GPIAAF
Gabinete de Prevenção e Investigação de Acidentes com Aeronaves e de Acidentes Ferroviários
RAILWAY TRANSPORT

# PRELIMINARY REPORT

| GPIAAF FILE No. F_Inv20250903 | Classification: Serious Accident | Type of occurrence: Derailment |
|---|---|---|

**OCORRÊNCIA**

| Data | Hora | Location | GPS coordinates |
|---|---|---|---|
| 03-SET-2025 | 18:03 | *Calçada da Glória*, Lisbon | 38°42'57.0"N 9°08'35.4"W |

Summary description: Derailment and subsequent collision of the Glória funicular cabins, following the rupture of the cable connection to cabin no. 1.

## 1. FOREWORD

This preliminary report aims to present the findings established so far in the course of the investigation, for the purpose of disseminating relevant safety information and supporting the safety recommendations that are, at this stage, deemed appropriate to issue. It also seeks to inform the public about the actions undertaken and those planned as part of the investigation.

It should be clearly understood that this document contains incomplete information, which still requires significant elaboration as a result of the examinations and tests to be carried out, along with the corresponding analysis of their results. Its content does not represent, nor should it be interpreted as, final or comprehensive conclusions regarding the accident.

The release of information in this document necessarily takes into account the constraints arising from the fact that the investigation led by the Public Prosecutor's Office is subject to judicial secrecy. However, in coordination and agreement between GPIAAF and that entity, all currently available information relevant to prevention has been made public herein.

Unless exceptional circumstances justify otherwise, GPIAAF does not intend to publish further information prior to the final report, which is expected to be published within one year of the occurrence.

## 2. THE INVESTIGATION

Following the serious accident that occurred at 18:03 involving the *Glória* Funicular, GPIAAF was notified by telephone 50 minutes after the event by the National Authority for Emergency and Civil Protection (ANEPC).

Given the nature and consequences of the accident, it was immediately determined to constitute as a serious accident, as defined in Decree-Law No. 394/2007, thereby requiring the mandatory initiation of a formal safety investigation, in accordance with Article 4(1) of the said Decree-Law.

A two-person GPIAAF team began collecting evidence on site at approximately 08:30 the following day, in coordination with the Public Prosecutor's Office, the Judiciary Police (*PJ*), the Police force (*PSP*), the Health and Safety Authority (*ACT*), and with the cooperation of *Companhia Carris de Ferro de Lisboa, E.M., S.A. (CCFL)* and the maintenance service provider.

Following the initial observations and documentation of evidence at the scene, the wreckage of Cabin No. 1, Cabin No. 2, as well as parts of the haulage cable and other relevant components, were removed from the site during the night of the 4th to 5th of September and secured in a safe location for subsequent technical examinations.

Subsequently, the entire haulage cable remaining in the trench beneath *Calçada da Glória* was also recovered.

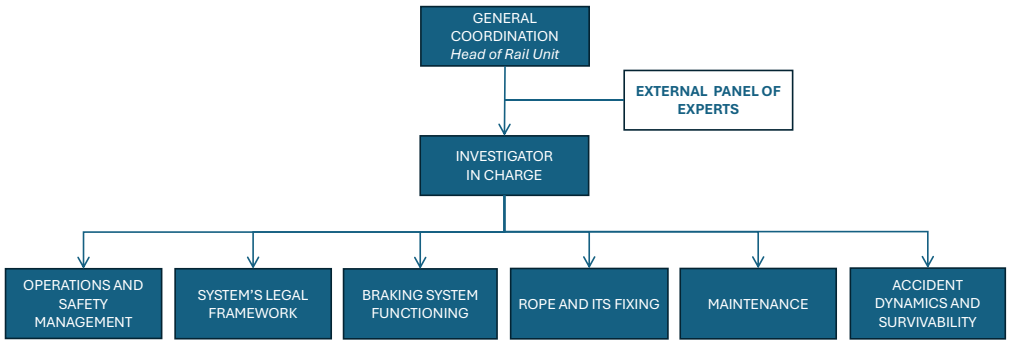
The majority of the physical evidence is currently under the custody of the Public Prosecutor's Office, with GPIAAF having access to it for the purposes of its investigation, in accordance with the aforementioned Decree-Law.

It should be clearly stated that both investigations are entirely independent and serve different purposes. However, given the need for evidence sharing and the joint execution of certain expert examinations and tests, there has been close interaction and cooperation between the investigations conducted by GPIAAF, the Public Prosecutor's Office, and the Judiciary Police, particularly in the preparation of specifications for the tests to be carried out, without compromising the independence of either investigation.

The interaction between the GPIAAF investigation and that of the Health and Safety Authority has also been proceeding satisfactorily, once again with due regard for the independence and distinct objectives of each investigation.

All other entities involved — namely *CCFL* and the maintenance service provider, along with their personnel, as well as the cable manufacturer, relevant specialist entities and laboratories, and the Institute for Mobility and Transport / National Railway Safety Authority (IMT/ANSF), have shown the utmost cooperation with the GPIAAF investigation.

For the purposes of this investigation, GPIAAF established a multidisciplinary team composed of investigators from both of its investigation units, assigned across the various areas deemed relevant to the investigation at this stage. Additionally, an external panel of experts was appointed to support the team in the preparation and analysis of test results concerning certain highly specific technical aspects.




Among other aspects, the GPIAAF investigation is focusing on the following:

- Disconnection mechanism between the cable and the trolley (*trambolho* in Portuguese), including analysis of the cable's attachment condition to the trolleys and its execution;
- Initial design of the funicular, its successive modifications, and the assumptions underlying of its safety systems;
- Verification of the operation, constitution, and effectiveness of the braking systems;
- Specification of the type of cable and its attachment to the trolleys, including quality controls during execution and acceptance;
- Maintenance procedures for safety-critical components, their implementation, and verification;
- Conditions and feasibility of carrying out inspection and maintenance tasks;
- Training, experience, and proficiency of the technicians involved in maintenance tasks;
- Supervision of service delivery by the contracting entity, including resources and frequency;
- Criteria for selecting the service provider;

- Training, drills, and proficiency of operating personnel to manage emergency situations;
- Survivability aspects;
- Legal framework governing the *Glória* Funicular and its oversight;
- Conduct of rescue operations.

At this stage of the investigation, several tests and reconstructions have already been carried out, for example, of maintenance operations, using the *Lavra* Funicular, which is similar to the *Glória* Funicular. Technical specifications have also been prepared for the specialised tests to be conducted, most of which are being coordinated with the Public Prosecutor's investigation. These tests require the engagement of specialised entities and other external resources, and their preparation and execution are time-consuming.

Requests for information have also been made to *CCFL*, comprising of 46 items of varying complexity. All have now been addressed, although some only very recently. Information is also currently being collected from the maintenance service provider.

This constitutes a very large volume of documentary information, requiring lengthy analysis.

Several meetings and interviews were already undertaken with management and staff from CCFL and the service provider, tram drivers and their coordinators, workers representatives, and other relevant entities.

In due course, tests, expertise and additional interviews and information gathering will be undertaken, as relevant, to establish the accident's causal and contributing factors, either direct or systemic.

## 3. THE SYSTEM AND ITS FUNCTIONING

The funicular installed at *Calçada da Glória*, classified as a national monument, in its current form and configuration dates back to 1914, although over the past 111 years it has undergone several conservation and improvement projects, in addition to the periodic maintenance required. Since 1926 it is operated by *Companhia Carris de Ferro de Lisboa*.

It has a 260-meter travel length and covers a 45-meter drop, with an average gradient of 18%. Its maximum operating speed is 3,2 m/s (11,5 km/h), taking a little over a minute to complete the journey.

It consists of two vehicles, known as *cabinas* (cabins) and numbered 1 and 2, each weighing approximately 14 tons and holding 42 people, 22 of which seated, plus the brakeman (called *guarda-freio*). Each cabin consists of a metal chassis to which a body is attached made up of a frame of wooden columns and crossbars, covered also in wood and thin sheet metal, according to the classic construction standards at the time of its entry into service.

The cabins are connected by a cable, which balances their weight through a large-diameter pulley located at the top of *Calçada da Glória* in an underground technical compartment.

Unlike the most common system used in funiculars, this pulley is not powered to drive the cable and thus moving the cabins; it is instead a very rare, if not unique, variant of the type sometimes referred to in the literature as a self-propelled funicular. In this system, each of the two cabins is equipped with two 18 kW electric motors, which, through the wheels and their adhesion to the rails, provide the necessary traction force to overcome the internal forces resisting movement and those resulting from the weight difference between the cabins resulting from their respective passenger loads. The system's four motors (two in each cabin) are all electrically connected in series through overhead conductors through which the two cabins are in contact. This means that the two cabins and their haulage cable only start moving when the control system in each cabin is moved to the drive position by the respective brakeman.

The haulage cable between the two cabins runs underground, guided by pulleys in a trench whose opening to the pavement surface is delimited by two Z-shaped metal profiles. This cable is attached to the frame of each cabin in a special trolley (*trambolho* in Portuguese), which extends from the frame of the cabin into the trench and to which the cable is attached. There are two *trambolhos* in each cabin, interconnected by another cable itself independent of the haulage cable between the two cabins.

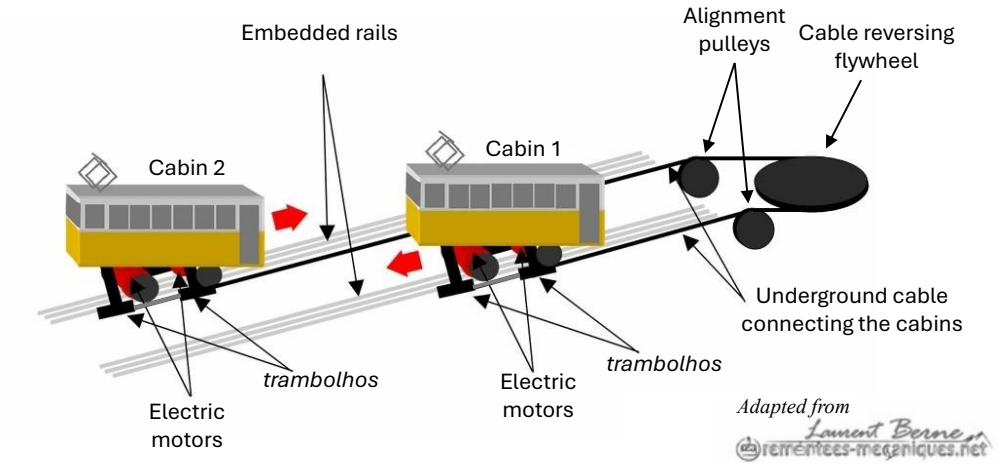



Fig. 1 – Overview of the funicular's operation. [*Adapt. from Laurent Berne - remontees-mecaniques.net*]

The haulage cable is attached to each cabin at its respective upper trolley via a special swivel, which, through a series of bearings, is able to rotate axially, thereby allowing the cable to rotate around its own axis. A similar device is installed on the lower trolley, although in this case it only connects to the interconnecting cable between the two cabins.

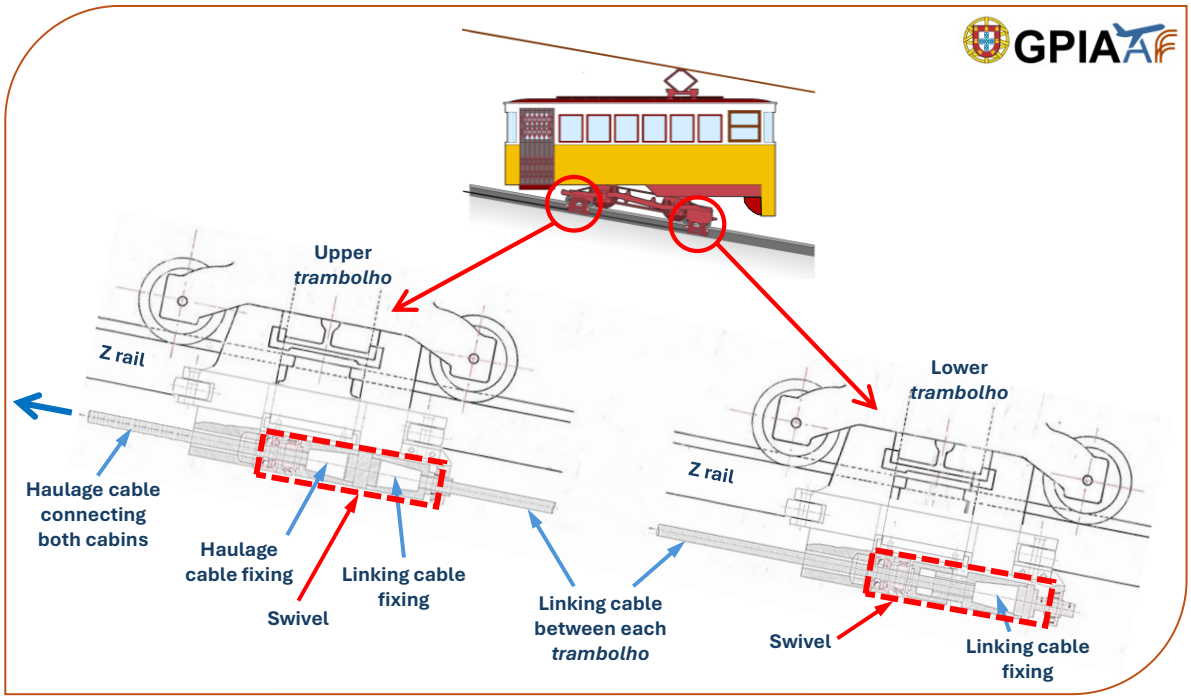



Fig. 2 – Arrangement of the *trambolhos* and of the haulage and linking cable fixings.

