

Inland Marine Transportation System (IMTS)

Welcome to IMTS On-line Seminar

Date and Time:

Monday, Nov 1

1 pm CENTRAL (2 pm EASTERN, 11 a.m. Pacific)

Topics and Speakers:

McAlpine Bushing Failures by Richard Nichols, LRL

Applications of Self-Lubricating Materials in Portland District by Ron Wridge, NWP

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PARTICIPANT CODE: 551996

Please Mute your phone unless you are asking a question or making a comment!

Regional Navigation Design Team

Chairman: Steve Stoltz, LRP

To get copies of today's presentations:

They will be posted on Navigation gateway: we will provide a link

You can request a copy from the speakers or by sending an e-mail to IMTS@usace.army.mil

Regional Navigation Design Team Meeting

15-16 September 2010

Olmsted Lock and Dam

Applications of Self-Lubricating Materials in Portland District

The Dalles Miter Gate – Use of Composites Materials for Adjustable Quoin and Miter Blocks

Portland District

Prepared By:
Ronald S. Wridge, PE
Mark J. Sawka, PE

Replacement: Matt Hess

TOPICS:

Self-Lubricating Materials

Review of Applications

Testing Results

Lessons Learned

Design Criteria

Advantages, Disadvantages, & Costs

Case Studies

The Dalles Navigation Miter Gate

Use of Composites Materials for Adjustable Quoin and Miter Blocks

Applications in Portland District

NON-NAVIGATION

Bonneville Swing Bridge

- Center Pivot Bearing
- Centering/Lifting Wedges
- Balance Wheels

Other Applications

- Tainter Gate Trunnion Bushings
- Tainter Gate Thrust Washers
- Tainter Gate Hoist Rope Anchorages
- Numerous Applications in Fish Collection and Transportation Facilities, Spillway Gates, Power Generation, etc



Applications in Portland District

NAVIGATION

Bonneville

- Floating Mooring Bit, Guide Rollers, Reaction Rollers, and Lower Guide Plates
- Filling and Emptying Valve Trunnion Bushings
- Miter Gate Pin Bushings

The Dalles

- Filling and Emptying Valve Trunnion, Crosshead, and Line Shaft Bushings
- Sector Gear Pin Bushing and Support Roller Bushings
- Miter Gate Pin Bushings
- Miter Gate Pintle and Gudgeons

John Day

- Filling and Emptying Valve Trunnion, Crosshead, and Line Shaft Bushings
- U/S Navigation Lock Lift Gate Reaction and End Guide Rollers
- U/S Navigation Lock Lift Gate Counterweight Guide Blocks
- U/S Navigation Lock Lift Gate End Plate Rub Plate
- D/S Lift Gate Reaction and End Guide Rollers



Typical Design Criteria/Parameters

Self-Lubricating Polyester Composites:

Design Contact Stresses

Dynamic: 5,000 to 10,000 psi

Static: 15,000 to 20,000 psi

Crush Strength: 50,000 psi

Coefficient of Friction

Observed: 6% to 10%

Design: 15%

Mating Surface Material

Stainless Steel

Surface Texture of Mating Surface

Frequent Operation: 16 micro-inches

Infrequent Operation: 63 micro-inches

Mating Material Surface Hardness

30 Rockwell C (preferable)

Installation Methods:

Epoxy Bonded (preferred)

Shrink Fit

Bonding Radial Clearances:

0.020-0.030 inches

Bearing Clearance Rule of Thumb

0.001 inches per inch of bore dia.
with a minimum of 0.005 inch



Testing Results

CERL Technical Report 99-104: Greaseless Bushings for Hydropower Applications: Program, Testing, and Results (1999)

- USACE HDC and BC Hydro jointly developed testing procedures and rating system for wet and dry applications
- Testing Performed by Powertech Laboratory Inc.
- Self-Lubricating Material Manufacturers submitted samples for testing
- Materials ranked by performance
- New Material Testing Ongoing (2010 cost per sample \$20,000)

Navigation Lock Self-Lubricating Pintles (2004)

