Introduction to VT Packaging Center and Overview of Pail and Pallet Interactions

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VIRGINIA TECH™

COLLEGE OF NATURAL
RESOURCES AND ENVIRONMENT

SUSTAINABLE BIOMATERIALS

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CENTER FOR PACKAGING AND UNIT LOAD DESIGN

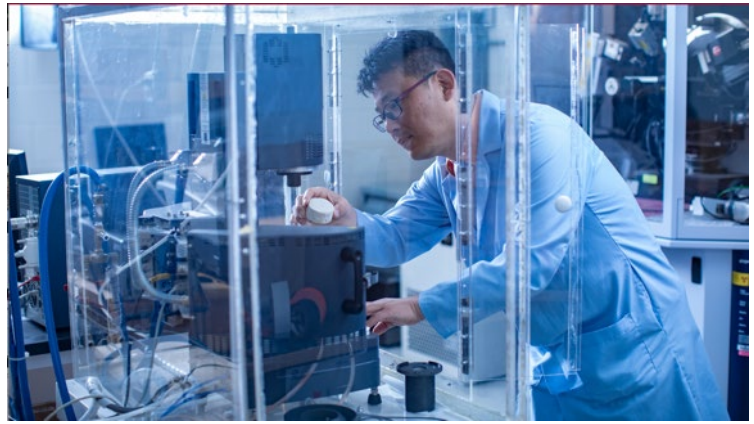
Center for Packaging and Unit Load Design

Established in **October 28th 1976.**

Laboratories:

Distribution Packaging Laboratory

Corrugated Packaging Laboratory



Primary Packaging Laboratory

Our Vision

Our vision is to be the hub of packaging innovation where researchers, students, and industry professionals work together to improve the efficiency of the supply chain.

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OUR MISSION

INDUSTRY OUTREACH

Solve problems that matter

Our researchers work collaboratively with pallet and packaging industry to provide rapid solutions to their most pressing problems from Amazon certification to custom test development.

RESEARCH

Optimize the Packaging Supply Chain

Our researchers and students are developing information and technologies which optimize the relationship between the design and performance of packaging systems and maximize the efficiency of the packaging supply chain.

EDUCATION

Educate through real life projects

We are involving our students into every aspects of our operation from testing to website design. Industry projects from our partner companies allows us to educate our students by solving relevant real life problems.

Services

Short Courses:

- Pallet Design and Performance
- Unit Load Design
- ProLogis Warehousing and Packaging

Testing:

- Packaging and Pallet Certification
- IKEA and Amazon Certification
- Fastener Evaluation
- Supply Chain Audit

unitload.vt.edu

Industry Certifications

ista
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amazon
CERTIFIED LABORATORY

NMFTA
National Motor Freight Traffic Association, Inc.

IKEA®
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Industrial Affiliate Membership

- **Gold Members**
- **Silver Members**
- **Bronze Members**

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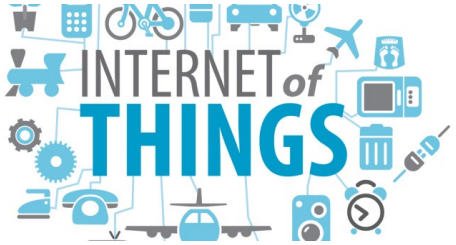
Nelson

