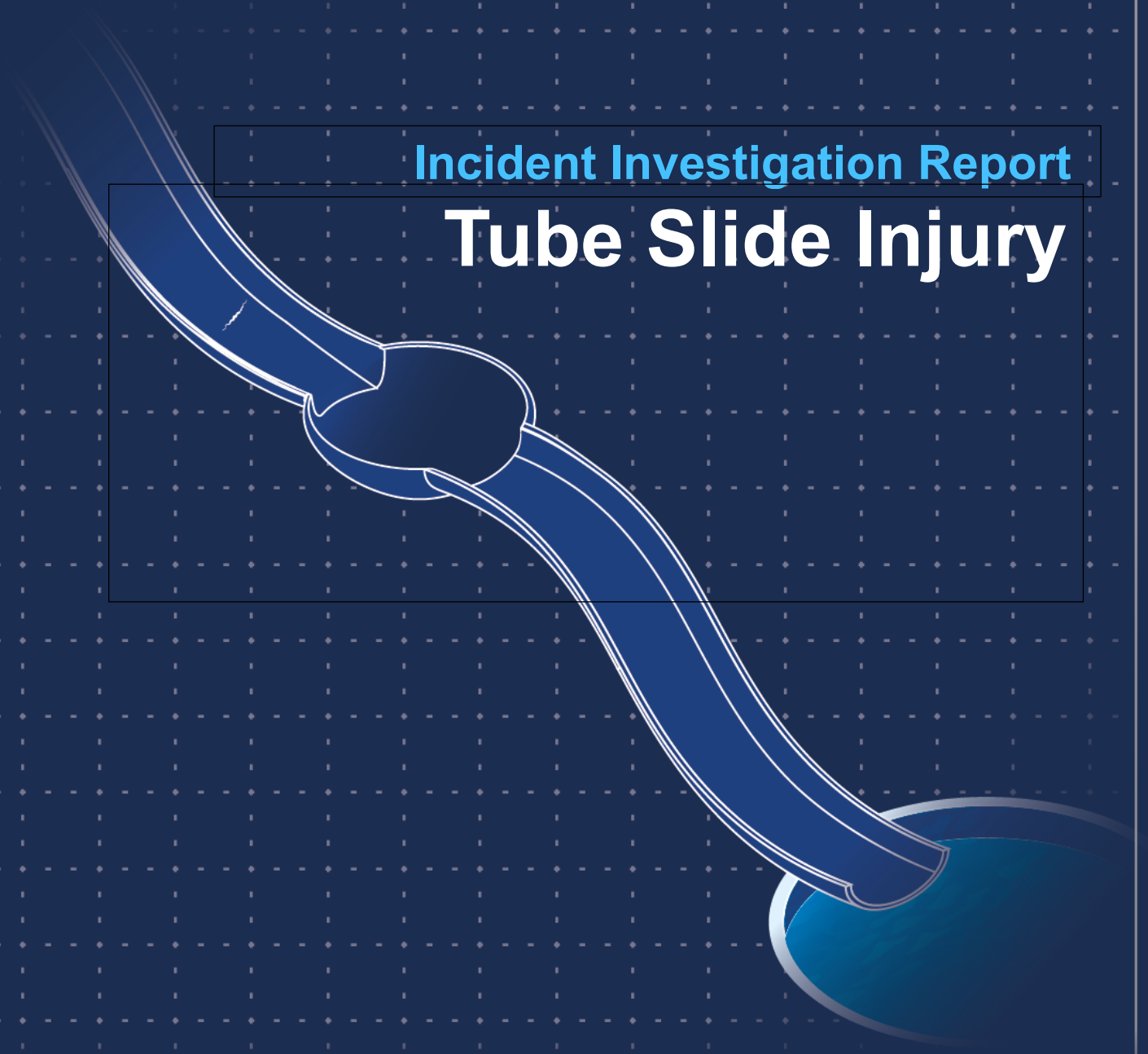
Incident Investigation Report

Tube Slide Injury



TECHNICAL SAFETY BC

February 2025

Summary

Incident

On July 14, 2024, an incident occurred involving multiple injuries on a waterslide in BC, including a major laceration to the leg of an 11-year-old.

The incident occurred at a waterpark in Bridal Falls operating with several waterslides including a tube slide that consisted of a series of fibreglass flumes[1] and fibreglass and concrete pool sections (the Tube Slide). At approximately 2:45 pm, a rider progressing down the Tube Slide received a significant foot laceration. They reported to first aid and were attended to by several staff members and eventually, an ambulance was called for further treatment. At this time, the General Manager was informed an ambulance had been called. While the first aid was occurring, several additional riders progressing down the Tube Slide received scrapes, torn bathing suits, and an injured ankle. The injuries were reported to various staff members. The general manager was not aware of these additional injuries. At approximately 3:30 pm, a patron informed the general manager of the waterpark of an “irregularity” on the Tube Slide. The general manager brought an additional employee to investigate and reported identifying a crack at the bottom of the seventh flume section of the Tube Slide. During this inspection, the general manager made the decision that the Tube Slide should be closed but they would evacuate the remaining riders in queue down the slide first. The general manager asked the slide attendant positioned at the top of the slide section upstream of the crack to push those riders around the crack. Despite attempts to direct patrons around the crack, an 11-year-old passed directly over the failed section of the Tube Slide and received a major laceration/tear to the posterior side of their leg. Recovery from that injury is expected to be long-term.

For the purposes of this report, the “Incident” refers to the Tube Slide failure and all subsequent injuries that occurred before the Tube Slide was shut down.

Technical Safety BC Jurisdiction and Role

Technical Safety BC administers the Safety Standards Act and the Elevating Devices Safety Regulation which applies to Amusement Rides in BC, including flume rides and waterslides.

Following an incident, Technical Safety BC may investigate to learn from the incident and inform the prevention of similar incidents in the future. Additional details regarding jurisdiction and role can be found in Appendix A.

Investigation

Technical Safety BC was notified of the Incident the next day by a concerned member of the public. Following notification, Technical Safety BC immediately started an investigation into the Incident. The investigation sought to understand the circumstances leading to the crack in the fibreglass flume of the Tube Slide, as well as operational decisions that resulted in riders continuing to progress down the Tube Slide after that same failure caused previous injuries.

Findings

The findings are summarized here for ease of reference. Expanded analysis can be found in the findings section at the end of the main body of the report.

1. Flume: Portion of a waterslide used for the conveyance of water and passengers (i.e. the sliding surface)

Flume Failure

1. The flume failure and resultant injuries were caused by a pre-existing crack (or cracks) on the flume surface at the base of flume section 7 of the Tube Slide, which progressed rapidly on the day of the Incident resulting in a sharp edge that protruded directly into the path of riders.

2. The crack progressed rapidly because the structure of the Tube Slide had significantly degraded in two ways, resulting in unsupported, and bulged fibreglass:

    a) the ground, which had previously supported the underside of the flume, had shifted and eroded resulting in voids beneath the flume; and

    b) the interior wood core, meant to provide strength and rigidity, had rotted away several years prior to the Incident.

Assessment and Identification

3. It is likely that the imminent failure was not identified by inspections for two reasons:

    a) Prior to, and on the morning of the incident, any visible cracks likely did not meet the established criteria for daily inspections to flag them for repair (i.e. no exposed sharp edges).

    b) Those performing inspections were unaware of the extent that the flume structure and support had degraded because they had no reference for how it was supposed to look or feel.

Post Failure Response

4. The evacuation of patrons down the Tube Slide once staff were aware of the flume failure led to additional and more severe injuries. This decision was influenced by:

    a) limited communication between staff resulting in those making the decision being unaware that any of the previous injuries were associated with the flume failure; and

    b) reliance on an obstructed visual inspection of the crack which inaccurately assessed the severity of the hazard.

Recommendations

Technical Safety BC has made three recommendations to owners of fibreglass waterslides pursuant to this investigation. The recommendations and explanations can be found on Pages 22 and 23 of the report.

Scope of Investigation

The content and findings in this report are based upon the evidence presented and available at the time of Technical Safety BC's investigation, conducted between July and October 2024. The investigation sought to understand the cause and contributing factors that led to the injuries on

the Tube Slide for the purpose of informing and preventing these types of incidents in the future. The investigation looked at practices intended to identify and prevent failures before they cause injury, the materials analysis of the failure itself, as well as the post failure response. A complete list of reviewed evidence can be found in Appendix B.

