



APPLIED TECHNICAL SERVICES, INCORPORATED



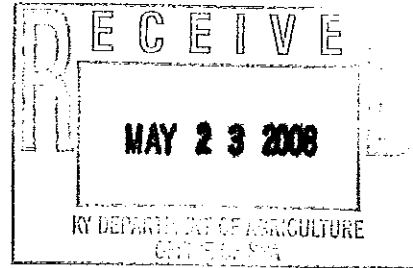
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May 20, 2008

"Privileged Work Product"

Mr. Clint Quarles
Staff Attorney
Kentucky Department of Agriculture
500 Mero Street, 7th Floor
Frankfort, KY 40601



Re: Six Flags Kentucky Kingdom
Tower of Power Ride Incident of 6/21/2007
ATS Job # D125113
Your P.O. # PO2 035 0800015306 1

Dear Mr. Quarles:

I have reviewed the IMR report dated January 17, 2007 that detailed the analysis on the wire rope samples from the subject ride. I have also reviewed the tensile testing data that was provided by CTL Group on the exemplar and subject 11 mm wire ropes. In addition to these documents, you have provided me with certain sections of the ride manual, and some photographs of the area of the hoisting mechanism which was located at the top of the tower.

The metallurgical testing conducted on the wire ropes indicate that the failure was caused by fatigue. This is a progressive failure mechanism where breaks of individual wires (flat fractures) occur over repeated load cycles resulting in reduction of the load carrying capacity of the rope. This condition ultimately leads to complete separation via overload of the remaining intact wires (cup-and cone fractures) since they can no longer support the load. The photograph that was provided suggests that the hoisting system consisted of traction sheaves (tackle block system) rather than a drum. Regardless, all wire ropes operating over drums or sheaves are subjected to cyclic bending stresses, hence the rope wires will eventually experience fatigue failures. Relationship between sheave (D) and rope (d) diameters is a critical factor in defining the rope's expected service life. Depending on the construction of the rope, industry standards contain specified or suggested minimum D/d ratios. For example, ASME A17.1 Safety Code for Elevators and Escalators specify a minimum ratio of 40, which would have meant a 440mm diameter sheave for this size rope.

Some of the microscopic features (i.e. untempered martensite-referred to as white layer in the IMR report) found on some of the wires during the inspection also indicate that there was excessive frictional heat generated between the rope and the traction sheaves during the operation of the ride. A KKI maintenance personnel has reportedly testified about slippage problems and use of corn starch to reduce this slippage. The condition of the rope (lack of lubrication and presence of rust) in the section of the rope that coincides with the area of the rope that is within the traction sheaves is consistent with this KKI practice. The ultimate failure appears to have occurred within this portion of the rope during the initial upward movement of the vehicle where the maximum lifting load is most likely being experienced due to the resistance of the magnetic brakes.

Review of the mechanical test data generated by CTL Group indicated that the various sections of rope removed from cars 3 and 5 along with a new rope were tested to determine their breaking loads. The wire rope's tensile strength (approximately 25 kips) met the expected levels for 8X19, 11 mm wire rope with the exception of one sample which was believed to have been removed from the "affected zone" (i.e. at 127 ft location) of the sister rope, labeled "3R". The breaking load was approximately 35 % lower for this section demonstrating the effect of broken wires. Assuming that both ropes carry approximately the same amount of load, the failed rope, "3L", possibly had its strength reduced further due to the broken wires, which may explain why it was the one that broke during the incident.

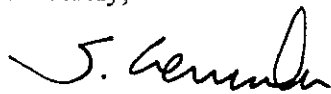
Although I have not investigated the various factors that may have played a role in developing the fatigue cracks (e.g. whether the subject rope is the appropriate rope for this application, if the sheave diameter/rope diameter ratio meets the requirements, possible cause(s) of rope slippage, to name a few), the progressive nature of the failure would have made it possible for the maintenance personnel to detect the deterioration if they had followed the manufacturer's instructions detailed in section 2.3 of the Mechanical Maintenance Manual¹, which are consistent with standard industry practice of wire rope inspection methods. Paragraph 2.3.6.2 of the supplied manual allows a maximum of 2 fractured wires over a length of 66mm (6d) and 4 fractures over a length of 330mm (30d). Crack count data given in Tables 18 through 20 in the IMR report shows that the allowable values were exceeded greatly.

It was reported that the ropes on the subject ride were last replaced in 2003, and periodic inspections by the park personnel were performed over the entire length. Details of park personnel's inspection techniques were not provided. The "rag test", which is specified in the maintenance manual of the ride, typically consists of wrapping a cotton rag around the rope while it is run, and relies on the rag to be snagged by broken wires. However, if the broken wires are still tightly wound and in line with the rope without any protruding wires, they could possibly go undetected using this technique. Therefore, the possibility of not detecting the fractured wires using the "rag test" makes a complete visual inspection necessary. Such an inspection was also specified in the ride's maintenance manual, to be performed monthly, along the entire length of the rope after removing the dirt and lubrication off the rope's surface.

The extent of progressive (fatigue) cracking would have made it possible for the park personnel to detect the deteriorating condition of the rope had they been following the inspection instructions given in the maintenance manual.

The author reserves the right to modify, change and/or supplement any opinions and analysis contained in this report if and when additional information becomes available.

Sincerely,



Semih Genculu, P.E.
Manager, Materials Testing

¹Mechanical Maintenance Manual, Chapter 8, P-297 Giant Drop, 23.1.98/V5.1