Research Areas

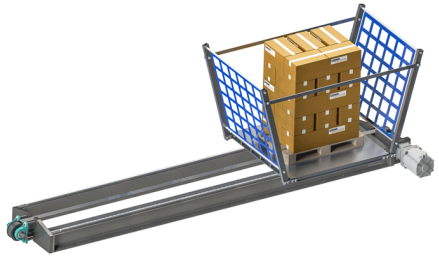
SUSTAINABILITY STUDIES

MARKET STUDIES

UNITLOAD INTERACTIONS



SMART PACKAGING



UNIT LOAD STABILITY

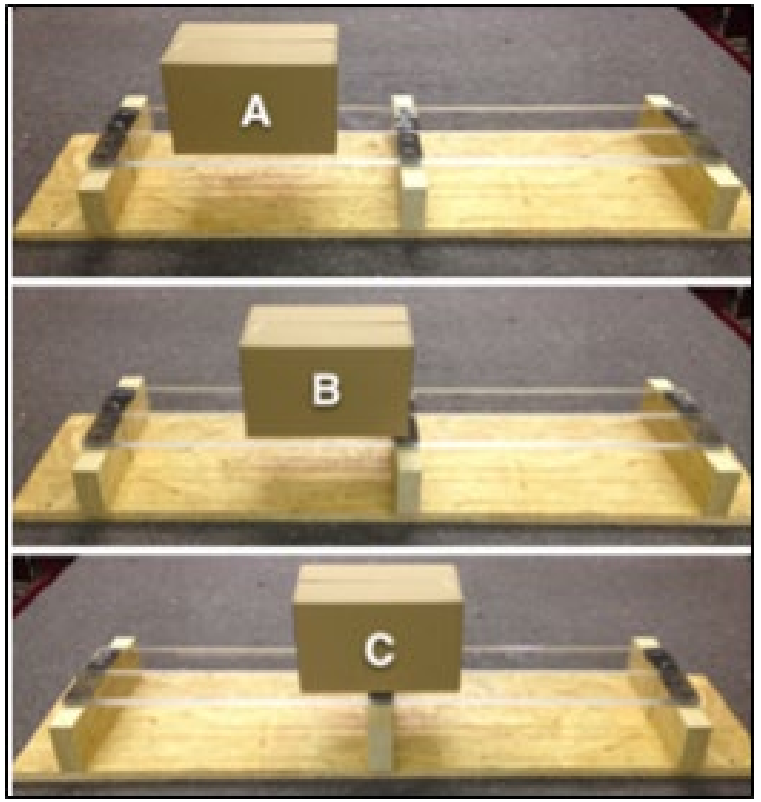
PALLET DURABILITY

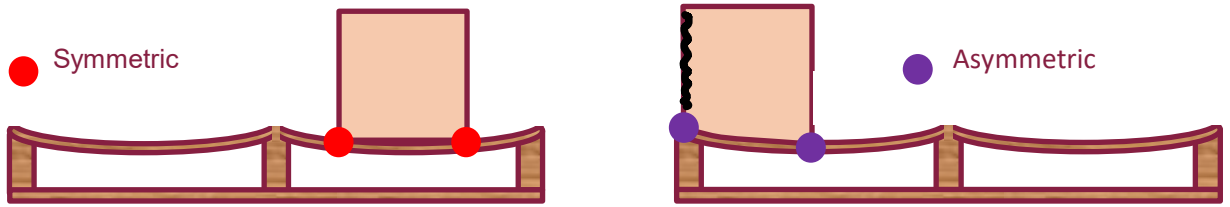
Background

- 508 Million pallets produced in 2016
- 80% of packaged goods are shipped using pallets in the United States
- Understand the interactions of the pallet and packaging → better design decisions
- Create sustainable, cost effective, and safe palletized unit loads

Background

- Deckboard gaps increase → compression strength decreases
- Relation of area supported and compression strength
- Asymmetrical loading vs. symmetrical loading