- Panama Canal Authority developed testing procedures for self-lubricating pintles
- Testing Performed by Powertech Laboratory Inc.
- 200,000 cycles in brackish water
- Tested at 870 psi vertical pressure and 665 side pressure



Lessons Learned

- Specify self-lubricating materials that have been successfully tested by an independent party (Powertech)
- Bushings bonded in place have advantages over those installed using a shrink fit
- 17-4 PH stainless steel is an excellent mating material
- For marine applications in salt/brackish water 316 stainless steel is recommended
- Chamfer edges to prevent excess edge loading and eliminate edge failure
- Only use self-lubricating materials that contain graphite in absolutely dry applications
- Plugged bronze self-lubricating materials tend to be less effective
- Use stainless steel wires to center bushing in housing when bonding in place
- Design Consideration: Preferable to use seals in debris laden marine environments (easily accomplished with O-rings or wiper seals)
- Chroming of the mating surface does not replace the use of stainless steel
- Retrofit Applications: A corrosion inhibitor (grease) can be used to prevent corrosion of existing carbon steel components when switching to self-lubrication materials
- Do NOT rely on Contractor designed self-lubricated bearings
- As a general rule the harder and smoother the mating material the better



Advantages, Disadvantages, Cost Differences

Advantages

- Lower Coefficient of Friction (0.06 to 0.1)
- Higher allowable loads
- Reduce Environmental Impacts as Compared with Petroleum Based Lubricants
- Decreased maintenance
- Dependable Lubrication in the Loaded Zone
- Surety of Lubrication System
- Easier to Machine
- Eliminates Galvanic Corrosion
- Reduces the Occurrence of Stick Slip
- Allows For Easy Replacement

Disadvantages

- Newer Technology, newer design paradigms
- Typically Requires Stainless Steel Mating Surfaces
- Recommended for Low PV Applications

Cost Differences

- Capital Costs are roughly the same
- Lower Life Cycle Costs



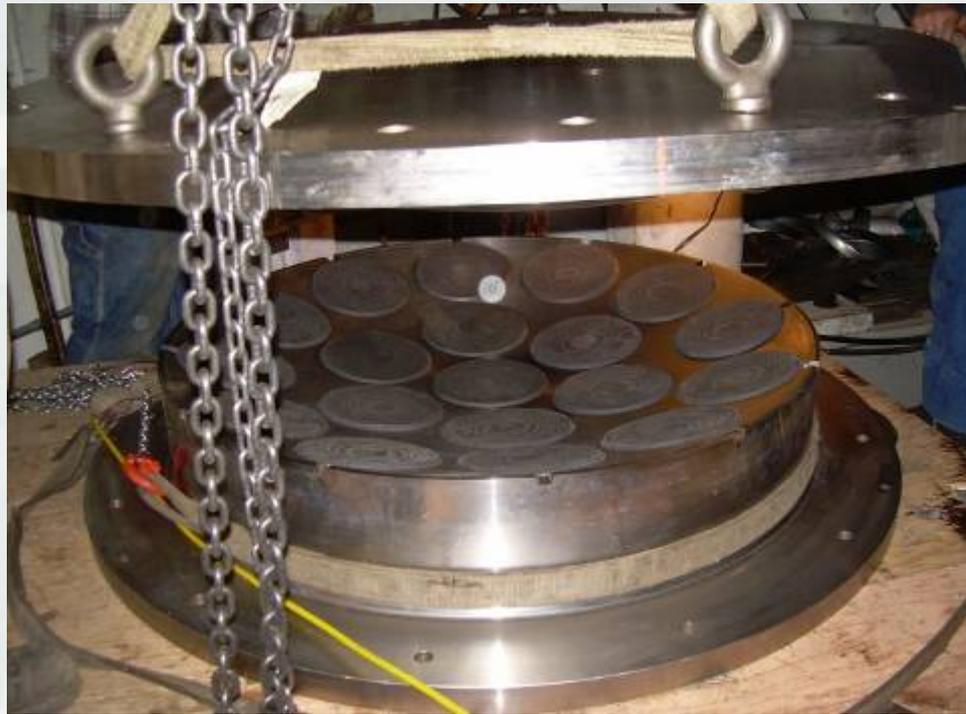
Applications in Portland:

Bonneville Swing Bridge



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Applications in Portland: Bonneville Swing Bridge Center Pivot Bearing



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Applications in Portland: NAVIGATION

Bonneville: Floating Mooring Bit, Guide and Reaction Rollers, and Lower Guide Plates

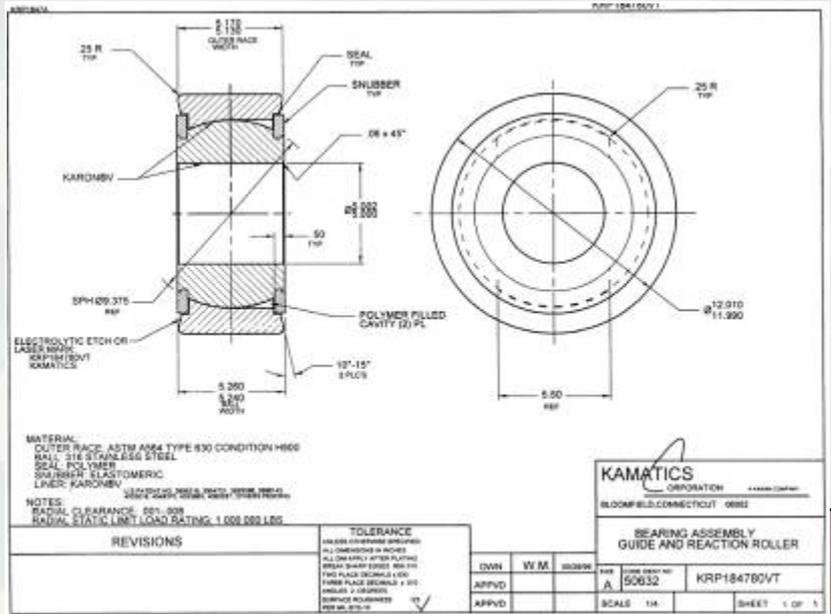


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Applications in Portland: NAVIGATION

Bonneville: Floating Mooring Bit, Guide and Reaction Rollers, and Lower Guide Plates

- Stick-slip operation of the FMB's occurred immediately after the lock became operational in 1993
- Final FMB modifications were completed in March 1997



Applications in Portland: NAVIGATION

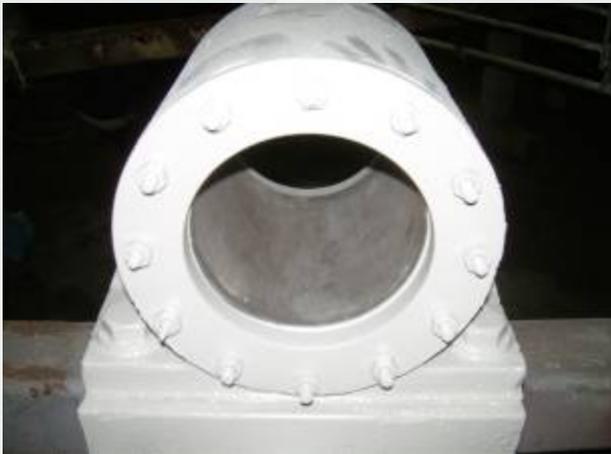
Bonneville: Lock Filling and Emptying Valves



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Applications in Portland: NAVIGATION

