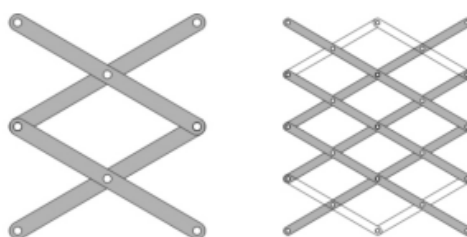


Figure 2. The difference between two double chain and three double chain

2.3. Combination Mode of Upper and Lower Parts of Foldable Expansion Stair Lift

The upper half of each side plate can also be connected by a docking structure. The top plate is fixed with the upper joint part of the butt structure, and the upper half of the side plate is fixed with the butt structure lower junction. Further, the lower half of each side plate and the bottom frame are also detachably connected by a butt structure, the lower part of the side plate is fixed on the upper part of the docking structure, and the bottom frame is fixed on the lower part of the docking structure joints. One end of the connecting piece is fixed to one of the upper and lower connecting parts of the docking structure; The other part of the upper and lower joint parts of the butt joint structure is provided with a through hole, and the connecting piece passes through the through hole, and the connecting piece. The other end is fixed with a limit piece that cannot pass through the through hole: the guide element is provided with a channel suitable for the connecting piece through and at least one guide groove, and the channel is connected with the at least one guide groove. The limiting member is projecting from the connecting member and is limited to at least one projection in at least one guide slot.

2.3.1. Double chain

The cutting fork mechanism is a combined multi - bar mechanism, and its basic component unit is X - shaped cutting fork mechanism. When X shaped units are connected in series, parallel and other different forms, different scissor mechanisms can be formed. For example, 2X-shaped basic units were connected in series to obtain the two-level scissor-type mechanism [6], and 3X-shaped basic units were connected in series to obtain the three-level scissor-type mechanism [7-9], as shown in the figure 3.

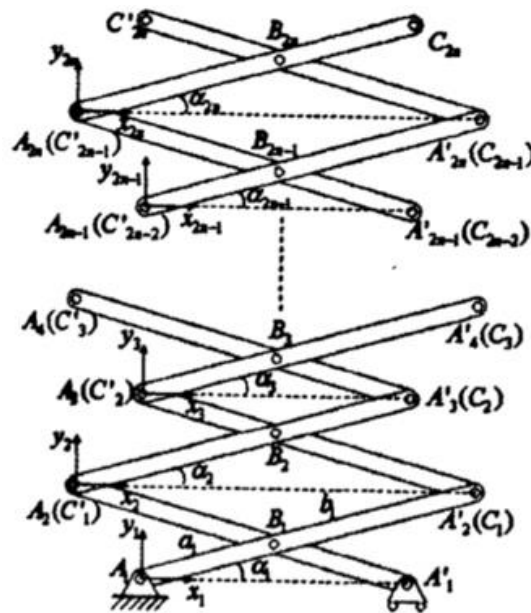


Figure 3. 2X-shaped and 3X-shaped

Due to the isometric symmetry and motion similarity of the X-shaped cutting fork mechanism, when the horizontal inward thrust is applied at the first hinge of the lowermost X-shaped element, all hinge points of the upper X-shaped element move inward and upward [10]. Since the top end hinge is connected to the upper output structure and can move horizontally along the upper structure, the scissor lifting mechanism can convert the horizontal thrust into vertical upward motion, as shown in the figure 4.

