Oregon's Approach to Timber Pile Repair

2016 WBPP Annual Conference

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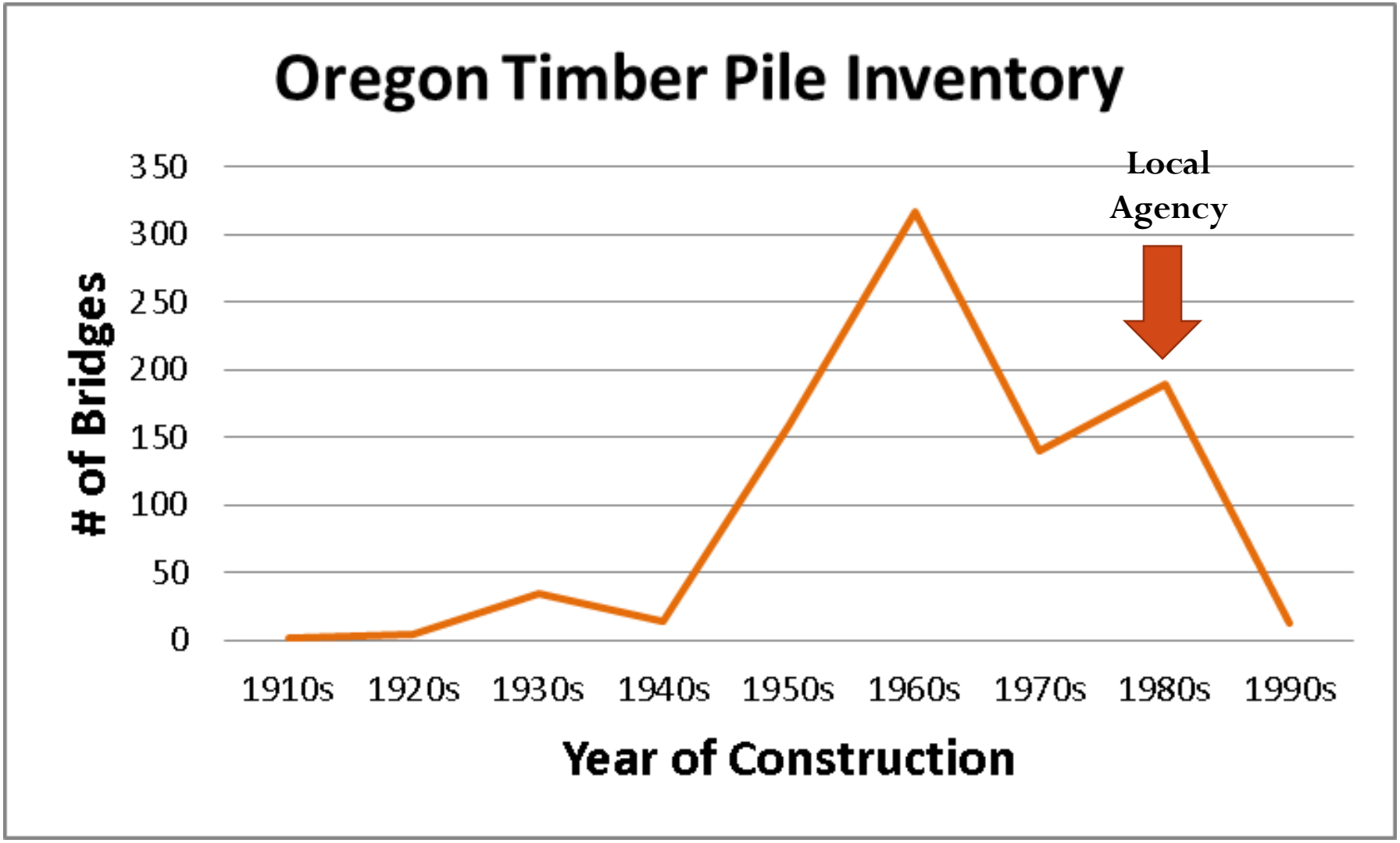
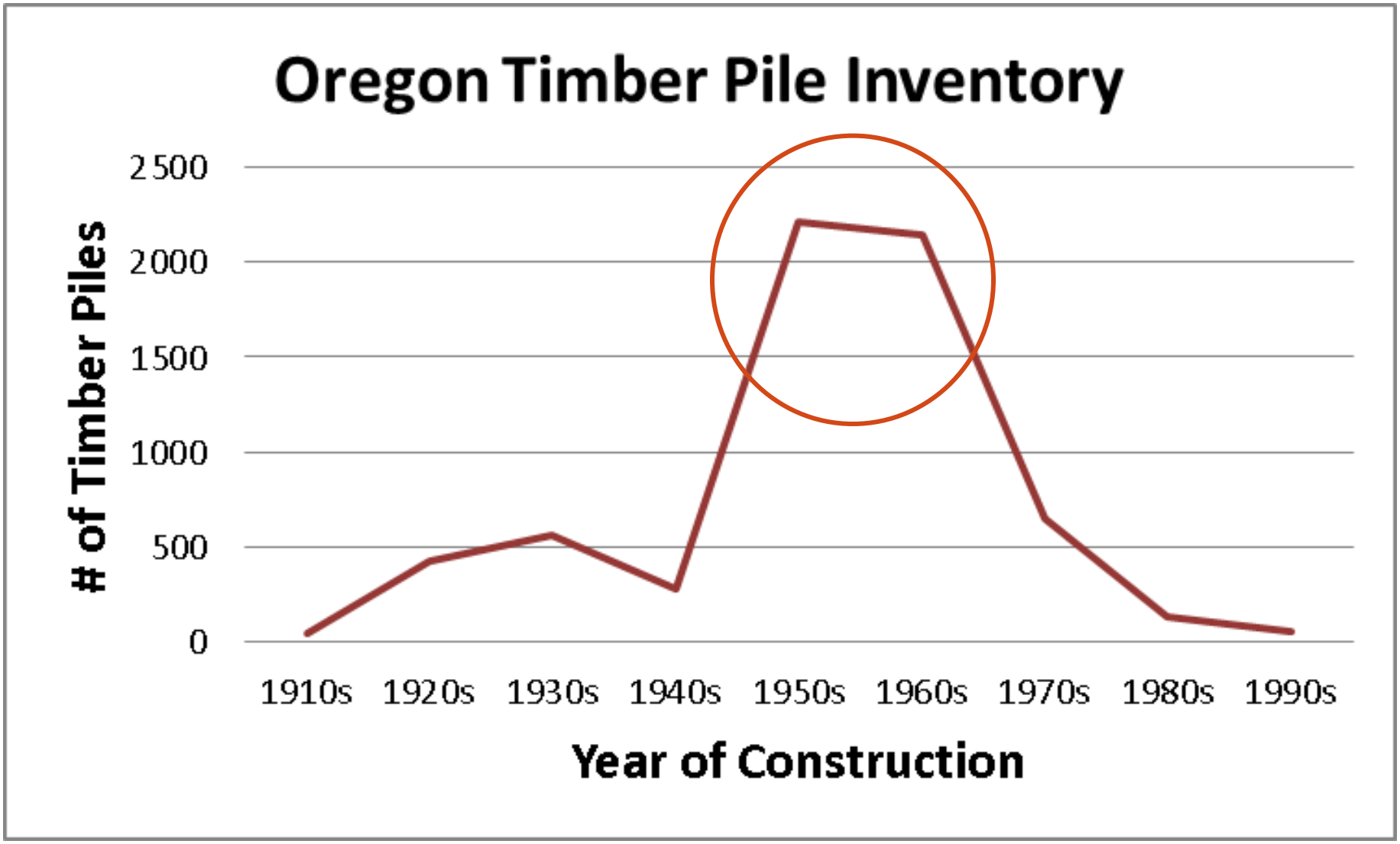
Overview

