Micropile Threaded Connections at PDX Airport TCORE

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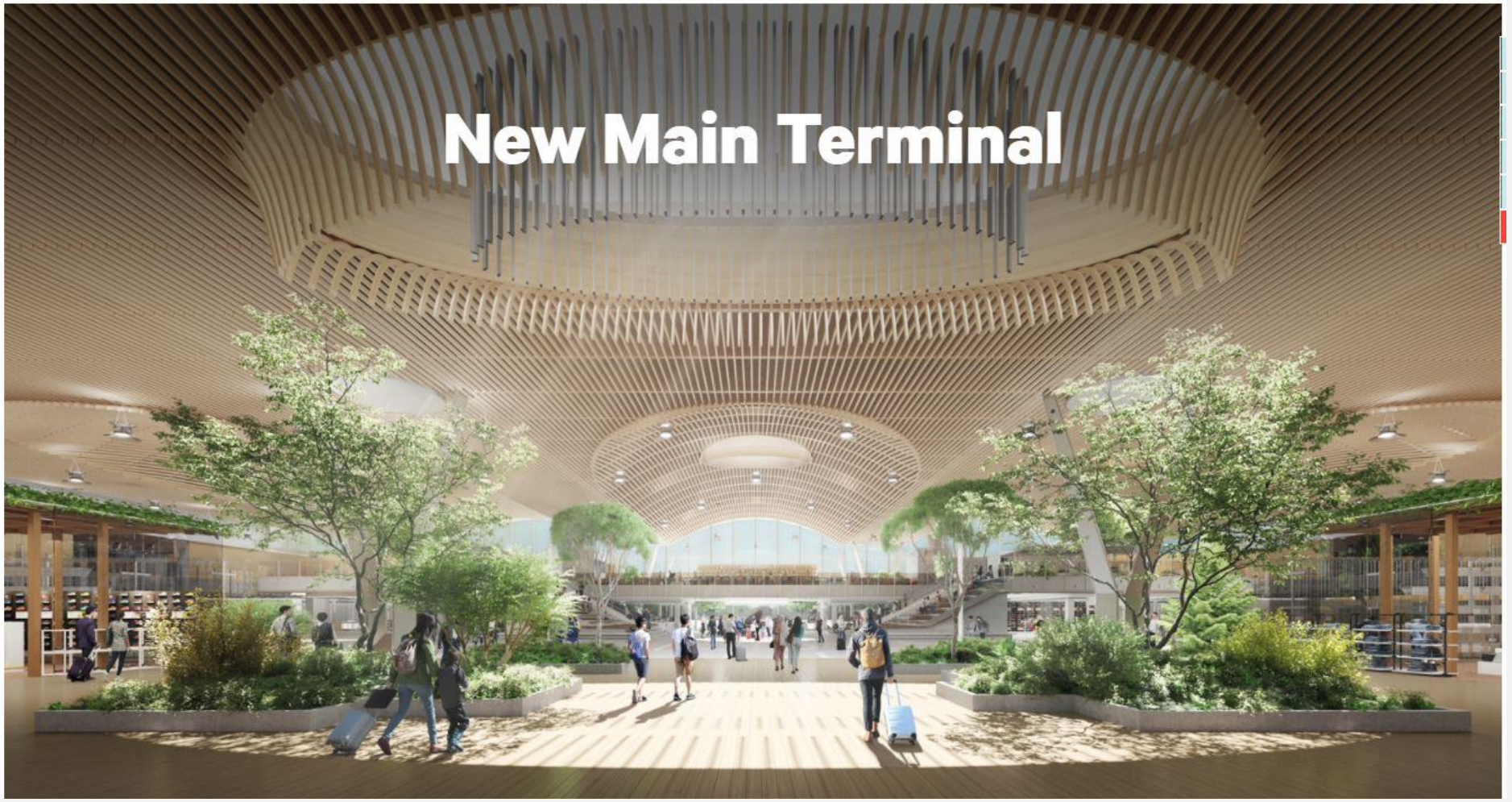
CONTRACTORS AND ENGINEERS