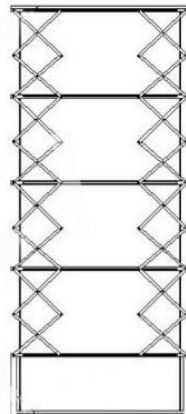


Figure 4. Mechanism side room diagram

2.3.2. Mechanical analysis method

The geometric relationship is shown in the figure 4,

h is the distance between the upper and lower fixed hinges of the cutting fork mechanism;

r is the length of the short arm of the cutting fork arm; $R = 2$.

r is the length of the long arm of the cutting fork arm; θ is the acute Angle between the shear arm and the horizontal direction; l Distance from the first or last hinge point to the central axis. The geometric relationship of the relevant quantities shown in the figure can be expressed as

$$L = r \cos\theta. \quad (1)$$

$$H = 4 r \sin\theta. \quad (2)$$

Thrust calculation: Set the virtual displacement under the action of horizontal thrust F as dl , and the virtual displacement under the action of lifting load Q as dh . Differentiate the left and right ends of equations (1) and (2) with respect to θ , and obtain

$$dl/d\theta = -r\sin\theta. \quad (3)$$

$$dh/d\theta = 4r\cos\theta. \quad (4)$$

According to the principle of virtual displacement.

$$Q dh + 2 F dl = 0. \quad (5)$$

Equations (3) and (5) can be obtained simultaneously

$$F = -Qdh/(2dl) = 2Q\cot\theta. \quad (6)$$

Due to the symmetry of the cutting fork mechanism, half of the mechanism was taken for study, and its force analysis was shown in figure 5.

In summary, it can be concluded that the scissored fork structure can support telescopic staircase planting.

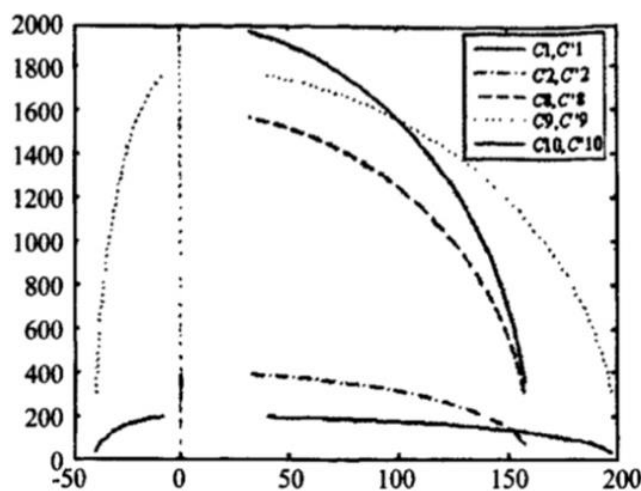


Figure 5. Shear difference force analysis

Table 1. Statistic of optimize solutions

Iterations	Improved algorithm	Stage evolution strategy	Adaptive evolutionary strategy	Traditional evolutionary strategy
	$a_1=a_2=0.05$	$a=0.258$		$P_m=0.6$ $P_c=0.8$
<100	12	7	6	8
100~200	14	14	4	6
200~300	3	5	7	8
300~400	1	1	2	5
400~500	0	1	3	2
>500	0	2	8	1

Table 1 shows the genetic algebra of several strategies when the optimal solution appears in 30 computational experiments. As can be seen from the table, most of the improved algorithms find the optimal solution within 200 generations, and the probability of finding the optimal solution increases to 100%. The improved algorithm not only retains the characteristics of fast searching speed and saving resources, but also reduces the risk of falling into local optimal compared with the traditional phased evolutionary strategy [11].

3. Results and Discussion

Adaptive evolutionary strategy refers to the use of large P for individuals whose fitness value is lower than the current one and P. For individuals whose fitness value is greater than the current 7, a relatively small P is adopted and P. Do not mutate or cross the best individuals. The P of adaptive evolutionary strategy. And P. The values are,

$$P_c = \begin{cases} \frac{K_1(f_{MAX}-f')}{f_{MAX}-f^-} & f' \geq f \\ k_2 & f' < f \end{cases} \quad (7)$$

$$P_M = \begin{cases} \frac{K_3(f_{MAX}-f')}{f_{MAX}-f^-} & f' \geq f^- \\ k_4 & f' < f^- \end{cases} \quad (8)$$

Where is the maximum of the two cross individual adaptation values , namely (7) The female. And $\bar{U}$.Is the adjustment coefficient of crossover r. And $\bar{U}$. Is the adjustment coefficient of variation rate. Equations (4) and (5) show that (7) First, the smaller the population is, the more likely it is to reach local optimum and the more likely it is to precocity. Then, let P. And P. To increase the capacity of the population to produce new individuals; On the contrary, the larger, the more dispersed the population, the lower P. And P. In order to improve the ability of individuals to converge and maintain the convergence direction. So let's say that P. And P. It's inversely proportional to δ .

