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ABERGO

DESCRIPTIVE STUDY FOR THE ELABORATION OF LIFTING PLATFORMS IN STAIRS

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ABSTRACT

This article aims to describe the process of designing stairlift platforms, focusing on the Brazilian Standards (NBR): NBR 9050:2020 and NBR ISO 9386-2:2012. Such norms refer to accessibility, the right and scope, in addition to representing the social inclusion of people with some type of disability, or with reduced mobility. In this way, through a case study in a kindergarten school, we sought to develop a project for a 2D elevator platform on stairs, to improve the accessibility of children with disabilities and elderly people with reduced mobility who attend the site, in order to enable locomotion by means of a lifting platform for stairs. From the information and technical specifications presented in NBR 9050:2020 and NBR ISO 9386-2:2012, it was possible to develop the project for the school, considering the measures specified in the standards, as well as activation, speed, displacement, safety measures, among others. Thus, in addition to the search for knowledge, the elaboration of the project made it possible to develop studies on lifting platforms that guarantee safer accessibility for all, and also guarantee the full exercise of citizenship.

KEYWORDS: Accessibility; Lifting platform; Stairs

1. INTRODUCTION

Accessibility is one of the key factors contributing to the quality of life and full exercise of citizenship for people with reduced mobility and disabilities (Cercal et al., 2014). A built environment that is accessible to all can provide equal opportunities to its users (Cruz et al., 2020).

According to data released in 2019 by the National Health Survey (PNS), 17.3 million people aged two and older (8.4% of this population) had some form of disability, and approximately 8.5 million (24.8%) of elderly individuals were in this condition. It's worth noting that the highest percentage of people with disabilities was in the Northeast region (9.9%), followed by other regions: Southeast (8.1%), South (8.0%), North (7.7%), and Midwest (7.1%). Among children aged 0 to 9 years, 1.5% (332 thousand) had some type of disability, while among the elderly (60 years or older), this percentage was 24.8% (8.5 million) (Brazilian Institute of Geography and Statistics, 2021).

In this context, considering the number of people with disabilities and reduced mobility in Brazil, it is relevant to point out specific legislations aimed at establishing guidelines for the adaptation of public and private spaces to provide accessibility for this population. However, even with specific regulations, numerous inadequately constructed stairs, non-standard elevators, and other irregularities are still found (Cercal et al., 2014).

As highlighted by the authors Oliveira & Resende (2017), architectural barriers can be defined as obstacles built in urban environments or buildings that hinder or impede the free movement of people with temporary or permanent disabilities.

One solution for promoting accessibility on stairs is the construction of electric platform lifts. The choice of platforms designed to transport the user along an inclined path that generally follows the slope of the stairs is mainly due to practicality and cost-effectiveness in most cases. Additionally, projects like these require less intervention in the environment, typically confined to a small portion of the staircase. In comparison to more invasive projects, such as elevators, which often require substantial modifications to the entire space to create the necessary infrastructure (Mota & Ribeiro, 2016).

Based on the above, with the aim of contributing to the process of developing accessibility projects for people with reduced mobility and disabilities, this study aims to describe the process of designing stair platform lifts, with a focus on Brazilian Standards (NBR): NBR 9050:2020 and NBR ISO 9386-2:2012.

2. MOBILITY AND ACCESSIBILITY

As per Maciel (2021), the concepts of mobility and accessibility are often used interchangeably, but mobility is related to the desire to reach a specific destination and an individual's ability to move.

Mobility, as described by Mota & Ribeiro (2016), is the ability to move, influenced by physical and economic conditions, and it is associated with individuals and their different responses to their transportation needs, considering the dimensions of urban space and the complexity of activities within it.

Accessibility involves individuals' capacity to reach a particular place, considering the effort required for such movement. In the case of individuals with special needs, the level of accessibility in a space is increased by promoting easier movement or mobility, aiming to reduce the effort required. Thus, accessibility should always be treated as a project requirement (Mota & Ribeiro, 2016).

The Brazilian Association of Technical Standards (ABNT), which is the responsible body for technical standardization in Brazil, defines accessibility through NBR 9050:2020 as follows:

> [...] the possibility and condition of reaching, perceiving, and understanding for use, safely and autonomously, spaces, furniture, urban equipment, buildings, transportation, information and communication, including their systems and technologies, as well as other services and facilities open to the public, for public use or private use by the community, both in urban and rural areas, by people with disabilities or reduced mobility (ABNT, 2020, p. 2).

In the context of accessibility, environments that offer opportunities for individuals with special needs not only provide stimuli to users but also promote the development of physical and psychological skills and enhance social relationships. Conversely, if the built environment does not allow for exploration and adaptation to the existing social lifestyle, a person with physical disabilities may not be able to develop their abilities and, as a result, may become frustrated by their inability to understand spaces and socialize through a common process experienced by all (Santos, 2018).