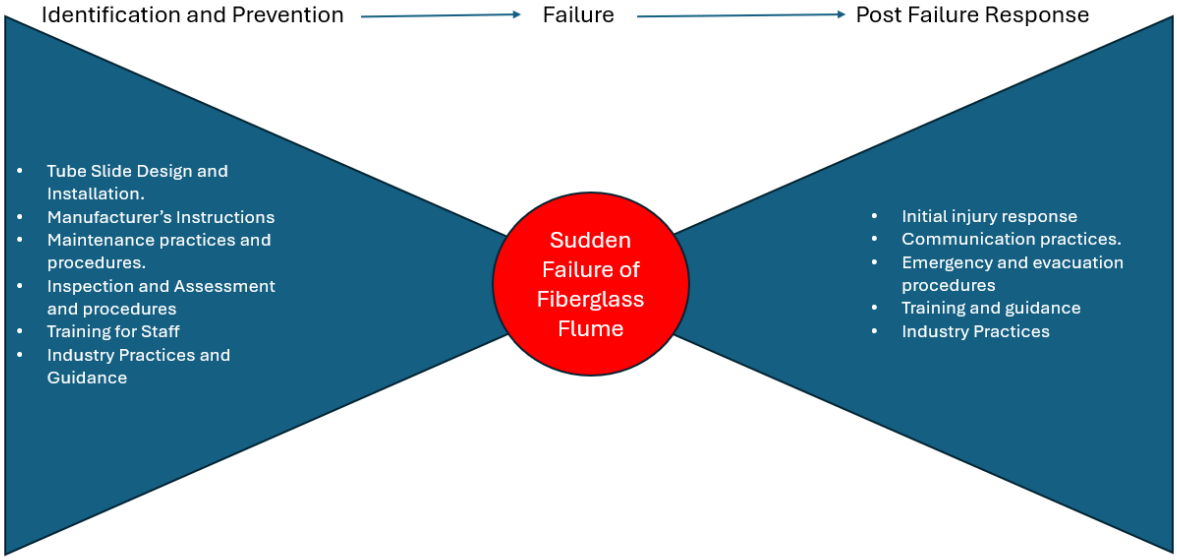


Figure 1 - Bowtie diagram depicting the scope of the investigation

Site System and Components

Overview

The waterpark consisted of a series of waterslides fully or partially inset into the side of a hill. The waterpark, including the Tube Slide was manufactured in Canada and installed in 1983. The waterpark was owned and operated by a contractor licensed with Technical Safety BC. The Tube Slide had an active operating permit. Under the Safety Standards Act, and Elevating Devices Safety Regulation, the owner, who was also the licensed contractor in this case, is responsible for maintaining and operating the ride safely and in compliance with the applicable code.

Act, Regulations, and Code

Amusement rides and devices, which include waterslides and flume rides, are subject to the Elevating Devices Safety Regulation (the Regulation), as enacted by the Safety Standards Act (the Act). The Regulation sets out requirements for the ownership, design, operation, maintenance, and alteration of amusement rides and devices and adopts the applicable code, CSA Z267-00 (the Code). The Act, Regulation, and Code rely heavily on the instructions

expected to be provided by the manufacturer when an amusement ride is designed and constructed.

The Regulation indicates that in order to do regulated work on an amusement ride, an individual must be, or be employed by, a licensed contractor (section 3). Class “AM” contractor’s licenses allow contractors, or those employed by them, to design, construct, install, alter, operate, repair, maintain or test amusement rides in the Province of British Columbia. The contractor’s license is granted by the Provincial Safety Manager. At the time of the Incident, the owner of the waterpark had an active “AM” contractor’s license with Technical Safety BC.

The Code sets out operational requirements for waterparks, including how amusement rides are inspected and maintained. However, the relevant clauses all reference specifications, programs or procedures provided by the manufacturer. In this case, those were not available to the owner as they were not available from the manufacturer. However, procedures developed by the owner over time provided a similar level of instruction to staff as what is available for a typical waterslide. Examples of documentation referenced as being provided by the manufacturer in the Code include pre-opening inspection procedures, repair and maintenance procedures, recommended wear limits, non-destructive testing requirements, and operating instructions. In the absence of manufacturer’s instructions, procedures were developed based on staff experience over time, rather than by someone familiar with the specific construction and requirements of the Tube Slide.

Annex A of the Code is also adopted as a mandatory annex under the Regulation. The Code is generic to all amusement rides, but Annex A provides specific requirements for waterslides including instructions for daily inspections and requirements for documenting all inspections, incidents and maintenance activities (including all modifications made to the waterslide).

Applicable Act, Regulation, and Code sections are included in Appendix C.

The Tube Slide Construction

The Tube Slide was one of the largest slides at the facility and consisted of 3 concrete pools and 6 fibreglass pools connected with sloped, fibreglass flume sections. Riders progressed through alternating sloped flume sections where they moved quickly, and flat “pool” sections where they slowed down. The slide accommodated many people at once, with natural bottlenecks above each sloped section that allowed one tube through at a time. Slide attendants often must be positioned in the pool sections to keep patrons moving at the proper pace and prevent pileups. The Tube Slide was significantly wider than the other water slides at the park. The flume sections consisted of layers of fibreglass built around a wood core to create the necessary strength to support riders as they progressed down the slide. The fibreglass was then coated with a gelcoat to create a smooth surface for sliding. See Figure 1 below.

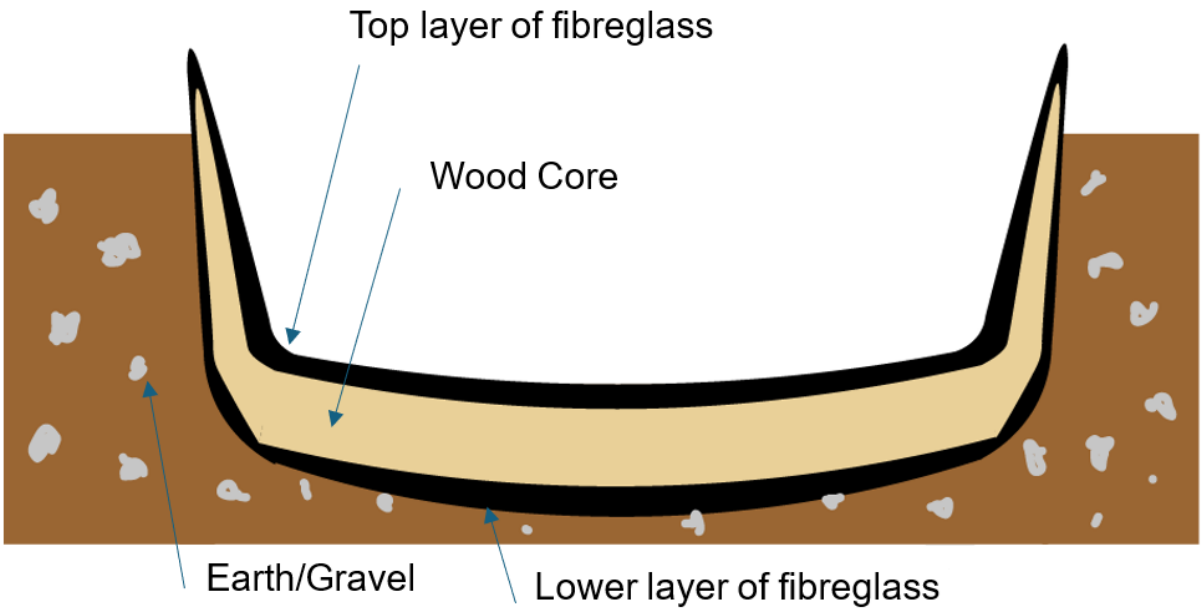


Figure 2 - Representation of the slide cross section at the time of the incident

The Tube Slide is built into the ground and therefore the ground is used as the support structure. In some areas, wood blocking was located between the slide and the ground for additional support. Since the slide was not raised on a traditional support structure, the bottom fibreglass surface could not be visually inspected without specialized tools and/or excavation. In addition, the support provided by the ground was uneven, and subject to change over time. If areas washed out and created voids beneath the slide, they were not typically visible.

Maintenance and Operation

Under the Act and Regulation, owners have a responsibility to ensure that amusement rides are maintained and operated in accordance with the Regulation and manufacturer's specifications (Appendix C – Act, Regulation and Code). In this case, the owner also held the contractor's license for the waterpark. The Regulation states that only licensed contractors or individuals employed by licensed contractors are allowed to do regulated work with respect to amusement devices in BC. In addition, under the Act, licensed contractors must maintain current knowledge of the Act, relevant regulations, relevant regulatory instruments (including directives and safety orders), and ensure that the individuals who do regulated work maintain a similar, current knowledge.

