Hydraulic Modeling an Olympic Example John Felton - Design Director WPI

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Physical Hydraulic Modeling





Purpose

- 1. inform the detailed design phase,
- 2. provide a basis for any necessary revisions
- 3. establishes an initially compliant obstacle configuration and whitewater features that will effectively demonstrate Olympic technical specifications can be achieved.

Objective - Satisfy Olympic Technical Specifications

- 1. Optimise hydraulic performance and mitigate energy losses
- 2. Obstacle / obstruction positioning to deliver interesting and useable whitewater features of Olympic caliber
- 3. Specified depths achieved/exceeded in flow, features and eddies
- 4. Optimal velocities achieved in flow, features and eddies
- 5. Flow and obstacle adjustments for legacy flows.
- 6. User safety
- 7. Achieve IF Technical Delegate sign off

Physical Hydraulic Modeling



As noted, for calculations and comparing the full size project with the 1:13 scale model, we used Froude similitude. The following tables (Table 2-1 & Table 2-2) show the relative conversions for each type of unit. Example 2-4 below demonstrates how a scaled flow rate was practically applied to model function.

Parameter	Symbol	Dimension	Scale of Similarity	Model scale
Length	L	m	ML	1 : 13
Area	S	m²	ML ²	1 : 169
Velocity	v	m/s	ML ^{1/2}	1 : 3,605
Discharge	Q	m³/s	ML ^{5/2}	1 : 609,3

Table 2-1 Model Parameters and Froude Similitude Scaling

Table 2-2 Froude Scale Dimensional Conversions for 1:13 Scale Model

	Full Size	Unit	Model	Unit
Parameter	Course			
Length	250	m	19,23	m
Max slope	2	%	2	%
Min slope	0	%	0	%
Two drops	0,5	m	38,46	mm
Elevation	4,5	m	0,35	m
Flow rate - Olympic Configuration	12,0	m³/s	19,69	l/s
Flow rate – Legacy Configuration	9,0	m³/s	14,77	l/s

Hydraulic Modelling













Main Current – Course Centerline

Nominally 1.5m deep Minimum depth 600mm throughout No overtopping

Hydraulic Feature – Hydraulic Jump Acceptably stable

Minimal surging Olympic suitable



Eddy – recirculating current upstream

Minimum 1m depth Maximum 1.5m/s velocity Minimal surging



- The design is set out in scaled drawings to provide model construction detail
- Relevant calculated location points are laid out on the floor of the laboratory.
- Construction tolerance of +/- 2%.

Construction Materials include:

1. Plywood and brick/mortar support structures



- 3. Extruded polystyrene for construction of banks and obstacles
- 4. Steel plates for creating channel floor/walls
- 5. Magnets obstacles are equipped with magnets (size D = 5 mm



Physical Hydraulic Modeling - Video









The Easy River



Hydraulic Modeling





Computational Modeling for Easy River and Integration to Hydraulic Model







(Loop Pumps Off) - OLYMPIC CHANNEL CONFIGURATION



Operating – OPTIONAL OLYMPIC CHANNEL CONFIGURATION

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