Architectural accessibility is an essential condition for using space safely and autonomously. Therefore, one of the principles of architectural design is to provide conditions that facilitate the mobility of all individuals with special needs. Furthermore, urban planning should facilitate mobility so that each individual can choose to move as they prefer and adapt to their situation (Santos, 2018).

It's also important to consider that accessibility is not only related to physical and spatial factors but also to political, social, and cultural aspects that influence the execution of activities (Maciel, 2021). Landim (2011) highlights the issue of accessibility in public spaces and buildings in Brazil:

> . Often, environments are built with great artistic and cultural potential, but without concern for inclusion and the participation of all potential users, such as people with disabilities or reduced mobility. Ensuring accessibility, both in space and in communication and information, is an important action to ensure that everyone has the right to leisure, social interaction, and culture. (Landim, 2011, p. 30).

Thus, the importance of accessibility for everyone, including individuals with physical disabilities and the elderly, is evident (Maciel, 2021). In this context, Federal Decree 5,296/2001 established Law No. 10,048/2000 and Law No. 10,098/2000. Law No. 10,048/2000 establishes priority service for people with disabilities, individuals aged 60 or older, pregnant women, nursing mothers, individuals with infants, and obese individuals within public agencies, financial institutions, and also includes the reservation of seats in public transportation companies and concessionaires. This law also mandates the expansion of sidewalks and restrooms in public buildings to ensure access for people with disabilities (Maciel, 2021).

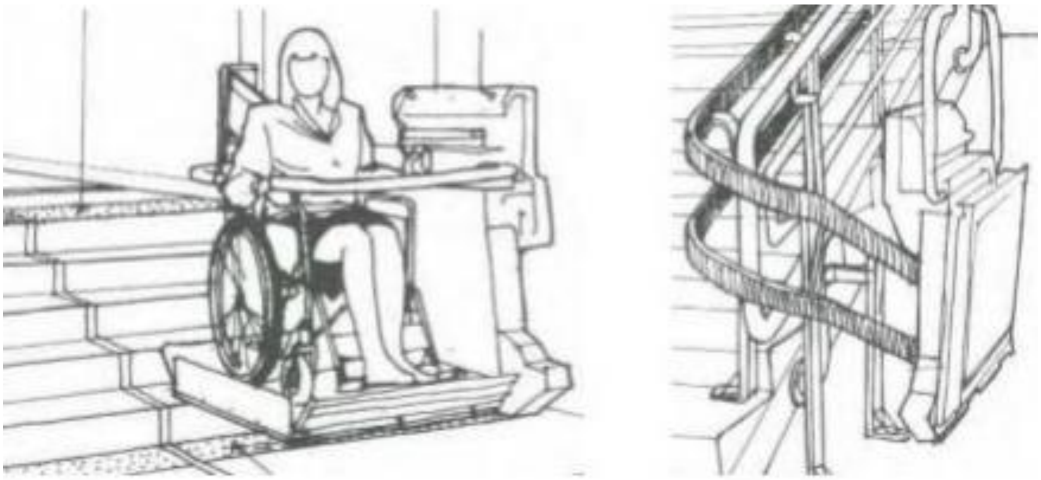
Federal Law No. 10,098/2000 expands the rights of people with disabilities by setting general standards and basic criteria for promoting the accessibility of individuals with disabilities or reduced mobility. This includes the removal of barriers and obstacles in public roads and spaces, urban furniture, building construction and renovation, and means of communication and transportation (Maciel, 2021).

In summary, improvements and adaptations in public, private, and residential environments can prevent disabilities and lead to increased social participation. Such initiatives contribute to ensuring that people with disabilities or reduced mobility do not suffer from social exclusion (Cercal et al., 2014).

3. ELEVATION PLATFORMS

According to Sebastião et al. (2017), a platform lift is an ideal solution to assist in the transportation of individuals with reduced mobility who need to overcome staircases and inclined ramps. Its installation is straightforward and does not require significant construction work or modifications to the existing staircase. When the platform is not in use, it can be folded vertically, further reducing its space requirements, as can be seen in Figure 1.

Figure 1 - Stairlift Platform



Source: Sebastião et al. (2017, p. 15).

It's also important to note that the accessibility platform is fully automated, providing complete autonomy and freedom to the wheelchair user. They can operate the platform without the need for assistance from another person because the platform has automatically lowering access ramps and safety handrails. Additionally, the platform can be installed in both indoor and outdoor environments, as it is resistant to various weather conditions and adverse circumstances (Mota & Ribeiro, 2016).

Sebastião et al. (2017) mention various types of accessibility platforms in their study, such as the Artira platform, Xpress II platform, and X3 platform. The Artira is an inclined platform designed to transport passengers in a straight line or on curved staircases, over flat landings or spiral staircases. The Artira is equipped with Smart-Lite technology, a feature that makes it the easiest inclined platform on the market and guides the user through sequences of operations, as can be seen in Figure 2.

