Water Slide Design

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Abstract

The Water Slide Design project dealt with the structural and hydraulic design of a water slide for use at Sesame Place in Langhorne, PA. The design goals of the project were to create a water slide that is fun and exciting for children who are 7-9 years old to increase the appeal of the theme park. The design of the slide included the determination of the flume geometry and subsequent structural and hydraulic design. A dynamic analysis was performed on the flume geometry, once finalized, to determine the critical loading conditions that were used in the structural design of the slide. The structural design involved the design of the flume sections, supports positioned at every-other flume connection, and a queuing structure used to access the top of the slide. The structure was designed with HSS 20.00x0.5 circular steel columns with HSS 8x8x1/2 and HSS 6x6x5/8 square members for bracing. The hydraulic design of the slide involved the modeling and selection of the design flow rate within the flume and the design of a pumping system capable of delivering that flow to the top of the water slide. A 2-dimensional unsteady flow model was created within HEC-RAS, from which the design flow rate was selected to be 0.25 cubic feet per second. The design flow rate was used to calculate the head required of 73.27 feet from the pump. A straight centrifugal pump was selected that can deliver the needed flow at the required head. The estimated engineering services and construction costs for this project are $62,800 and $250,700, respectively.

Design/Methods

Structural Design

- Designed flume geometry and standard sections based on industry standards [1] [2] (Figure 1)
- Determined loading conditions and quantities [1] [2] [3]
- Determined critical live load of rider through dynamic analysis
- Designed location of columns and attachment points of supports (Figure 1)
- Designed cantilevers, cantilever bracing, and columns for deflection, shear, moment, and compression for the slide and queuing structure [4] (Figure 1)

Hydraulic Design

- Created a 2-dimensional unsteady flow model within HEC-RAS [5]
- Simulated a range of flows to determine the optimal flow rate that gave appropriate maximum depths and velocities (Figure 2)
- Designed a piping/pumping geometry based on the slide structure (Figure 3)
- Calculated the head required at the design flow rate based on pipe diameter and piping system geometry
- Selected a pump to be used: Straight centrifugal high head pump by Goulds Water Technology