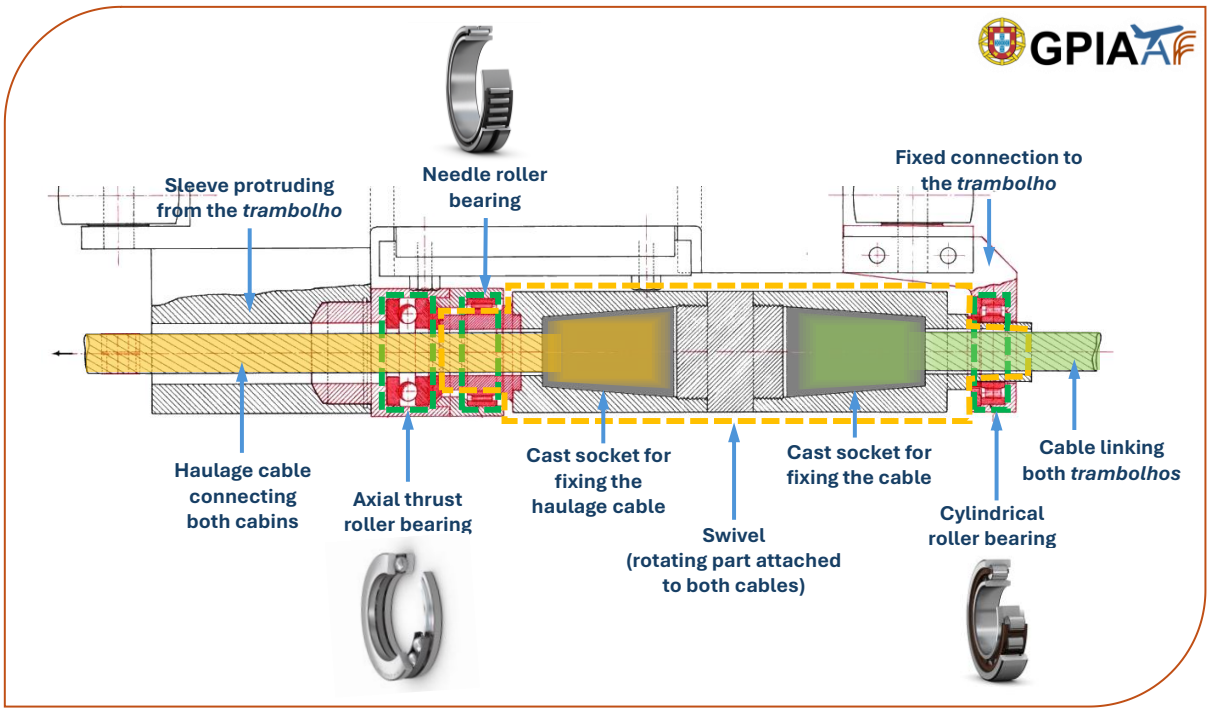



Fig. 3 – Composition of the swivel at the upper trolley (*trambolho*), where the haulage and the linking cable between the trolleys are attached.

Each *trambolho* also incorporates four movable brake pads (eight pads per cabin), operated by a pneumatically actuated lever system against each flange of the aforementioned Z-profiles, embedded in the pavement. This constitutes the cabins' primary braking system, both for service and emergency use. This braking system can also be actuated manually through a handwheel.

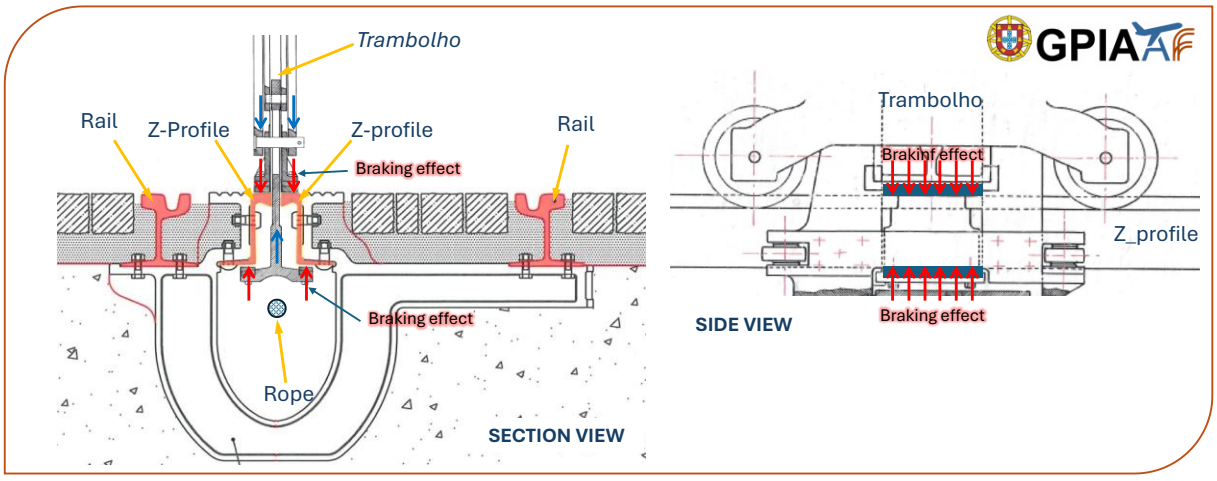



Fig. 4 – Diagrams illustrating how the brakes actuate on the Z-profiles.

The cabins also have a fully manual braking system actuating a brake shoe on each wheel.

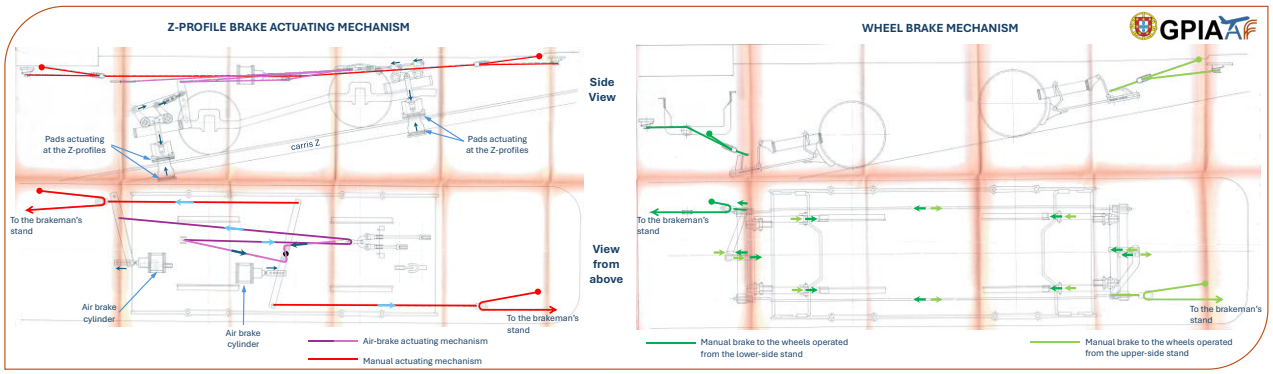



Fig. 5 – Diagrams illustrating the brakes' actuating mechanisms.

The brake systems are actuated by the brakeman from the drive stand at either end of the cabins.

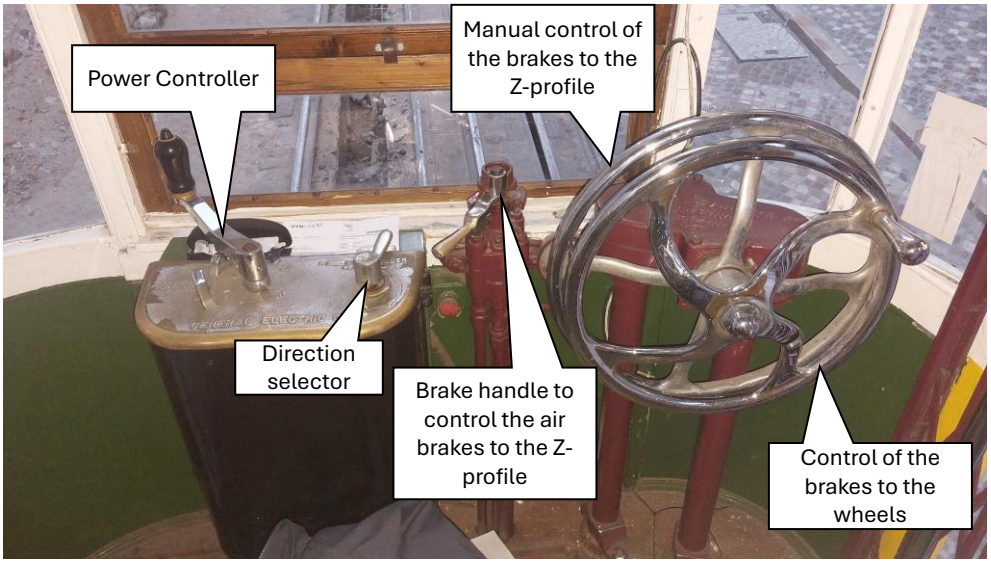



Fig. 6 – Brakeman's commands.

The pneumatic brake to the Z-profiles can also be quickly actuated by the brakeman in case of an emergency by acting on a lever in a breaker attached to the ceiling, over the left to his head. This actions immediately cuts power to a solenoid valve which, when de-energized, allows compressed air from an auxiliary reservoir to feed both brake cylinders, thus applying the brake pads to the Z-profiles.


Fig. 7 – Automatic brake actuation solenoid valve (left) and trolley braking pads – side view (right).

In the event of a haulage cable failure, the funicular system, as designed, is expected to cut power to the vehicles and bring them to a safe stop. This is accomplished via a device located in the technical compartment at the top of the *Calçada da Glória*, integrated into the cable's pulley support table. This table is movable and slides backwards forced by a very strong spring when not under the tension of the haulage cable, mechanically tripping the power circuit breaker to the cabins.

The lack of electric energy in the cabins has the same effect on the solenoid valve as described previously regarding the emergency actuation by the brakeman.

Regarding the operational usage of the vehicles, over the past 20 years the *Glória* Funicular has experienced relatively consistent utilisation, with the exception of extended periods of inactivity due to the Rossio tunnel works (2006 and 2007) and the SARS-CoV-2 pandemic (2020 and 2021), with a slight downward trend in the average daily number of passengers.

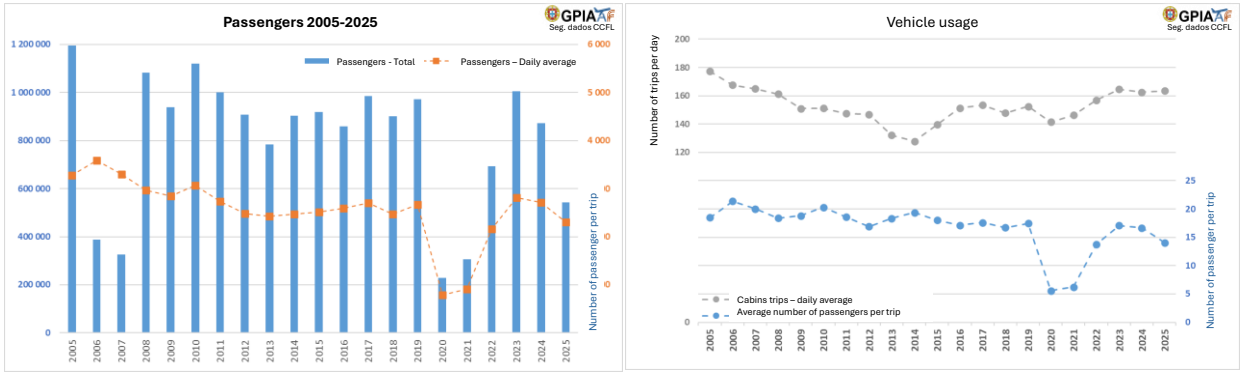



Fig. 8 – Passengers transported and vehicle utilisation between 2005 and 2025.