Figure 2 - Artira Platform

Source: Tecno Mobile (2020).

The Xpress II wheelchair lift platform is presented as an ideal accessibility solution for straight staircases with two landings, which can be installed on either side of the staircase, depending on its design and location. The Xpress II model is powered by the electrical grid and is available both as a backup option for full functionality in case of a power outage or emergency. It consists of the sturdiest straight-incline wheelchair lift platform available on the market, suitable for heavy commercial applications (Sebastião et al., 2017). Figure 3 illustrates this model.

Figure 3 - Xpress II Platform

Source: Archiproducts (2022a).

The X3 inclined platform is ideal for installation on straight staircases within homes or commercial facilities. This model is powered by rechargeable batteries, which are charged when the lift is not in use or parked at one of the landings. The wall controls are wireless, which allows for a simpler installation compared to traditional wheelchair lifts (Sebastião et al., 2017). In this model, there is no need to install wires on the walls, and the X3 inclined platform can be installed with minimal structural modifications. Figure 4 illustrates the X3.

Figure 4 - X3 Platform

Source: Archiproducts (2022b).

Inclined platform lifts have the advantage of requiring lower power from the drive system. The fact that the movement occurs within an inclined plane reduces the forces to be overcome in components parallel to this plane. This reduction in power directly translates into cost savings in the drive system adopted in the design. For example, if this system includes an electric motor, the reduced power requirement calls for a less robust and consequently more cost-effective motor (Mota & Ribeiro, 2016).

It is important to note that further specifications regarding the sizing of the stairlift platform, as well as measurements of the carriage, drive system, travel speed, among other information, are detailed in the results section.

4. Regulatory Standards

According to Cercal et al. (2014), approaches related to people with disabilities were often superficial and limited in scope, mainly focusing on identifying barriers to their integration. The primary accessibility standard, NBR 9050, was only published in 1985, which contributed to these limitations. NBR 9050 was created to address technical requirements related to accessibility, but there were still shortcomings and gaps in its formulation.

In 1993, with the support of the Government of the State of São Paulo, a study group was established to update and expand the scope of NBR 9050. Subsequently, the revised standard was published in 2004 with the aim of encompassing a range of specifications related to the adaptation of physical spaces for the inclusion of individuals with special needs (Cercal et al., 2014).

In 2020, NBR 9050 was revised again to establish technical parameters for the design, construction, installation, and adaptation of urban and rural environments and buildings for accessibility. NBR 9050:2020 also considered various mobility and environmental perception conditions, with or without the assistance of specific devices, such as prostheses, support aids, wheelchairs, tracking canes, assisted hearing systems, or any other devices that complement individual needs (ABNT, 2020).

The parameters set in standards aim to provide the necessary framework for anyone to adapt to the conditions of a given space while also enhancing comfort and functionality, with adjustable safety levels as needed by individuals (ABNT, 2020).

As clarified by Cercal et al. (2014), in the current scenario, there are standards applicable to residential and commercial environments aimed at improving the quality of life for individuals with reduced mobility or disabilities. These standards include ABNT NBR 9050: 2020 - Accessibility in Buildings, Furniture, Urban Spaces, and Equipment; and ABNT NBR ISO 9386-2:2012 – Powered stairlifts for persons with mobility impairment - Safety requirements, dimensions, and functional operation Part 2: Stairlifts for seated, standing, and wheelchair users moving on an inclined plane.

It is important to note that before adapting an environment for individuals with special needs or reduced mobility, it is necessary to adhere to the parameters established in NBR 9050:2020, so that subsequent implementation of the environment can include equipment and structures that can contribute to and assist in the mobility of these individuals (ABNT, 2020).

In this context, NBR ISO 9386-2:2012 is highlighted as it contains all the specifications, specific requirements, covering mechanical and electrical aspects, and necessary parameters for the development of a mobile lifting platform project, including specifying the travel speed (ABNT, 2020).

There are also Regulatory Standards (NRs) that can assist in the development of lifting platforms in environments, such as NR 06 - Personal Protective Equipment (PPE); NR 10 - Safety in Electrical Installations and Services; and NR 12 - Safety in Machinery and Equipment.

NR 06 addresses the responsibility of companies to provide and ensure the use of PPE for all workers. PPE in this NR is considered as any device or product, for individual use by the worker, intended to protect against potential risks that may threaten safety and health at work (Brazil, 1978a).

NR 10 establishes requirements and minimum conditions aimed at implementing control measures and preventive systems to ensure the safety and health of workers who directly or indirectly interact with electrical installations and electrical services (Brazil, 1978b).

NR 12 provides technical references, fundamental principles, and protection measures aimed at safeguarding the health and physical integrity of workers, establishing minimum requirements for accident and occupational disease prevention in all phases of machinery and equipment design, manufacturing, import, marketing, exposure, and assignment in all economic activities (Brazil, 1978c).