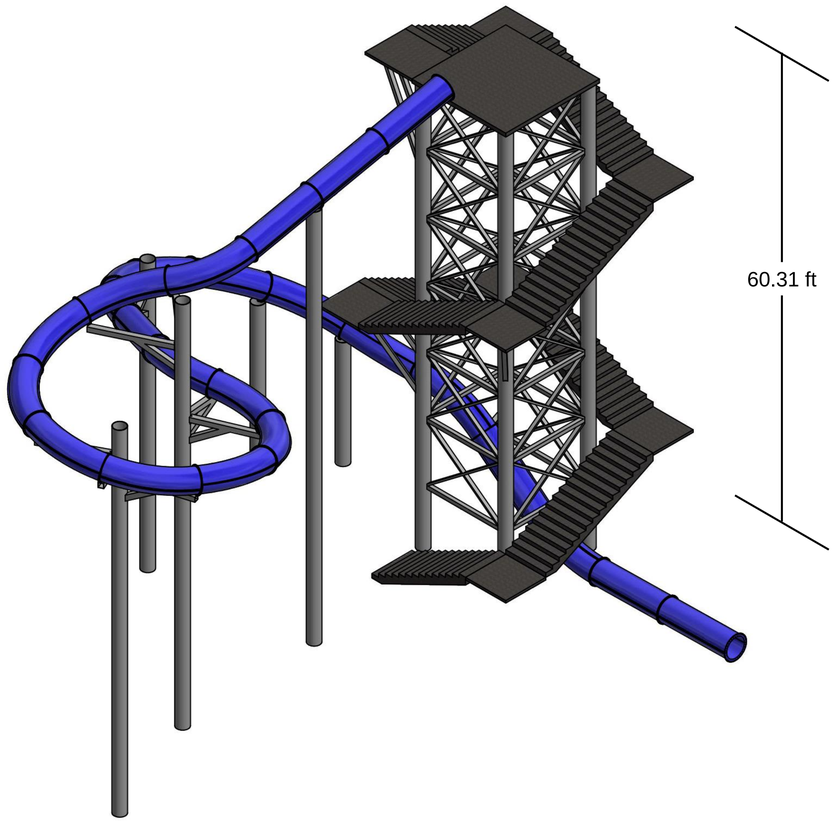

Figure 1 - Isometric View of Water Slide Structure

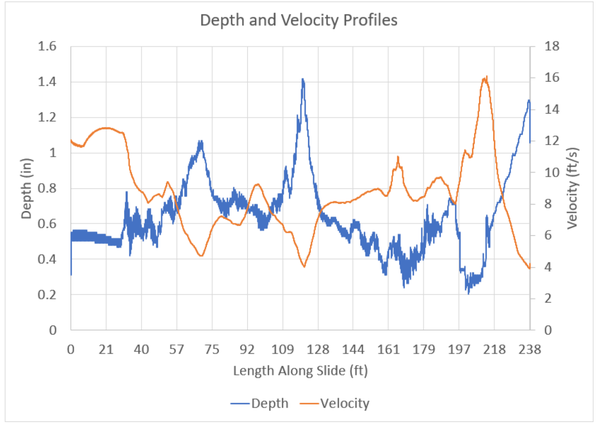

Figure 2 - Depth and Velocity Profiles

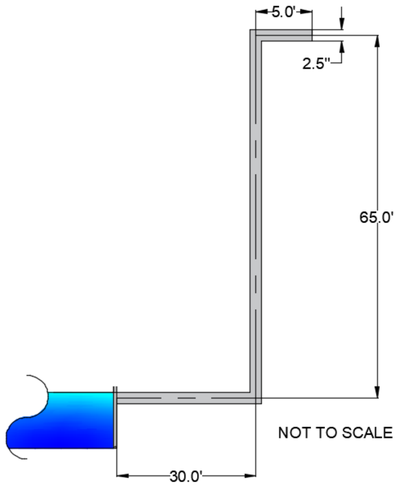

Figure 3 - Pumping Configuration

Results

Table 1 – Summary of Water Slide Geometry

Water Slide Geometry	
Total Height	60.31 ft
Total Length	237.36 ft
Average Length per Section	10 ft

Table 2 – Summary of Water Slide Structural Design

Structural Design	
Structural Members	
Element	Member (A500 GR.C Steel)
Queuing Structure Bracing	Square HSS8x8x1/2
	Square HSS6x6x5/8
Cantilevers	Square HSS8x8x1/2
	Square HSS6x6x5/8
Cantilever Bracing	Square HSS8x8x1/2
Columns	Circular HSS20.000x0.500

Table 3 – Summary of Water Slide Hydraulic Design

Hydraulic Design	
Flow Design	
Design Flow	0.25 cfs
	112.50 gpm
Maximum Depth of Flow	0.12 ft
	1.44 in
Maximum Velocity of Flow	16.14 ft/s
	10.98 mph
Pump Design	
Pipe Diameter	2.50 in
Required Head	73.27 ft
Change in Elevation	65 ft
Pipe Length	100 ft
Pump	Straight Centrifugal High Head Pump

Conclusion

The standard flume sections and slide geometry were designed for a fun water slide. The cantilevers, cantilever bracing, and columns for supporting the flume and the columns and supports for the frame of the queuing structure and its staircase were designed for deflection, compression, moment, and shear in accordance with the AISC Steel Manual [4]. The flow rate within the flume was modeled in 2-dimensional unsteady flow in accordance with practices outlined in the HEC-RAS Hydraulic Reference Manual [5], and the pumping and piping system were designed based on standard practices and technical specifications from the pump manufacturer.

References

[1] ASTM F2291-18 (2018)

[2] ASTM F2376-17a (2017)

[3] ASCE 7-02 (2002)

[4] AISC Steel Construction Manual, 15th Edition (2017)

[5] HEC-RAS Hydraulic Reference Manual (2016)