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Original Paper

Research and Design of Special Airport Ferry

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Abstract

With the rapid development of China's air transport industry, the airport shuttle bus has become an indispensable part of the airport special vehicles. At present, disabled passengers in civil aviation airports have difficulty in getting on and off the shuttle bus, therefore, this design takes this as a starting point to design an airport ferry with special functions to assist disabled passengers boarding and disembarking functions and to improve the service level of airport barrier-free facilities while solving problems.

Keywords

shuttle buses, scissor platform, strength check, CATIA

1. Introduction

At present, China's air transport industry has entered a period of rapid development. However, as the second largest air transport system in the world, there are fewer gallery bridge seats in domestic civil aviation airports which cannot meet the contradiction of huge passenger flow. As one of the airport special vehicles, Airport Ferry is mainly used to provide passengers with ferry transport services between passenger seats and terminal buildings. At the same time, with the promotion of social development and progress in our country, more and more disabled people gradually try to participate in social life, and civil aviation airliner as a convenient and fast way of transportation suitable for long-distance travel is undoubtedly favored by disabled people. According to the latest statistics, about 7% of the total population of China has nearly 83 million people with disabilities, of which 29.07% are people with lower limb disabilities, and the number of people with disabilities is still growing at a rate of 1% per year. Civil aviation airports need more attention on accessibility facilities for disabled passengers.

At present, there are still some deficiencies in the service of barrier-free facilities for disabled passengers in China Airport, especially for the disabled passengers on and off the plane there are many

inconveniences. Aiming at the problem of incomplete service guarantee for disabled passengers when they get off the airport at present. This research design combines the airport ferry with the hydraulic cylinder-driven lifting platform to assist the disabled passengers to arrive at the far seat independently from the terminal so as to achieve safe and fast boarding and disembarking, which will effectively improve the level of airport service.

2. Content Research and Design

2.1 Overall Design

This design is based on Toyota COAST and combined with scissors and forks lifting structure, and according to the special needs of the disabled, the ferry carriage is designed accordingly. The final design is shown in Figures 1 and 2.

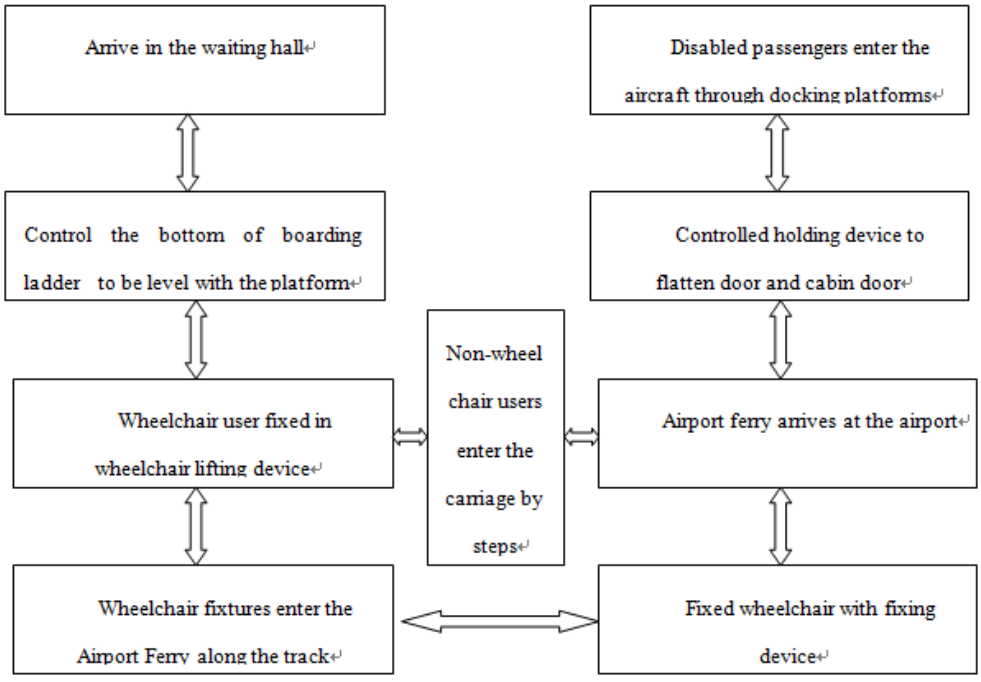
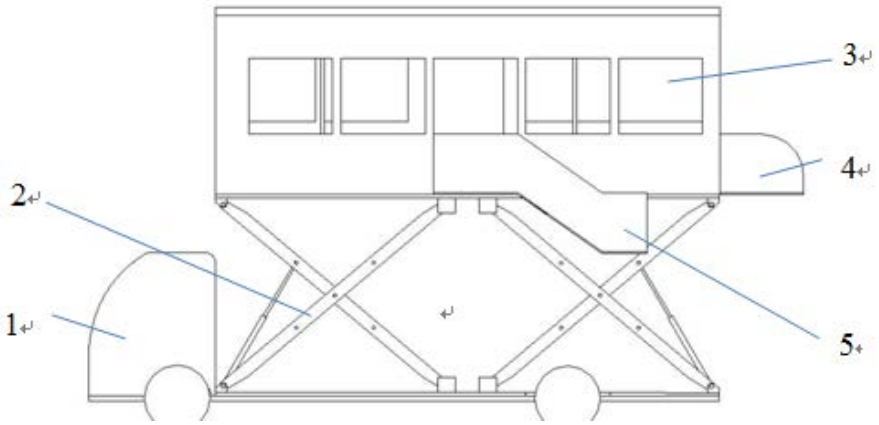