Waterpark Staff and Responsibilities

The waterpark is operated by staff on contract for the waterslide season (typically runs June through September) and an on-call contractor for maintenance work. Off-season maintenance, and administration is scheduled and handled by management that remain on staff throughout the year. The waterpark operated with the following relevant staff positions during the 2024 season:

Vice-President Operations – Responsible for major decisions typically involving waterpark changes or capital expenditures. Named on the contractor's licence and responsible for declaring when non-compliances from inspections have been resolved.

General Manager – Responsible for day-to-day operation of the waterpark including decision making around slide operation, calls to the maintenance contractor for small repairs, and dealing with client issues as they come up. Held a pool operator's certificate for managing pool chemicals and mechanical systems.

Office Manager – Responsible for record keeping, client interaction at the front desk, and various other administrative and scheduling tasks.

Leads – Supervise slide attendants. Responsible for monitoring the lower slide exit pools and hot tub areas. Perform and document daily pre-operational inspections before opening. Leads also respond to incidents, or client complaints that can't be handled by attendants and administer first aid. Leads had first aid training but no documented lifeguard training. Leads received an additional day of orientation from more experienced staff (leads and General Manager) before the season started with instructions on their responsibilities.

Attendants – Responsible for monitoring patron use of slides by regulating the flow of patrons, ensuring slide rules are being adhered to, and escalating patron complaints and issues to Leads. The attendants had no lifeguard or first aid training. Attendants received an orientation at the beginning of the season from more experienced staff.

Fibreglass Contractor – Contracted to perform an assessment of the slide fibreglass, gelcoat, and joints prior to each season. Provides recommendation to the General Manager and vice president for repairs that should be completed and proceeds with completing any authorized repairs. The contractor is also on call to complete repairs for issues found during daily slide inspections during the operating season.

Operating Manuals and Procedures

The waterpark has several pieces of documentation they developed that guide their operational procedures, responses to emergency situations, and worker training/orientation. The manuals were developed in house, as manufacturer's documentation was not available from the manufacturer. A review of the relevant portions of the manuals compared to modern documentation provided by waterslide manufacturers found they contained a similar level of detail and instruction. However, the investigation found that the documents did not contain any specific direction on how to properly identify, evaluate, and react to bulging or deformation of the flume. Although cracks were expected to be documented, the guidelines were not clear on what constituted a hazard and what didn't.

General Operating Guidelines

These guidelines, created by the owner, provided instruction regarding slide inspections. Staff were trained on the procedures during pre-season orientation and the manuals were available in the on-site office. It stated that daily inspections should include checks for a list of items including *"cracks"* and *"excessive movement of the flume when walked on".* It stated permanent logbooks should be kept to document the inspections. The repair manual described that cracks were a common occurrence that could occur from

"normal usage" and that "although unsightly, they do not necessarily affect structural strength." These guidelines were compared to manuals provided by waterslide manufacturers for modern slides and found that they had a similar level of detail and requirements, in particular with respect to conducting daily slide inspections (Appendix D – Comparison of Slide Manuals).

Responding to, and mitigating accidents was also included in section 4 of the guidelines. The only mention of accidents or injuries from the sliding surface was that "abrasion from sidewalls" could occur. The "Emergency Procedures" section referred to the emergency plan.

Emergency Measures Manual (2024)

In the emergency measures manual, procedures to cover "injury" were included on page 5. The section included 5 bullet points. Among them was a bullet to notify the Park Manager and VP Resort Operations in the event of a serious injury. No timeline or requirements on how they were notified was included nor were there any details on what qualified as a serious injury.

Pre-Season Inspection and Maintenance

Safety Officers completed assessments prior to each operating season to validate that the owner and licensed contractor upheld their responsibilities under the Act and regulations for the safe operation of the slides. Pre-season safety inspections were completed by a fibreglass contractor, who had been retained by the owner to upkeep the slides. The waterpark management stated that they relied on these inspections to ensure the slides were safe to operate for the season and that any safety concerns would be identified. These inspections identified various deficiencies through the years such as cracking, misalignment of flume sections, and bulging fibreglass. In each case, local and surface level repairs were made that likely contributed to obscuring underlying issues with the support and structure of the flumes.

Fibreglass Contractor Inspections

For several years prior to the Incident, and prior to each operating season a fibreglass contractor was hired to inspect the slides and provide estimates for any repairs. The fibreglass contractor had several years of previous experience as an employee of a large waterslide manufacturer and had owned a waterslide repair contracting company for several years. He had clear knowledge of fibreglass repair practices and provided suggestions on which repairs to prioritize before each upcoming season. The owner stated that if the fibreglass contractor recommended repairs they would be completed, regardless of cost. However, the contractor stated that recommended repairs across the various slides were prioritized based on the budget allocated for each season. Both the fibreglass contractor and owner stated that if repairs recommended by the contractor were important for safety, they would be completed. No repairs had been recommended for the Tube Slide before the 2024 season.

The owner stated that significant repairs and upgrades had been completed on several slides in the waterpark over the previous 5 years, including resurfacing, caulking, and applying new gelcoat finish. This was corroborated by the fibreglass contractor. However, according to the fibreglass contractor, no significant repair work had been

done to the Tube Slide in approximately 3 years. Prior to that, the contractor stated they had done various fibreglass repairs and widespread resurfacing. The fibreglass contractor also stated they did realignment of the flume because of shifting in the ground approximately 3 years ago that resulted in some joints separating. Aside from statements by the contractor and owner, there were no available maintenance records of any kind that provided any record of what work was completed on the slides over the previous eight years.

At no point was the Tube Slide recommended for replacement by the fibreglass contractor, nor had planning for future replacement started according to the waterpark, although they were aware it would have to happen at some point. Significant investments had been made into backend infrastructure such as pumps and boilers in the previous years by the waterpark.

Safety Officer Assessment

In addition to the fibreglass contractor's inspection, a Safety Officer from Technical Safety BC performed an assessment prior to each operating season. In accordance with the Act and the Regulation, the Safety Officer noted any identified non-compliances with the Code on a certificate of inspection, which the licensed contractor was responsible for rectifying and declaring compliant by a specific deadline.

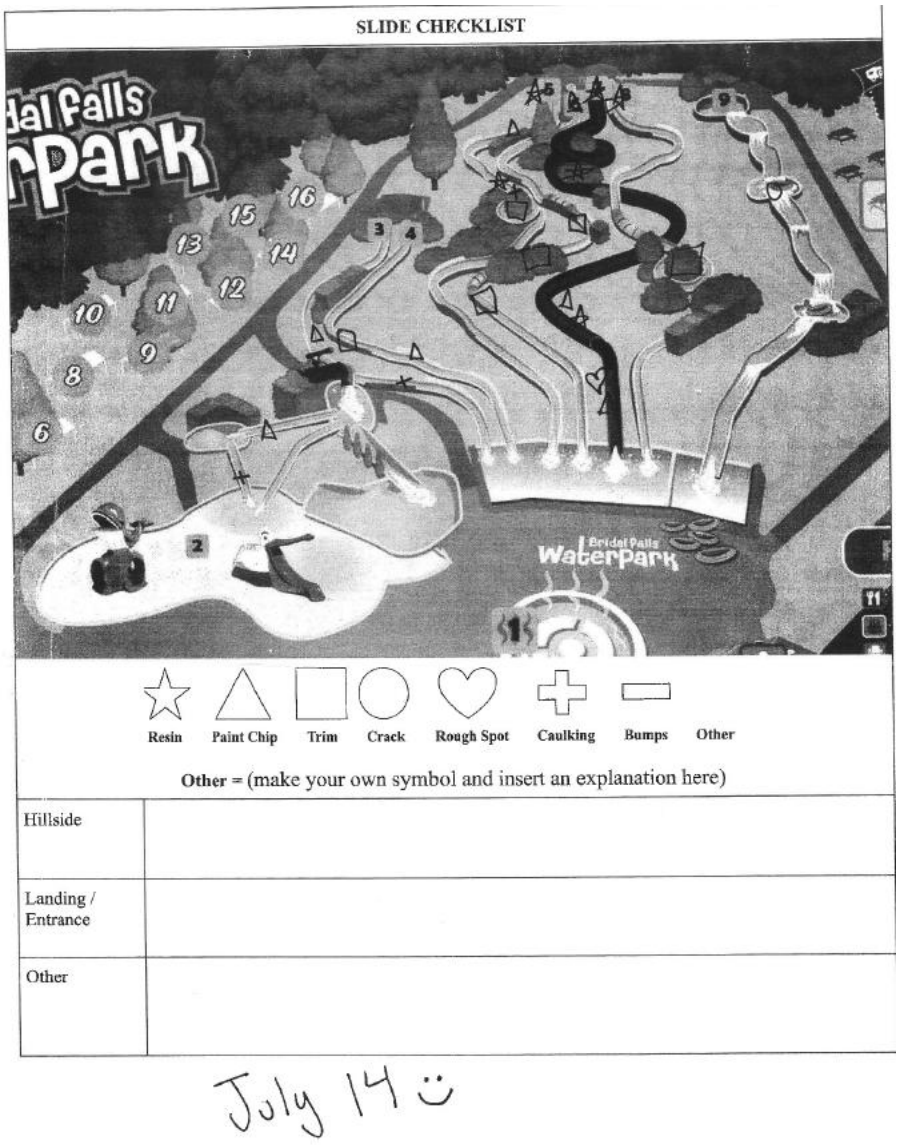
Upon review of the certificates of inspection issued since 2014, multiple indicated that there were non-compliances noted with the Tube Slide structure relating to supports being "washed out" and "bulges" in the flume that the owner was required to repair. In addition, several certificates of inspection noted cracked areas of the fibreglass requiring repair. Recent certificates of inspection (for the last 3 years) noted the requirement for the licensed contractor to keep a maintenance log of repairs and maintenance done to the Tube Slide in accordance with the Code requirements. The licensed contractor/owner, declared that non-compliances were resolved in connection with each certificate of inspection. Following the Incident, no maintenance logs were available.