A similar trend is observed in the utilisation of the funicular cabins, which—despite increasing from 2020 to 2023 and remaining relatively stable since then at just over 160 trips per day—still remains below the levels recorded up to 2007. The average number of passengers per trip has also shown a slight decline.

It is worth noting that until 2015 there were no fixed service timetables; only the operating hours were defined, with the decision to carry out trips left to the brakemen, based on passenger demand.

## 4. THE EVENTS OF THE ACCIDENT

The vehicles were equipped with several CCTV cameras and a device fitted with low-precision accelerometers. Additionally, multiple surveillance cameras are installed along the Calçada da Glória. This enabled the investigation to establish, with sufficient accuracy, the sequence of events leading up to the accident.

On the 3rd of September 2025, at approximately 06:07, a maintenance technician arrived at the overnight parking location of the *Glória* Funicular vehicles, near *Largo da Oliveirinha*, and began by opening cabin no. 2. Less than a minute later, he moved to cabin no. 1, opened it as well, entered and exited the vehicle, and walked away at around 06:09.

At approximately 06:56, the security guard who had been watching the vehicles overnight exited cabin no. 1 and walked away.

At approximately 07:01, a brakeman arrived, entered cabin no. 1, then cabin no. 2, before returning to cabin no. 1. At 07:03, the other brakeman arrived and entered cabin no. 2. At 07:05, the cabins began their movement, with cabin no. 1 descending to the lower terminal and cabin no. 2 ascending to the upper terminal. Commercial service commenced at 07:15.

After completing 35 trips, the brakeman of cabin no. 1 was relieved by his afternoon shift colleague at 14:20, and at 14:30, the brakeman of cabin no. 2 was similarly relieved. Both brakemen involved in the accident had been properly qualified for their roles and experienced in the job.

The trips proceeded normally throughout the afternoon. Maintenance personnel were also present during the day; they spoke with both brakemen and accompanied the brakeman of cabin no. 1 to the workshop at *Largo da Oliveirinha* during the last upward trip of that cabin.

By 18:00, the funicular cabins were stationary at their respective stations, cabin no. 1 at the top of *Calçada da Glória* and cabin no. 2 at the bottom, near *Praça dos Restauradores*, receiving passengers.

Immediately prior to preparing for the next trip, cabin no. 1 contained 27 passengers, including one child and the brakeman, while cabin no. 2 held 33 passengers, including three children and the brakeman, both well below the maximum capacity of 42 occupants.

At 18:02:57, the brakeman of cabin no. 1 closed the gate and proceeded to the driving station, following the standard coordination procedures between the respective brakemen.

At 18:03:10, he inserted the controls into the driving stand and, one second later, released the pneumatic brake and engaged traction, initiating immediately the vehicle's descending movement, in coordination with cabin no. 2's ascent from the bottom of the *Calçada*.

Three seconds after movement began, and having travelled no more than two metres, the haulage cable failed inside the trolley of cabin no. 1, causing both cabins to suddenly lose the balancing force provided by the connecting cable. This triggered the safety device located in the upper pulley housing, cutting power to both vehicles.

In the absence of traction, both from the haulage cable and its motors, cabin no. 2 rolled back abruptly. Its brakeman immediately activated the circuit breaker that engages the emergency brake, halting the cabin's movement after approximately seven metres, following a partial overrun beyond the end of the track when the underside of the *trambolho* dug into the end of the cable trench.

Cabin No. 1, at the top of *Calçada da Glória*, continued its downward movement, suddenly increasing its speed. Less than a second after feeling the sudden acceleration caused by the cable failure, the brakeman immediately set the traction control to zero and activated the pneumatic brake valve to its maximum setting, an action that was redundant, given the automatic response triggered by the loss of electrical power. Not detecting any significant response from the vehicle, three seconds later he forcefully turned the manual wheel brake, giving it 12 full rotations and then applied downward pressure to keep it tightly engaged.

Each of the braking system actions slightly reduced the vehicle's acceleration which even though remained positive, resulting in a continued increase in speed down the slope. The vehicle navigated the slight left-hand curve at the end of the straight section of track without difficulty, with a slight reduction in its acceleration. Approximately 180 metres after the start of its descent, at the beginning of the right-hand bend in the final section of the *Calçada*, the vehicle derailed due to its speed and the bend's tight radius. It began to tip to the left in the direction of travel, partially restrained by the engagement of the trolleys in the Z-profiles. This resulted in a reduction of the vehicle's acceleration which, nevertheless, remained positive throughout.

However, the extent of the forces ended up pulling apart the Z-profiles from the pavement and the cabin completely lost its guidance, colliding laterally with the upper part of the cabin against the wall of the building on the left side of the *Calçada*, which began the destruction of the wooden frame and then head-on against a streetlight pole and another supporting the funicular's overhead electrical connectors, both made of cast iron and which caused very significant damage to the structure of the cabin, and shortly thereafter ending its uncontrolled movement by striking the corner of another building.

The first impact, with the vehicle already partially tipped over, occurred at a speed estimated to be between 41 and 49 km/h, due to uncertainties in the available data, having elapsed a total of 33 seconds since the preparation for the journey, 20 seconds since the start of movement, and a further 2 to 3 seconds until the vehicle came to a complete stop.

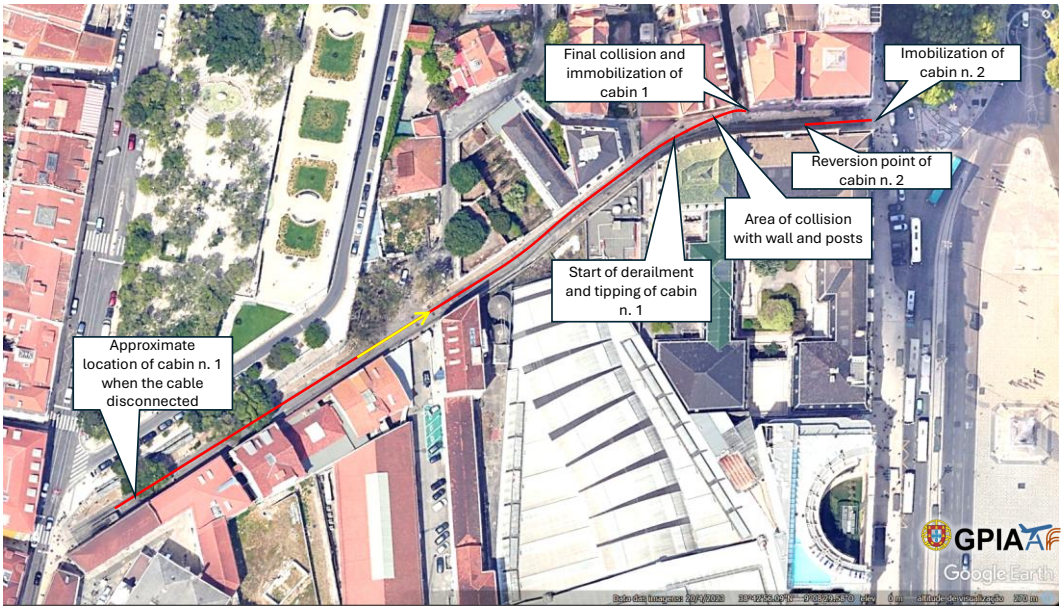



Fig. 9 – Description of events in both cabins during the accident.

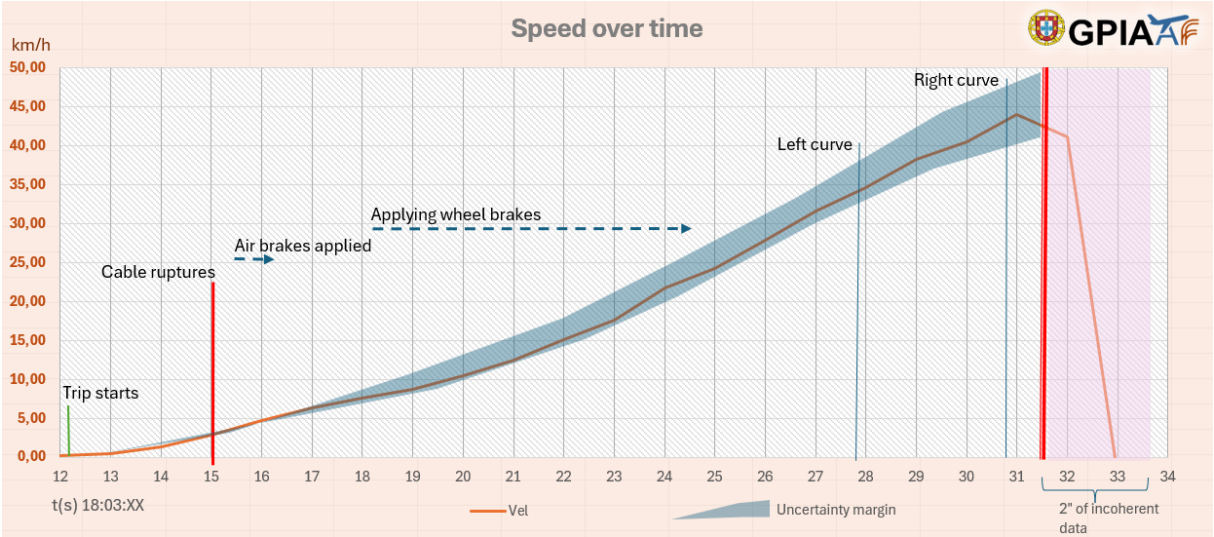



Fig. 10 – Graph illustrating speed over time and the timing of key events.

The violent impact was immediately noticed by bystanders and law enforcement officers nearby. Emergency services were promptly notified, and a significant rescue operation was activated without delay, with medical emergency teams arriving on site within minutes.

As a result of the accident, 15 people sustained fatal injuries on site, 13 sustained serious injuries, and 9 sustained minor injuries, some of whom were not passengers in the vehicles. On the following day, one of the seriously injured died, increasing the total fatalities to 16.

During the day, the vehicles had completed a total of 53 trips. The average occupancy was of 22 passengers in cabin no. 1 and 17 in cabin no. 2, with the maximum capacity of 42 people reached on two trips in cabin no. 1 and on one trip in cabin no. 2, not simultaneous.

## 5. RELEVANT FINDINGS TO DATE

This section presents the findings made to date that are considered relevant for dissemination, both for prevention of similar systems and for public information.

It should be made clear that the information presented in this section of the preliminary report is necessarily limited and incomplete and does not constitute definitive information or conclusions, requiring further in-depth investigation, which remains dependent on specialised laboratory testing and other expert analyses, as well as the collection and examination of additional data.

### 5.1. Rupture of the cable

The haulage cable connecting the two cabins ruptured inside cabin no.1's upper trolley cable swivel, just a few centimetres from its socketed termination.

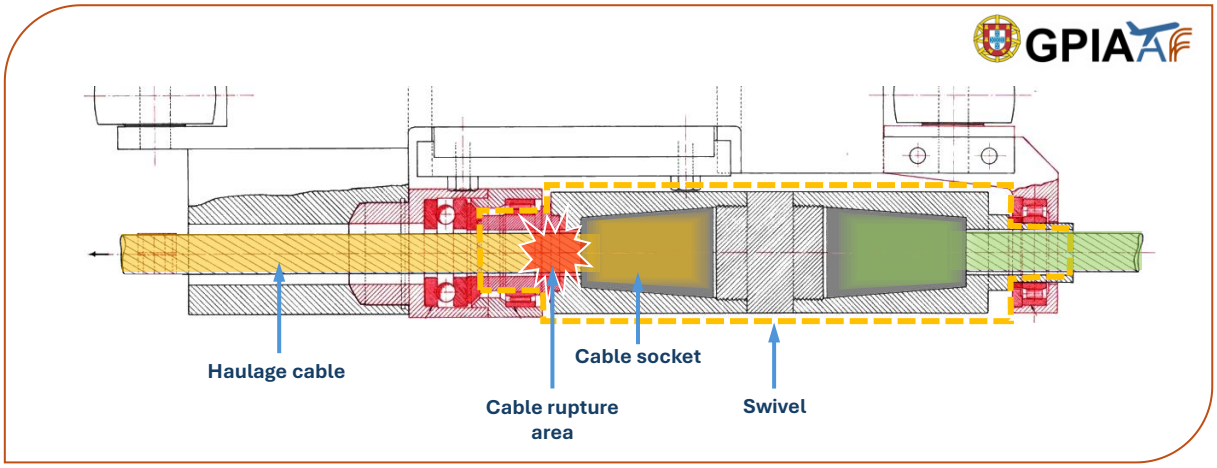



Fig. 11 – Location of the cable rupture.

Fig. 12 – Close-up images of the wire fractures.

A macroscopic analysis of the fractured ends of the broken strands reveals ruptures of varying ages, indicating that the failure occurred progressively over time and involved multiple fracture types. The metallurgical examinations to be carried out during the investigation will clarify the failure mechanisms involved. As is evident from the diagram above, the fracture location was not visually accessible without disassembly of the swivel.