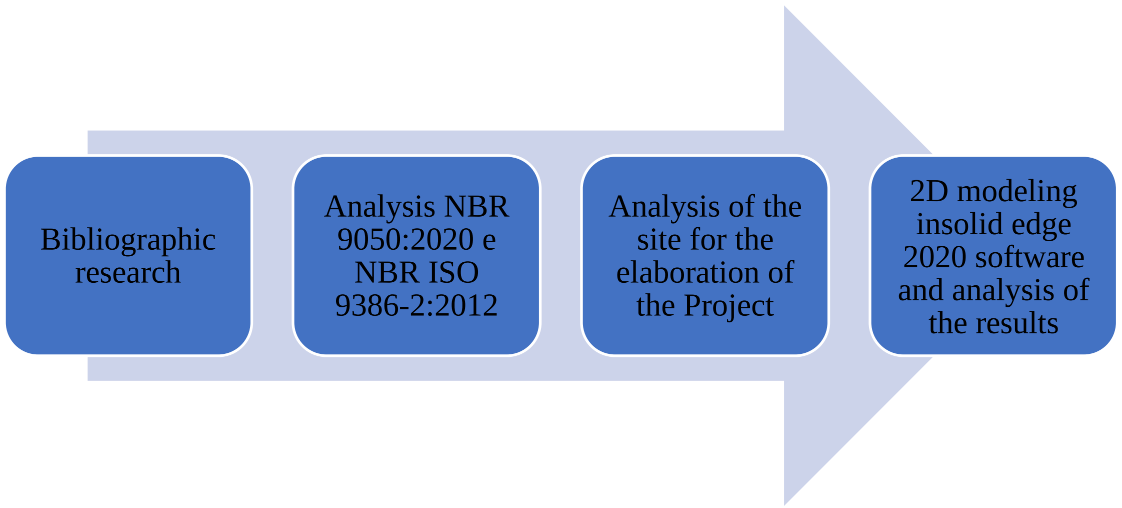
5. METHODOLOGY

This is a qualitative, applied, and descriptive research study conducted through a 2D modeling of a stairlift platform project.

The project was designed to be implemented in a nursery school that receives many elderly visitors with reduced mobility and also caters to children with disabilities.

The purpose of this study is to describe the process of modeling the stairlift platform, and it went through several stages, which are illustrated in Figure 5.

Figure 5 – Methodological stages of the study



Source: The authors(2022)

To achieve the research objective outlined in this article, the study began with the development of the theoretical framework. This step was crucial for planning the research, providing context on mobility and accessibility, discussing types of stairlift platforms, and reviewing the regulatory standards currently considered for such projects.

Following the theoretical groundwork, an analysis was conducted on NBR 9050:2020 and NBR ISO 9386-2:2012. This analysis was complemented by an examination of the project's implementation site, considering the specific measurements outlined in NBR ISO 9386-2:2012, as well as details related to the carriage, operation, travel speed, and other relevant information.

Subsequently, a 2D modeling process was carried out using Solid Edge software version 2020. This modeling was based on the specifications provided in NBR ISO 9386-2:2012. It's important to note that the data collected in this phase were predominantly descriptive, as the standard provides descriptions of essential requirements for inclined accessibility platforms.

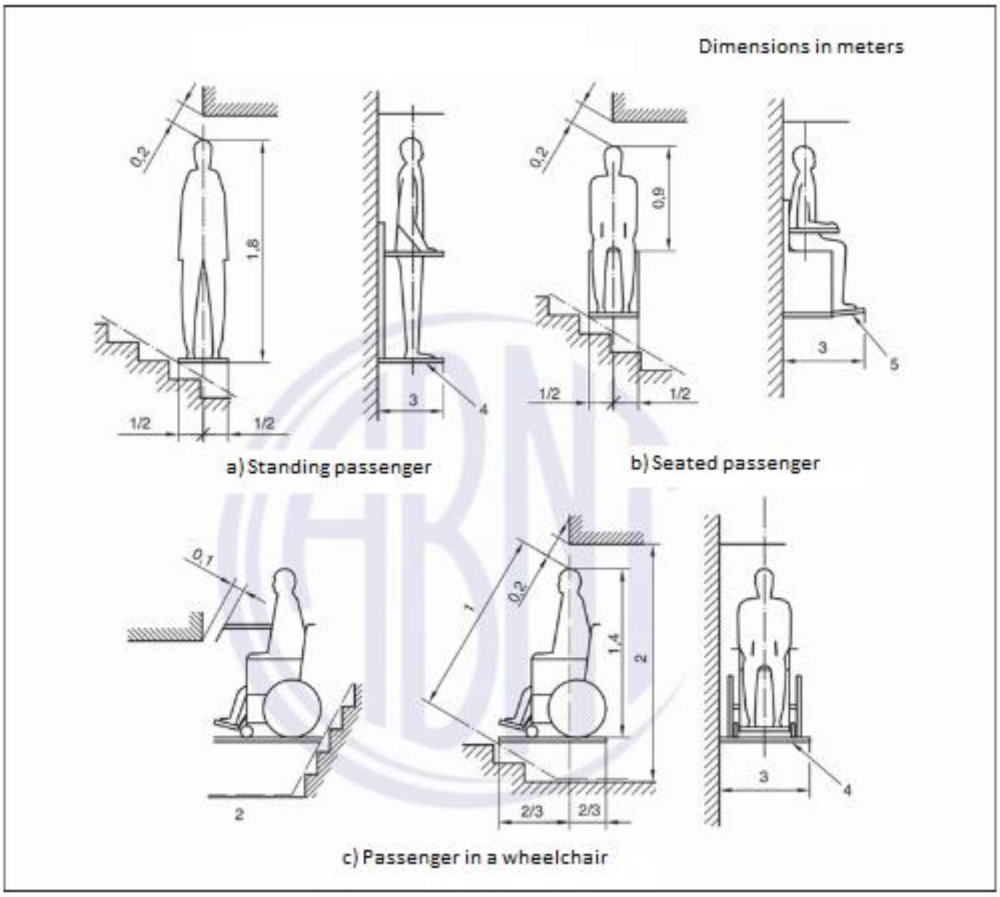
The data collected throughout the study primarily consisted of descriptive information. This included details about the company, job tasks performed at workstations, worker characteristics, and other relevant variables related to the study. The research employed field studies and case studies as the main research methods to gather this data.