Figure 1. Flow Chart of Auxiliary Device for Special Ferry



1-car body, 2-Lifting mechanism, 3-Ferry car, 4-Docking platform, 5-External ladder

Figure 2. Overall Design Sketch of Auxiliary Device of Ferry Car

2.2 Design of Scissors Lifting Platform

The Scissor-fork lifting platform will adopt articulated scissors. The whole lifting mechanism consists of two groups of scissors, and a single Scissor-fork mechanism is composed of internal and external scissors. Two groups of fork-shearing mechanisms are fixed at both ends of the platform. The fork-shearing arm and the fixed part of the platform are called the fixed end, while the opposite end is called the mobile end. The moving end of the fork-shearing arm is combined with the slider and is randomly arranged at the track of the platform to move horizontally. At the same time, the single group of fork-cutting mechanism is powered by two hydraulic cylinders, and the two groups of fork-cutting mechanism have four hydraulic cylinders powered by the same hydraulic pump. This design method can further enhance the stability of the lifting mechanism.

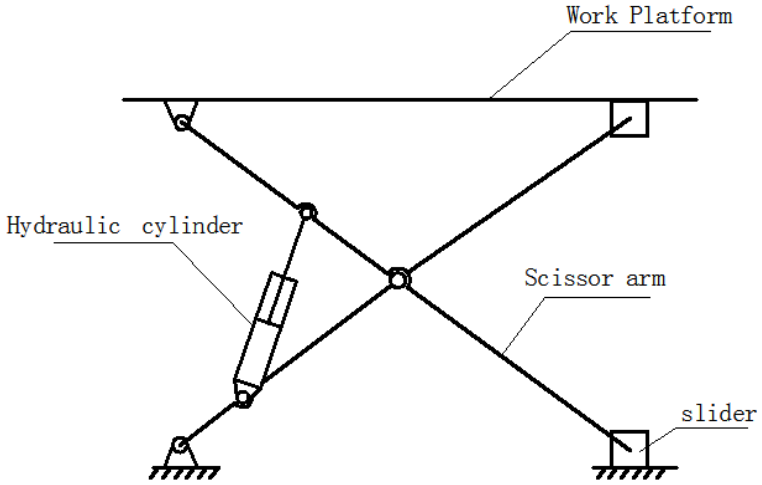


Figure 3. Basic Structure Diagram of Double-Articulated Shearing Fork Mechanism

Fig. 3 shows the basic structure of the double articulated shearing fork mechanism, in which the "X" type shearing fork arm of the shearing fork lifting mechanism acts as the load supporting the working platform, on the other hand, the expansion motion of the hydraulic cylinder can be transformed into the vertical motion of the platform. The thrust provided by the hydraulic cylinder enables the fork shearing mechanism to work normally. The hydraulic cylinder is articulated on the inside of the fork shearing mechanism, making full use of space and making the structure more compact and reasonable. Finally, through the cooperation of these mechanisms, the stable and reliable operation of the lifting platform can be achieved.

3. Selection of Hydraulic Components

3.1 Selection of Hydraulic Cylinder

According to the national standard, the rated load of the body should not be less than 100 kg/m and the rated load of the body should be 150 kg/m when calculating, the safety factor should be 1.5.

According to the working requirements of the lifting platform, the hydraulic cylinder of the fork shearing mechanism is a single piston cylinder, and the two ends are articulated by earrings.

Referring to the fifth edition of the mechanical design manual by GB/T 2348-1993, after consulting the series table of piston rod diameter of hydraulic cylinder, the piston rod diameter was selected as 32 mm.

Table 1. Technical Requirements of Hydraulic Cylinders

Theoretical thrust (N)	Bore diameter (mm)	Working pressure(MPa)	Piston rod diameter(mm)	Trip(mm)
18852.11	40.00	15.00	32.00	562.23

At the same time, considering the safety performance of hydraulic cylinder, self-locking device should be added to ensure the safety of disabled passengers.