When the cable broke, its sudden release generated a significant loop approximately at mid-length, within the maintenance pit, coiled in the direction of the cable's lay.

Fig. 13 – Loop formed by the post-fracture coiling of the cable.

### 5.2. Cable

The cable in place at the time of the accident was installed during an intermediate repair intervention on the *Glória* Funicular, which took place between 26 August and 30 September 2024. It is considered to have entered service on 1 October 2024. Therefore, at the time of the accident, it had been in use for 337 days.

It consists of a steel cable with a nominal diameter of 32 mm, type 6x36WS-FC gr1960 zZ, that is, composed of six strands, each consisting of 36 steel wires of varying diameters with a tensile strength of 1960 MPa, arranged within each strand in a Seale-Warrington configuration, and laid in a right-hand Lang lay around a synthetic fibre core.


Fig. 14 – Illustration of the 6x36WS-FC cable and right-hand Lang's lay configuration.

This type of cable is commonly used and is not unusual for funicular applications. Its use for this purpose is specified in the standard PT EN 12385-8:2014 – Steel wires. Safety. Part 8: Traction wire ropes and haul ropes for installations intended for persons.

Its Minimum breaking load (MBL) of 662 kN, as declared in the manufacturer's inspection certificate, although below the requirement of the aforementioned standard, was more than sufficient for the load to which it had been subjected in the *Glória* Funicular, significantly exceeding the safety factor required by standard EN 12927 (Safety requirements for cableway installations designed to carry persons – Ropes).

However, the investigation made the following significant findings:

- The cable did not comply with the specification in force at CCFL for use on the *Glória* Funicular.
- The inspection certificate provided by the manufacturer stated that the cable could not be used with a swivel, which was not the case on the *Glória* Funicular.

Each of these findings will be detailed in the following sections.

### 5.2.1. Cable non-compliance with CCFL specification

The cable for the *Glória* Funicular is assigned article code 400701 in the CCFL inventory system. In 2011, the engineering department defined the following technical specification for this item, which has remained in force since then:

> Item: **400701 – Steel wire rope for the Glória Funicular, with a nominal diameter of 32 mm and length of 276 metres**
> **Specification:**
> Steel cable, class 6x19+1 Seale, with a steel core, tensile strength of 1770 N/mm² and Minimum breaking load (MBL) of 711 kN, right-hand (zZ) lay direction, in accordance with standard EN 12385-8.
>
> **Alternative:**
> Steel cable, class 6x19, fibre core, with a tensile strength of 1770 N/mm² and a MBL of 634 kN, right-hand (zZ) lay direction, in accordance with standard EN 12385-8.
>
> **Operating conditions to be specified in the inquiry to suppliers**

Cable to be used in a funicular intended for passenger transport:
- Inclined movement (approximately 18% gradient) with three curves in each section (radii of 50, 60, and 50 metres), including two consecutive curves in the same direction;
- Cable attached at both ends to each vehicle, which are equipped with onboard motors;
- System featuring one cable return pulley (diameter 2700 mm), made of hollow steel, located at the upper station, and 36 cable guide pulleys along each vehicle's route (15 with vertical axes, diameter 225 mm, and 21 with horizontal axes, diameter 150 mm);
- Vehicle route length approximately 260 metres;
- Cable exposed to environmental conditions, although running in a dedicated trench, with ambient temperatures ranging between -2°C and 40°C.

**Information to be requested from suppliers (both in the inquiry and the order):**
- Confirmation of compliance with the specified standard;
- Type of cable construction;
- Type of core;
- Cable grade;
- Wire finish;
- Direction/type of strand lay;
- Specific lubricant and cable lubrication requirements;
- Minimum breaking load;
- Cable weight per unit length, with information on how this value was obtained (measured or calculated);
- Cross-sectional drawing of the cable showing the composition of each strand;
- Special requirements for packaging and storage of the cable.

**Information to be requested from the supplier with the order:**
- Completion of the "Certificate of Conformity and Testing" including test data and confirmation of the cable specification.

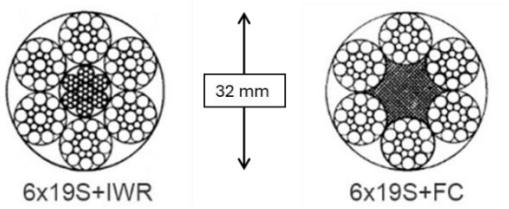



Fig. 15 – Types of cable permitted under the *CCFL* specification for the Glória Funicular

The 6x19S-IWRC gr1770 zZ cable, with a steel core, was the type traditionally used by CCFL on the Glória and Lavra Funiculars for several decades. Its performance was well understood and had performed reasonably satisfactorily.

The 6x19S-FC gr1770 zZ cable, with a synthetic fibre core, was accepted as an alternative based on a recommendation from an accredited and specialised entity in the field. CCFL adopted and incorporated it into the specification in view of potential difficulties in sourcing the usual cable, a situation that was already occurring at the time the specification was drawn up.

Indeed, due to precisely that difficulty, in 2011, and for a period that the investigation was unable to determine, but which is known to have been relatively short, a 6x19S-FC cable with a textile fibre core was installed on the *Glória* Funicular. According to the recommendation of the same accredited body, this cable was subject to special monitoring due to the lack of operational experience with its use in this system, and because it was not certified for such application.

From that time until December 2022, and despite some contradictory documentation, the usual 6x19S-IWRC gr1770 zZ cable appears to have been consistently used, until, without doubt, the 6x36WS-FC gr1960 zZ cable (the one present at the time of the accident) was installed for the first time, despite not conforming to either of the two cable types specified in CCFL technical documentation.

The following table shows the ropes known to have been installed on the *Glória* Funicular since 2017 — the earliest date for which chronologically referenced information is available.

| Date | Event | Rope | Days in operation |
|---|---|---|---|
| **2017-12-11** | **Rope in operation** | **DN32 6x19S+IWRC, gr 1770, zZ** | **166** |
| 2018-05-18 | Rope withdrawn | | |
| **2018-07-04** | **Rope in operation** | **DN32 6x19S+IWRC, gr 1770, zZ** | **600** |
| 2020-02-24 | Rope withdrawn | | |
| **2020-03-01** | **Rope in operation** | **DN32 6x19S+IWRC, gr 1770, zZ** | **620** (ver nota 1) |
| 2021-11-13 | Rope withdrawn | | |
| **2021-11-14** | **Rope in operation** | **DN32 6x19S+IWRC, gr 1770, zZ** (ver nota 2) | **384** |
| 2022-12-04 | Rope withdrawn | | |
| **2022-12-20** | **Rope in operation** | **DN32 6x36WS-FC, gr 1960 zZ** | **601** |
| 2024-08-26 | Rope withdrawn | | |
| **2024-10-01** | **Rope in operation** | **DN32 6x36WS-FC, gr 1960 zZ** | **337** |
| 2025-09-03 | **Accident** | | |

NOTAS:
1- Includes the stopping period due to SARS-Cov2 epydemic.
2- One document mentions that it was a rope with sZ lay and galvanized.
3- The gaps between the withdrawn and in operation dates correspond to maintenace periods.

It was found that the rope involved in the accident was the second of that type to be used on the *Glória* Funicular. The first had entered into service on 20th of December 2022 and had been in operation uneventfully for 601 days.

Ropes of the same type had also been in use on the *Lavra* Funicular since 22nd of March 2023.

It is important to set out the events and reasons that led to the use — at the time of the accident — of a rope that did not correspond to the type specified by CCFL for that application, as determined from the documental evidence.

### a) Procurement process of the cable

In mid-March 2022, works were underway to retrofit the motor system of the *Santa Justa* Lift. On 17th of March, the CCFL Electrical Mode Maintenance Directorate (DME) identified that the required cables for this work (inventory items 400704 and 400705) were not available in stock and made an urgent request for their procurement to the company's Logistics and Assets Directorate (DLP).

On the same day, the DLP requested the cable specifications from the DME, which in turn provided the specifications for the cables corresponding to inventory items 400704 and 400705, along with a technical opinion from a certified body outlining various supply conditions. All these documents were clearly identified as pertaining to the *Santa Justa* Lift cables and were the subject of all email correspondence exchanged throughout that day.

Also on the 17th of March 2022, and again on the morning of the following day, the DLP launched an inquiry with four companies for the supply of items 400704 and 400705 for the *Santa Justa* Lift, as requested by the DME. To this inquiry, items 400701 and 400702, relating to the cables for the *Glória* and *Lavra* Funiculars, respectively, were also added:

Solicitamos envio de cotação para os cabos identificados em baixo, nas quantidades indicadas.

| CÓDIGO | CABOS | QUANTIDADE |
|---|---|---|
| 0000400701 | Cabo de aço não galvanizado 32 mm de diâmetro, com 1770 N/mm2 | 2 |
| 0000400702 | Cabo de aço não galvanizado 32 mm de diâmetro, com 1770 N/mm2 | 2 |
| 0000400704 | Cabo de aço não galvanizado 16 mm de diâmetro, com 1770 N/mm2 | 12 |
| 0000400705 | Cabo de aço não galvanizado 19 mm de diâmetro, com 1770 N/mm2 | 8 |

ESPECIFICAÇÕES TÉCNICAS

| **Nominal rope diameter** | **Approximate nominal length mass**[1)] | **Minimum breaking force (kN)** | | | |
|---|---|---|---|---|---|
| | | **Dual tensile** | | **Single tensile** | |
| mm | kg/100 m | Rope grade 1180/ 1770 | Rope grade 1370/ 1770 | Rope grade 1570 | Rope grade 1770 |
| 16[2)] | 91,9 | 116 | 127 | 133 | 150 |

| **Nominal rope diameter** | **Approximate nominal length mass**[1)] | **Minimum breaking force** (kN) |
|---|---|---|
| mm | kg/100 m | Rope grade 1370/1770 |
| 19 | 132 | 179 |
| 32 | 376 | 507 |

According to statements made to the investigation, items 400701 (cable for the *Glória* Funicular) and 400702 (cable for the *Lavra* Funicular) were added to the same inquiry because there was an outstanding purchase request for those items in the company's internal system, submitted by the DME on the 18th of November 2021.

It is important to note that the inquiry included, as its only attachments, the two files provided on that same day by the DME, containing the specifications for the two cables intended for the *Santa Justa* Lift, along with the applicable standard, as clearly indicated in the respective file names:

**Anexos:** 400705 - Cabo aço alma fib 6x36 WS-FC - 19 mm - Folha EN 12385-5 2002.pdf;
400704 - Cabo aço alma fib 6x25 F-FC - 16 mm - Folha EN 12385-5 2002.pdf

For reasons that CCFL was unable to explain to the investigation, and for which no documentary trace could be found, the specification provided by the DME for one of the *Santa Justa* Lift cables (item 400705: type 6x36WS-FC cable) was adopted, with only the diameter changed, for the two additional items included in the supplier inquiry (corresponding to the cables for the *Glória* and *Lavra* Funiculars), in the inquiry carried out on 17th and 18th of March 2022.

Between the 24th and 31st of March, responses were received from the four suppliers. Two of these responses partially failed to meet the requirements stated in *CCFL*'s tender, specifically, they offered cables manufactured with 1960 MPa grade steel instead of the required 1770 MPa and certified under EN 12385-4 rather than the required EN 12385-5.

There is no record that this non-conformity was identified, and all proposals were considered valid by CCFL.

On the 31st of March itself, referring back to the email chain from the 17th of March concerning the urgency of acquiring cables for the *Santa Justa* Lift, the DLP sent the DME a list of total prices and delivery times for each proposal, without any accompanying technical information on the products offered. Given the urgency of acquiring the cables (for the *Santa Justa* Lift) and noting that the proposal with the shortest delivery time was only marginally more expensive than the least expensive one, the DME selected the option with the shortest delivery time. This was one of the proposals that included cables with characteristics that differed from those specified in CCFL's inquiry.

Following this, the DLP proceeded with the procurement process with the selected supplier. The corresponding contract (No. 4600000785) was signed by CCFL and the supplier on the 14th of April 2022. A contract manager from DLP was appointed in this document, with responsibilities including ensuring proper contract compliance.