In-Season Inspection and Maintenance

In-season inspections and maintenance failed to identify the risk associated with deficiencies that existed throughout the fibreglass sections of the Tube Slide.

During the waterslide season, an inspection occurs on each slide everyday. The slide inspections are performed by leads who are trained at the beginning of the season to look for defects on the sliding surface. The training was performed by other leads who were more experienced and had received training the previous season. Season to season turnover was low so there was always more experienced staff available to perform the training. Daily slide inspections were documented on a form and kept in the waterpark office and reviewed each day by the General Manager. If areas of concern were noted, the General Manager requested maintenance by their fibreglass contractor on a case by case basis. A sample of a daily slide inspection form is shown in figure 3 below. A summary of slide inspections leading up to the Incident are included in Appendix E. On multiple occasions the daily slide inspections indicated that cracks were observed, including some in the general vicinity of where the Incident occurred. However, they were inconsistent and at times, cracks that were identified one day were not there the next, despite no repairs occurring. The fibreglass contractor was not called out to

make repairs to these cracks as they were not deemed to be an imminent hazard (i.e. when leads ran their hands over them, no sharp edges were felt). Several of the leads who performed the inspections were interviewed. Although they recall identifying cracks during their daily slide inspections, they did not perceive them as a hazard based on the training that was provided to them. The main concern, according to their training, was to feel the cracks for sharp edges, if they weren't sharp, no immediate action was required.


SLIDE CHECKLIST

Resin Paint Chip Trim Crack Rough Spot Caulking Bumps Other

Other = (make your own symbol and insert an explanation here)

Hillside	
Landing / Entrance	
Other	

July 14 ☺

Figure 3 - Sample of a waterslide daily inspection form from the Waterpark

Daily Slide Inspection Demonstration

To understand how daily inspections of the Tube Slide were done during the operating season, Technical Safety BC investigators requested to walk alongside one of the Leads as they performed an inspection of the Tube Slide, while providing a verbal account of their findings. The following was noted from the demonstrated inspection:

1. The lead was very detailed and diligent in looking for deficiencies on the slide. They performed the inspection walking in the flume, observing and feeling for deficiencies.
2. Multiple cracks and rough spots were observed which the lead felt by running their hand along it. If the crack did not feel sharp or represent a hazard of laceration at the time of inspection, the crack would typically be noted on their inspection sheets. If it was sharp, they would inform the General Manager.
3. The lead also noted the bubbled and “soft” areas on multiple areas of the slide by showing the movement by pushing down with their feet. They stated previously (before the Incident) they didn’t classify these as a hazard. They felt that the bubbles were features of the slide, or otherwise did not represent a concern.

Slide Investigation

Documentation of Flume Failure

The failure location was documented by staff and the fibreglass contractor post incident, and prior to removal. The failed location was cut out prior to Technical Safety BC’s involvement but was retained for further analysis. The documentation identified an approximately 8-inch crack was present at the base of the seventh sloped flume section. The crack was jagged and protruded upward on the downstream side of the crack creating a significant hazard to those progressing down the slide.

The crack was located in a section of the fibreglass that had deformed into a convex shape compared to its original form. The crack occurred approximately at the transition from the sloped flume section to the nominally horizontal section that redirected riders out into the fibreglass pool.

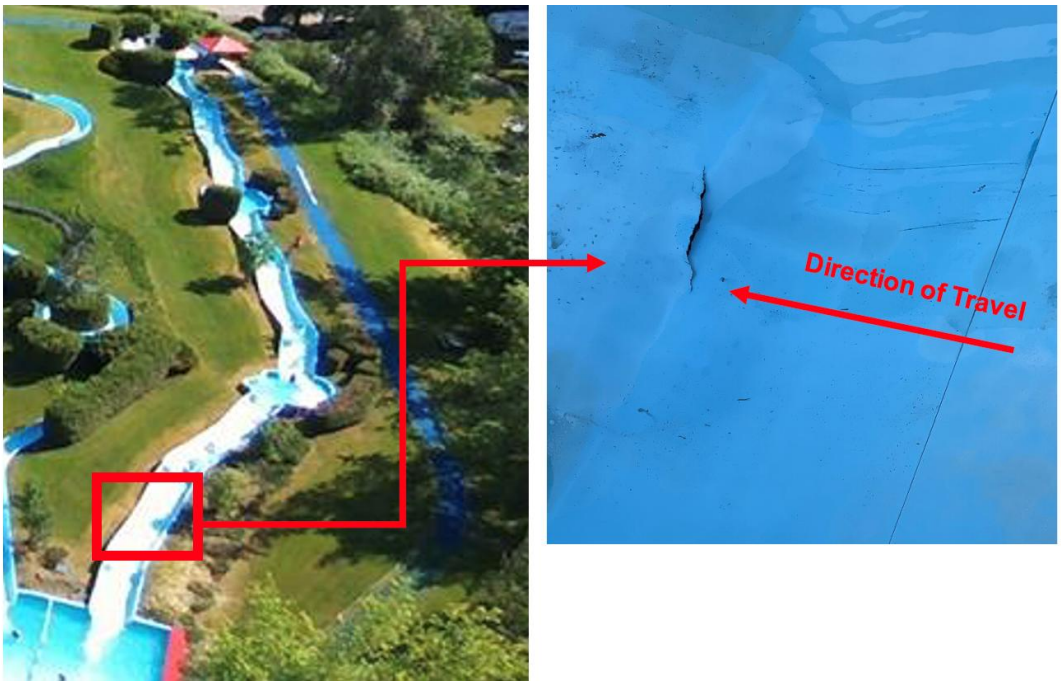


Figure 4 - Overall view of the tube side with the area of the failure highlighted (Photograph provided by Fiberglass Contractor)