- Background on timber pile inventory.
- Previous pile repair standard.
- Development and field installation.
- Destructive Testing

Timber Pile Inventory

- Oregon has 874 bridges with exposed timber piling.
  - 296 are state owned.
  - 578 are local agency.
- Most were constructed between the 1950's and 1980's, but the range goes from 1906 to 1996.
- Local agency bridges account for the majority of these built during the 1970's and 1980s.


Oregon Timber Pile Inventory
# of Bridges
350
300
250
200
150
100
50
0
1910s
1920s
1930s
1940s
1950s
1960s
1970s
1980s
1990s
Year of Construction
Local Agency


Oregon Timber Pile Inventory
# of Timber Piles
2500
2000
1500
1000
500
0
1910s
1920s
1930s
1940s
1950s
1960s
1970s
1980s
1990s
Year of Construction

Annual Timber Repair Costs

- Over the last 5 years (2012-2016):
  - 100 Major Bridge Maintenance Projects
  - Total Cost of $4.3 Million
  - Accounts for 10% of major bridge maintenance budget

Timber Substructure Inventory

- South Yamhill Bridge
- Built in 1951
- Located in Willamette Valley
- Reinforced Concrete Deck Girder on Timber Pile Trestles.
- 990 ft. in length
- 34 Timber Bents
- 204 timber piles (As constructed)
- Estimated cost of replacement = $35 Million