The contract includes a technical specification sheet, signed by all parties, from which the following relevant excerpts are reproduced:

**PARTE II – ESPECIFICAÇÕES TÉCNICAS**

**Tipo cabos:**

| MATERIAL | TEXTO BREVE | NECESSIDADE | UNIDADE | Comprimento por unidade | UNIDADE |
|---|---|---|---|---|---|
| 0000400701 | CABO AÇO NÃO GALVANIZADO 32 mm de DIÂMETRO, COM 1770 N/mi | 2 | Un. | 53 | m |
| 0000400702 | CABO AÇO NÃO GALVANIZADO 32 mm de DIÂMETRO, COM 1770 N/mi | 2 | Un. | 53 | m |
| 0000400704 | CABO AÇO NÃO GALVANIZADO 16 mm de DIÂMETRO, COM 1770 N/mi | 12 | Un. | 53 | m |
| 0000400705 | CABO AÇO NÃO GALVANIZADO 19 mm de DIÂMETRO, COM 1770 N/mi | 8 | Un. | 53 | m |

| Referência | Designação | Quant | Preço | Total |
|---|---|---|---|---|
| 001 013 636 160 | Cabo de aço16 m/m 6x25F-CF U 1960 ZZ L3 CRM - 166 Kn | 1.000,000 | 4,83 | 4.830,00 |
| 001 013 636 180 | Cabo de aço 19 m/m. 6x36SW-CF U 1960 ZZ L3 CRM-233 Kn | 1.000,000 | 7,06 | 7.060,00 |
| 001 013 636 220 | Cabo de aço 32 m/m 6x36SW-CF U 1960 ZZ L3 CRM-662 Kn ( 2 x 500 mts) | 1.000,000 | 16,05 | 16.050,00 |

Com a encomenda deve ser exigida ao fornecedor a seguinte informação:

– Referência à conformidade dos cabos com a norma EN 12 385-5.

**Anexos:**

*400704 - Cabo aço alma fib 6x25 F-FC - 16 mm - Folha EN 12385-5 2002.pdf*

*400705 - Cabo aço alma fib 6x36 WS-FC - 19 mm - Folha EN 12385-5 2002.pdf*

*Elev Santa Justa Cabos - Relatorio 1 CATIM - 2012-01-30 Copia PB.pdf*

Once again, the differences between the steel grade and the certification standard requested by CCFL and those proposed by the supplier, as stated in the document, were not identified by the signatory parties. Nor did the inventory item numbers listed in the specifications (400704 and 400705), as compared to those actually to be supplied, raise any concerns.

**b) Warehouse reception and acceptance process of the cable**

The cables covered by Contract No. 4600000785 were received at *CCFL*'s warehouse on 9th of August 2022, and each was assigned the corresponding inventory item number. In this way, the two reels of DN32 6x36WS-FC cable were added to the stock of items 400701 and 400702.

According to the company's standard NE 0029 – *Purchased product verification*, the process of verifying the conformity of delivered goods at the warehouse is performed by its staff regarding visual control, while qualitative control is done by personnel from the logistics department technical support. Additionally, under internal standard NG 0062 – *Purchases* and NG 0065 – *Contract Management*, one of the responsibilities of the contract manager is to verify the conformity of the goods received and the full execution of the terms of the contract.

According to statements gathered during the investigation, the contract manager did not take part in the reception process. Acceptance was carried out in quantitative terms by the warehouse department. Staff from the end-user department is said to have looked the cables upon delivery, although no evidence was produced to confirm this involvement, nor is it clear at this moment in the investigation if that inspection was to verify conformity and if the staff was duly trained to perform such verification.

According to the investigation's findings, up until 2020, the engineering department responsible for defining cable specifications was routinely involved in the reception and acceptance process. However, since that date, it has no longer been asked to participate in such procedures.

Regardless of these facts, the cables were ultimately received and accepted by *CCFL* without any of the discrepancies, either in relation to the terms of the contract or to the company's specifications for any of the items, being detected.

For clarity, the following table summarises the non-conformities identified in the supply covered by the contract:

- Item 400701 – Cable for the *Glória* Funicular: The cable supplied did not comply with the construction type, steel grade, or certification standard set out in the specification for this item, nor did it match the steel grade and certification standard specified in the procurement inquiry.
- Item 400702 – Cable for the *Lavra* Funicular: The cable supplied did not comply with the construction type, steel grade, or certification standard set out in the specification for this item, nor did it match the steel grade and certification standard specified in the procurement inquiry.
- Item 400704 – Cable for the *Santa Justa* Lift: The cable supplied did not comply with the steel grade or certification standard set out in either the specification or the procurement inquiry for this item.
- Item 400705 – Cable for the *Santa Justa* Lift: The cable supplied did not comply with the steel grade or certification standard set out in either the specification or the procurement inquiry for this item.

**c) The use of the cable**

Once the reels of DN32 6x36WS-FC cable had been received and assigned the inventory item number 400701 (or 400702, as the cables were identical), any request by the end-user department (DME) to the warehouse for the specified item would result in its issue, provided it was in stock, which it was in this case. At that stage, the question of the cable's conformity was neither verified nor raised by the end-user department.

According to statements collected during the investigation, during the first installation of the 6x36WS-FC cable on the *Glória* Funicular in December 2022, both the contractor's personnel and *CCFL*'s on-site inspectors noted its different construction and handling characteristics, namely, the presence of a fibre core and the fact that it

was significantly more flexible and easier to handle. Indeed, during an installation, once the cable was subjected to the weight of the cabins, it underwent a considerable elongation compared to its nominal length, requiring a 4.5-metre section to be cut off in order for the cabins to align correctly.

However, the personnel involved did not have the technical expertise to identify the cable as being non-compliant with the specification. Furthermore, the engineering department, when informally consulted by the maintenance team regarding the cable's unusual behaviour, assumed that it corresponded to the alternative fibre-core type permitted under the specification they had previously issued. Having no reason to suspect that the cable supplied did not match that specification, the department considered the different behaviour to be normal and as expected.

As a result, and as the culmination of all the aforementioned events, the DN32 6x36WS-FC cable was installed and brought into service without *CCFL* ever detecting that it did not conform to the specification established for the *Glória* Funicular.

### 5.2.2. Inspection certificate stating that the cable must not be used with a swivel

As discussed in Chapter 3, the cable connection to the vehicles at the trolleys is made through connecting components known as swivels, designed to allow the cable ends to rotate about their longitudinal axis.

Most stranded wire cables, by their very construction, naturally tend to develop internal torsional forces under load. These forces arise from the helical path followed by each strand around the rope's core and, in attempting to balance themselves, they induce a torque along the rope axis. If the rope ends are free to rotate, this torque results in progressive unlaying of the strands, a phenomenon whose severity depends on the rope's construction and the magnitude of the load applied[1].

To counteract this effect, ropes must be specifically constructed with opposing strand lay directions between the outer and inner layers, and with a sufficient number of strands. Such ropes are referred to as rotation-resistant or anti-rotational ropes.

According to multiple tests conducted by manufacturers and research institutes, a general-purpose six-strand rope used with swivels may see its minimum breaking load reduced by 40% to 60% compared to its nominal value. Moreover, at the points where the rope is attached to the swivels, the individual wires within the strands are subjected to varying stress cycles, due to the twisting and untwisting induced by load variations. Test data also show that a six-strand rope under 20% of its minimum breaking force, when used with swivels, can rotate in the unlaying direction up to 18 times more than an anti-rotational rope.

The pronounced loop formed in the lay direction of the cable, as observed following the accident, is consistent with a rope that had accumulated significant torsional rotation in the unlaying direction at the moment it detached from Cabin no. 1.

Lang's lay ropes, whether right- or left-hand, offer several advantages which explain their use and development. However, because both the wires in each strand and the strands around the core are laid in the same direction, these ropes are more susceptible to unlaying under tension. For this reason, technical manuals issued by rope manufacturers consistently state that Lang's lay ropes must not be used with swivels, but only in applications where end rotation is physically restrained, to avoid unintentional unwinding under load.

This restriction is reflected in the applicable standards. EN 12385-3:2020 (Steel wire ropes – Safety – Part 3: Information for use and maintenance), in Annex B, explicitly identifies which rope constructions are suitable or

[1] For example, see Verreet, Roland. The rotation characteristics of steel wire ropes. PR GmbH. Aachen, Germany, 1984-1997.

unsuitable for use with swivels. According to this classification, the 6x36WS-FC rope is not rotation-resistant and must not be used with swivels, as was clearly stated in the inspection certificate provided by the manufacturer for the ropes delivered to CCFL, unless its use is supported by a specific technical study assessing its behaviour under the intended conditions.

There is no indication or evidence that this critical characteristic, or the restriction mentioned in the certificate received on 29th of August 2022, was noticed or taken into account by *CCFL*.

In fact, the use of swivels to connect the cable to the vehicles does not appear to have been recognised by *CCFL* as a factor limiting cable selection. Its effects were never assessed, and the presence of swivels, despite its implications on cable performance, was not included in the technical information shared with external experts for review or with suppliers during procurement processes.

Yet, it is worth noting that the previously used 6x19S+IWRC cable, historically applied by *CCFL* on the Funicular and despite some record of cable damage, did not result in serious failures. This cable, while also Lang's lay and not rotation-resistant, may have exhibited greater torsional stability due to its stiffer construction, with thicker outer wires and a steel cable core, potentially making it more tolerant to the forces imposed by this specific application. This matter will be further analysed in the course of the investigation.

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To conclude this section concerning the funicular cable, it is important to highlight, as previously mentioned, that the 6x36WS-FC rope installed prior to the one involved in the accident had been in service for the typical period deemed appropriate by *CCFL* for such use (600 days) without any record of damage.

**Accordingly, it must be stated that, at this stage, it cannot be concluded whether the use of this non-compliant cable contributed to the failure that occurred after 337 days in service, nor what role, if any, it may have played. It is, however, certain to the investigation that other contributing factors must necessarily have been involved.**

This matter, which constitutes one of the central aspects of the accident, will be duly clarified as the investigation progresses.

On the other hand, as CCFL has a Quality Assurance System under ISO 9001, the investigation will also look into the shortcomings that have allowed the highlighted non compliances to occur.

### 5.3. The maintenance

For many years, *CCFL* has maintained a maintenance programme for the *Glória* Funicular established on the basis of over a century of experience in the operation and upkeep of that system, prescribing varying inspection intervals for each activity, all of which supported by internal standards.

With regard to the subsystems comprising the cabins, cable, and associated equipment, the said maintenance programme is defined in internal standards EGZ.4.01, EGZ.4.02, EGZ.4.03, EGZ.4.04 and EGZ.4.05, which are summarised in the table below.

| ASCENSOR DA GLÓRIA - PLANO DE MANUTENÇÃO | | | | | | |
|---|---|---|---|---|---|---|
| ID NORMA CARRIS | | DESIGNAÇÃO | periodicidade | | | |
| | | | diária | semanal | mensal | semestral |
| MA.30 | EGB.1.01 | Pantógrafo - Verificação - Lubrificação | X | X | X | X |
| MA.30 | EGG.2.01 | Obliterador - verificação | | | X | X |
| MA.30 | EGH.0.01 | Cancelas - verificação | | X | X | X |
| MA.30 | EGJ.0.01 | Disjuntor máxima intensidade - verificação | | X | X | X |
| MA.30 | EGJ.4.01 | Baterias - verificação | | X | X | X |
| MA.30 | EGJ.8.01 | Conversor EFACEC - verificação | | | X | X |
| MA.30 | EGO.3.01 | Motor de tracção GE59 - verificação | | X | X | X |
| MA.30 | EGP.1.01 | "Controller" K10 (modificado) - verificação | | X | X | X |
| MA.30 | EGQ.4.02 | Cabo de tracção - Verificação "total do cabo" | X (após 500 dias) | X (bi-semanal após 400 dias) | X | X |
| MA.30 | EGQ.4.03 | Cabo de tracção - cabo lasso - verificação | | | X | X |
| MA.30 | EGQ.5.01 | Roldanas Guia - lubrificação | | | | X |
| MA.30 | EGR.2.01 | Caixa de eixo - "Boques" - Lubrificação | | | X | X |
| MA.30 | EGT.8.01 | Válvula de guarda-freio - verificação | | X | X | X |
| MA.30 | EGT.8.02 | Válvula de guarda-freio - lubrificação | | | | X |
| MA.30 | EGU.0.01 | Depósitos de ar - purga | | X | X | X |
| MA.30 | EGU.1.01 | Compressor - verificação | | X | X | X |
| MA.30 | EGU.2.01 | Governador GE - verificação | | X | X | X |
| MA.30 | EGW.0.01 | Correntes e Ferragens - Inspecção Visual | X | | | X |
| MA.30 | EGW.0.02 | Chapas de protecção das garras - verificação | | X | X | X |
| MA.30 | EGZ.0.01 | Lubrificação geral | | X | X | X |
| MA.30 | EGZ.1.01-G | Esquema de lubrificação - óleos e massas | X | X | X | X |
| MA.30 | EJW.0.01 | Correntes e Ferragens - Inspecção Visual | | X | X | |
| MA.30 | SZD.3.01-RO | Baterias - Carga - Procedimentos e cuidados (Glória) | X | X | X | X |

The investigation identified five instances within this maintenance programme where references were made to non-existent, inapplicable, or outdated standards, which had not been updated to reflect changes or cancellations.

Regarding the maintenance of the cable, the maximum monthly interval defined was in accordance with the applicable European standard (EN 12927 – *Safety requirements for cableway installations designed to carry persons – Ropes*). However, it did not comply with this standard in terms of the inspection of the cable's end connections, an issue which will be addressed separately in the following section.