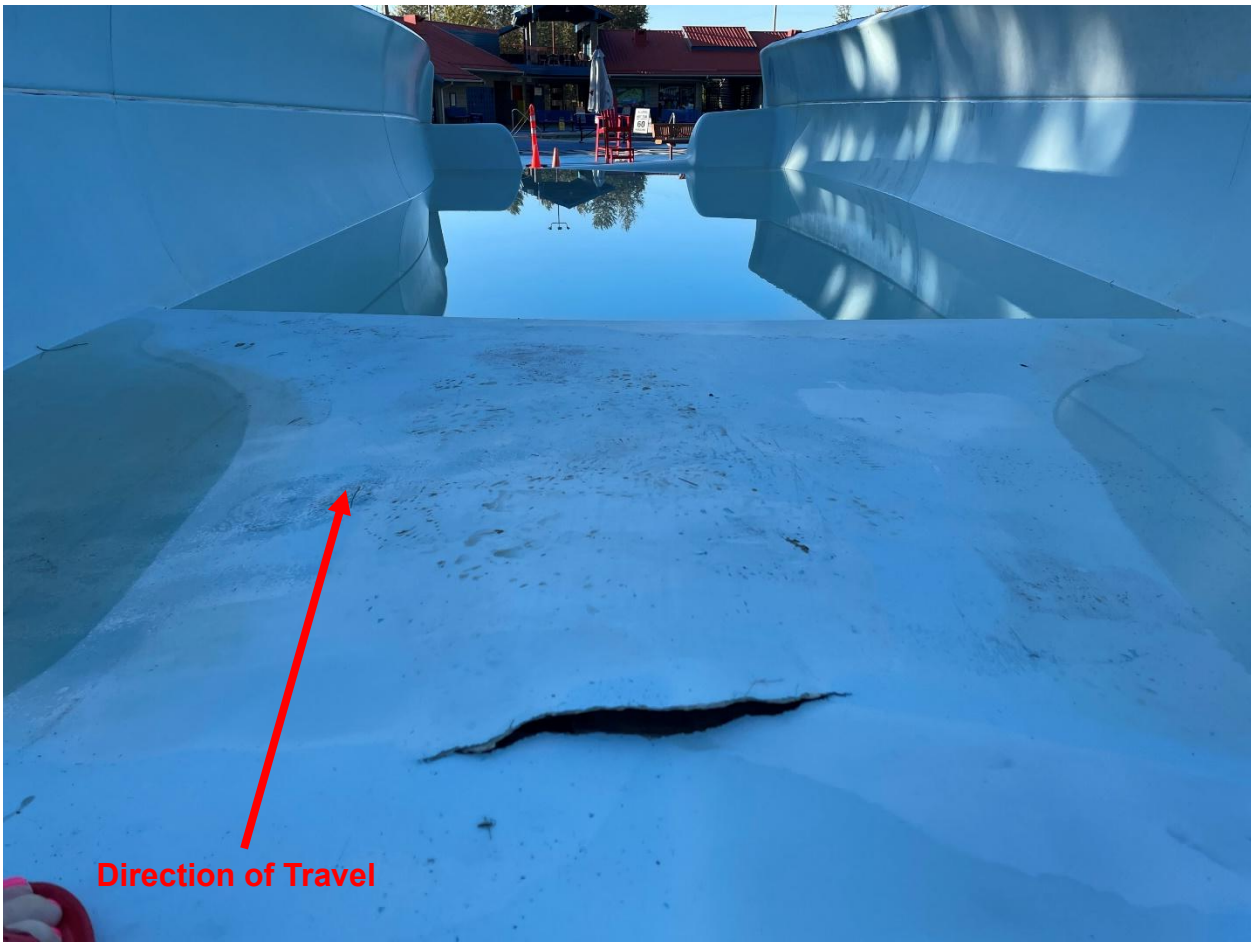


Figure 5 - Close-up of the failure showing direction of patron travel (Photograph provided by a Lead from the Waterpark)

Upon removal of the first layer of fibreglass, there was evidence of gravel being washed into the space between the two layers of fibreglass. The wood core was rotten and disintegrated to the point of no longer being present. The bottom layer of fibreglass was also fractured with the crack extending much further (and in multiple directions) compared to the crack on the top surface.

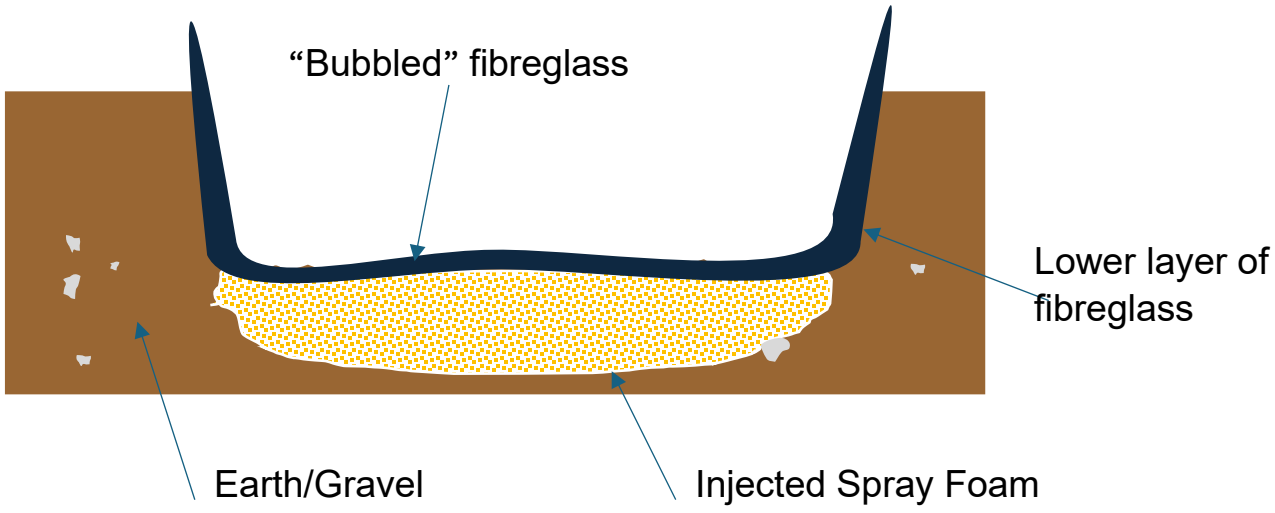


Figure 6 - Representation of the slide cross section at the time of the incident

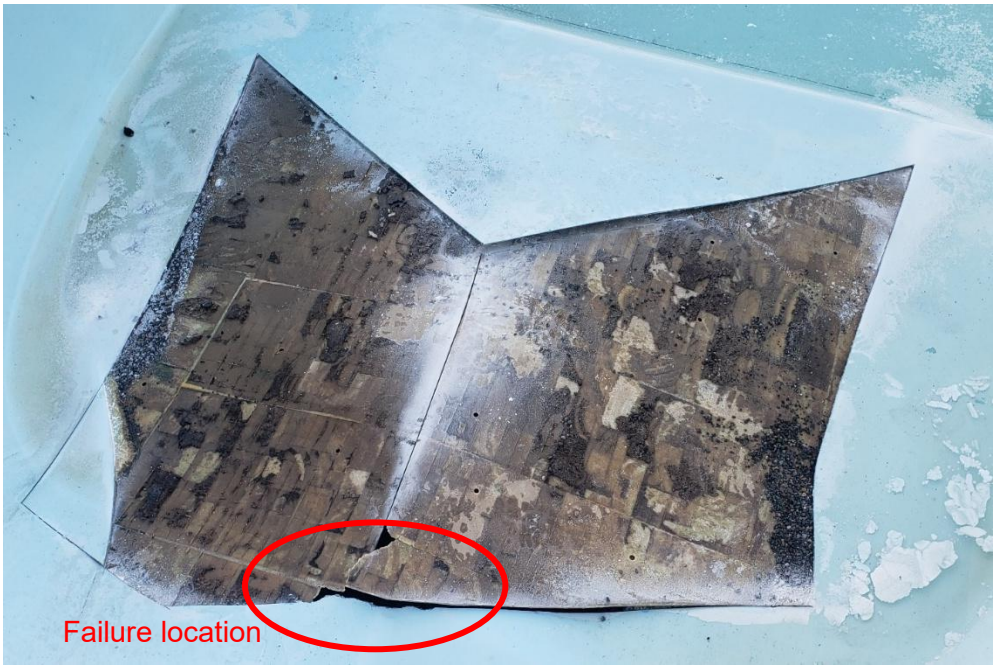


Figure 7 - Failure location, top layer of fibreglass removed. Note the wood core has completely disintegrated (Photograph provided by Fiberglass Contractor)

The bottom layer of fibreglass had a series of round holes drilled through it. Upon removal of the bottom layer of fibreglass, there was a thick layer of spray foam visible that had been injected beneath the slide to support it at some time in the past. However, the spray foam stopped short of where the crack was located leaving a gap between the ground and fibreglass flume.

Figure 8 - Failure location after bottom layer of fibreglass was removed. A large mass of spray foam was located beneath the flume, but did not fill the area below the failure (Photograph provided by fiberglass contractor).