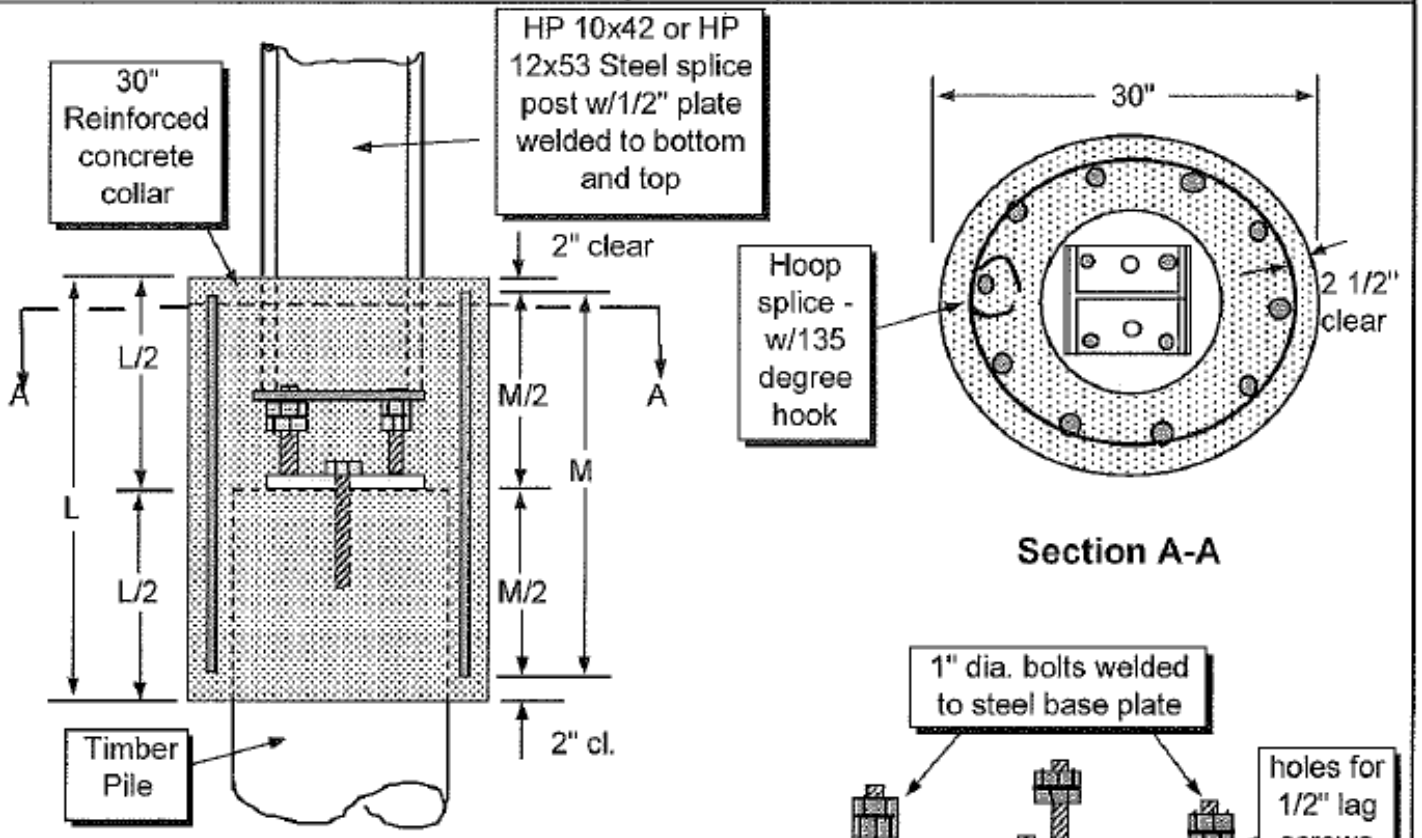
Replacing bridges 1-piece at a time

- 85 of the original 204 timber piles have been repaired.
- The remaining 119 are just waiting their turn.

Previous Standard Pile Repair

- Splice new steel H-Pile to existing timber with reinforced concrete collar.
- Standard detail provided in 1983.
- Make splice at 100% solid timber section.
- Concrete splice has a 30" diameter and is 4' in length.
- Uses 10 #6 reinforcing bars w/ #5 hoops @ 6" spacing.

OREGON DEPARTMENT OF TRANSPORTATION
Timber Pile - Steel Splice Repair
(7/18/83)



Drawbacks

- Difficult to install in tight spaces (abutments)
- Required excavation to continue at least 2' deeper than rot.
- Typical excavation = 2.5 cu. yd.
- If rot extended more than 2' below ground level then shoring or benching excavation was required.
- 18 cu. ft. of concrete for splice (2,700 lbs.)
- Steel cage difficult to stage.

New Pile Repair Wish List

- Avoid the reinforced concrete splice.
- Reduce the required splice length.
- Reduce depth of excavation. (Splice at a section with less than 100% solid timber x-section).
- Use hydraulic jack to preload the pile instead the screw jacks.