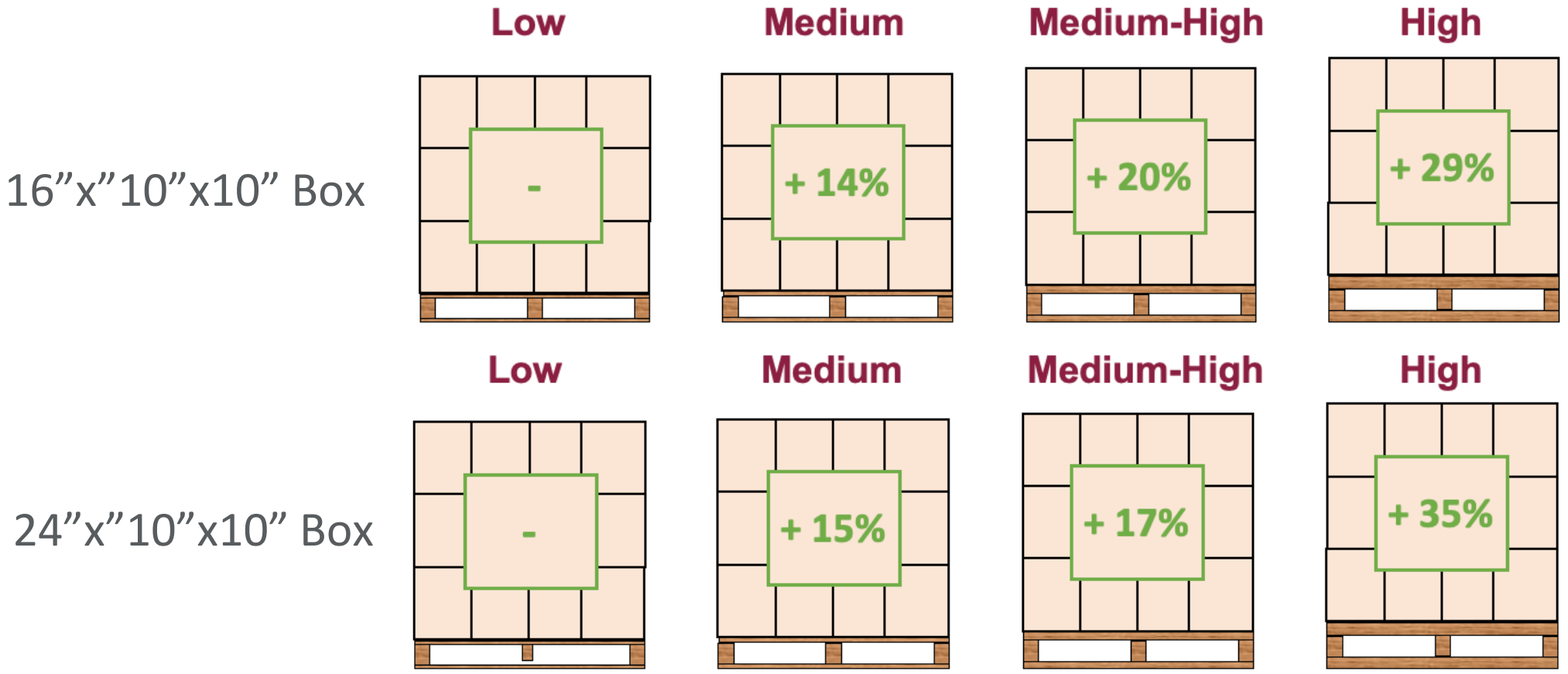


Source: *Baker, M, Horvath, L, White, M.S. (2016) Effect of pallet deckboard stiffness on corrugated box compression strength, Packaging Technology and Science, 29(405) 263-274.*

Background

- Pallet stiffness significant in corrugated box performance
- Increase in impact of stiffness when deckboard gaps increase
- Quesenberry found relation between decreasing box material and increasing pallet material → relationship of pallet and package

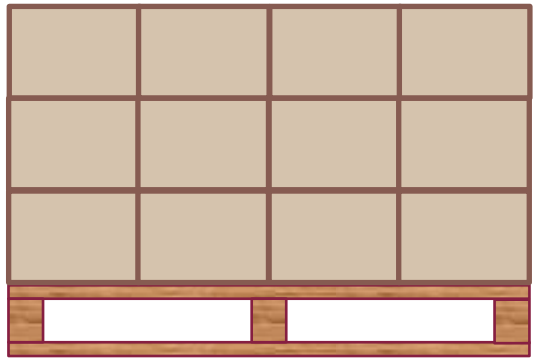
Pallet Stiffness Effect on Box Strength



- Boxes can be **35% stronger** on stiffer pallets

Impact on Financials

Unit Load A

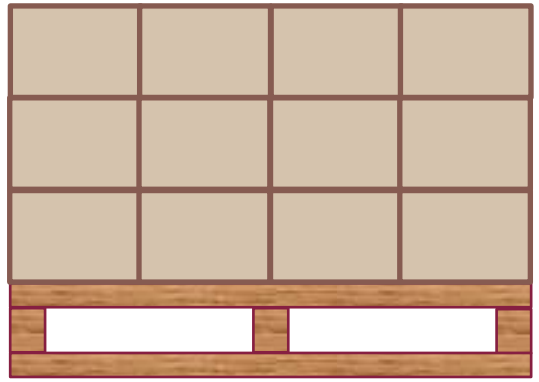


- 3/8 in. top deckboards
- 40 ECT C-flute Corrugated Box

Cost Analysis:

Pallet:	$9.82
48 boxes:	$35.47
Total Unit Load:	$45.29

Unit Load B



- 5/8 in. top deckboards
- 32 ECT C-flute Corrugated Box

Cost Analysis:

Pallet:	$12.11
48 boxes:	$31.34
Total Unit Load:	$43.45

-$1.84 Savings per Unit Load

Background

The objectives of the studies were the following:

- Investigate the effect of a plastic pail's location on a pallet on the pail's compression strength.
- Investigate the effect of a pallet's top deck thickness on pail compression strength.

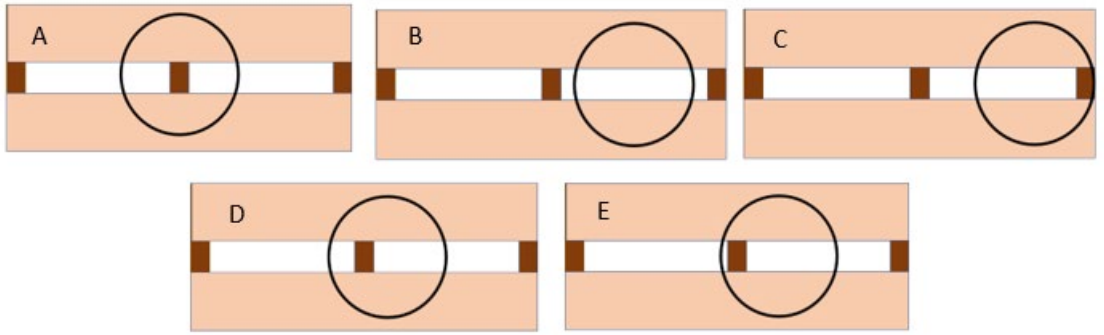
Materials and Methods

Materials & Methods

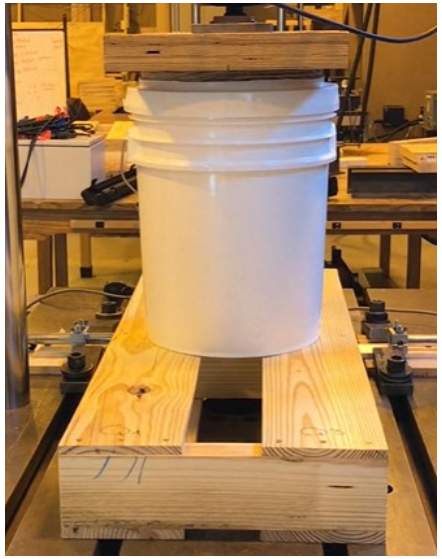
Package: 5-gallon Uline Pail
Load application: Rigid jig → bottom of a pail
Five pail locations on the pallet
Pallet:

- Small scale pallet: 14.5 in. x 36 in.
- 3/8 in., 1/2 in., 5/8 in. & 3/4 in. deckboard thicknesses

Compression testing: ASTM D642 guidelines at ambient laboratory conditions (72 F) with 50 lb preload
Failure: pail sidewall buckled or lid failure
Collected data points: cross head movement, pallet deflection using an LVDT and load applied