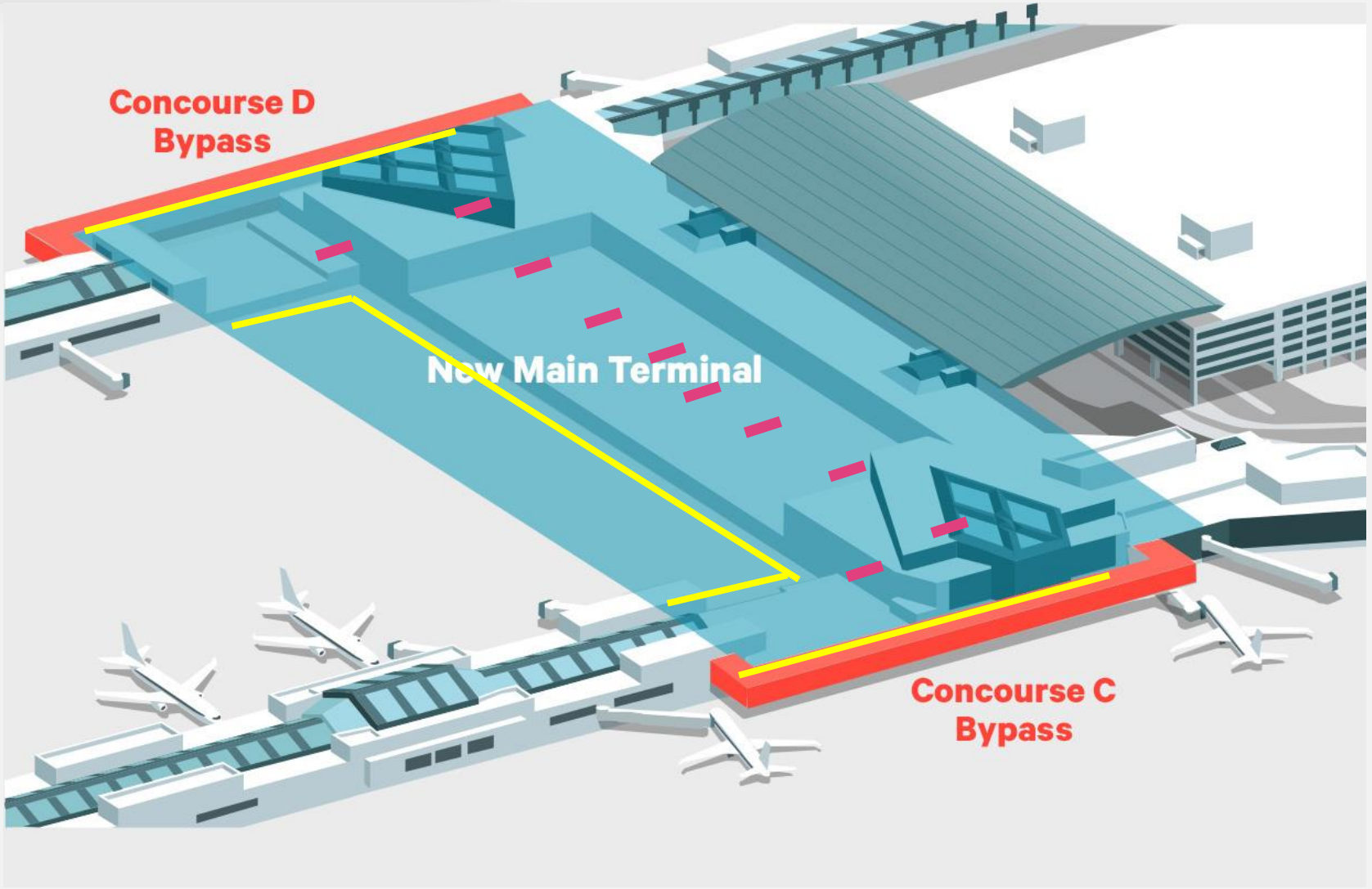
PDX TCORE WESTERN EXPANSION

- Overall Project is $1B renovation and expansion of the PDX Main Terminal
- Owner Port of Portland
- GC Hoffman-Skanska JV