Proposed Pile Repair Method

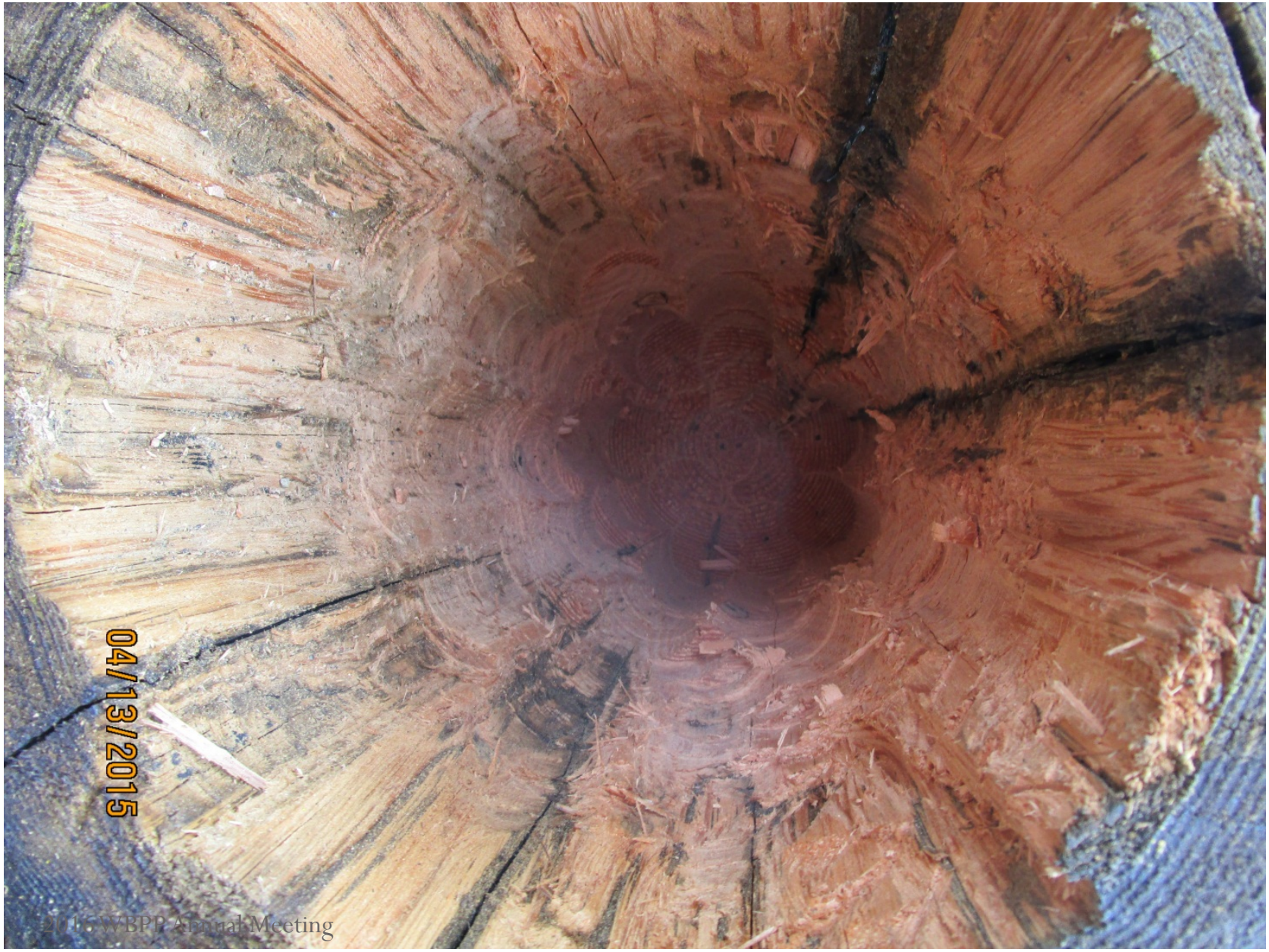
- Replace reinforced concrete collar with oversized steel pipe pile grouted to timber pile.
- Allow splice at a location with less than 100% solid timber section.
- Auger out remaining rotten timber pile core and fill cavity with high early strength concrete.
- Spice steel pipe pile to square structural steel tubing.
- Replace screw jacks with hydraulic jack and field welded shims.

Step 1: Install shoring as required by jacking plan

Step 2: Excavate 2’ below Ground Line

Step 3: Cut out section of rotted pile

Step 4: Remove remaining rotten core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Step 5: Install borate rods

Step 6: Fill cavity with high early strength concrete.