6. Results And Discussion

Elevated platforms serve the same purpose as elevators but can be installed on staircases to facilitate their use in spaces with limited room, which is especially helpful when traditional elevators require adequate space for installation. As a result, stairlift platforms provide greater independence to users.

For the 2D modeling of the project, the specifications outlined in NBR ISO 9386-2:2012 were taken into consideration. According to NBR ISO 9386-2:2012, there are three configurations for inclined accessibility platforms, namely: a) standing passenger; b) seated passenger; and c) passenger in a wheelchair, with both configurations illustrated in Figure 6 for better visualization.

Figure 6 – Accessibility inclined platform settings



Source: ABNT (2012, p. 47).

Legend: 1 Passage height.

2. Minimum dimensions at steep inclines.

3. Stairlift path width.

4. Platform.

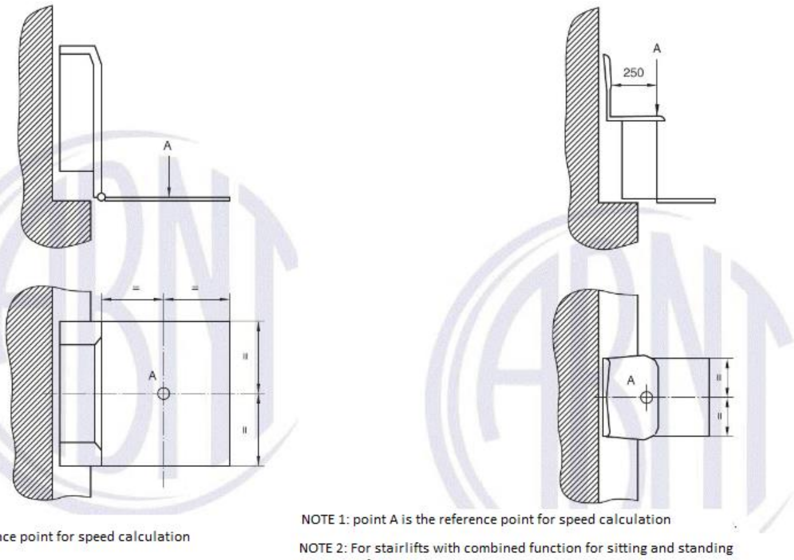
5. Footrest.

According to the specifications of NBR ISO 9386-2:2012, it is recommended that headroom dimensions should be obtained across the entire width of the stairlift. Additionally, the standard advises that the project components should be of safe mechanical and electrical construction, using materials free from obvious defects and with sufficient strength and adequate quality. Furthermore, the specified dimensions should be ensured despite wear and tear. Consideration should also be given to the need for protection against corrosion, minimizing noise and vibration.

Stairlifts should be designed, constructed, and installed to provide easier access for periodic maintenance and repairs. The materials used in the construction of the stairlift should not promote combustion, pose a danger due to their toxic nature, or emit excessive gas and smoke in the event of a fire.

Regarding the nominal speed in the direction of travel, it should be equal to or less than 0.15 m/s when measured at the reference points shown in Figure 7.

Figura 7 – Reference point for the user in a wheelchair standing and sitting



NOTE: point A is the reference point for speed calculation

NOTE 1: point A is the reference point for speed calculation

NOTE 2: For stairlifts with combined function for sitting and standing users, use figure 1

NOTE 3: The speed for the stair lift when measured at point A may not exceed the maximum rated spped at any point of the route

Source: ABNT (2012, p. 42-43).