Finally, according to Table 1, consulting the mechanical design manual, the model of HSG F-40/32 B E-EGZ1 hydraulic cylinder manufactured by Yuci Hydraulic Industry Co., Ltd. of Taizhong Group was selected from the HSG series engineering cylinders.

3.2 Selection of Hydraulic Pump

The piston rod of the hydraulic cylinder generally moves at a uniform speed. In order to ensure the safety of passengers with disabilities and the stability of the hydraulic system, the speed is maintained at 30 mm/s. The flow rate of a single hydraulic cylinder is 2.26L/mib, and the flow rate of the hydraulic pump is selected as 10.85L/min.

The CB-FE hydraulic pump manufactured by Yuci Hydraulic Industry Co., Ltd. of Taizhong Group was selected in the mechanical design manual. Its parameters are as follows.

Table 2. Technical Conditions of Hydraulic Pumps

nominal arrange capacity(mL/r)	Rated pressure(MPa)	Rated speed(r/min)	Maximum speed(r/min)
10~50	20、25	2000	2500

4. Strength Checking Calculation

Combining with the force of the shear fork arm and pin shaft, the strength conditions of the shear fork arm and pin shaft are satisfied through the calculation of MATLAB software.

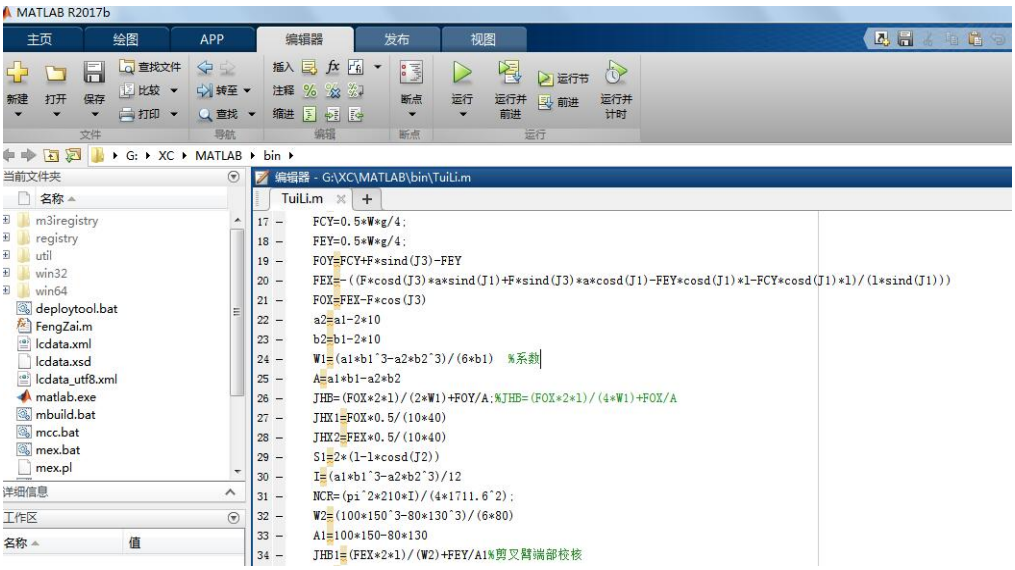


Figure 4. Cascade of MATLAB

5. Result

Aiming at the design of the auxiliary device of the ferry, the size parameters of the main components of the scissors lifting mechanism and the selection of the main components of the hydraulic system are obtained after calculation and verification. In order to show the design objectively and vividly, it is necessary to use it.CATIA software carries out three-dimensional modeling of the whole structure.

Toyota COAST is selected as the reference vehicle, and its basic parameters are as follows:

Table 3. Toyota Coast Basic Parameters

External Size of Vehicle	7004mm×2040mm×2645mm
Front Axis Distance	1690mm
Rear wheelbase	1490mm
Front suspension	1050mm
Rear overhang	1800mm
Minimum ground clearance	185mm

The combination of hydraulic lifting platform and Airport Ferry can solve the difficulties of disabled passengers in the process of boarding and disembarking passengers on the basis of reasonable and stable requirements. Aiming at the distance between the carriage and the ground, we can add boarding ladder at the carriage door to assist disabled passengers to get on and off. At the same time, for the passengers who use wheelchairs, the effective solution is to install slope-type electric folding guide plate device or disabled wheelchair lifting device. The slope type electric folding guide plate device can expand the mounted slope at the rear or side of the car, and then make the wheelchair enter and exit the carriage through the slope. But because the chassis of the car has a certain height, it will cause a large angle slope after the device is deployed, so it needs the help of other people to get off and off smoothly. Another solution is the wheelchair lifting device for the disabled. The wheelchair lifting platform of the device realizes the independent boarding and disembarking of wheelchair users.