PDX TCORE WESTERN EXPANSION

- 750ea total quantity
- Unlimited Overhead Piles, 433ea
- Limited Overhead Piles, 315ea
- Micropiles - Design Build Criteria
- 9-5/8” 300kip Service Compression
- Minimum 100-ft Cased Length due to liquefaction



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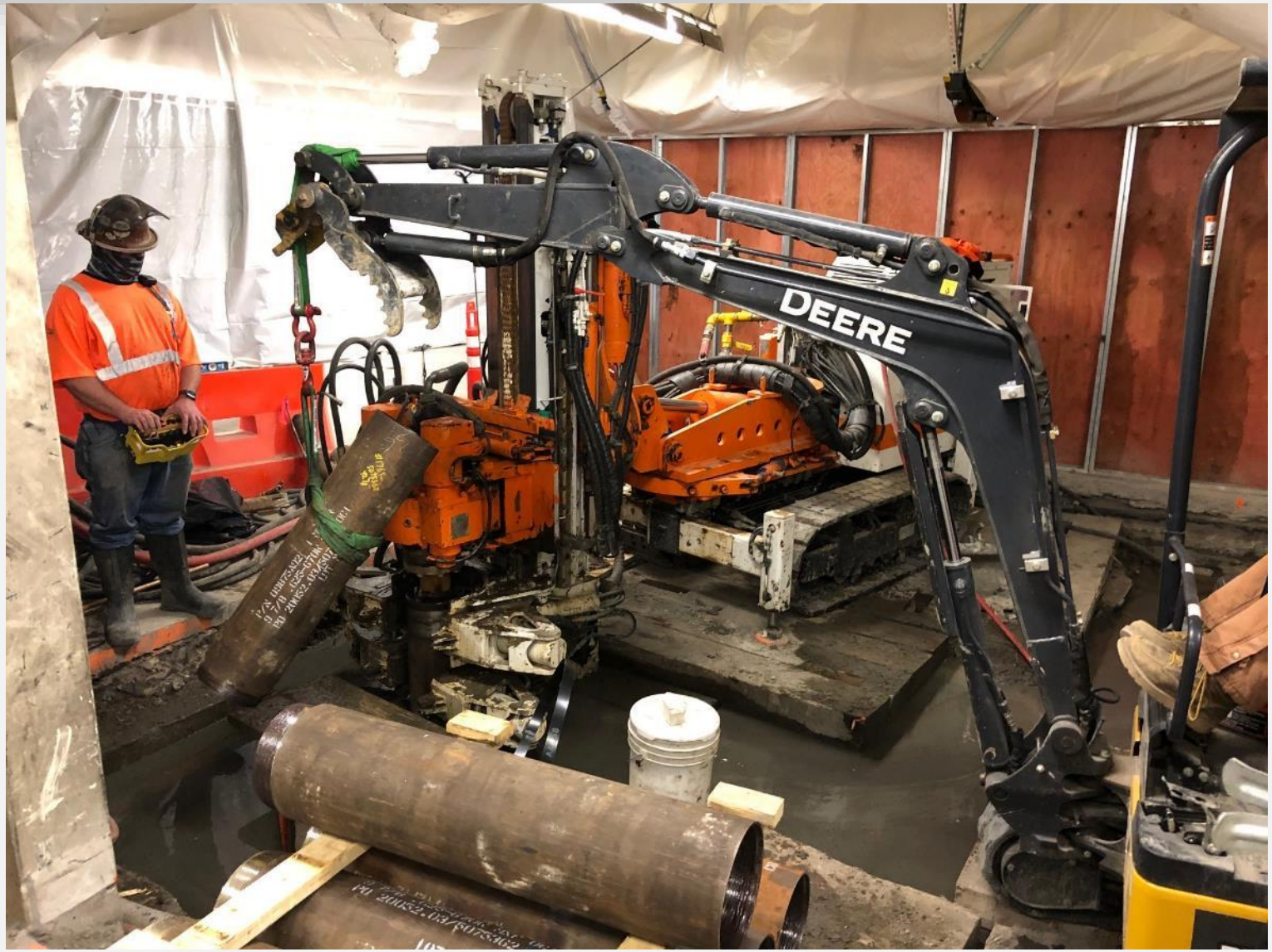


