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1. Problem Statement:

ADM is experiencing issues transporting and setting grain aeration tubes in ground piles. The current method causes damage to the tubes, creates an inefficient operation, results in excess manual labor, and transporting issues.

2. Background:

Grain aeration tubes are used to remove moisture from ground piles at ADM facilities. Tubes need to be moved from holding locations to the piles during pile construction and during grain removal. Current solutions do not sufficiently solve the issues of damage during transport, issues setting tubes, and streamlined transport.

3. Purpose:

To design and fabricate a skid steer attachment that will be able to pick-up, transport, and set tubes with a reduction in damage, manual labor, transportation issues, and time needed to perform operations.

4. Design Criteria

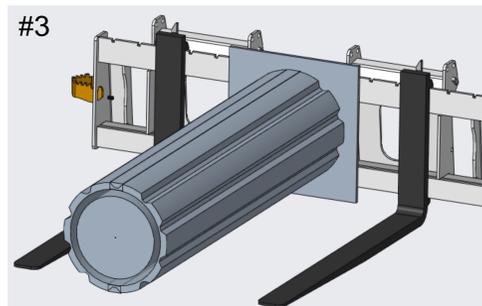
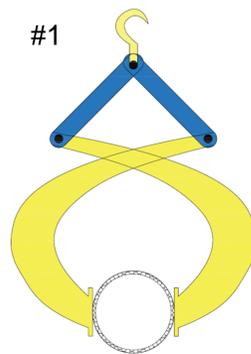
- Attach to skid steer
- Reduce damage of tubes
- Able to remove and place tube in storage
- Reduce need of manual labor in transport

5. Factors Considered

- Customer Needs
- Budget Requirements
- Safety of Operation
- Economic Viability

6. Alternative Solutions:

1. Barricade Lifter
2. Tractor Grapple
3. Expanding Mandrel
4. Fork Extension
5. Profiled Grapple
6. Mechanical Thumb & Curved grapple



7. Final Solution:

Dual Curvature/Profiled Grapple

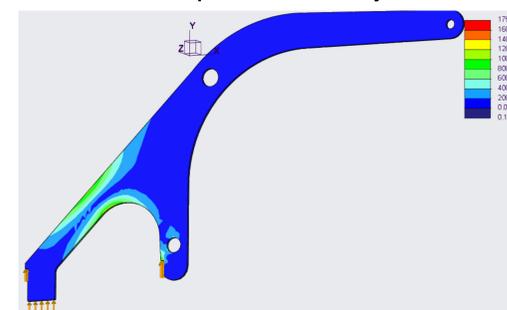
- Ability to handle tubes from various orientations
- Grapple designed for tube profiles
- Hydraulically actuated
- Three forks for less pressure on tube

Design and Analysis

- CAD model and Tolerances using Creo Parametric
- Profile radius of 14" designed for only 24" ID tubes
- Finite Element Analysis (FEA) used to determine potential failures in model
- Cantilevering of tube causes the most stress
- Factor of Safety of 4

Fabrication

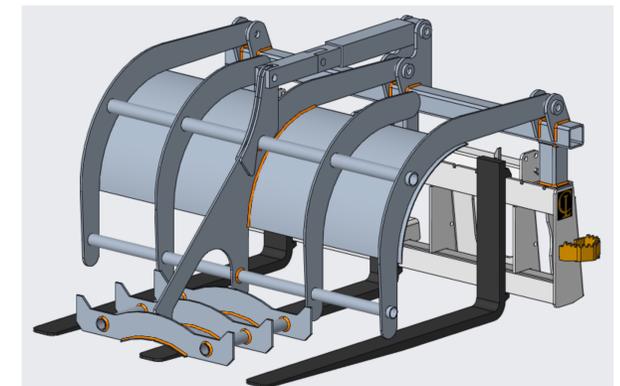
- 5' wide fork attachment bought from CL Fabrication in IA
- CNC plasma cut parts
- Powder coated complete assembly



FEA of Middle Profile



Prototype during Testing



Final Creo Model

8. Cost Analysis

Material	Cost
Attachment Base	\$960.00
Steel (\$0.75/lb)	\$241.84
Powder Coating	\$195.00
Hydraulic System	\$326.60
Fuel Costs/Hardware/Misc.	\$587.99
Total Attachment Cost	\$2,311.43
Savings from not damaging tubes/year	\$4,125.00
Savings from manual labor	\$3,600.00
Total Savings/year	\$7,725.00

9. Testing, Impact, Conclusion

Testing

- FEA displayed successful results of stress concentrations
- Able to pick up tube from both orientations
- No manual labor needed to pick up tube

Impact

- Increase in productivity
- Lowering purchasing costs of new tubes
- Increased grain flow to the public

Future Changes

- A grapple for various tube dimensions
- Less expensive fork attachment to mount on

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Standards:
OSHA 1910.178(a)(4)
ASME B56.1,2000
SAE J2513