At the side door of the carriage, an external ladder and wheelchair lifting device are designed to meet the needs of passengers; at the same time, an emergency escape door is set on the other side of the carriage, which can pop up a safety air cushion to help the disabled passengers flee the carriage quickly in case of emergency; in the interior of the carriage, the original seat is removed to expand the space of the carriage while at the same time providing the carriage with an emergency escape door. The inner wall of the carriage is paved with soft flame-retardant materials, and a number of wheelchair fixtures are installed to meet the needs of disabled passengers when they ride on the ferry. Passenger doors are opened at the rear of the carriage and an extension platform is installed below the passenger doors so as to connect the carriage and the door of the aircraft safely and steadily under the working condition of the ferry. Finally, the designed body structure is modeled by CATIA software, and the results are shown in Fig. 5.

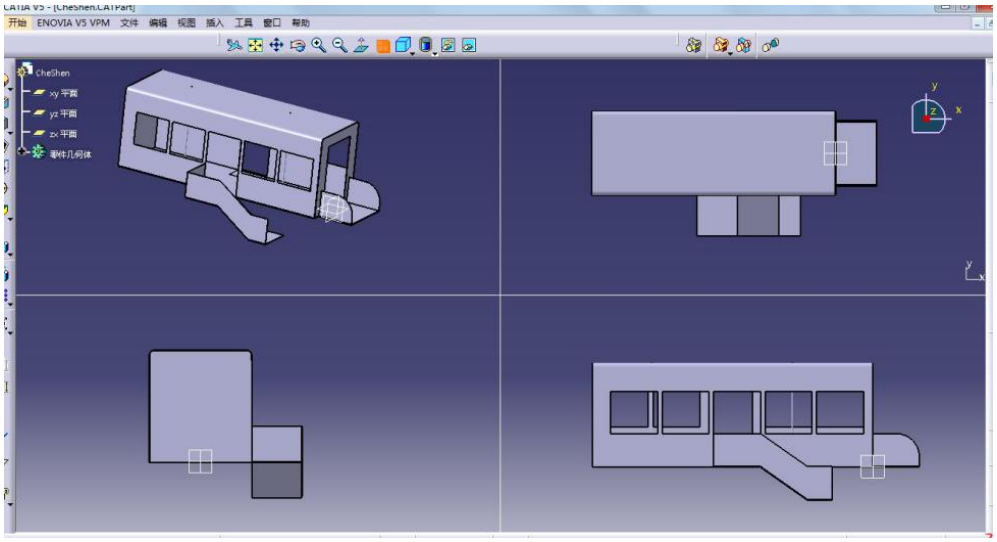


Figure 5. Three-Dimensional Model of Carriage Design

Using the same method, the body structure, fork-cutting mechanism and the chassis of the ferry are imported into the CATIA assembly module for the whole assembly of the ferry. As shown in Figure 5.

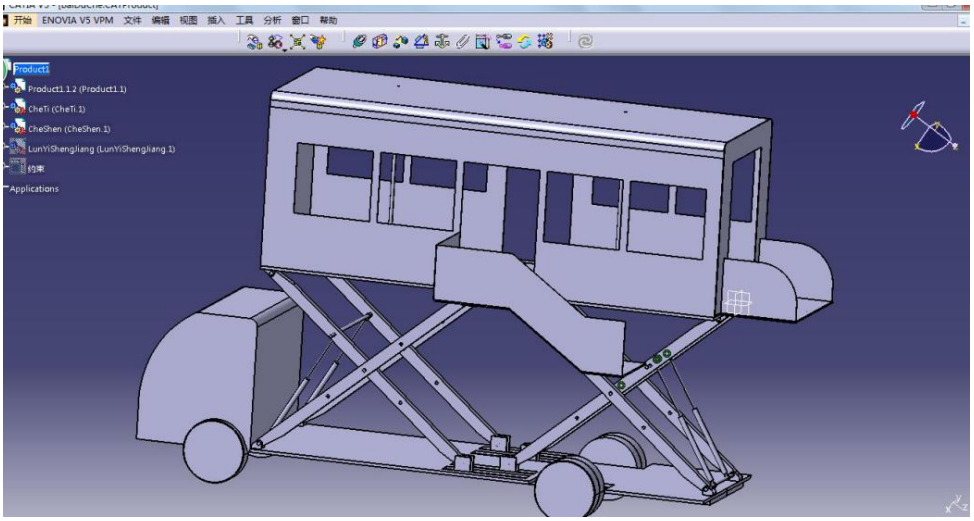


Figure 6. Three-Dimensional Model of Special Airport Ferry

Finally, “interference analysis” is used to check that the whole ferry mechanism has no collision, so the design is reasonable. As shown in Figure 6.

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