CAUSE FOR BEND TESTING

- Once the structural design & liquefaction analysis was fully completed, Owner's engineers required micropiles to have 1,600 kip-in of moment capacity in the top 40' of the micropile.

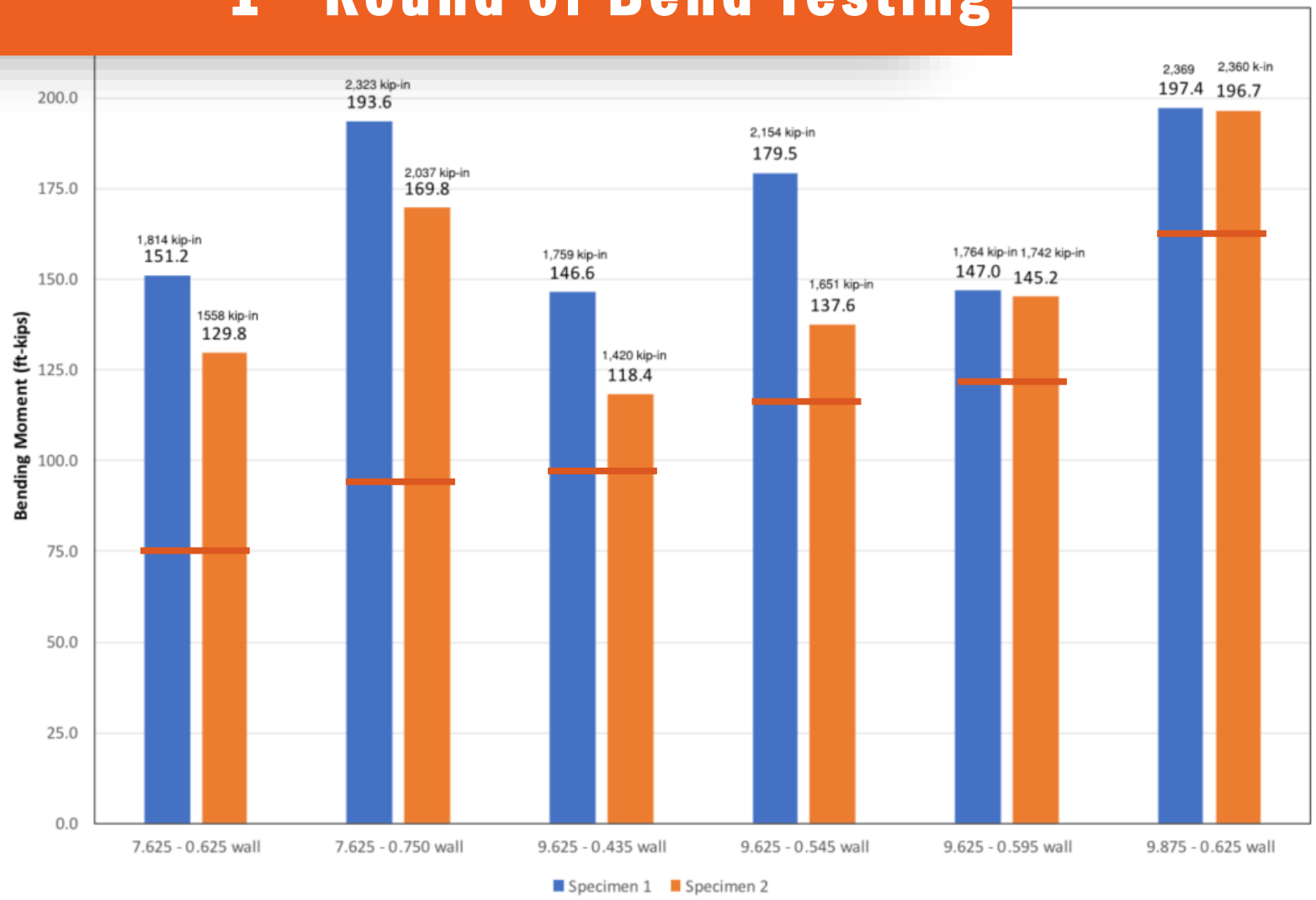
- City of Portland (Permitting Agency) was not comfortable using the 50% moment capacity design philosophy despite showing former full scale testing.

