Automatic Nose Ballasting (CNH)

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Introduction

Problem Statement:
- Changing front end ballasting weights is a labor intensive and time consuming task. Thus, consumers neglect to properly ballast machinery.

Objectives:
- Design a quick exchange solution, utilizing the hydraulic front suspension’s movement, to decrease the time required to gain proper ballasting weight.
- Provide an adequate storage rack for standby ballast weight.

Project Background:
- Current market demand is pushing for new agricultural equipment that provides less soil compaction and fuel consumption.
- The increasing age of farmers encourages the reduction of manual labor.

Incorrect Ballasting

Over-ballasted(f):
- Greater Soil Compaction
- Increased Fluid Consumption

Under-ballasted(f):
- Potential for Wheel Slip
- Risk of Injury from Turnover

Simple Ballast Equation:
\[ NF(f) \times D(f) = NF(r) \times D(r) \]
- \( NF = \) Normal Force
- \( D = \) Distance from Fulcrum

Target Ballasting

Final Design

Project Deliverables:
- Class 10.9 M20 Shoulder Screw
  - Six screws to be anchored in frame rail
- Redesigned Weight Bracket
  - Keyhole slots to allow easy attach / detach motion
- Updated Front Frame Rail
  - New hole locations created to accommodate weight bracket design
- Weight Storage Rack
  - Used in quick attach process
  - 4000+ lb. capacity
  - Movable from all sides

Design Analysis

Impact

Four Bolt Scenario:
- Maximum Stress – 499.3 MPa
- Maximum Deflection – 0.2185 mm
- Factor of Safety – 2

Six Bolt Scenario:
- Maximum Stress – 346.2 MPa
- Maximum Deflection – 0.1515 mm
- Factor of Safety – 2.9

Economical Analysis

| Cost of rack material: | $468 |
| Cost of machining: | $70 |
| TOTAL cost of system: | $868 |

Recommendations

Testing:
- Further FEA testing to ensure safety and reliability
- Prototype trials to prove repeatability

Future Improvements:
- Latching Mechanism
- Weight Rack Height Adjustability