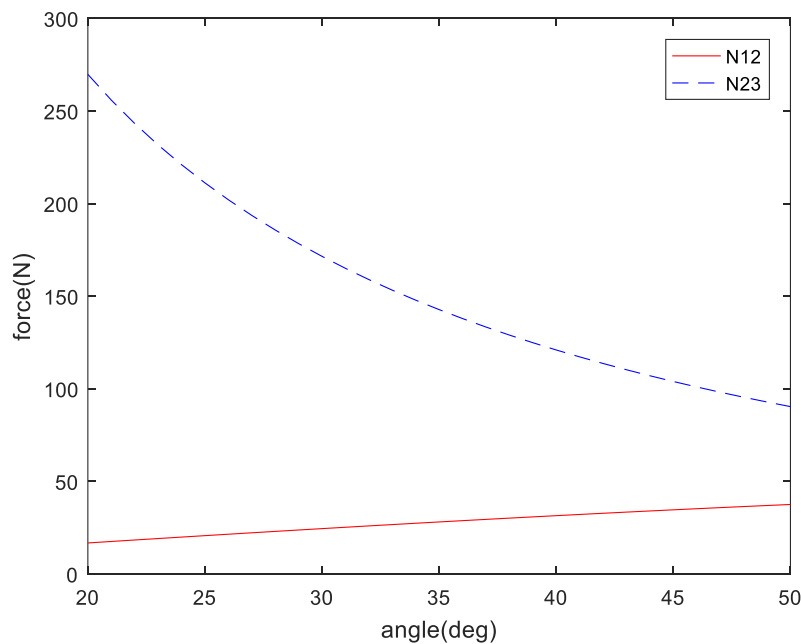


Figure 6. Angle in relation to N12 · N23

The maximum values are 37.5362N and 269.7738N respectively.

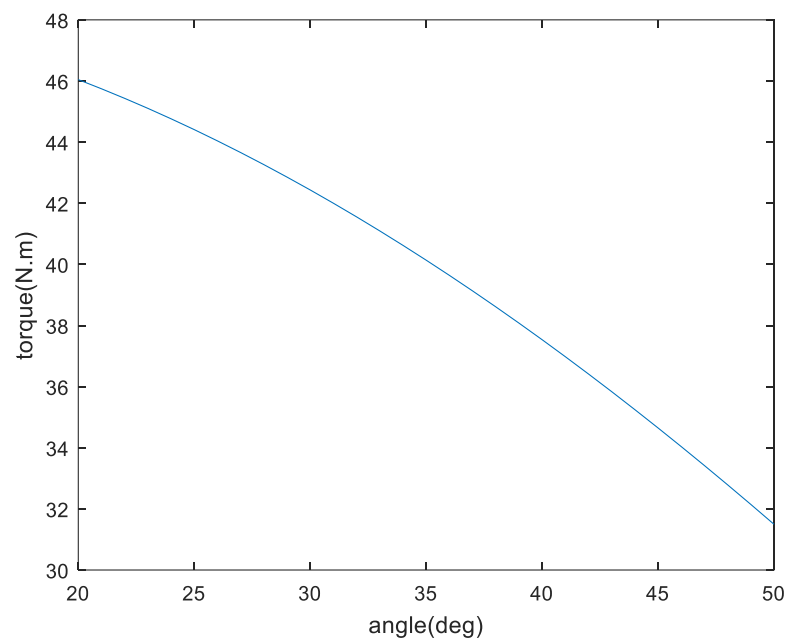


Figure 7. The relation between Angle and M2

The maximum value is 46.0449N·m.