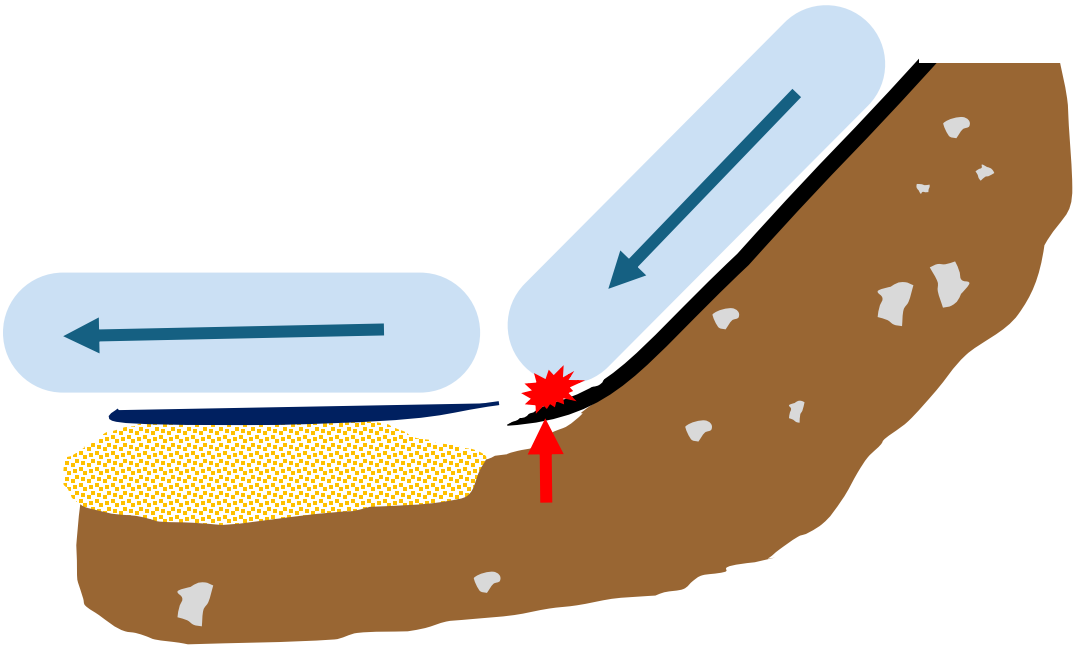


Figure 9 - Representation of the slide profile post failure. Tubes showing direction of travel and impact location.

Additional Slide Documentation

Technical Safety BC attended the site to document the Tube Slide's overall condition including the area of the crack on July 25, 2024, and again on August 13, 2024. Selected photographs taken during the slide inspection are included in Appendix F.

The Tube Slide was examined to document its condition post failure. The exterior of the slide was sitting on grass and dirt with some additional wood blocking at some joint locations. Except in some areas where the ground was partially washed away, the bottom of the slide was not visible for inspection (Image 1).

At the time of the field visit, the cracked section of the Tube Slide and underlying spray foam had been removed and the area was covered by a tarp (Image 2). The tarp was removed and the void between the slide and ground was measured to be up to 5 inches in some areas (Image 3).

The Tube Slide fibreglass flume sections were coated with a light blue gelcoat. Variations in colour in several areas on the flume sections indicated that it had been patched on multiple occasions in the past (Image 4). The flume sections were deformed and "bubbled" upwards in multiple locations, and when the staff members stood on them, they flexed downward and cracking sounds could be heard (Images 5 through 7). In other areas, the contours of the ground, including large rocks or ridges could be seen pushing on, and deforming the fibreglass from below (Image 8). Patches of exposed resin were visible in some areas where the gelcoat had been worn away (Image 9).

Cracks were noted in multiple locations along the Tube Slide flume surface, and in the fibreglass pools (Image 10 through 15). There were multiple cracks originating in the transitions between the sloped and flat sections on other flume sections in a similar location to where the incident crack was located on flume section 7. The area near these cracks was often bubbled and deformed and in locations where previous patches had already occurred. These cracked and bubbled areas are likely indicative of what the failed section may have looked like before the complete rupture occurred resulting in the injuries.

One such cracked section, was removed. Beneath the top layer, the wood core was rotten and could be wiped away by hand, similar to the failed location. In this location, the crack did not extend to the bottom layer. The removed section from the flume along with the sections removed from the Incident crack location were retained for materials analysis.

Materials Analysis Results

Technical Safety BC retained a materials engineering laboratory to assess the fibreglass from the failed section of the Tube Slide and comment on the mechanism of failure. Slide fibreglass samples including the failed section of Tube Slide and additional cracked areas were provided to the engineering consultant for analysis. The complete analysis can be found in the consultant's report (Appendix G). A summary of the findings is presented below:

1. Analysis of the fibreglass sections consisted of visual examination, visual analysis with the aid of high intensity backlighting, and scanning electron microscopy.
2. The evidence showed that the fibreglass slide material failed by a progressive fracture mechanism consisting of both fatigue (repeated stress) and sudden, brittle fracture.
3. Deteriorated wood core and missing ground support increased the rate of cracking in the fibreglass.
4. Any loss of support by ground erosion or by deterioration of the wood core pieces would have resulted in increased deflection of the fibreglass on both the outer and inner fibreglass sheets. Bending stresses in the fibreglass would increase due to the larger deflections incurred.
5. Small cracks in the fibreglass and gelcoat were visible by viewing the panels under high intensity light. These small cracks would eventually join up in the direction of principle bending stress and result in fibre breaks near the outer and inner surfaces of the panel.
6. The small cracks were visible throughout the removed fibreglass sections not just in the area of the "rupture" failure.

Flume Deflection and Spray Foam Alteration

Many waterslides are manufactured with only fibreglass cross sections without the need for internal reinforcement because of their semi-circular or circular cross sections which distribute the load and are naturally resistant to bending. However, the Tube Slide flume cross-section likely necessitated the addition of a wood core for rigidity and support against bending stress. The wide, nominally flat, section between the walls is highly susceptible to movement under bending. The addition of the wood for thickness would have increased the rigidity of the flat section and prevented excessive bending stress from being exerted on the fibreglass. It's likely that, once the wood core had deteriorated in the area of the failure from water ingress over the years, there was significant movement, and likely the formation of cracks. At some point in the past, the spray foam was added below this section to prevent the excessive movement.

However, the spray foam was injected from above through holes drilled in the fibreglass. This resulted in some areas receiving excessive foam which expanded as it cured (resulting in bulging), and other areas that were not supported by the foam (such as in the area of the failure which had no foam below it). Materials analysis of the cracked area found that, missing support in the area of the failure was a primary factor in the cause of the crack.

Waterpark Incident Reports

First aid records for the previous 3 years were reviewed. There were no significant lacerations noted that would relate to the fibreglass failure until the day of the Incident. On the day of the Incident there were 3 relevant incident reports (Appendix H – Waterpark Incident Reports).

The first one had a documented time of 2:45 on July 14, 2024. The first aid report was for a laceration to a foot. Two first aid workers attended and eventually an ambulance was called to attend to the wound as the attendants were unable to control the bleeding. The description of what occurred stated the patron was “on the tube ride and cut her toe on the large crack in the last pool before landing.”

The second one had a documented time of 3:15 pm on July 14, 2024. It stated the patron’s “Foot got caught in a crack on the tube ride and bent the wrong way. Light swelling (swollen to the touch).” Technical Safety BC interviewed the attendant who did first aid and they indicated that they were still attending to this first aid when the next one occurred and that the reported time was estimated.

The third first aid report was for the most severe injury and had a documented time of 3:45 pm on July 14, 2024. It stated the patron was “on the tube ride in the last pool there was a large crack. When her tube got into the last pool the crack ripped her right leg . . .”