- CJA proposed doing a series of bend testing on varying casing sizes to see what was the optimal diameter x thickness to meet 1,600 k-in

Casing Bend Testing

- Objective of testing was to gather project specific information for Permit Approval with City of Portland
- Four point bend test performed by Stress Engineering in Houston, Texas
- All casing was from OCI Division
- Thread Length was 2.5” from shoulder to shoulder for all joints.
- Uses a tapered thread which has a thickened section towards the shoulder

1st Round of Bend Testing



1st Round of Bend Testing

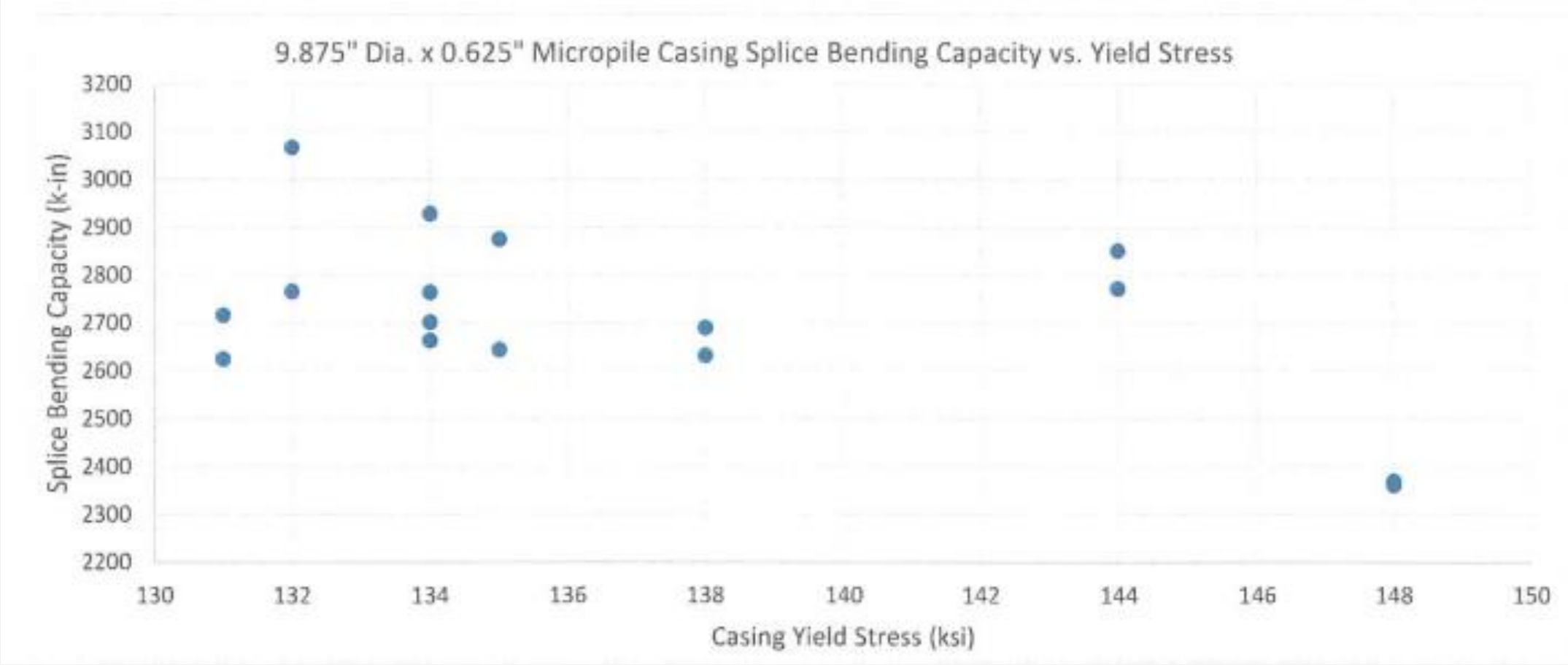
CASING	OD	WALL THICKNESS	THOERETICAL YIELD STRENGTH (KSI)	UNREDUCED CASING SECTION (BLANK) BENDING CAPACITY (K-IN)	MEASURED JOINT BENDING CAPACITY (K-IN)	ACTUAL %
7-5/8" X 0.625"	7.625	0.625	80	1780.58	1686	95%
7-5/8" X 0.75"	7.625	0.750	80	2032.16	2180.4	107%
9-5/8" x 0.435	9.625	0.435	80	2208.96	1590	72%
9-5/8" X 0.545"	9.625	0.545	80	2672.98	1903.2	71%
9-5/8" X 0.595	9.625	0.595	80	2872.37	1753.2	61%
9-7/8" x 0.625"	9.875	0.625	100	3952.18	2365.2	60%