Furthermore, concerning cable maintenance, there was evidence that, since 2021 and on *CCFL*'s initiative, occasional inspections of the cables had been carried out using a magneto-inductive method, performed by an external, specialised, and certified entity, particularly when the cable exceeded one year of use.

For over more than twenty years, the maintenance of the aforementioned subsystems of the *Glória* Funicular had been contracted by *CCFL* to an external service provider, under a contract which also covered the *Bica* and *Lavra* funiculars and the *Santa Justa* lift. The current service provider has been responsible for maintenance since 2019.

In addition to other aspects not relevant to the present matter, the service contract covered the following:

- Permanent assistance with a maximum response time foreseen for emergency interventions;
- Preventive, predictive, curative, and corrective maintenance services, covering systems, mechanisms, and components, including the structures and housings, as well as the disassembly and assembly of the haulage cables;
- The supply of materials (consumables) required for maintenance, including greases and lubricating oils in accordance with *CCFL* specifications. The supply of haulage cables was explicitly excluded, being the responsibility of the contracting authority.

Under the terms of the maintenance contract, the service provider was obliged to carry out the services with the diligence and quality required for the type of work in question, in compliance with contractual terms, legal standards, and industry best practices. The contractor was expected to deploy all necessary and appropriate human, material and IT resources, as well as to establish an organisational system to ensure the full and proper execution of the tasks under its responsibility.

Although a considerable amount of documentation relating to maintenance still needs to be analysed by the investigation, the evidence gathered thus far allows for the following findings:

The current maintenance contractor carried out maintenance activities, performing routine operations such as opening/closing and preparing equipment, daily monitoring of operations alongside brakemen, and carrying out medium and low-complexity preventive maintenance tasks.

In addition, although contractually bound to the execution and validation (inspection) of all work carried out, it was found that, in practice, the maintenance service provider operated more as labour for scheduled maintenance tasks of a certain complexity or specific corrective actions, which were carried out under the instruction and supervision of two *CCFL* technicians assigned to the four Funiculars and the *Santa Justa* Lift.

At the time of the incident, the services were staffed by five technicians working in three shifts, covering operating hours from 06:00 to 00:00 (or until 03:00 on two days per week), on a fixed weekly schedule. These technicians were supported by four indirect staff responsible for planning, documentation and administration, quality system, and occupational health and safety, as well as by a business manager.

The training process for the five technicians, who had between 11 years and 8 months of experience at the company, was based on on-the-job training, with no use of theoretical training or specific technical courses for the various types of equipment covered by the contracts. Knowledge had been passed down over the years from *CCFL* technicians to the contractor's workers, and subsequently between workers. Although the workers were aware of the existence of written procedures, the execution of their tasks was based partly on the guidance transmitted directly by *CCFL* supervisors (rather than formal training based on written procedures), and partly on checklists drawn up by the contractor for the tasks based on *CCFL* maintenance standards.

The contractor's technicians carried out their tasks with the diligence and proactivity permitted by their level of knowledge and the means available to them, with the investigation having gathered several statements and pieces of evidence demonstrating a reactive and responsive approach to any faults or issues that arose.

The maintenance procedures, also developed by *CCFL* many years ago, had neither been updated nor did the contractor have a sufficiently qualified engineering team with the necessary technical knowledge or resources to develop, update, or adapt maintenance actions to operational realities. There was no guidance on how specific tasks should be performed from the contractor's technical staff, nor any internal supervision, which remained the responsibility of *CCFL*.

Although the planned maintenance activities were being logged as completed in the contractor's record-keeping system (to which *CCFL* had direct access), there was evidence that these records did not reflect the work that had actually been carried out. There was evidence of critical tasks being executed in a non-standardised manner, with varying execution and validation criteria.

The contractor's quality management system did not ensure the identification of weaknesses or opportunities for improvement, focused on its maintenance activities, instead being mainly focused on issues of occupational health and safety. Despite the investigation having found multiple areas clearly requiring improved procedures, there was no record of any non-conformity or opportunity for improvement identified in the contractor's operations over the previous two years, either through internal audits or by the external auditor responsible for ISO 9001 certification.

The maintenance plan for the *Ascensor da Glória* is noted has complied by the service provider and accepted by CCFL supervisors.

The inspections scheduled for the day of the accident and preceding days were recorded as completed, however, there is evidence that they were not performed during the recorded timeframe. During the funicular operating period, a maintenance worker from the service provider observed the cabins and interacted with the brakemen.

On the day of the event and the day prior, the cable was not inspected in the maintenance pit, nor was such an inspection included in the maintenance programme, although the contract specifications were contradictory on this particular point. The lubrication of the cable, scheduled on a weekly basis, was recorded as having been carried out on 28th of August. The monthly inspection of the cable was recorded as having taken place on the 1st of September.

The section of the cable where it eventually failed was not accessible for observation during any of these inspections. Nevertheless, in this moment of the investigation it's not possible to assess if any advance symptom could be detected some time before the rupture on the visible part near to the trolley.

### 5.4. The attachment of the cable to the cabins

The attachment of each end of the cable to the Funicular cabins has been carried out, at least since 1929, using a truncated cone-shaped fitting made from a low-melting-point cast alloy, into which the ends of the metal wires comprising the cable are embedded after specific preparation. This cast component, commonly referred to as a *"pinha"* (socket), once solidified, fits into a suitably shaped receptacle to which it conforms once subjected to the tension of the cable.

Although more modern solutions exist, namely those using special resins, this method of securing the cable is still relatively common in steel cables, regardless of whether they have a steel core or not, and, when properly executed, ensures a strength at least equal to that of the cable itself. It is duly provided for and specified in European standards, both in terms of its execution and its inspection, since this component is critical for the safety of the connection between the cable and the vehicle.

Prior to the disassembly and detailed laboratory analysis that the socket, closest to where the cable failed, will undergo, as part of the investigation, a gamma-ray radiographic inspection was carried out on both sockets of the cabin where the cable rupture occurred, to document their condition before any dismantling. This analysis revealed that the socket of the failed cable exhibited significantly less dense or even empty areas within the casting. This issue was not observed in the socket of the interconnecting cable between the two trolleys of Cabin no.1.

The maintenance service contract explicitly states that the cable installation works, including the making of the socket, are the responsibility of the service provider, with *CCFL* only supplying the cable.

The sockets are made during the cable installation following a historical empirical process at *CCFL*, the details for which has been passed down through generations of technicians in-charge, based on an old, typed notebook, written by a former technician and not part of *CCFL* documental system.

Unlike other maintenance operations on the Funiculars, there is no internal standard within *CCFL*'s documentation system defining the preparation of the cable wires or the composition and preparation of the casting alloy used for the socket termination.

The management, technical staff, and workers of the service provider stated that they were unaware of the composition of the alloy used to make the sockets, or of the specific details of the execution process.

The procedure used to make the sockets described in the notebook and used by workers is not in accordance with the applicable guidelines or alloy composition specified in European Standard EN 12927 (Safety

requirements for cableway installations designed to carry persons – Ropes). This standard outlines precautions for cable preparation and the manufacture of metal alloy sockets, as well as requirements for the personnel carrying out the work, and the tests and inspections to be performed after execution and during operation. For instance, in such use cases, the sockets and the portion of cable immediately adjoining must undergo monthly visual inspections, as well as monitoring of the settling of the socket, thus highlighting the criticality of inspecting the cable area near to the socket.

Following the production of the sockets for the *Glória* Funicular, no testing was planned or carried out to verify the quality of the casting.

CCFL procedures do not include any provisions for monitoring the ongoing condition of the socket or the adjoining part of the cable.

CCFL drawing no. 7428, dated 1961 and related to the swivels currently in use, included provision for the installation of a collar fixed to the cable a short distance from the trolley, presumably to monitor potential slippage of the socket or of the adjoining cable. For example, a similar device is still prescribed in the corresponding Swiss regulations[2]. The investigation was unable to determine whether this collar was ever used, and none of the current *CCFL* technicians recall it ever being in place.

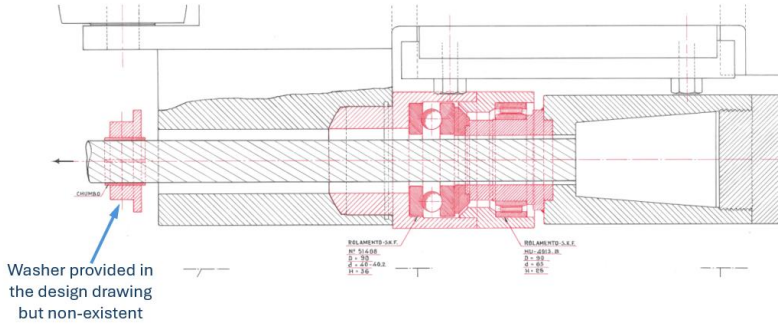


Fig. 17 – Excerpt from CCFL drawing no. 7428, dated 1961.

The magneto-inductive inspections carried out on the cables, due to inherent limitations of the process, did not cover the last two metres at either end of the cable.

The maintenance service provider did not establish any system for quality control of the socket and cable termination, and *CCFL*' maintenance procedures are omissive on this matter.

The location where the cable failure occurred, corresponding to the area identified in standard EN 12927 as requiring special attention, is not accessible for inspection under the maintenance procedures set out in *CCFL*' defined plan. Inspection is only possible by stopping the cabins and dismantling the swivels, an operation that involves at least two days of equipment downtime.

Given the historical pattern of cable use in the Funicular, the risk associated with general cable degradation was indirectly managed through a usage limit of 600 days per cable. For this reason, there was no justification for changing the inspection procedures.

[2] Notice explicative – *Surveillance de l'étirement des têtes coulées*. Office federal des transports. Switzerland, 2009.

### 5.5. The braking system of the cabins

It is a basic principle – and a regulatory requirement – for funiculars that, in the event of a haulage cable failure, there must be a system in place to safely stop the cabins. This system must be regularly tested and can take various forms.

The *Glória* Funicular was designed in accordance with this principle and, although no evidence has yet been found to confirm this, the investigation has little doubt that, during its reconstruction in 1914, the safety system would have been properly tested to verify its effectiveness, both in terms of activation and its ability to stop the cabins.

There is evidence that, at the time of the accident, the emergency system in the driving cab operated correctly, cutting the electrical power to the cabins, which should have triggered emergency braking in order to safely bring them to a stop.

On the other hand, there is also evidence that the brakeman applied the pneumatic brake (action of the eight brake blocks of the trolleys on the Z rail flanges) as well as the manual wheel brake.

Despite this, the braking applied was not effective enough to bring the cabins to a stop, although it did have the effect of preventing the speed from increasing beyond the levels observed.

Given the specific system used in the cabins, the investigation's functional tests and measurement of clamping forces on the braking systems require the construction of a special structure to hold the vehicles, which has already been designed and is under construction. Only once these tests are carried out will it be possible to obtain further information about the actual performance of the system.

There are no known calculations regarding the braking capacity of the cabin’s brake systems.

The historical information available suggests that the braking system of the vehicles was modified some years after the electrification of the Funicular. There are also indications that the weight of the cabins increased significantly since the time of electrification, with conflicting documentation reporting their current weight as 14, 18 and 19 tonnes. The exact weight is unknown to *CCFL*. During the functional tests, the investigation will weigh cabin no. 2 in order to determine its actual weight.

Even among the most senior technicians still in service, there is currently no recollection within *CCFL* of the emergency brake having ever been tested in a scenario simulating cable failure.

Several technicians and employees of *CCFL* associated with the funiculars stated to the investigation that there was a perception that the safety of the system relied entirely on the cable, and that the brake system was not capable of stopping the cabins without the cable link between them. This led to extremely strict monitoring of the cable's use and condition, limiting its operational lifespan to 600 days – far below the typical service life of a Funicular cable. However, this perception, which was not individual, was never formally translated into an organisational reassessment of the system’s overall safety conditions.

With regard to maintenance, the cabins' braking system was frequently subject to adjustments by the maintenance contractor, based on feedback from the brakemen. However, faults requiring such adjustments were rarely recorded in the defect logbooks available on the vehicles, which were intended to be filled in by the brakemen, and were only reported to *CCFL* operations control when they affected service. The evidence gathered by the investigation also shows that these brake adjustments were seldom documented specifically by the maintenance contractor.

*CCFL* has not defined adjustment values for the various mechanical components of the Funicular's braking system in its maintenance procedures, only specifying the wear limit for the brake pads on the Z rail flanges as the replacement criterion.

The maintenance provider had not implemented any quality control system for the work carried out, including adjustments to the braking system.

There was, however, a swift response from the maintenance company to any intervention request made by the brakemen, and any fault considered to jeopardise safety resulted in the immediate suspension of the Funicular's operation until it was resolved. The operations team never objected to such stoppages. Workers from the maintenance contractor and various brakemen confirmed that there was good cooperation between the two parties, and that faults affecting safety or functionality of the Funicular were reported directly, in person or by phone, by the brakemen to the maintenance workers.