Regarding the nominal load capacity, NBR ISO 9386-2:2012 emphasizes that stairlifts should be designed for one person, with a nominal load capacity not less than 115 kg, or for one person in a wheelchair, with a minimum nominal load capacity of 150 kg. If the load to be transported is unknown, it is recommended that the nominal load capacity of the wheelchair stairlift not be less than 225 kg.

The safety factor for all equipment parts should be equal to or greater than 1.6, based on deformation resistance and maximum dynamic load. This safety factor is based on steel and equivalent ductile materials. "Higher safety factors should be considered for other materials" (ABNT, 2012, p. 8).

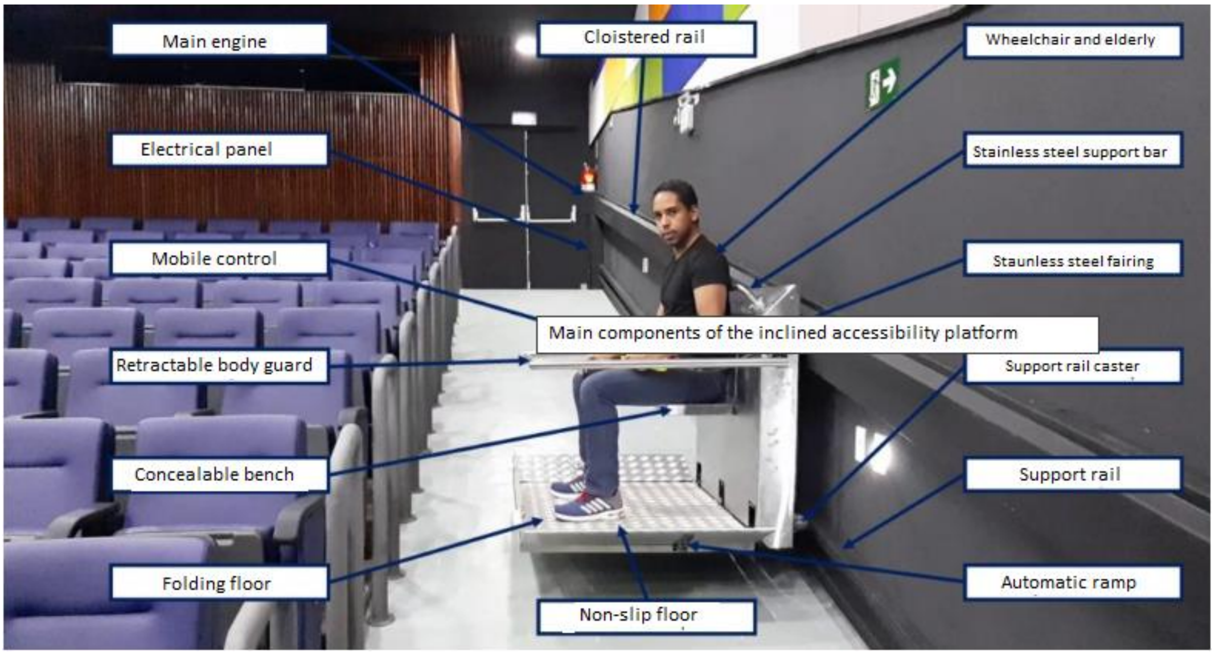
The complete installation of the stairlift should withstand, without permanent deformation, the forces imposed during normal operation, during the activation of safety devices, and when impacted against stops while traveling at the nominal speed. Guide components, their accessories, and connections should support deflections due to uneven loads without affecting normal operation.

Electrical and mechanical components should be protected against harmful or hazardous effects of external influences in the intended installation area, such as water and solid objects ingress, moisture, temperature, corrosion, atmospheric pollution, solar radiation, and the actions of flora, fauna, among others. The protection should be designed, constructed, and installed in a way that these influences do not prevent safe and reliable operation.

According to NBR ISO 9386-2:2012, there should be an emergency control device that, when activated, renders the platform inoperative, even if the operation buttons are pressed and the platform is energized. It should be noted that emergency/manual instructions should be prominently displayed, and the stairlift should be turned off and kept under constant supervision when in emergency operation.

NBR ISO 9386-2:2012 includes several safety requirements for accessibility platform designs, such as non-slip flooring, the need for a foldable seat, automatic opening and closing, automatic ramp movement, automatic gate movement, and ramps with a maximum inclination of 8%. Figure 8 illustrates the main components of an inclined accessibility platform.