- Average of 2ea bend tests per joint size.
- All test specimens were grout filled with NO center bar.

2nd Round of Bend Testing

- Owner opted for the 9-7/8” x 0.625” to be conservative but determined additional testing was required to develop a sample size that would be make it through permitting.
- Casing supplier could potentially provide casing with a 100KSI yield strength, however the lowest yield test specimen was 130KSI.
- This lead us down a rabbit hole of what if we had a load of casing delivered to the site that had a yield less 130 KSI.
- 16ea additional 9-7/8” x 0.625” bend tests were completed to see if we could develop a correlation between yield and bending capacity

2nd Round of Bend Testing



2nd Round of Bend Testing

Casing	Specimen	Measured Bending Capacity (Kip-ft)	Kip-In	% of Unreduced Bending Section	Coupon Yield Stress (KSI)
9.875" x 0.625"	1A	225.1	2701.2	68%	134
9.875" x 0.625"	2A	244	2928	74%	134
9.875" x 0.625"	1B	230.4	2764.8	70%	132
9.875" x 0.625"	2B	255.5	3066	78%	132
9.875" x 0.625"	1D	224.1	2689.2	68%	138
9.875" x 0.625"	2D	219.3	2631.6	67%	138
9.875" x 0.625"	1F	220.3	2643.6	67%	135
9.875" x 0.625"	2F	223.9	2686.8	68%	135
9.875" x 0.625"	1R	221.9	2662.8	67%	134
9.875" x 0.625"	2R	230.3	2763.6	70%	134
9.875" x 0.625"	1S	226.3	2715.6	69%	131
9.875" x 0.625"	2S	218.7	2624.4	66%	131
9.875" x 0.625"	1B2	230.9	2770.8	70%	144
9.875" x 0.625"	2B2	237.5	2850	72%	144
9.875" x 0.625"	DD-1	192.5	2310	58%	148
9.875" x 0.625"	DD-2	202.4	2428.8	61%	148
9.875" x 0.625"	FF-1	194	2328	59%	113
9.875" x 0.625"	FF-2	196.9	2362.8	60%	113
				67%	

Predominate Failure Method

Specimen - 9.875" OD - 0.625" Wall - S1

Predominant Failure Mode - Thread Jumpout

Single Pin Critical Failure

Specimen - 9.625" OD - 0.435" Wall - S2

Predominant Failure Mode - Critical Cross-Section Failure

Conclusions

- All joint testing achieved 50% bending capacity of the unreduced section
- No significant correlation between yield strength of material and bending capacity.
- Failure mode was almost exclusively thread jump out
- Smaller Diameter and Thicker casing resulting in higher bending %

Questions?