The manual brakes, operated by two concentric wheels at each driving station, did not receive much attention from the maintenance team, as according to several statements given during the investigation, they were rarely or never used by the brakemen. In fact, some of the retaining pawls of the gears, essential for their operation, were found to be stuck to the floor of the vehicles with paint.

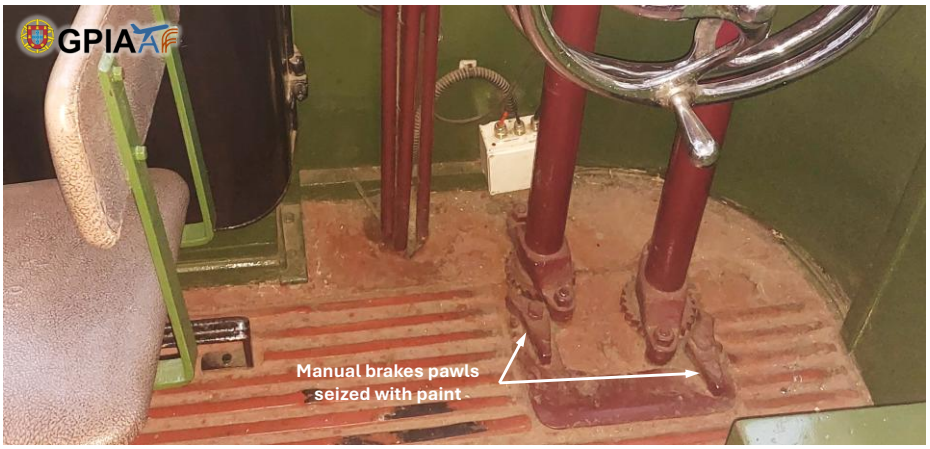


Fig. 17 – Picture showing the manual brakes pawls seized with paint.

The investigation, following the tests and expert assessments currently being contracted and prepared, will determine the theoretical and actual capabilities of the vehicles' braking systems and will examine the material and organisational conditions that led to the ineffectiveness of the safety system in the event of cable failure.

### 5.6. Mishaps with the vehicles

There is no known history of a similar accident to the one under investigation having occurred on the *Glória* and *Lavra* Funiculars since their electrification in 1914 and 1915.

The investigation requested that *CCFL* provide a list of the accidents and incidents that occurred during the operation of the *Glória* Funicular over the past ten years, including copies of the reports issued and the mitigation actions taken for each of them. This documentation was only provided on the eve of the finalisation of the drafting of this report and still requires analysis.

However, in addition to the rare complaints recorded by the brakemen in the defects logbook concerning deficiencies in the brakes, which were promptly addressed by maintenance, the investigation had already been able to identify the occurrence of a collision of cabin no. 1 with the staircase at the top of the *Calçada da Glória*, on 3rd of October 2024, and the collision of a road maintenance vehicle with the upper side of cabin no. 2 on 4th of May 2025. Naturally, in both of these events, the cable and its attachments would have been subject to abnormal stress.

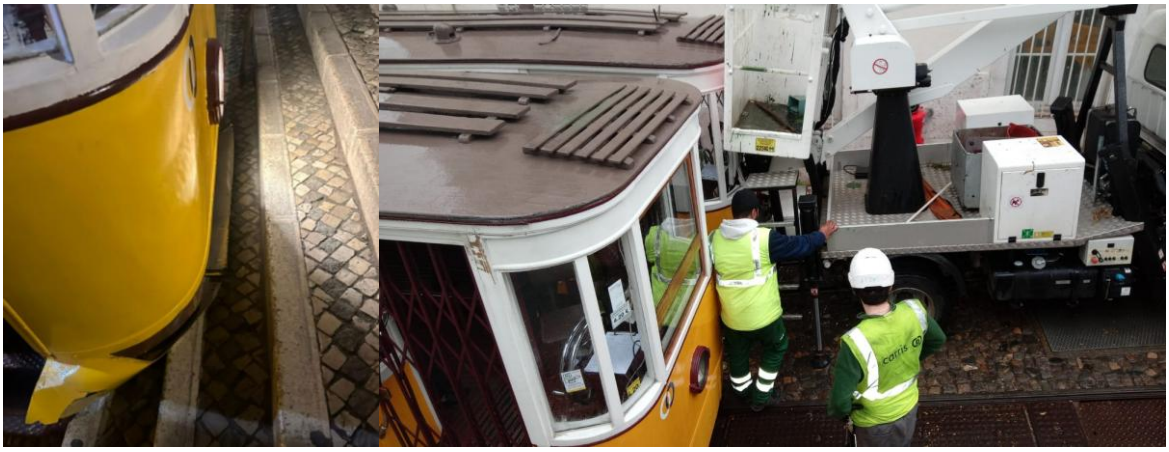

Fig. 18: Images of the accidents of 3rd of October 2024 (left) and 4th of May 2025 (right).

The relevance of these and other recorded occurrences will be duly assessed in the course of the investigation.

### 5.7. Legal status of the *Glória* Funicular and its technical supervision

In the approach taken so far by the investigation regarding this matter, it was found that the unique characteristics of the *Glória* and *Lavra* Funiculars, with a configuration that is extremely rare, if not entirely unique in the world, appear to have historically created difficulties and uncertainties in defining the legal framework applicable to them. Indeed, the fact that the traction of the cabins is not ensured entirely by the cable, but also by the drive mechanism of their respective wheels, led to certain interpretations that these transport systems were not funiculars and, as such, were not covered by cable transport legislation.

Decree-Law no. 313/2002, of 23rd of December, which transposed into national legislation Directive 2000/9/EC of the European Parliament and of the Council, of 20th March 2000, applicable to cableway installations designed to carry persons and brought into service after its entry into force, defined cableway installations as:

- Funiculars and other installations whose vehicles are supported by wheels or other support devices and moved by one or more cables,
- Cable cars whose vehicles are supported and/or moved by one or more cables, including
- Gondola lifts and chairlifts,
- ski lifts, intended to transport users equipped with suitable equipment by means of a cable.

Although the European legislation stated that it applied only to installations constructed and put into service from the date of its entry into force, the national decree extended this regime to installations that were already in service, but with some specific provisions.

Indeed, installations that were already in service, or whose construction had already commenced, could be authorised by the National Institute of Railway Transport (*INTF*) until 1st of August 2004, provided that the applications were submitted with documents proving technical capacity, insurance coverage for civil liability, and a safety report prepared with the necessary adaptations.

However, as foreseen in the transposed Directive, “traditional cable-driven electric cars” were explicitly excluded from the scope of that legislation.

According to statements made to the investigation by the Portuguese Institute for Mobility and Transport (*IMT*):

> At the time, it was understood that “the *Glória* and *Lavra* funiculars could thus be classified as such because the cable in this type of vehicle serves only to synchronise the movement, in addition to

mechanically compensating for the ascending and descending journeys." This matter was raised by *Carris* itself in a series of communications, which can be briefly summarised as follows:

a. On 27th of February 2003, the *INTF* sent an official letter to *Carris* (...) requesting a statement, within the scope of a hearing of interested parties, regarding the draft regulation on the construction, commissioning, and operation of funiculars;

b. On 18th of March 2003, *Carris* issued an opinion (...), stating that, having analysed the repealed Decree-Law no. 313/2002, "some doubts were raised, particularly concerning its applicability to our funiculars. According to point (b) of article 3, it seems to us that the *Glória* and *Lavra* funiculars are not covered by this Decree-Law. Thus, this regulation might possibly apply only to the *Bica* funicular."

c. On 11th of April 2003, an internal legal opinion was issued at the *INTF* regarding the issue identified by *Carris* (...), concluding "that these latter funiculars (*Glória* and *Lavra*) are not covered by the repealed Decree-Law no. 313/2002, and that the company should be formally notified of this circumstance;"

d. On 23rd of May 2003, the *INTF* replied with an official letter (...) confirming its agreement that the *Glória* and *Lavra* funiculars would therefore not be covered by the legal instrument (repealed Decree-Law no. 313/2002);

e. On 20th of June 2003, Carris acknowledged receipt of the *INTF* letter "expressing your agreement with our opinion that the *Glória* and *Lavra* funiculars are not covered by Decree-Law no. 313/2002."

Thus, CCFL, being familiar with the operating system of the systems it managed, held the view that the *Glória* and *Lavra* funiculars fell within the category of "traditional cable-driven electric cars," a position with which the *INTF* agreed. Consequently, both funiculars were excluded from the application of Decree-Law no. 313/2002 and, therefore, from the *INTF*'s supervision within that framework. In fact, being equated with traditional electric cars, they remained excluded from any regulatory framework and supervision, as has been and still is the situation for these vehicles.

It is also important to highlight here that the assumption then accepted, that "the cable in this type of vehicle serves only to synchronise the movement, in addition to mechanically compensating for the ascending and descending journeys", in the view of the investigation, could not have been considered valid as a specific characteristic. This is because the force in the cable corresponding to the weight of the descending vehicle actually constitutes by far the majority component of the traction force required to move the ascending cabin, just as in any other classic funicular. The traction provided by the wheels is only the component necessary to overcome the difference in weight between the cabins and the mechanical resistances to movement, much like the electric motor of the drive pulley in a classic funicular.

Therefore, the *Glória* and *Lavra* funiculars possess the essential attributes of a funicular and similar risks, making it logical that they should be subject to the operational and supervisory regime applicable to them.

Decree-Law no. 313/2002 remained in force until 20th of April 2018, the day before the entry into force of Regulation (EU) 2016/424 of the European Parliament and of the Council, concerning cable installations and repealing Directive 2000/9/EC. The scope of application of this Regulation differs from that previously set out in the repealed Decree-Law no. 313/2002, particularly regarding exceptions, as it does not apply, among others, to "cable installations classified by Member States as installations of historic, cultural, or heritage interest, which entered service before 1st of January 1986 and are still in operation, and which have not undergone

significant design or construction changes, including in the subsystems and safety components specifically designed for them."

Decree-Law no. 34/2020, of 9th of July, is the national legislation ensuring the implementation of Regulation (EU) no. 2016/424 in the Portuguese legal system. It defines "cable installations classified as installations of historic, cultural, or heritage interest" as those provided for in Decree-Law no. 309/2009, of 23rd of October, in its current wording, that entered service before 1st of January 1986, are still in operation, and have not undergone significant design or construction changes, including in the subsystems and safety components specifically designed for them[3].

At this stage of the investigation, no analysis was conducted on whether significant changes made to the *Glória* (and *Lavra*) funiculars before or after 1st of January 1986 and before the Regulation's entry into force would have automatically brought them within its scope, nor which entity, the operator or the *IMT*, would be responsible for identifying or investigating such changes. What is clear is that, as these funiculars are classified as national monuments and are installations of historical interest that entered service before 1st of January 1986, they were effectively considered by the *IMT* and *CCFL* as excluded from the scope of Regulation (EU) no. 2016/424 and the relevant provisions of Section II of Decree-Law no. 34/2020. This resulted in them not being under the supervision of *IMT*, or, as far as the investigation could determine so far, under the supervision of any other entity regarding safety aspects of their operation.

Consequently, both Funiculars were under the sole responsibility of *CCFL* as the operating entity, without supervision by any independent, public, or private authority, and without an effective legal framework governing their operation unless any significant changes were made to their infrastructure or subsystems.

It should be noted here that the use of a new type of cable in 2022 could be considered a significant change to one of its subsystems. However, as explained in section 5.2, this change was made inadvertently by *CCFL* and without awareness of its significance, so it would not have triggered in any case the initiation of the process set out in Section II of Decree-Law no. 34/2020.

From what GPIAAF has been able to ascertain so far, through contact with its counterparts in other European States or jurisdictions subject to the same rules, the situation in Portugal contrasts sharply with the reality in those States, where all funiculars are subject to compliance with technical rules and periodic supervision by national or regional authorities, regardless of their date of commissioning or historical interest.

Indeed, this reality aligns with Regulation (EU) no. 2016/424 itself, which clarifies in its Recital 12, dedicated to installations of historical, cultural, or heritage interest, that "Member States should ensure a high level of protection for the health and safety of persons and property concerning these cable installations, if necessary through their national legislation."

Thus, the establishment of safety rules duly adapted to the specificities of these historic means of transport and an effective technical supervision regime can and should be undertaken by Member States, who are responsible for guaranteeing the definition of the technical and safety regulatory framework on the one hand, and inspection supervision on the other, for all land transport equipment involved in public passenger transport services, regardless of their special technical characteristics.

