Quarterly Progress Report

Jerome B. Johnson

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Project Name:	Eagle Hydrokinetic Project - Eagle Hydro - INE - Debris - Anchoring
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Period of Report:	October 2012, through December 2012.

Introduction

The debris mitigation project goals are to:

(1) Develop a test debris mitigation platform that will allow us to test various debris mitigation technologies and methods. (completed)
(2) Prepare the Nenana test site infrastructure (e.g., anchoring/mooring system) to be able to accommodate the debris mitigation platform tests (completed) and possibly retest the New Energy Turbine, as appropriate (Cost estimates to refurbish the New Energy Turbine and our work on debris testing indicates that it is beyond the scope of this project retest the turbine as part of this project).
(3) Obtain necessary permits and conduct the necessary baseline studies to prepare for the debris mitigation testing. (completed)
(4) Conduct the debris mitigation technology and debris management methods testing (completed).

Note: With all major tasks of the project completed we are now analyzing data with the intention of completing project reports and providing recommendations on debris mitigation technology and methods.

Refer to previous quarterly reports for a general description of the project and activities to-date. Previous quarterly reports were submitted on 10/15/2011, 1/16/2012, 4/3/2012, 7/24/2012, and 10/18/2012.

Activities and Progress

During October through December we stored equipment and started sorting and started analyzing data from the summer tests of the Research Debris Diversion Platform (RDDP). Our analysis objective is to understand the factors that affect RDDP effectiveness at shedding surface debris and the RDDP's affect on downstream current flow. We conducted an analysis of a debris diversion boom to determine the factors that are important to its operations. The derivation result show that the forces that determine if a debris object will be pinned to or swept off of a derivation boom depend on the balance between forces that push the debris along the boom and the resistance force of the boom.

When the friction forces equal or exceed the sweeping forces then the debris is pinned to the pontoon rather than swept downstream. This condition is expressed as the inequality:

$$Q = \frac{F_{pE}+F_{p\eta}}{F_{\mu}} > R. \qquad (1)$$

Where F_{pE} is the force of water acting on the upstream end of a debris object, $F_{p\eta}$ is the drag force of the water in contact with the surface of the debris object. These two forces are the driving forces that act to sweep a debris object along a diversion booms surface. F_{μ} is the force of friction between a debris object and the diversion boom's surface a resistance force that the driving forces must overcome. When the ratio Q is greater than R (R is a threshold value of sliding) then debris will slide along the RDDP pontoon, the condition expressed in Eq. 1. If Q is less than R then a debris object will be pinned to the RDDP pontoon. Using simplified expressions for the force relationships to the current velocity (V), angle of the RDDP (θ), friction coefficient of debris against a diversion boom (μ), and the ratio of debris length to its radius (β) gives

$$Q = \frac{\pi \, \mathrm{V}\cos\theta\left(\mathrm{V}\cos\theta+\frac{\beta}{2}\right)}{2\mu\beta(\mathrm{V}\sin\theta)^2} > R. \qquad (2)$$

This equation indicates that as (θ) increases Q decreases, as V increases the contribution to sweeping forces from viscous drag decreases (hence Q decreases), as the friction coefficient increases Q decreases, and as β increases Q decreases. What all this means is that debris diversion boom effectiveness improves when the angle between the diversion pontoons is decreased and a low friction surface covers the diversion pontoons. It also means that for a given boom design effectiveness is better for debris that has larger diameter and shorter length and the effect of increasing current velocity depends on the debris type.

As part of this report I have placed several videos showing results from our RDDP tests conducted this past summer. The videos can be downloaded from a browser

http://ine.uaf.edu/temp/jbj

The videos will be left on the server for one month and then they will be taken down.

2_RDDP_overview_fin.mov – shows the RDDP moored in the Tanana River. The finned nose can be seen turning in the current.

3_Highlight__7-27-2012_Trapped_Log_fin.mov – shows a debris impact test that became torque balance on the RDDP when the nose was finned.

4_RDDP_DebrisShedingTest_Plastic.mov – showing a debris shedding test with a non-finned, low-friction plastic covering on the RDDP nose. The debris initially turned the

nose cylinder clockwise on impact then the river torque cause it to move counterclockwise before shedding.

5_RDDP_Plastic_debris_sheding_easy.mov – shows how easily debris is shed when it doesn't impact directly in the center of the debris length.

6_RDDP_wide_angle_debris_trap_Plastic.mov - showing a debris log that is shed off of the nose, but becomes pinned to the diversion pontoon. This occurred when the angle between the RDDP pontoons was at their widest angle.

Explanations about the mechanisms of interaction between the RDDP and debris are described in the 10/18/2012 quarterly report.

Planned activities for the next quarter

During the next quarter we will continue organizing ADCP and video data, continue analyzing ADCP data to determine the effect of the RDDP on current flow velocities and turbulence and start developing conceptual and physical models of RDDP interactions with debris. Examining the video and ADCP data and conducting analysis of it has turned out to be a major effort. Especially since we have, and continue, to develop a physical sense of the factors that control how well the RDDP sheds debris. To turn this physical sense into physical models that can be used to guide RDDP design and operation for users interested in using debris diversion booms to protect hydrokinetic devices will extend our project work past the current end date of the projects. I have asked Gwen to request a no-cost extension to the project though the end of the calendar year to allow us to do a thorough job of data analysis and interpretation. I expect the outcome will be more sophisticated understanding of how debris interacts with diversion boom than was discussed in this report.