Step 7: Weld cover plate in place

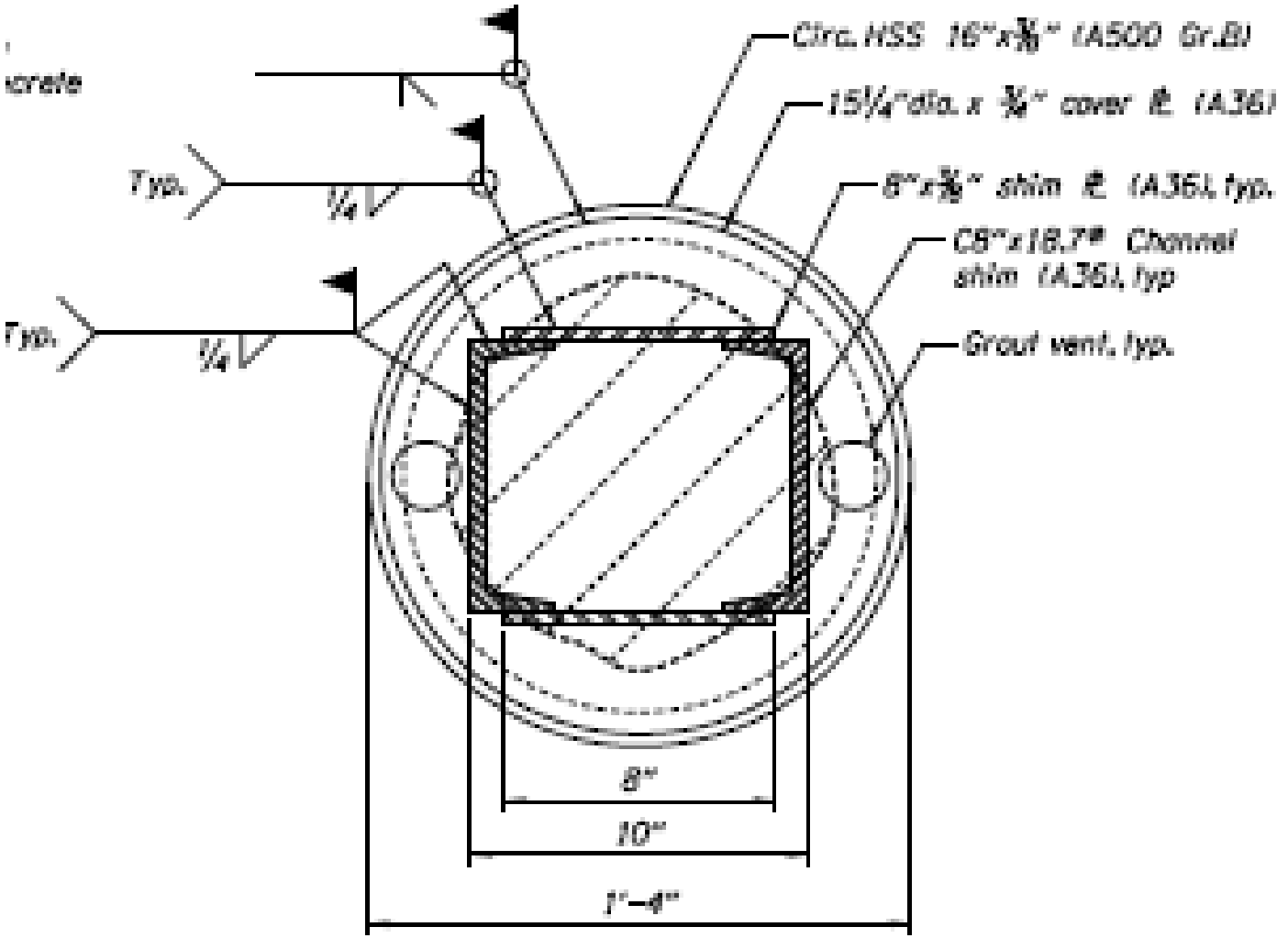
Step 8: Use vent holes to finish pour

Step 9: Preload with 20 ton hydraulic jack

Step 10: Cut shims to fit and weld in place

Step 11: Back fill to existing ground level

Pile Repair Plan Details

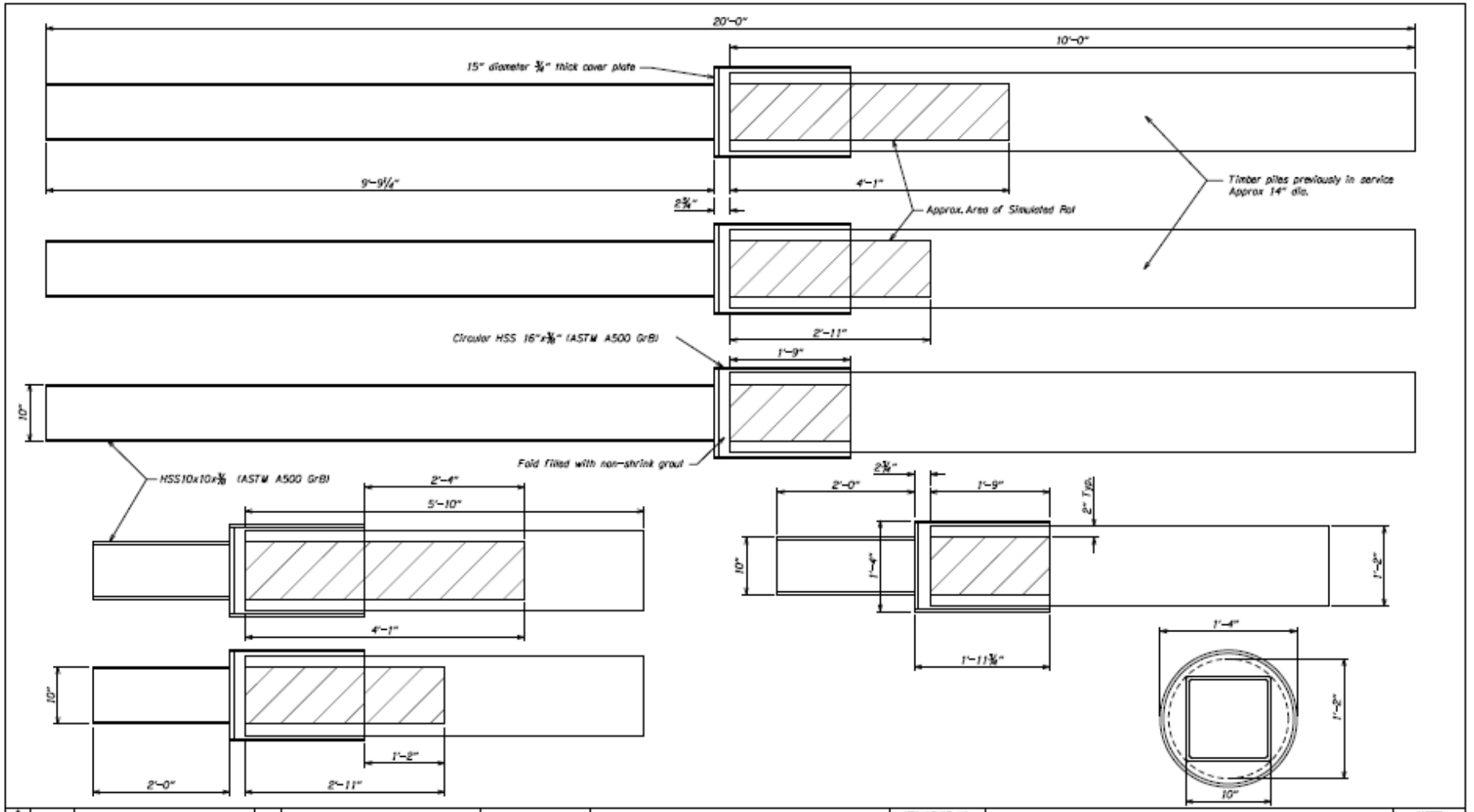


How much rot is too much to repair?

Timber Pile Splice Testing

- ODOT contracted with Oregon State University to destructively test pile splice detail.
- 6 piles in total were tested; 3 flexure and 3 compression.
- Rot was simulated to varying depths:
  - 21”
  - 35”
  - 49”

Timber Pile Splice Testing



DATE	REVISION	BY

ACCOMPANIED BY DWGS. See sheet 1 for this structure.

Travis Kinney

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STRUCTURE NO. Std. Design

DATE March - 2015

CALC. BOOK

TIMBER PILE REPAIR
STEEL SPLICE DETAIL TESTING

TEST PILE DETAILS

SHEET 1 OF 1

DRAWING NO. 00000

THIS IS THE FILENAME LOCATION ********** DD-MMM-YYYY HH:MM USERNAME

Rotation: 0° Scale: 1 1/2"=1'-0"

14” dia. piles previously in-service

Removed material to leave 2” solid shell.