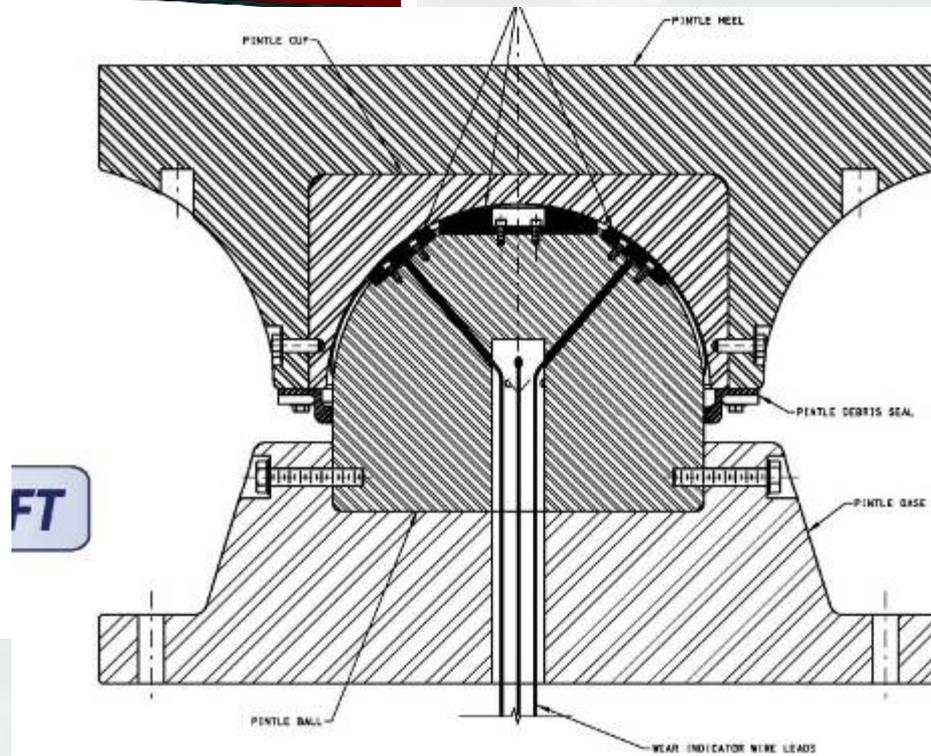
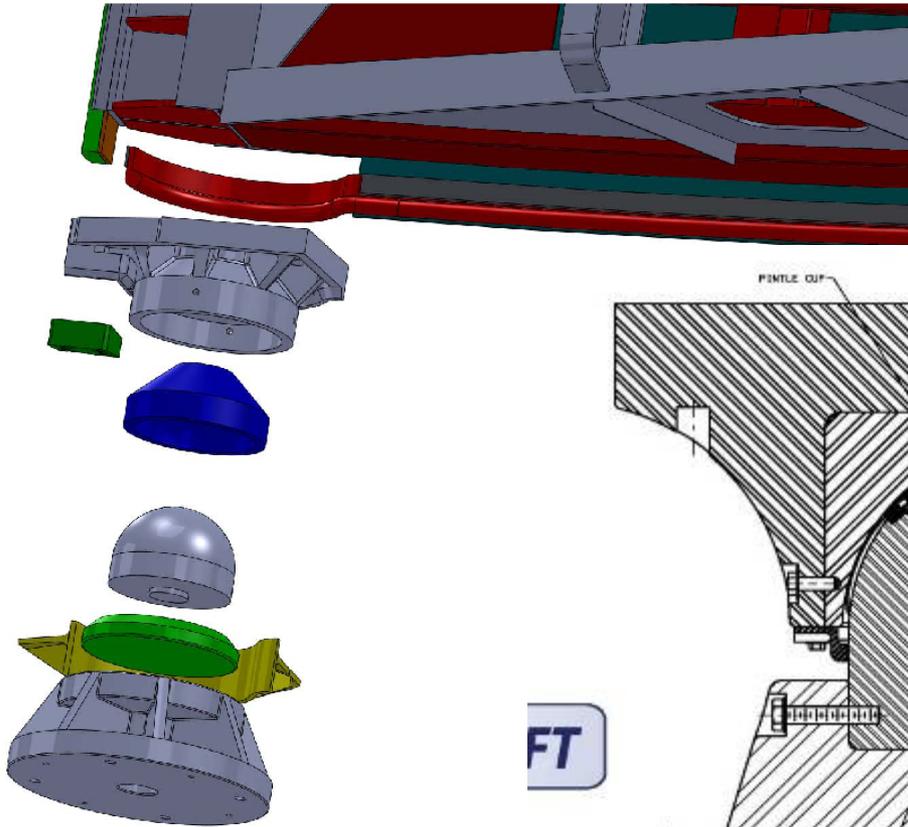
The Dalles: Filling and Emptying Valve Trunnion Bushings,