Locations that were tested

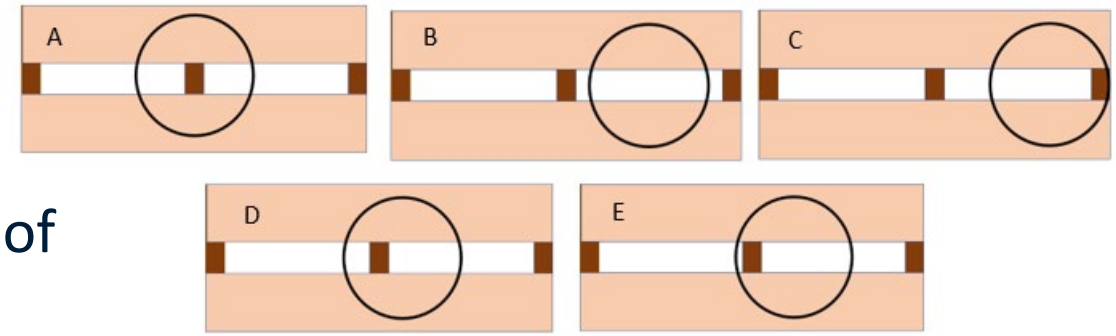


Example of test setup

Location Decisions

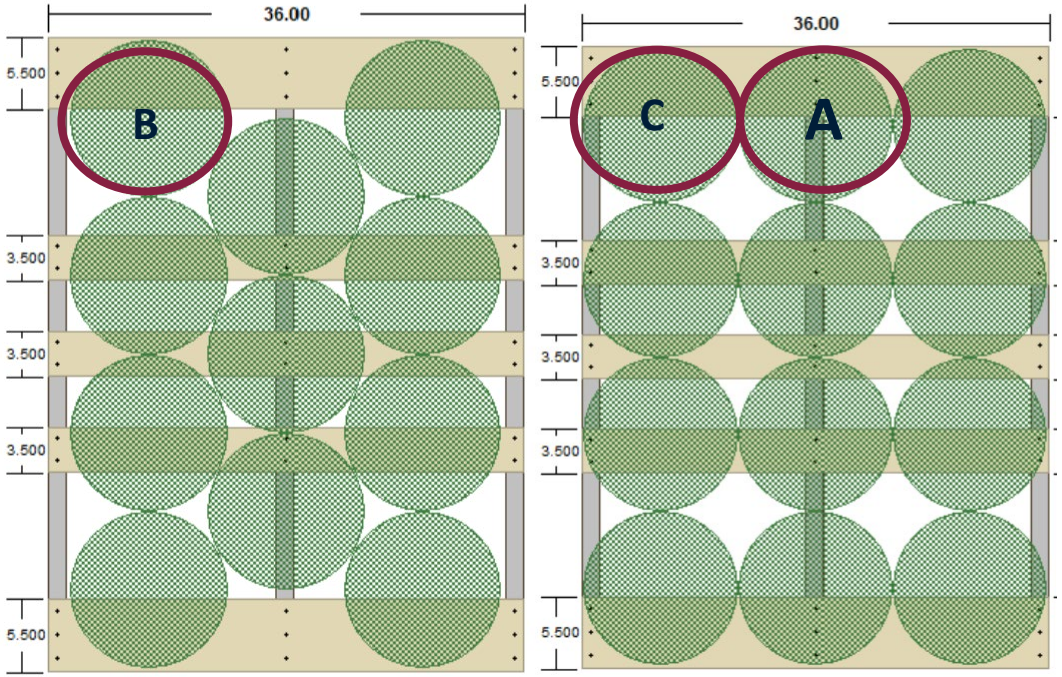
Locations chosen from pail arrangements on pallet

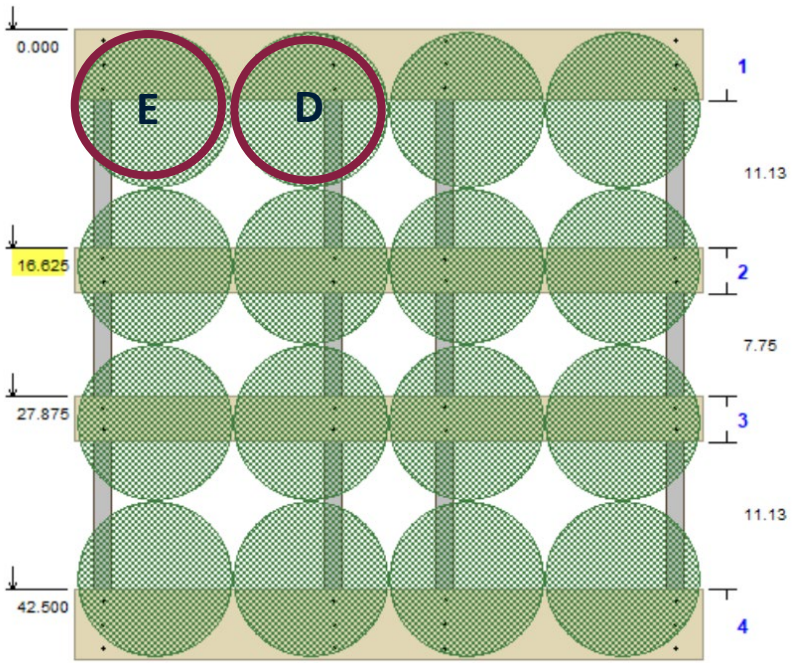
- Center of pallet, center of deckboard, edge of the pallet, 1.5 in. offset, 2.6875 in offset
- Rigid testing condition for comparison