When auger isn't deep enough…


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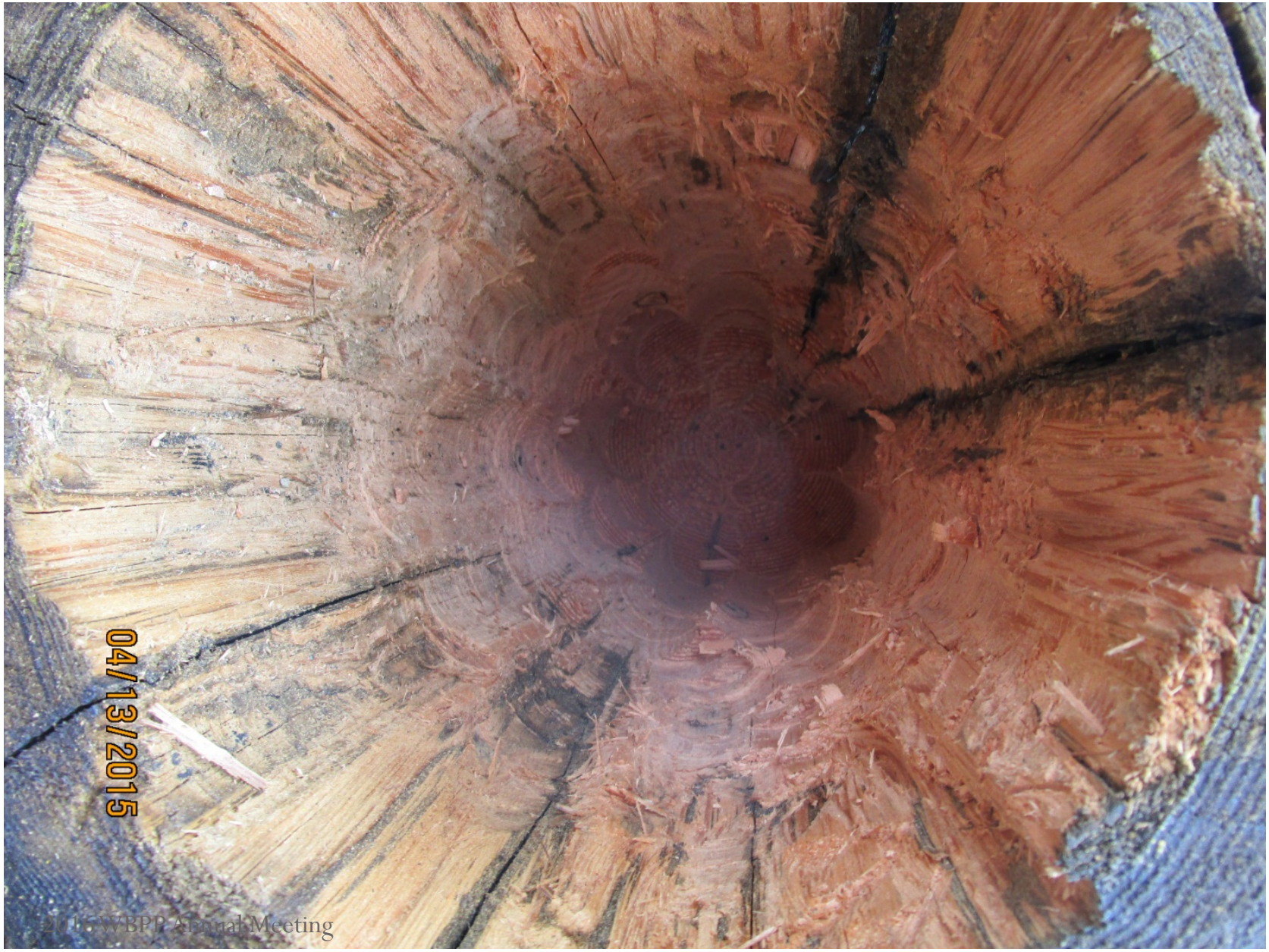
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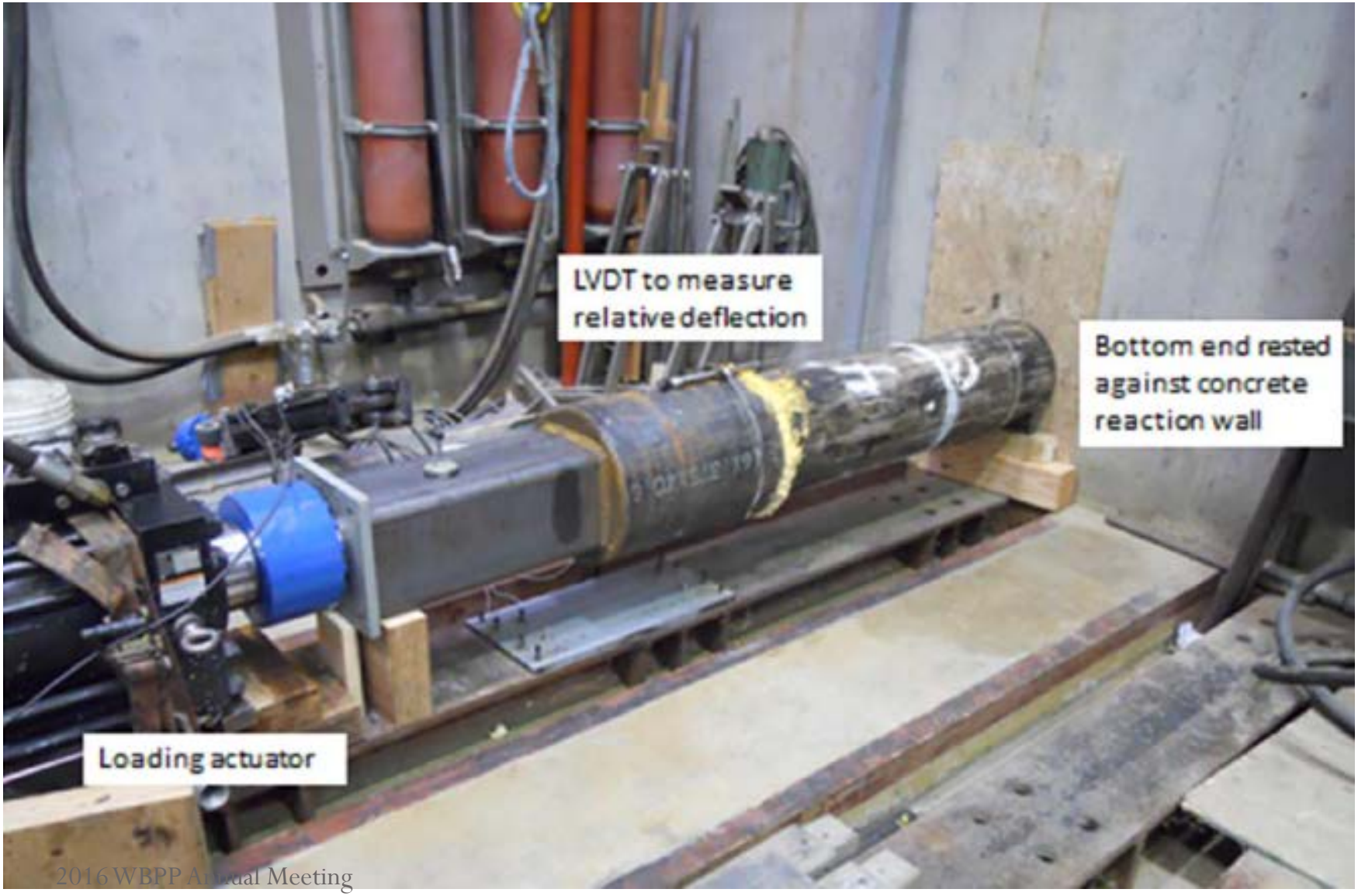
Compression Test Piles

- 13”-14” diameter.
- Core removed leaving 2” shell.
- 8’ in length.
- Steel pipe pile Circular HSS 16”x 3/8” (ASTM A500 Gr B)
- Testing cross-sectional capacity and localized failures around splice.
- Predicted failure mode: localized buckling in unconfined timber shell.