Incident Timeline and Overview

Incident Timeline

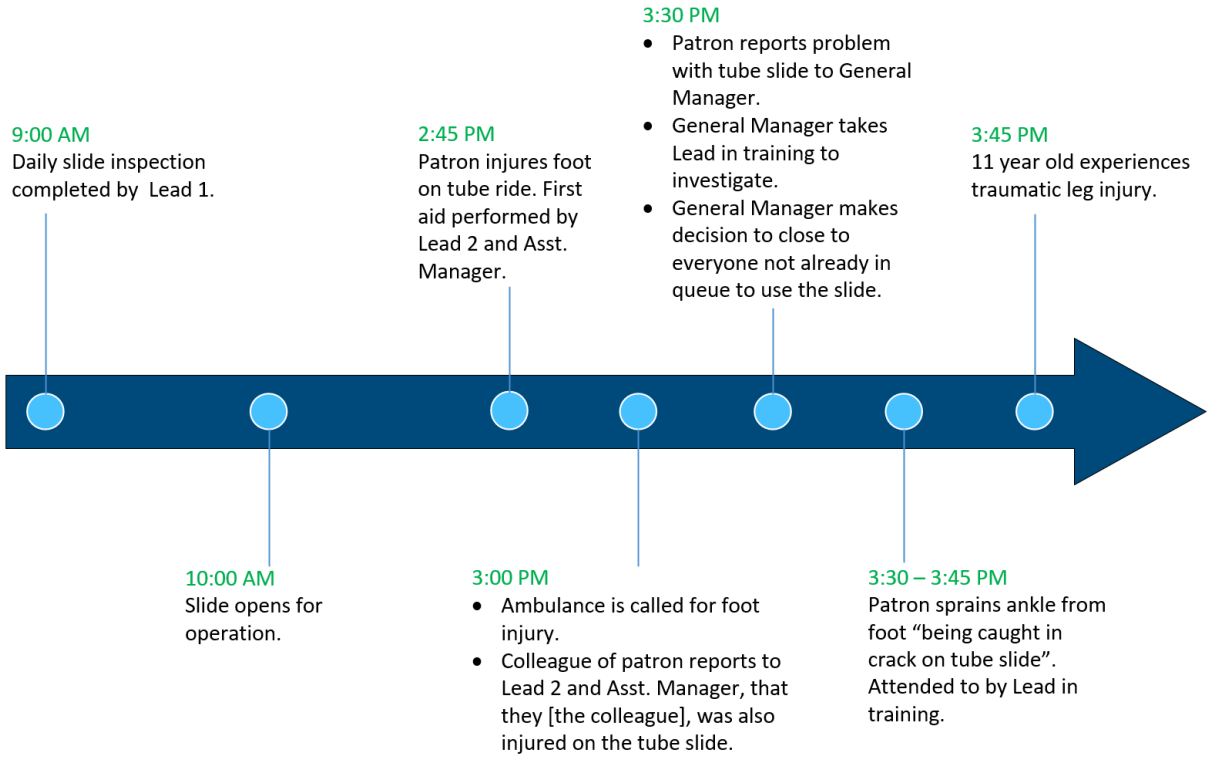


Figure 10 - Timeline of the Incident

Incident Overview

The Tube Slide was installed in 1983, and at the time, there was no requirement for the provision of detailed repair, maintenance or inspection practices by the manufacturer. Over decades of operation, and ownership changes, records and knowledge of previous maintenance and repair activities was lost. The current owner and maintenance contractor had no maintenance records of any kind for work completed on the Tube Slide; however, the patches on the slide indicated that many repairs had occurred. By 2024, the Tube Slide had degraded and weakened and the ground support was washed away in several locations; however, without knowledge of how the slide was manufactured, and what it was supposed to look and feel like, the extent of the degradation was not easily recognized in required visual inspections. In the area of the failure, the wood core had rotted away and, at some point in the past, spray foam was injected beneath it to support the fibreglass which was now flexible and soft; however, the spray foam did not extend all the way to the area of the failure.

On the day of the Incident, a slide inspection was completed at approximately 9:00 am by one of the Leads (Lead 1). The inspection did not identify any deficiencies in the area of the failure. Although a crack was likely present in that location, it's unlikely that any exposed, sharp edges were present at the time of the inspection. Lead's performed diligent slide inspections and consistently identified that if sharp edges were found on cracks they would be repaired before operation. With no deficiencies noted the Tube Slide opened with the waterpark at 10:00 am. At some point over the next several hours, as patrons used the slide, the pre-existing crack progressed rapidly. Additional force exerted by the waterflow likely flexed the unsupported fibreglass upstream of the crack downward, increasing its size and creating a hazard from the exposed downstream edge, which was bulged upwards from the previously installed spray foam.

At approximately 2:45 pm a patron received a severe laceration to their foot while progressing down the Tube Slide (Appendix H – Waterpark Incident Reports). The patron exited the slide and reported to the first aid room where the office manager began first aid. The office manager called for assistance from one of the leads (Lead 2) who came to the first aid room to help administer treatment. During first aid efforts, the patron reported that the injury occurred on the Tube Slide. In addition, a friend of the injured patron reported to Lead 2 and the office manager that their family had also experienced minor injuries and bathing suit tears on the Tube Slide. The staff members performing first aid did not immediately notify other staff members of where the injuries had occurred as they were occupied with treating the significant injury. Upon evaluating the injury and patron's condition, the lead and office manager decided to call an ambulance for the patron at approximately 3:00 pm. They made the General Manager aware that an ambulance had been called for a patron. At this time, the General Manager was dealing with vomit in the waterpark hot tub.

At approximately 3:30 pm, a patron reported an "irregularity" on the bottom of the Tube Slide to the General Manager. The General Manager took a lead-in-training to investigate. The crack was located near the base of a sloped flume section and was partially obscured by turbulent water. The General Manager and lead-in-training describe seeing different sized cracks at this time. The lead-in-training described the crack as 7 to 8 inches long. The General Manager described it as much smaller. Regardless, after watching some tubes go over the crack without getting snagged, the General Manager made the decision to close the Tube Slide. He and the lead-in-training began the process of closing the slide by blocking the access path, but those patrons that were already in the queue, or in the process of going down the slide, were allowed to continue down the slide.

Based on the perceived level of hazard created by the crack, the General Manager instructed one of the slide attendants to stand in the pool located upstream of the cracked flume section, and to try to push the tubes away from the crack as the riders went down (see image below). Several patrons and tubes progressed around and/or over the crack without injury.

Figure 11 - Photograph taken from the position of the slide attendant who was tasked with trying to direct tubes around the downstream failure.

After they had made the decision to shut-down the slide, an additional patron got their foot caught in the crack on the Tube Slide causing an ankle injury (See Appendix H – Waterpark Incident Reports). This was reported to the lead-in-training who treated the ankle.

Very shortly after, likely around 3:45 pm, an 11-year-old child was completing their run down the Tube Slide. The slide attendant attempted to push the child around the crack but saw that they passed directly over it. The child got out of the Tube Slide, and it was immediately evident they had suffered a major injury to their leg. First aid was provided, and an ambulance was called to take the child to hospital. Injuries were significant and required significant medical intervention.

Findings

Based on an analysis of the evidence available the following conclusions were made:

Flume Failure

THE FLUME FAILURE AND RESULTANT INJURIES WERE CAUSED BY A PRE-EXISTING CRACK (OR CRACKS) ON THE FLUME SURFACE AT THE BASE OF FLUME SECTION 7 OF THE TUBE SLIDE, WHICH LIKELY PROGRESSED RAPIDLY ON THE DAY OF THE INCIDENT RESULTING IN A SHARP EDGE THAT PROTRUDED DIRECTLY INTO THE PATH OF RIDERS PROGRESSING DOWN THE SLIDE.

From descriptions of the nature, time, and location of injuries discussed in this report, including the laceration to the foot and leg; all were the result of the same flume failure, at the base of flume section 7. On the morning of the Incident the crack likely would have appeared similar to cracks in other areas of the flume that had been present for some time and did not present an immediate hazard to riders. However, as a result of significant bulging, and deterioration of support in this area, rider impacts throughout the day caused the crack to rapidly progress during the course of the day before any additional inspections had occurred. Had the complete failure occurred prior to that day, the investigation found it likely would have been reliably identified as a hazard during daily inspections completed by Leads, and repairs would have been made before operation. Further, the rate of injuries once the failure occurred was high and first aid records and complaints related to the failure did not start until the afternoon of the Incident.

When the failure did occur, downstream bulging of the fibreglass, and the unsupported area upstream resulted in a height difference between the two edges which significantly increased the hazard associated with the crack and contributed to the severity of the injuries that followed.

THE CRACK PROGRESSED RAPIDLY BECAUSE THE STRUCTURE OF THE TUBE SLIDE HAD SIGNIFICANTLY DEGRADED IN TWO WAYS, RESULTING IN UNSUPPORTED, AND BULGED FIBREGLASS.

1) THE GROUND, WHICH HAD PREVIOUSLY SUPPORTED THE UNDERSIDE OF THE FLUME, HAD SHIFTED AND ERODED RESULTING IN VOIDS BENEATH THE FLUME; AND

2) THE INTERIOR WOOD CORE, MEANT TO PROVIDE STRENGTH AND RIGIDITY, HAD ROTTED AWAY SEVERAL YEARS PRIOR TO THE INCIDENT.

The Tube Slide is made of various sloped sections which transition to flat in order to push riders out into intermediary pools. This transition is the highest stress point on the slide as it has to redirect the weight of the riders and tubes, hundreds of times per day. The weight and speed (or momentum) of the riders is carried by the fibreglass flume and its support structure. Normally, the fibreglass surfaces of the flume are supported by an internal wood core built into the flume, and the entire flume is supported by the ground it is set in. However, at the time of the failure, both of these support systems had failed resulting in the fibreglass being forced to support the full load of the riders. The materials analysis showed that repeated loading and flexing of the fibreglass in this unsupported state resulted in a fatigue failure and cracking of the fibreglass including the rapid failure on the day of the Incident. The interior wood core was found to be rotten and completely missing in the area of the failure and significant voids, some previously filled with spray foam, were identified below the area of the failure. These are conditions which

take time and developed over the slide's many years of operation and were observed in previous years in various areas on the slide.