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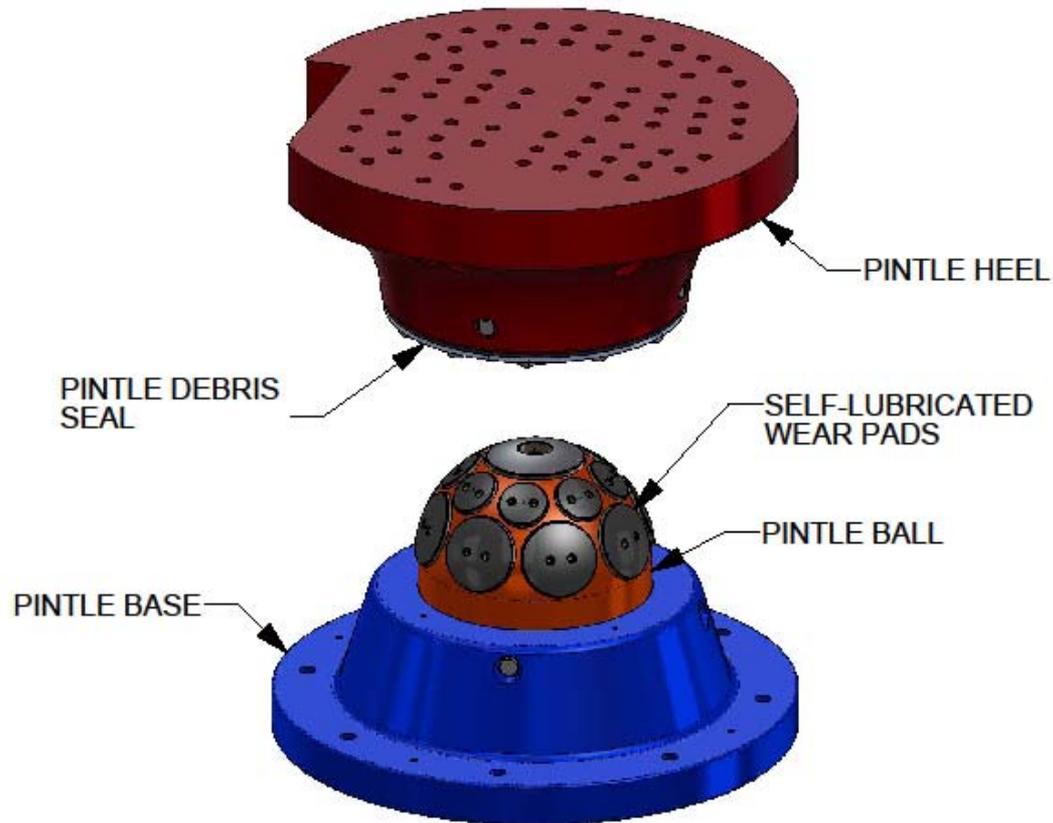
Applications in Portland: NAVIGATION

