SCJ ALLIANCE
CONSULTING SERVICES

Technical Memo

To	Ken Clayton, Jon Hotaling, Panadero Ski Corporation
From:	Mike Deiparine, PE Jamie Bunch, PE
Date:	August 22, 2023
Project:	Cuchara Chair 4
Subject	Entrance Beam Failure and field observations

1. Overview and Purpose

Panadero Ski Corporation (Client), acting as a lessee of property and chairlift equipment from Huerfano County, CO, has been in the process of refurbishing an abandoned chairlift formerly owned by the Cuchara Ski Area, near La Veta, CO. During the process of performing mechanical maintenance, a mechanical incident occurred resulting in damage to the support frame of the entrance beam at the lower terminal. According to statements by Client staff, the incident occurred on July 29, 2023. Client has contracted with SCJ Alliance (SCJ) to provide forensic investigation and assessment of the incident and resulting damage to the equipment.

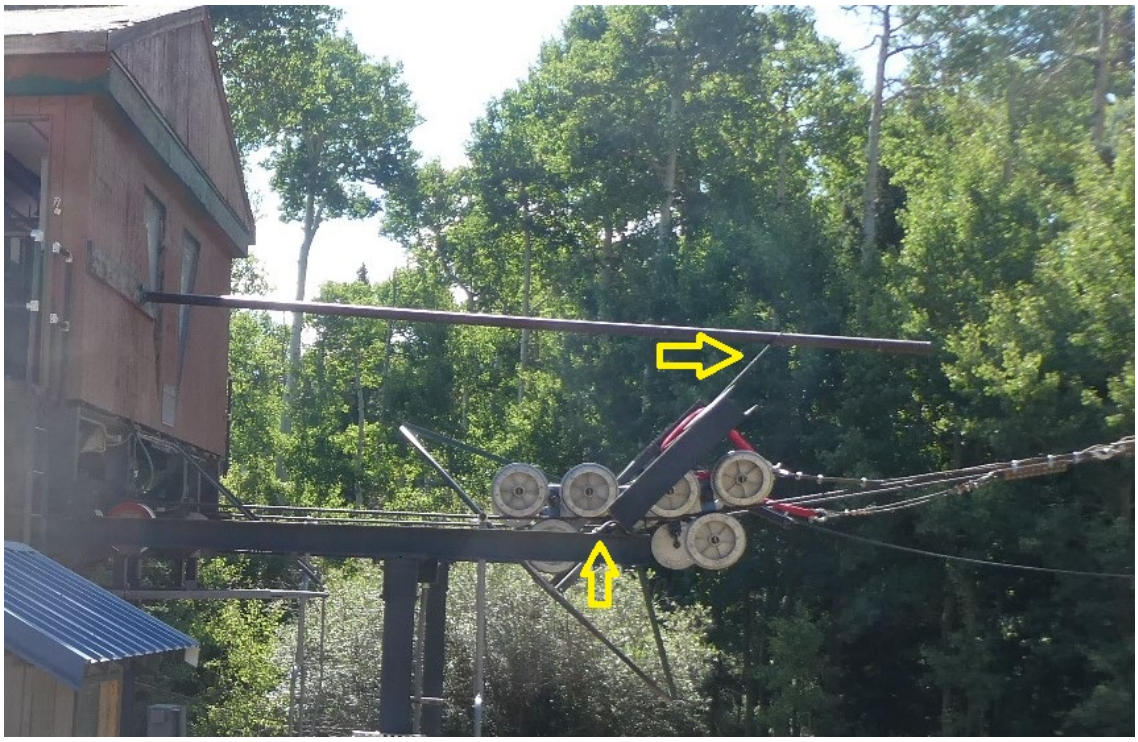

Figure 1 Lower Terminal Portal Structure Deformed

SCJ personnel Mike Deiparine, PE; Jamie Bunch, PE, and Matt Andrade visited Chair 4 at the Cuchara site on August 15, 2023, to investigate the incident and evaluate the options for correction of the damage. It should be noted that generally an abnormal situation that results in damage to the equipment or interruption of normal operation is considered an "Incident" and an accident refers to a situation which results in injury to personnel. Fortunately, no personnel injuries occurred during this mechanical failure and only the equipment was damaged.