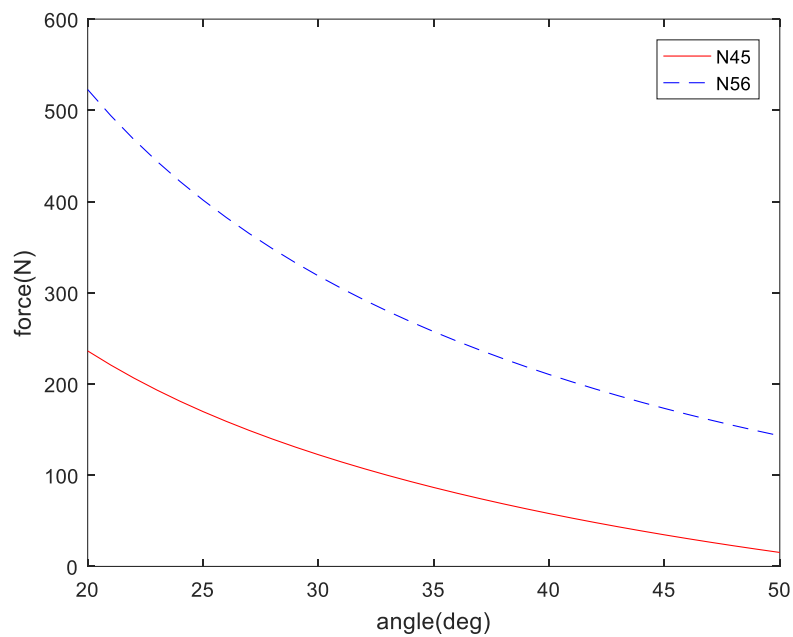


Figure 8. Angle in relation to N45 · N56

The maximum values are 236.2559N and 522.7887N respectively.

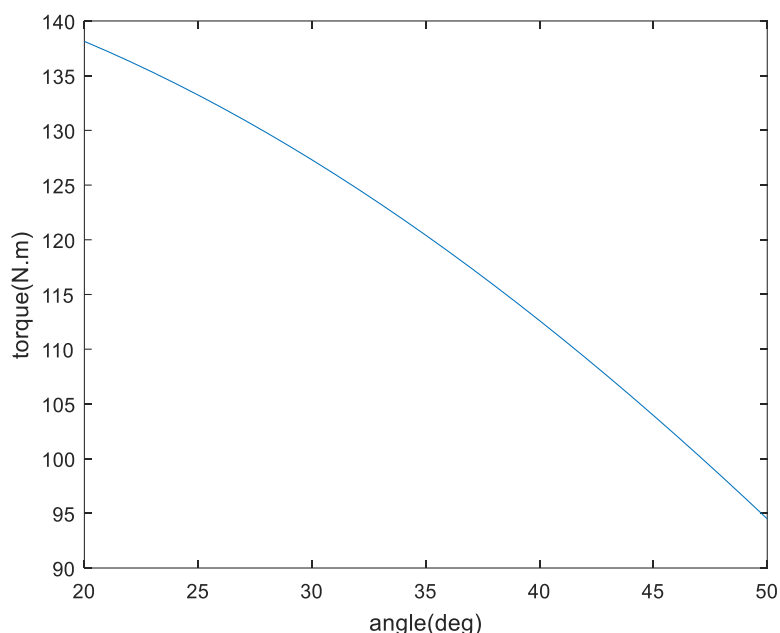


Figure 9. The relation between Angle and M5 The maximum value is 138.1348N·m.

4. Conclusion

This design research, on the basis of the telescopic folding staircase, put forward an expandable structure. A new mechanism model and motion concept model were established by the design method of shearing knife and fork linked simple folding box, and the influence of the maximum bearing limit of shearing knife and fork on the motion relationship was analyzed and discussed. Compared with the previous work, the design of this mechanism can provide good movement and guarantee the symmetry of the mechanism. In the telescopic stairs can have a longer service life and transport larger items, in the process of ensuring the entire movement, the movement of the same trajectory.

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