Figura 8 – Main components of the inclined accessibility platform



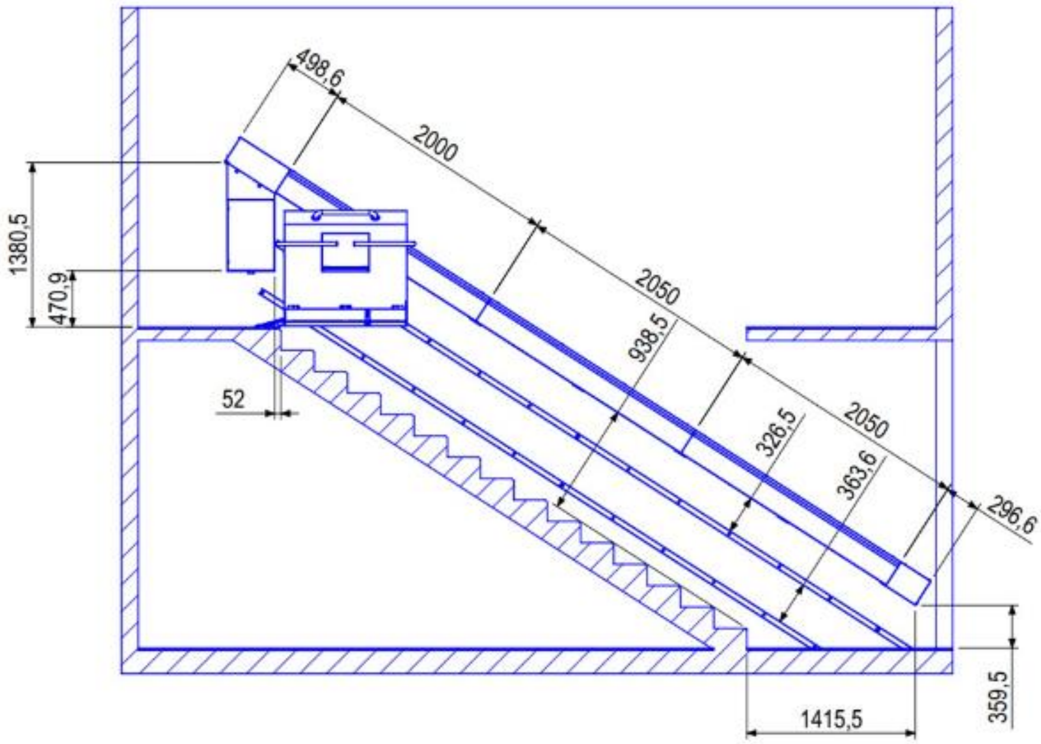
Source: IESAB (2021, n.p.).

In addition to the necessary platform components, it is essential to mention that the project must fully comply with current legislation. These are crucial elements for both user safety and the legal backing of the owner in the event of any inspection, unforeseen event, or accident. The project should adhere to the specifications of NBR ISO 9386-2:2012, NBR ISSO 9386-2, NR 10, and comply with the standardization requirements imposed by municipalities, in accordance with the specifications of each municipality.

Regarding the minimum dimensions of the project, the standard provides some minimum dimensions that must be respected for the construction of inclined accessibility platforms, namely: "the recommended maximum dimensions for the platform are 900 mm in width by 1250 mm in length. In buildings with public access, the minimum dimensions of the platform should be 750 mm in width by 900 mm in length."

Figure 9 provides an example with dimensions of a model of an inclined accessibility platform. It is important to note that since projects are tailored to the specifications of each location, there is no standard dimension.

Figure 9 - Dimensions of a model of an inclined accessibility platform



Source: IESAB (2022, n.p.).

After following the specifications and guidelines of NBR ISO 9386-2:2012, a project for stairlift platforms was developed to be implemented in a nursery school that receives many elderly visitors with reduced mobility, as well as children with disabilities.

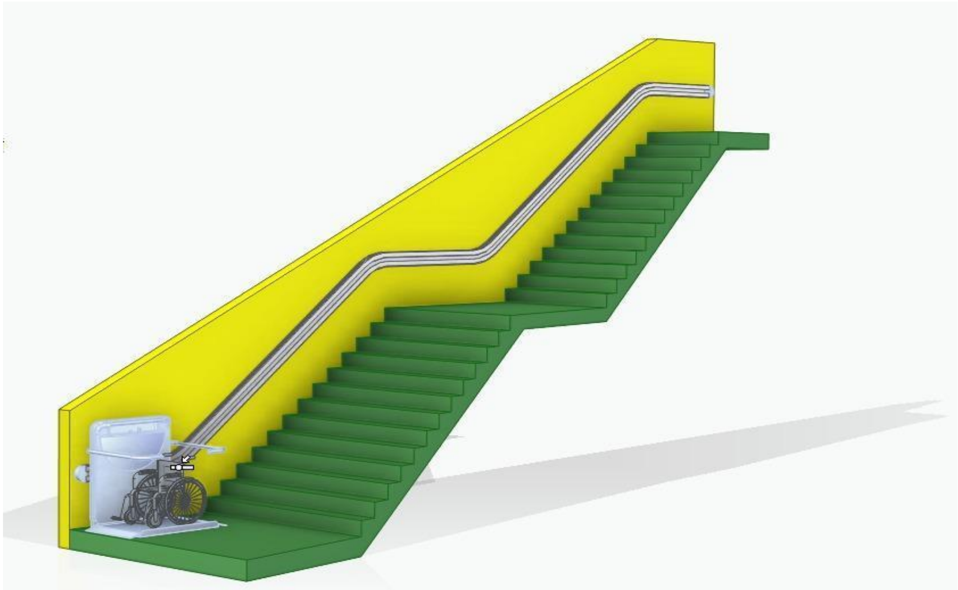
Considering the dimensions specified in NBR ISO 9386-2:2012, Solid Edge 2020 software was used to create the 2D modeling of the project, as shown in Figures 10, 11, and 12. Figure 10 demonstrates the path that the carriage will follow, as well as where it will be parked.