In fact, the fact that these funiculars were considered excluded from the scope of the legislation did not prevent the same rules applied to other installations from being applied to the *Glória* and *Lavra* Funiculars, with due adaptations to their specificities, including supervision, for example through a protocol or other appropriate

[3] A cable installation is divided between the infrastructure and the subsystems, listed in Annex I of the Regulation, namely: cables and their fixings, drive and braking systems, mechanical installations, vehicles, electrotechnical installations, and rescue equipment.

mechanism, the initiative for which could have come either from *CCFL*, as operator, or from the *IMT* within its remit.

The situation of the *Glória* and *Lavra* funiculars makes it clear that the current legal or regulatory regime in Portugal has not been adequate or sufficient to ensure that these transport systems were subject to an effective framework of technical rules to comply with, and, above all, to appropriate inspection and supervision to safeguard public safety.

Although peripheral to this investigation, it must be reiterated here that the exact same situation currently exists regarding *CCFL*'s electric trams, due to the absence of a legal framework for the technical and safety regulation of tram systems running on non-reserved tracks, as attested by the *IMT*. Therefore, the maintenance and safety conditions of trams, historic, modernised, or modern, operating on public roads in shared use with road vehicles, both at their entry into service and during their operational life, are not, in Portugal, subject to compliance with any rules other than those defined by the company itself, nor, crucially, to any form of independent supervision[4].

## 6. SUMMARY OF RELEVANT FINDINGS TO DATE

Regarding the haulage/equilibrium cable:

1- The cable between the cabins ruptured near the termination socket on cabin no. 1, inside the swivel, after 337 days of use. The exact mechanism of material failure and causal factors still need to be determined during the ongoing investigation, following analyses to be carried out.
2- The installed cable did not comply with *CCFL*'s specification for use in the *Glória* Funicular.
3- The installed cable was not certified for use in installations for the transport of people.
4- The installed cable was not suitable for installation with swivels at its ends, as is the system in the *Glória* (and *Lavra*) Funiculars.
5- The use of cables that were non-compliant with multiple specifications and usage restrictions was due to several accumulated failures in the acquisition, acceptance, and application process by *CCFL*, whose internal organisational control mechanisms were insufficient or inadequate.
6- Identical cables were in use for 601 days in the *Glória* Funicular (and 606 days in the *Lavra* Funicular) without incidents. **For this reason, it is not currently possible to state whether the non-compliances in cable use are relevant to the accident or not.**
7- The area where the cable broke was not accessible for visual inspection without dismantling the swivel.

[4] Although periodic inspections of the trams to be carried out by external entities are not provided for by law, *Carris* performs these inspections in accordance with the current vehicle maintenance plan, which foresees:
a) For historic trams – regular periodic inspections at 3,000 km, 12,000 km, 35,000 km, and 70,000 km;
b) For articulated trams – the same as the above, with an additional inspection at 280,000 km.

Regarding the maintenance of the Funicular:

1- *CCFL* has subcontracted the maintenance of the funiculars to a service provider, with the current provider being responsible for maintenance since 2019.
2- The service contract establishes the obligation for the provider to deliver services with the diligence and quality required for the type of work involved, in accordance with the terms and conditions set out in the specifications and contract, respecting legal standards and industry best practices.
3- Nevertheless, the service provider's workers essentially act as labour for *CCFL*, being trained on the job and performing interventions under the direct supervision of *CCFL*' inspectors.
4- There is no guidance or supervision from the technical staff of the maintenance service provider regarding the specific manner in which the work should be carried out.
5- There is evidence that maintenance tasks recorded as having been performed did not always reflect the work that had actually been carried out, and that critical tasks were being executed in a non-standardised manner, with varying execution and validation criteria.
6- The maintenance plan for the *Ascensor da Glória* is noted has complied by the service provider and accepted by CCFL supervisors.
7- The inspections scheduled for the day of the accident and preceding days were recorded as completed and workers were present at the site on those days, however, there is evidence that they were not performed during the recorded timeframe.
8- On the day of the accident and before, the cable was not inspected in the pit, nor was this inspection foreseen in the plan. Cable lubrication, scheduled on a weekly basis, is recorded as having been performed on 28th of August. The monthly cable inspection is recorded as having been performed on the 1st of September.
9- The location where the cable ruptured is not accessible for inspection during the maintenance procedures foreseen in *CCFL*' maintenance programme; inspection there is only possible by stopping the cabins and dismantling the swivels, a procedure that requires a downtime of at least two days.

Regarding the cable socket termination:

1- The analysis carried out so far on the cable socket termination to cabin no. 1 shows the existence of areas considerably less dense or even voids within the casting.
2- The maintenance service contract explicitly assigns responsibility for the cable assembly work, including the execution of the socket, to the service provider, with *CCFL* limited to supplying the cable.
3- The production of the sockets follows a historical empirical process within the company, passed down through generations, with no written procedure in *CCFL*' documentation system defining the treatment for preparing the cable strands, the composition and preparation of the casting alloy, or the execution and quality control of the socket.
4- The maintenance provider has no information on how to make the sockets.
5- At the time of manufacturing the sockets, no tests were conducted to verify the quality of the casting.
6- The composition, execution, and control of the casting of the sockets does not comply with the applicable European standards.
7- The critical area of the cable-to-socket connection, where the cable ruptured, was not accessible for visual inspection without disassembling the swivel.
8- Considering the history of cable use in the Funicular, the risk arising from the degradation of the cable condition, including that area, was indirectly controlled by limiting the cable's usage to 600 days.

Regarding the braking system of the cabins:

1- The cable failure detection system incorporated in the *Glória* Funicular operated properly, cutting the electrical power to the cabins in order to trigger the emergency brake system, to safely stop the cabins.
2- The cabin braking system was not effective in stopping the cabins, despite all the existing brakes, both automatic and manual, being applied in cabin no. 1.
3- No calculations are known for the emergency brake of the cabins.
4- The historical information available suggests that the brake system was modified a few years after the electrification of the Funicular, with some components having been removed. There are also indications that the weight of the cabins has increased significantly since electrification, with differing reports regarding the current weight.
5- The cabin brake system was frequently adjusted by the maintenance service provider, following reports from the brakemen.
6- The anomalies that motivated these adjustments were rarely recorded in the defect logbook maintained by the brakemen, just as the maintenance service provider seldom documented the adjustments performed in the intervention sheets.
7- *CCFL* has not defined, in the Funicular maintenance procedures, the adjustment values for the various mechanical components of the braking system; only the wear limit value for the brake pads on the Z-rail is specified.
8- The maintenance service provider did not establish any quality control system for the work performed on the braking system.
9- There was prompt response from the maintenance company to any intervention requests made by the brakemen, and any anomaly considered to compromise safety led to the immediate stoppage of the Funicular until resolved.
10- *CCFL* has no record of ever having tested the emergency brake in a cable failure situation.
11- Among various *CCFL* technicians and workers connected to the Funiculars, there was the perception that the system's safety depended entirely on the cable, and that the braking system was not effective in stopping the cabins without the cable. For this reason, great care was taken in controlling the cable, notably limiting its use to 600 days, well below the expected lifespan. However, this perception was never organisationally translated into a reassessment of the system's safety conditions.

Regarding the legal and supervisory framework of the Funicular:

1- The *Glória* Funicular (and the *Lavra* Funicular, with identical technology) was excluded from the scope of Decree-Law No. 313/2002, which transposed Directive 2000/9/EC into national legislation, applicable to cable installations for passenger transport. Although that national legislation provided a specific regime for installations already in existence at the time of its entry into force, it was considered excluded under one of its exemptions, corresponding to "traditional cable-driven electric cars."
2- With the entry into force of Regulation (EU) 2016/424 and Decree-Law No. 34/2020, the exclusions were altered; however, the *Glória* and *Lavra* Funicular, being classified as national monuments, remained excluded because they were considered cable installations classified as installations of historical, cultural, or heritage interest, having entered service before 1st of January 1986, still in operation, and allegedly having undergone no significant design or construction alterations.
3- Thus, as far as could be determined so far by the investigation, all safety aspects concerning the operation of both funiculars were the exclusive responsibility of *CCFL* as the operating entity, without supervision by

any independent public or private entity, and without an effective legal framework for their operation unless significant changes were made to their infrastructure or subsystems.

4- The fact that the funiculars were considered excluded from the legislation's scope in no way prevented the application of the same rules as those for other installations, with the necessary adaptations to their specificities.

5- GPIAAF found that the electric trams of *CCFL* are in an identical situation due to the lack of a legal framework for the technical regulation and safety of electric systems operating on non-reserved tracks. Consequently, the maintenance and safety conditions of electric trams, historic, modernised, or modern, running on public streets alongside road vehicles, both at their commissioning and during their operational life, are not subject in Portugal to compliance with any rules other than those defined by the company itself, nor, crucially, to any form of independent supervision.

## 7. SAFETY RECOMMENDATIONS

Safety recommendations are proposed for the purpose of improvement and are drawn up based on the conclusions, albeit preliminary where appropriate, of an investigation into one or more accidents or incidents.

The recommendations issued are addressed to the entity legally competent to ensure they are duly considered and, where applicable, implemented. The recommendations specify the implementing entity, that is, the body directly responsible for taking the actions necessary to close each recommendation, when different from the addressee.

Under the terms of Article 12 of Decree-Law No. 394/2007, as amended by Decree-Law No. 101-C/2020, it is the duty of the recipient of the recommendations to report to GPIAAF at least every six months on the measures taken or planned following the communication of the recommendation.

It should be emphasised that, in accordance with both European Union and national legislation, the safety recommendations issued by GPIAAF do not in any circumstances constitute a presumption of fault or liability in relation to the occurrence giving rise to them.

Considering that this preliminary report is essentially factual and has not previously been subject to consultation with the involved parties and recipients of the recommendations, this document presents only the areas upon which the formal recommendations will focus, which will be made by GPIAAF following consultation with the recipients regarding their content.

Thus, based on the facts established to date by the investigation and set out in this Preliminary Report, GPIAAF considers it necessary to issue safety recommendations relating to the following aspects:

- To **Companhia Carris de Ferro de Lisboa, E.M., S.A.**, concerning three domains:
  1- With the aim of carrying out a reassessment and review of its internal control system, particularly regarding the processes of specification, procurement, receipt, and application of components critical to vehicle safety, as well as supervision of the maintenance contract relating to *Ascensores* and Lift.
  2- So that it undertakes an evaluation of the advantages of defining and implementing a safety management system (SMS), aligned with European best practices but adapted to the reality of its organisation, which allows for an explicit and documented identification and analysis of operational safety risks and the measures implemented to ensure their control at an appropriate level, acting accordingly based on the outcome of this evaluation.

3- To clarify with the maintenance service provider the responsibilities that are expected from it under the contract and to revise the way how supervision of the work is undertaken.

- To **Instituto da Mobilidade e dos Transportes, I.P. (*IMT*)**, as the national public entity responsible for promoting the definition and updating of the regulatory and legal framework of the land transport sector, as well as for approving, endorsing, and certifying vehicles and equipment related to land transport systems, ensuring the required technical and safety standards, also in two areas:
  1- To proceed, in accordance with the provisions set out in Recital 12 of Regulation (EU) No. 2016/424, with the promotion of a legislative, regulatory, or other appropriate framework that ensures all funiculars and other similar or comparable public transport systems are properly governed from a technical and supervisory perspective, regardless of whether they fall within the scope of Section II of Decree-Law No. 34/2020, following the best practices of other EU Member States in this area.
  2- To proceed with the promotion of a legislative framework that guarantees that electric railcars (trams), whether historic, modernised, or modern, operating on public streets, both upon entering service and throughout their operational life, are subject to compliance with appropriate maintenance rules and safety conditions, following the best practices of other Member States in this field, and under an appropriate level of independent supervision.

GPIAAF will publish the full text of the safety recommendations on its website at the time of their formal issuance following the consultation process.

**IMPORTANT NOTES**

- This document aims to report the relevant information known and confirmed at the time of its drafting. It is a preliminary document intended to provide information on the progress of the investigation and is not the final report. As such, it still presents incomplete information and analysis regarding all factors directly or indirectly involved in the accident, which require further examination through testing and the collection of additional information until the conclusion of the investigation. However, all statements and any potential areas for safety recommendations that may have already been identified are supported by factual evidence that justifies them.
- Investigations conducted by GPIAAF in the field of railway transport are carried out in accordance with Decree-Law No. 394/2007, of 31 December, and follow the recommendations of the European Union Railway Agency as well as international best practices. These investigations are independent and do not preclude any other investigations that may be conducted by judicial authorities, the national railway safety authority, or the companies involved.
- In accordance with European and national legislation, investigations conducted by the GPIAAF have the sole purpose of contributing to the improvement of safety through the prevention of future accidents or the mitigation of their consequences. **They are neither intended nor conducted with the aim of establishing blame or determining liability.**
- **No fault or liability on the part of any organisation or individual involved in the occurrence should be presumed from the facts stated in this Preliminary Report.**
- This version of the report in English is provided for the benefit of international readers, and its wording is not binding. In case of discrepancy, the original Portuguese version prevails.

*Lisbon, 20th of October 2025*