2. Summary of Observations

During maintenance operations to replace the counterweight rope on Chair 4, Panadero staff secured the lift haul rope to the portal framing on the lower terminal to prevent excess movement of the haul rope while the tension from the counterweight was removed. Tension from the haul rope applied to the portal beam resulted in excess force on the portal column connections and the connections failed. The failure of the connections resulted in the portal frame rotating in the uphill direction and displacing the top of the structural frame uphill as shown in Figure 1. According to client staff, they have notified the Colorado Tramway Safety Board (CPTSB) of this incident to maintain communication with the Board.

Figure 2 Original incident photos from Panadero staff

The structural portal frame in question supports the depression combination sheave assemblies at the uphill end of the terminal. Photos of the original incident condition provided by Panadero staff (Figure 2) show the sheave assemblies upset without rope tension. While the connection at the bottom of the frame is severely distorted and broken (Figure 3), it appears to have sufficient strength to hold the frame in the current position. According to Panadero staff, following the failure, they pulled in the counterweight rope enough to stabilize the rope, sheaves, and frame. Sheave assemblies are currently pressing against the frame cross member and the tension rigging is not tight. The frame does not appear to have moved from the deformed position resulting from the incident.

Figure 3 Frame connection Damage

The lift rigging installed to hold the rope tension while the counterweight rope was changed was attached to the top of the sheave support portal frame. The connection point is about 3 feet above the connection plate. The haul rope tension is about 15,000 pounds. The rigging on the top beam caused a significant moment force on the connection plate on the order of 45,000 lb-ft. The welding on the base plate appears to have had adequate penetration and much of the weld is broken in the weld metal. Panadero staff stated that the broken connection did not have rust indications immediately after the incident. The base plate is distorted and broken along the weld line of the column web. The failure of the connection plate appears to be the result of over stress and not poor welding or fatigue cracking. Figure 4.

Figure 4 Failed Base Plate Weld Connection

The damaged portal frame was bolted to two wide flange beams that cantilever past the two uphill columns of the terminal structure. Observations with a straight edge did not indicate any observable distortion or bending of the support beams at the cantilever. The flanges of the support beams are distorted at the bolted connections to the portal frame, as shown in Figure 5.

Figure 5 Distorted Support Beam Flanges

When additional tension was applied to the haul rope to stabilize the beam after the incident, the sheave assembly came in contact with the cross beam (Figure 6). The sheaves should be inspected when the beam is repaired. Since the contact was slow with the retention process, it is not anticipated that the sheaves would be damaged, but a careful observation of the entire assembly should be performed.

Figure 6 Sheave Assembly Against cross beam

Observations of the haul rope tension rigging indicate some possible issues with the rigging arrangement. The rigging was connected to the top of the structural support frame for the terminal sheave assemblies. The support frame was designed to hold a vertical load and not a horizontal load. The rigging placed a significant bending moment on the frame connections. This type of loading should be avoided in the future unless the connection point is engineered and rated for the applied load.

Figure 7 Single 3/4" Rigging Sling

One side of the haul rope tension setup is connected using a single ¾" sling to the connection point on the cross beam (Figure 7). This sling is rated for 4.9 tons of load, 9,800 pounds. The haul rope tension at the lower terminal is about 15,000 pounds. While the tension reduces as the counterweight is lowered, this is poor practice. The actual tension is unknown until the rope is slack. Rigging should be sized for the maximum anticipated load with adequate design factors.

Figure 8 Parallel Slings of Small Size.