Figure 10 - Path to be followed by the carriage

Source: The authors (2022).

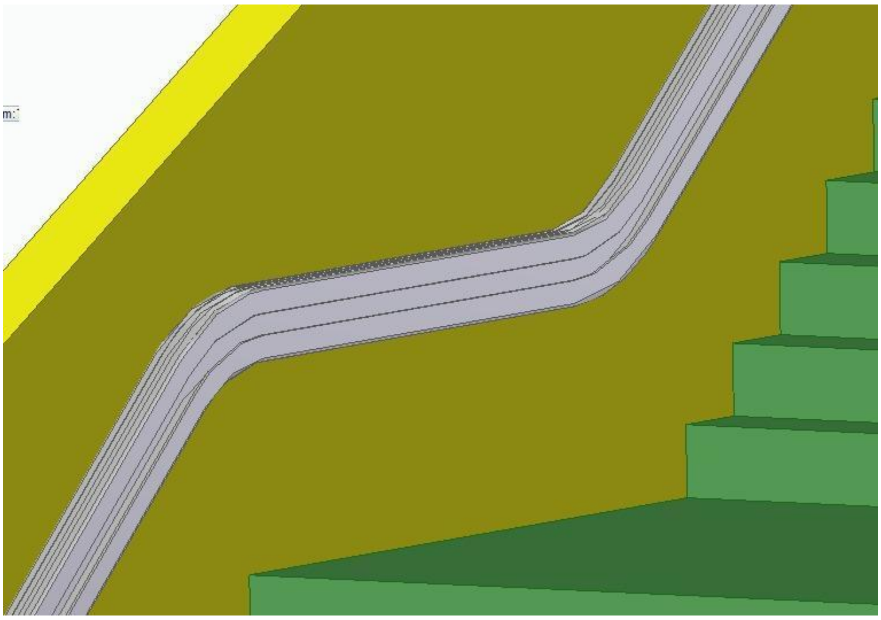
Figures 11 and 12 illustrate the location where the cart's support will pass, guiding it as it navigates the stairs' curves and stops.

Figure 11 - Cart Guide



Source: The authors (2022).

Figure 12 - Guide Detail



Source: The authors (2022).

According to NBR ISO 9386-2:2012, mechanical guides and stops must be provided to maintain and guide the cart along its entire path and should be made of metal. Articulated guides should not obstruct the staircase or floor when in the folded position. Additionally, manually articulated sections should be counterbalanced, and a safety switch should be installed to prevent the stair lift from reaching the articulated section of the guide unless the articulated section is properly positioned for lift operation. The control system for motorized articulated guides should operate with constant pressure, i.e., press to operate.

The design will incorporate different types of materials, such as stainless steel, steel 1020, and steel 1045. These materials have been chosen based on the technical requirements of the project while also aiming to please the school owner and its users aesthetically. The platform will include guides for visually impaired individuals and a lateral support for gripping. The guardrail will be retractable to minimize space when the system is not in use, with the goal of maximizing comfort.

The material used in the platform will comply with the specifications of NBR ISO 9386-2:2012 to meet the equipment's load capacity. It will also feature a distinctive design and non-slip flooring. The control panel will have the necessary functions for people with special needs to use the system easily and efficiently, including buttons for ascending/descending and emergency situations.

7. FINAL CONSIDERATIONS

When developing the project for the accessibility stair lift platform, theories and guidelines from NBR 9050:2020 and NBR ISO 9386-2:2012 were applied, including specific measurements, activation methods, speed, displacement, safety measures, among others. The objective was to create a well-specified project with clear goals, in accordance with current legislation and regulatory standards.

The key requirements that stood out during the project development were cost-effectiveness, safe operation, and the promotion of full citizenship. It's worth mentioning that in the development of the accessibility stair lift platform project, NRs (Normas Regulamentadoras) 06, 10, and 12 can also assist in the project development process, along with NBR 9050:2020 and NBR ISO 9386-2:2012.

As suggestions for future research, it is recommended to explore the automation of the lift system using electric motors, mechanical, hydraulic, and pneumatic systems to enhance the project in future studies.

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