The Dalles: Miter Gate Pintle



Applications in Portland: NAVIGATION

The Dalles: Miter Gate Pintle

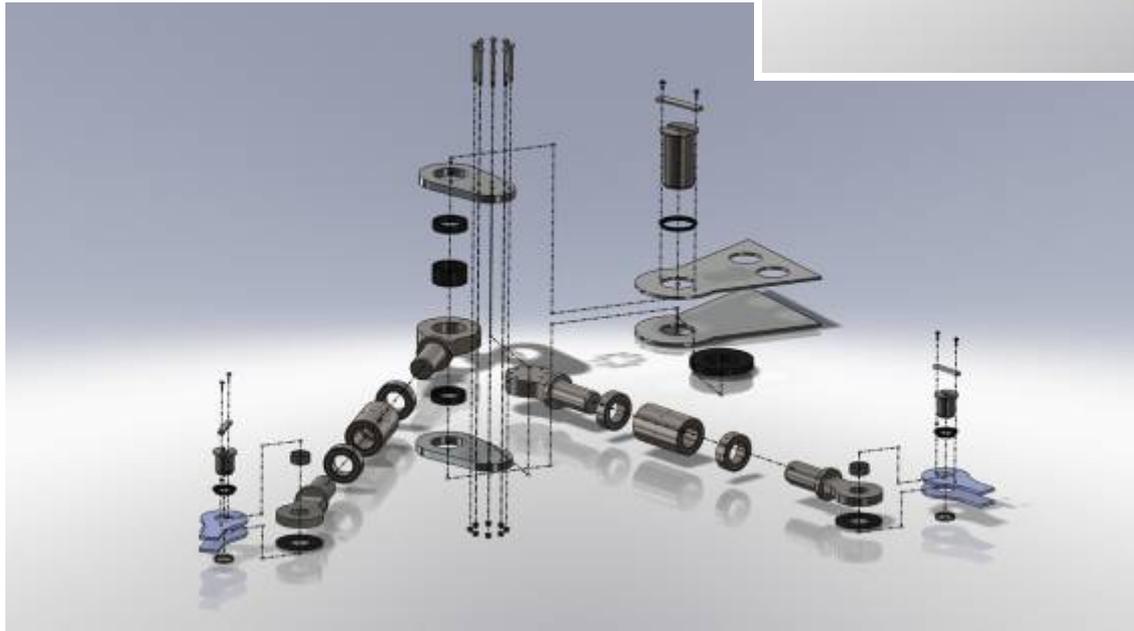
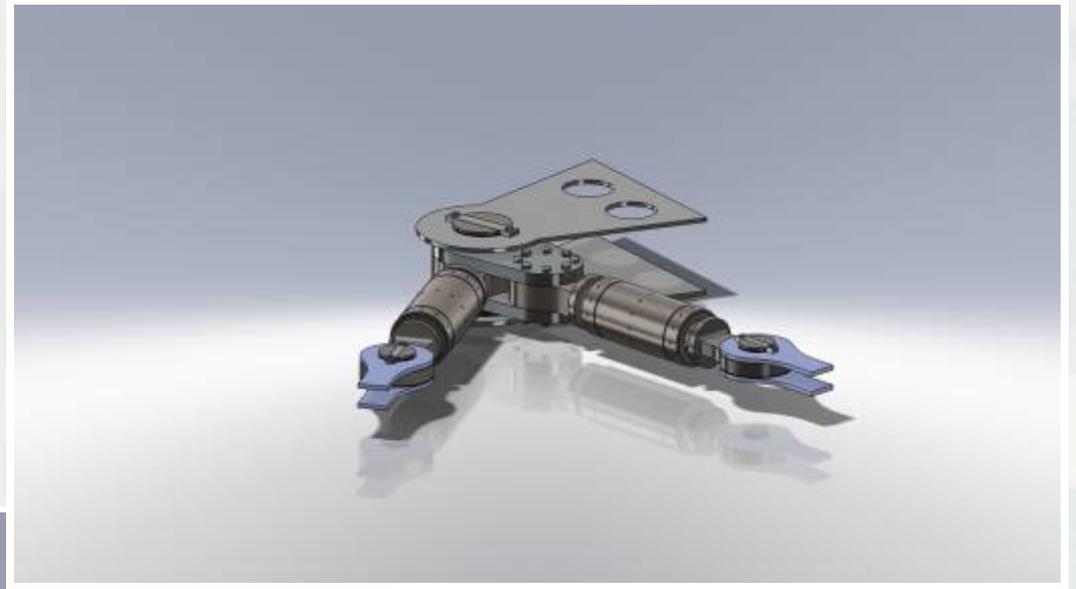


THE DALLES MITER GATE PINTLE ASSEMBLY



Applications in Portland: NAVIGATION

The Dalles: Miter Gate Gudgeons



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Applications in Portland: NAVIGATION

John Day: U/S Lift Gate Reaction and End Guide Rollers



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Applications in Portland: NAVIGATION

John Day: U/S Lift Gate Reaction and End Guide Rollers



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Applications in Portland: NAVIGATION

John Day: U/S Lift Gate and Counterweight Guide Blocks



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Applications in Portland: Non-Navigation