The other side of the haul rope rigging is much weaker. There are two parallel slings on a single load (Figure 8). The two slings cannot be equal length by definition and cannot share the load. This is equivalent to a single sling for rating. The slings appear to be constructed with ½" wire rope. A single ½" wire rope sling is rated for 2.2 tons, 4,400 pounds. This connection is severely under-rated, and the crew is fortunate that it did not fail catastrophically. These types of rigging errors can result in severe injury or death. The owner should consider formal rigging training for the staff prior to any future heavy load rigging. Rigging is one of the most dangerous procedures performed by lift maintenance personnel. It is important to have a proper rigging plan, calculations of the anticipated loads, an understanding of how a failure might occur, proper well-maintained rigging equipment, team safety talks, and a means to verify the loads.

It was noted that there is no designed connection point to apply rigging to the haul rope. Rigging connections points and proper procedures should be developed for future maintenance activities.

The newly installed counterweight rope was noted to be configured properly. The machine room and mechanical configuration was noted to be tidy and appeared to be in serviceable condition. No effort was made to operate the mechanical equipment.

Observations of the machine room indicate the lift has a Riblet relay control box which is assumed to be original equipment. There is a tower fault locator system which may be a modification or original equipment. A review of the control drawings indicate some modifications have been made.

The lift has a wound rotor drive motor controlled by a main-line contactor and pilot relay, sometimes referred to as a "2811" relay. In the original configuration, 2811 was the part number of the pilot relay used. The 2811 relay has been replaced by another relay style, due to some failures. This start/stop connection control is a single channel control path through the control relay and contactor and does not have redundancy required by the current CPTSB Rules for "Protection" circuits.

3. Corrective Action

While the lift appears to be in a safe condition, the current factor of safety of the portal frame connection as compared to the forces is not known. The lift should not be operated for any reason until all repairs are on the portal frame are completed.

In order to repair the damaged structural frame, the plate connections at the base of the vertical columns must be rebuilt. CPTSB will require design of the connection repairs to be performed by a Qualified Engineer. The repairs shall define specification for dimensions, materials, welding, and installation.

The original connection design probably has adequate strength for the vertical load applied by the sheave assemblies. However, it is not appropriate for the horizontal load required to hold the haul rope tension as rigged during the incident. A defined rigging plan and connection point should be developed by a Qualified Engineer to hold the rope tension for maintenance operations. It is recommended to install a concrete anchor below the hold-down assembly on the lower terminal frame. The concrete anchor can be used to hold the rope down for the depression assembly and to hold the haul rope tension to remove the rope from the lower terminal or splice.

A defined procedure should be developed to provide safe rigging techniques for the maintenance procedures. The procedure should include process options for holding the haul rope tension and pulling the rope down on the depression sheaves. Procedures should include required design loads, required rigging components, and arrangement of rigging.

Based on field observation and discussions with Client's staff, it is not anticipated that the haul rope was adversely affected by this incident. Following reassembly and normal tension of the rope it is always recommended to perform a close visual inspection of the rope and mechanical components associated with the maintenance operation to verify that the components are in normal condition and suitable for continued operation.

4. Regulatory Compliance

Client does not have an existing license with the CPTSB. While technically, official notice of a "Reportable incident" is not required because Client is not licensed, in order to maintain communication with the Board, it is recommended to keep the staff informed of plans and status of repairs. The repairs for the damage caused by the incident will require structural welding and likely structural modifications. As such a CPTSB minor modification will be required prior to obtaining a license to operate.

5. Next Steps

SCJ has proposed providing design development of the necessary repairs under Phase 2 of the current contract. If authorized by Client, SCJ will proceed with design recommendations for repair of the plate connection, installation of a rope rigging point, and rigging procedures.

In addition to repairs necessary to correct damage caused by this incident, SCJ Alliance strongly recommends that the electric motor, drive and control system be updated to modern standards. Even if the existing control system was brought back to the original design, it will be very difficult to locate faults with the current systems, which we believe could lead to a hazardous condition.