Locations that were tested

Rigid Deckboard Testing

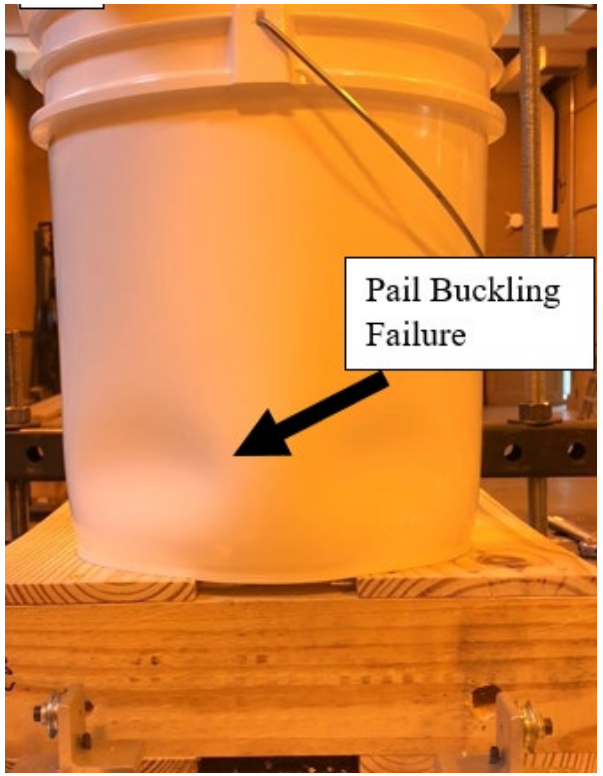




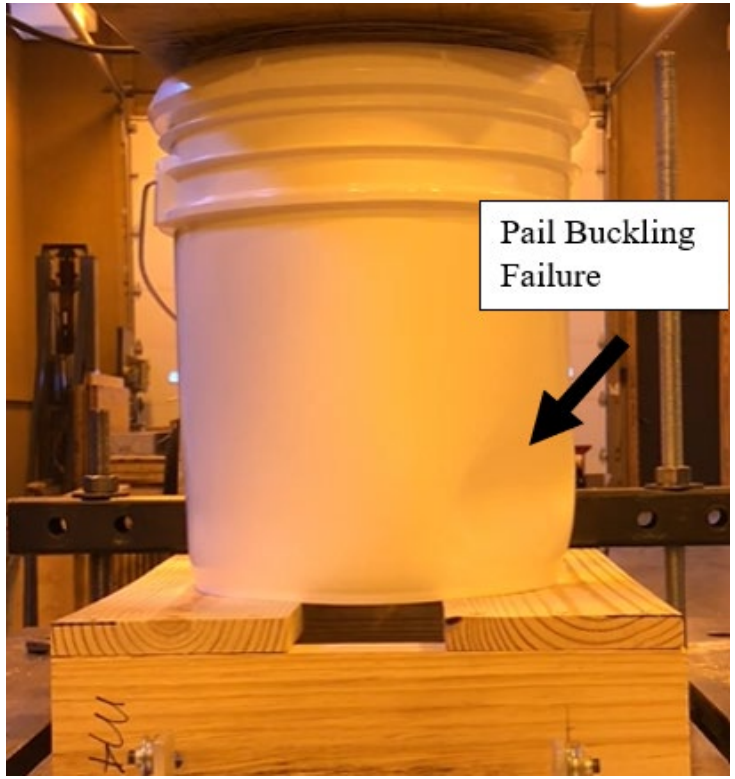