Assessment and Identification

IT IS LIKELY THAT THE IMMINENT FAILURE WAS NOT IDENTIFIED BY INSPECTIONS FOR TWO REASONS:

PRIOR TO, AND ON THE MORNING OF THE INCIDENT, ANY VISIBLE CRACKS LIKELY DID NOT MEET THE ESTABLISHED CRITERIA FOR DAILY INSPECTIONS TO FLAG THEM FOR REPAIR (I.E. NO EXPOSED SHARP EDGES).

Staff at the waterpark responsible for inspections were trained to carefully check each slide during daily inspections for any defects that may compromise the smoothness of the flume and injure a rider. The investigation found that staff diligently followed their training and it is likely that cracks with sharp edges would be caught prior to operation. Staff experience prior to the Incident was that cracks would typically either be long term, and benign, or would progress slowly until a sharp edge could be felt, at which time it would be repaired. As a result, the criteria that was used, which was found to be in line with typical industry practices, was that repairs were not necessary until a sharp edge or rough patch could be felt.

This incident shows that this criteria is not effective in preventing the observed failure because, when the right conditions exist, such as bulging and deformation, cracks can progress from smooth, to immediately hazardous between inspections.

THOSE PERFORMING INSPECTIONS WERE UNAWARE OF THE EXTENT THAT THE FLUME STRUCTURE AND SUPPORT HAD DEGRADED BECAUSE THEY HAD NO REFERENCE FOR HOW IT WAS SUPPOSED TO LOOK OR FEEL.

Deterioration of the slide flume likely occurred over many years. The wood core was likely rotten and missing since before the addition of spray foam which had occurred, at a minimum, 8 years before the Incident. Similarly, the ground support beneath the flume would have deteriorated over a period of many years from rain, water splashed from the slide, and movement of the ground. Staff who were hired and trained each year would have understood the current state of the slide as its "normal" state so long as it didn't change significantly from day to day. The Leads and General Manager stated that, prior to the Incident, they believed that the bulging and/or "soft spots" were not cause for concern, or were "features" of the flume surface meant to help direct or slow down patrons. Without any manufacturer's documentation, history of the slide, or other specific knowledge of the slide construction, they also indicated that they lacked the context of what the slide was supposed to look and feel like to assess the current condition of the slide.

Post Failure Response

THE EVACUATION OF PATRONS DOWN THE TUBE SLIDE ONCE STAFF WERE AWARE OF THE FAILURE, AND THAT IT POSED A HAZARD, LED TO ADDITIONAL AND MORE SEVERE INJURIES. THIS WAS CONTRIBUTED TO BY:

LIMITED COMMUNICATION BETWEEN STAFF RESULTING IN THOSE MAKING THE DECISION BEING UNAWARE THAT ANY OF THE PREVIOUS INJURIES WERE ASSOCIATED WITH THE FAILURE.

When the decision was made to evacuate patrons down the slide, those making the decision were not aware that injuries had already occurred as a result of the cracked flume. When patrons made staff performing first aid aware of where the injuries occurred, that information was not passed along to the remaining staff members or management. Although the General Manager was aware that at least one significant injury had occurred (that required an ambulance), they never inquired as to the source of the injury or attempted to investigate whether an ongoing hazard existed. When the General Manager was viewing the crack and making the decision to evacuate patrons down the slide, they did not make the connection that the crack and injuries could be related. As a result, the visual inspection of the crack was the only information used to assess the risk it posed.

RELIANCE ON AN OBSTRUCTED VISUAL INSPECTION OF THE CRACK WHICH LED TO THE INACCURATE ASSESSMENT OF THE SEVERITY OF THE HAZARD.

The visual assessment of the crack was primarily hampered by two factors. First, the visual assessment was done from outside the slide, standing on the hillside. This perspective would not have been ideal for observing the crack because of the distance which may not have made the size of the crack, or vertical offset between the two sides obvious. Second, the crack was located beneath a layer of turbulent water during Tube Slide operation. As a result, the visual inspection would have been hampered significantly by the water. This was reflected in the statements of the two observers who provided very different accounts of the size of the crack when it was first inspected. The General Manager stated that they also observed several of the tubes pass over the crack “without snagging” and therefore felt the risk was low. Still, instruction was provided to slide attendants to try and direct the remaining patrons being evacuated down the slide from going over the crack, which indicated that they perceived that the crack posed some level of hazard. There was no attempt to have staff members enter the flume to investigate or feel the crack, despite it being normal for slide attendants to stand in the water during morning inspections or during operation to help patrons down the slide.

Recommendations

This was a serious and impactful incident to all parties affected. Technical Safety BC is issuing three recommendations to support industry in making changes to inspection, and response procedures to prevent this type of incident from happening again.

Recommendation #1: To Owners of Fibreglass Waterslides

IT IS RECOMMENDED THAT DAILY INSPECTION PROCEDURES AND TRAINING SPECIFICALLY DETAIL THE NEED TO IDENTIFY BULGING, MOVEMENT OF THE FLUME, OR DEVIATION OF THE FLUME SHAPE WHEN IT IS LOCATED DIRECTLY IN THE PATH OF RIDERS. IF ANY OF THESE DEFICIENCIES ARE IDENTIFIED, IT IS RECOMMENDED THAT THEY BE IMMEDIATELY ASSESSED, AND SCHEDULED FOR REPAIRS.

The incident showed that bubbling, flume movement, and deviation of the flume from its original shape are evidence of significant structural issues with the flume that can result in sudden and severe failures of the fibreglass. Current industry standards, checklists and guidance around daily or pre-season checks do not specifically call out these issues, or the potential hazards associated with them. This incident showed that cracks in these locations can initiate, and progress rapidly, but bulging and movement of the flume is often detectable before the cracks

initiate. Since many waterslides are unique, and subject to unique conditions, owners and manufacturers should ensure those performing inspections and assessments have sufficient knowledge about the unique properties of the slides to identify when areas of concern require repair.

Recommendation #2: To Owners of Fibreglass Waterslides with Hidden Flume Supports and/or Structural Cores

IT IS RECOMMENDED THAT PRIOR TO EACH OPERATING SEASON, OR AT LEAST ONCE ANNUALLY, OWNERS HAVE COMPLETED A DETAILED SLIDE CONDITION ASSESSMENT BY A MANUFACTURER'S REPRESENTATIVE OR OTHER THIRD-PARTY QUALIFIED INDIVIDUAL TO IDENTIFY ANY DETERIORATION OF THE CORE AND/OR FLUME SUPPORTS THAT SHOULD BE MONITORED OR REPAIRED.

In this case, the internal wood core, as well as the in-ground installation of the slide degraded in a way that was not easily identified through a visual inspection. Both of these aspects of the slide construction were fundamental to the structural integrity of the flume. Slowly progressing changes to the flume shape, orientation, and strength were never identified or flagged for the owner to repair until eventually, a large failure occurred. Detailed annual inspections by someone with knowledge of the original slide construction can help identify visual indicators or slow progressing changes to the flume that might not be identified during regular daily inspections.

Off-season inspections also ensure there is adequate time for repairs, and changes without the pressures associated with mid-season inspections and any off-season changes to the flume will be captured. Owners are reminded that repairs are not only surface level and should address underlying structural issues to ensure defects will not return.

Recommendation #3: To Owners of Fibreglass Waterslides

IT IS RECOMMENDED THAT OWNERS TRAIN ALL OPERATORS AND ATTENDANTS TO, ONCE NOTIFIED OF AN UNSAFE CONDITION IN A FLUME SURFACE, IMMEDIATELY CEASE ALLOWING PATRONS TO ENTER, OR CONTINUE DOWN A SLIDE, UNTIL SUCH TIME AS THE CONDITION HAS BEEN INVESTIGATED THROUGH A DIRECT, AND HANDS-ON ASSESSMENT BY A STAFF MEMBER QUALIFIED TO PERFORM SLIDE INSPECTIONS.

In this incident, following a report of an unsafe condition, a decision was made to close the slide; however, patrons were allowed to continue down a flume section with a known hazard, resulting in the most serious injury. Owners, attendants, and operators are reminded that under the Act, the use of a regulated product, in this case a waterslide, where an unsafe condition exists is prohibited. When a possible unsafe condition is reported, staff have a responsibility to prevent the use of the slide until they investigate and assess whether there is a risk to the public. This incident establishes that visual only assessments, while the slide remains in operation, is unlikely to provide sufficient information to make an accurate assessment of the risk. As typical daily inspections involve staff members entering the flume, with the water off, and using their hands to evaluate the flume surface; a similar approach is reasonable when possible unsafe conditions are reported during operation.