Compression Test Setup

Compression Test Setup

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Compression Test Results:

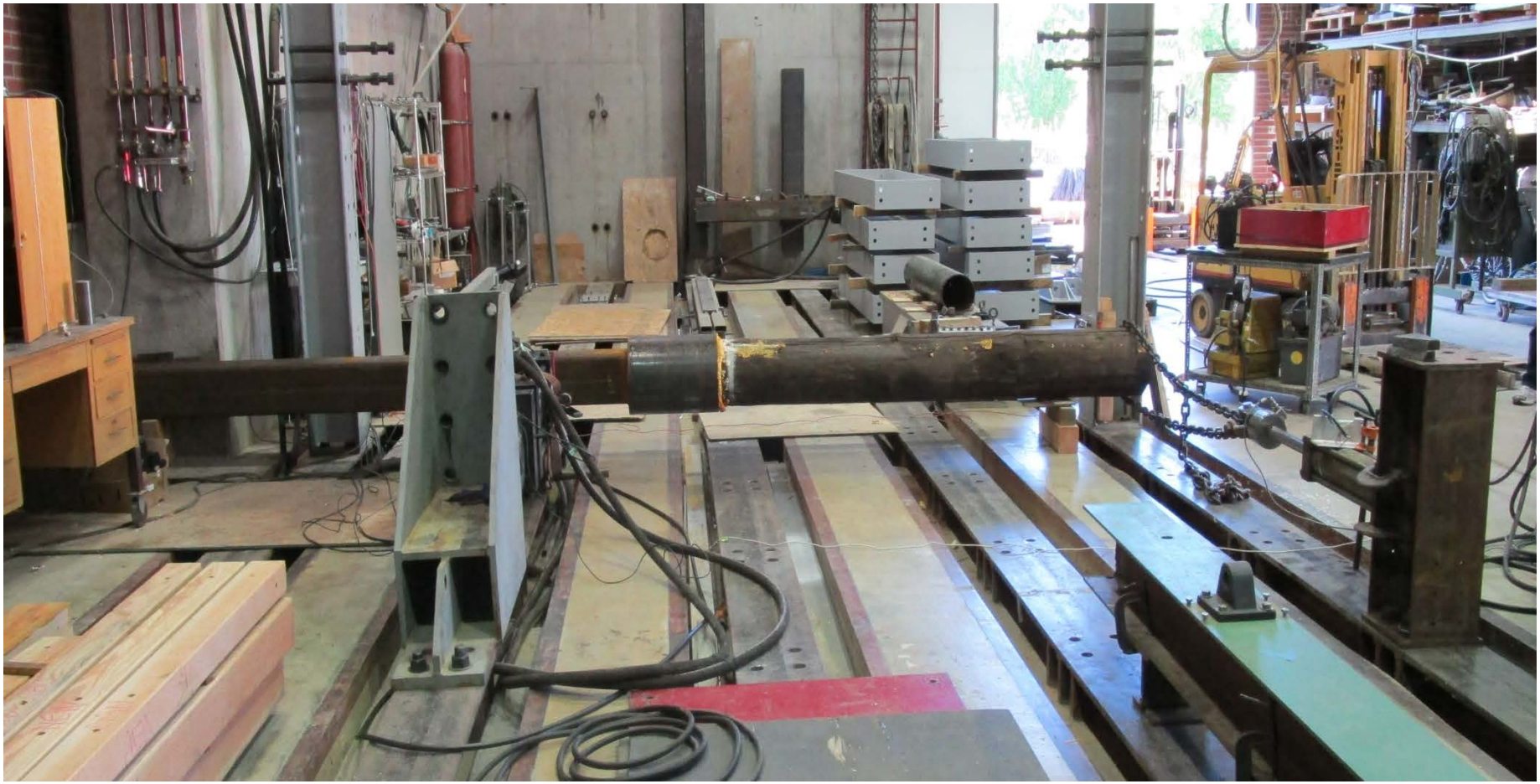
- 150 TON (300,000 lbs) actuator was not sufficient to fail any of the test specimens.
- An effect of concrete plug length could not be discerned.

Table 3.1: Compression test summary

Test Specimen #	Length of concrete plug (in)	Stiffness (Kip/in/in)	load at non-linear (Kip)
1	21	450	N/A
2	35	90	250
3	49	93	240

Lateral Test Setup

Lateral Test Setup

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Bending Test Results

- All three failed at the base of the splice.
- Failure loading consistent with anticipated capacity of un-repaired pile.
- Ductile failure (>12" of deflection at pile end)

Table 3.2: Summary of bending test results

Pile No.	Depth of concrete (in)	Maximum load (lbf)	Apparent Stiffness (lbf/in)	Moment induced at the failure section (kip.ft)
4	21	12233	3077	122
5	35	11217	2863	112
6	49	4843	1060	49

Conclusion

- Proposed pile repair can be used to fully restore axial capacity for short columns.
- Lateral demand and remaining capacity should be evaluated as part of repair plan.
- Provide additional lateral support as required.

Questions?

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