Other Applications: Foster Spillway Gate Trunnion Bushings, & Thrust Washers



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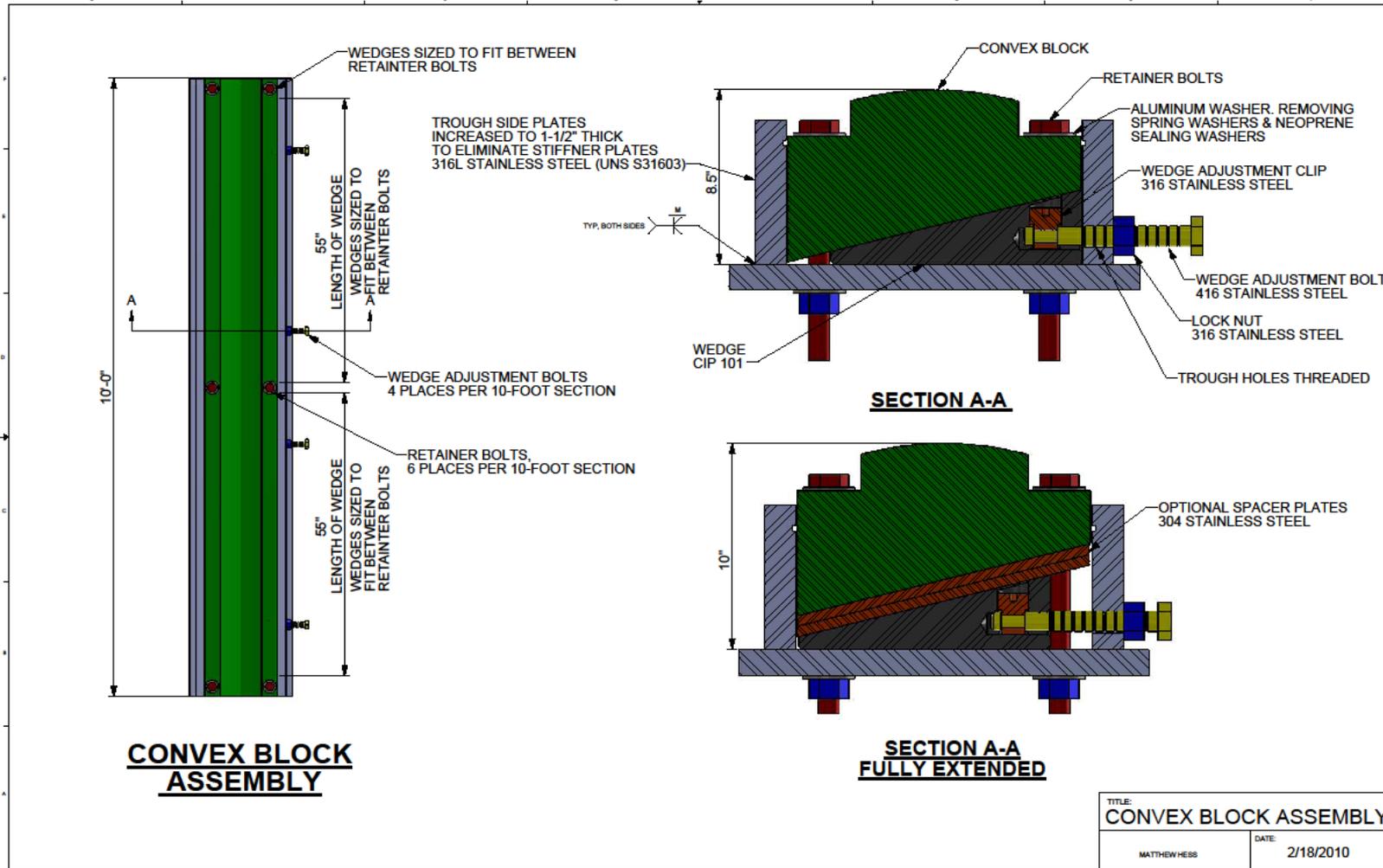
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Other Applications: Foster Spillway Gate Trunnion Bushings, & Thrust Washers



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The Dalles Miter Gate: Composites Material Use in Adjustable Quoin & Miter Blocks:



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