Results

Pail Failure Examples

Center of pallet

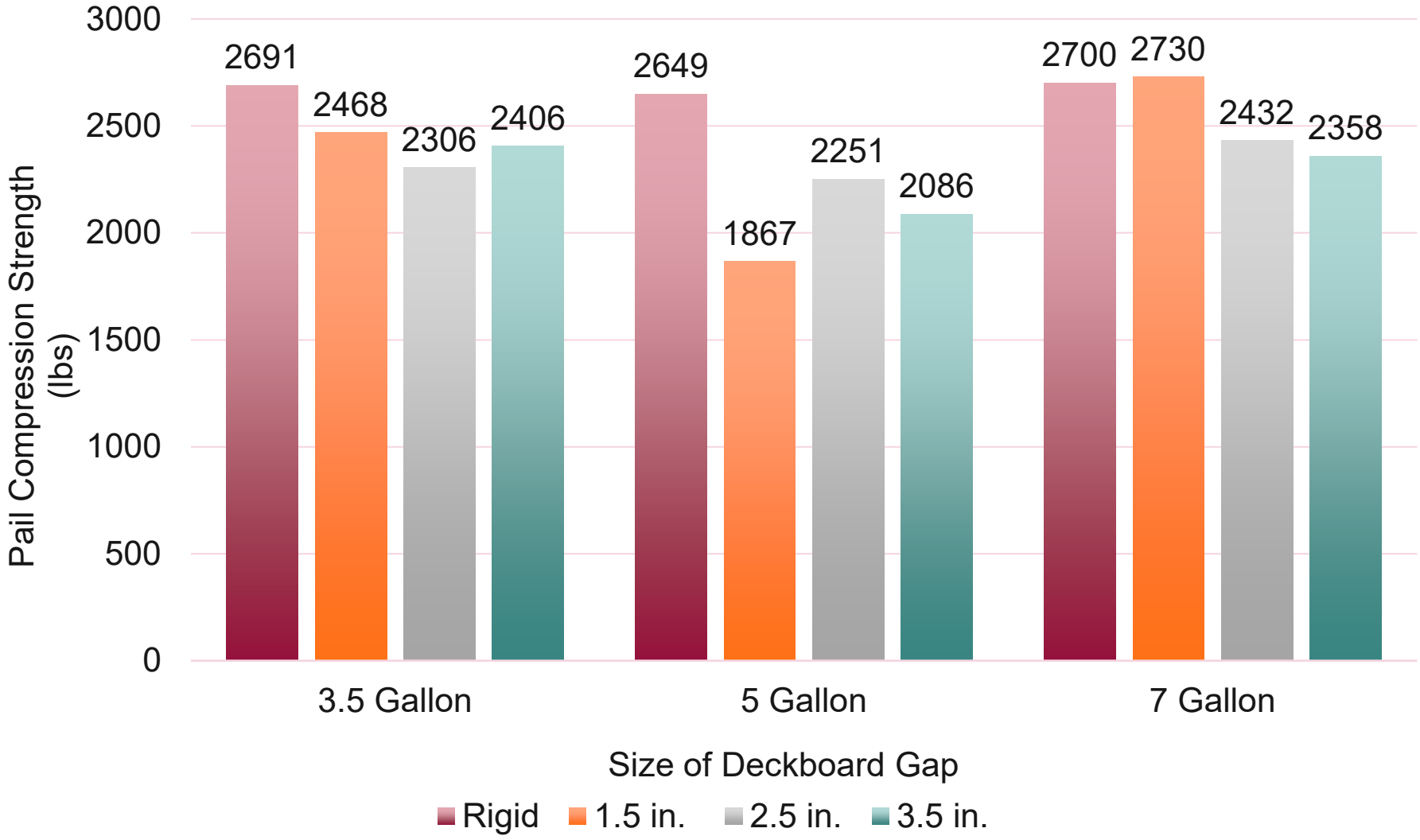


Edge of pallet



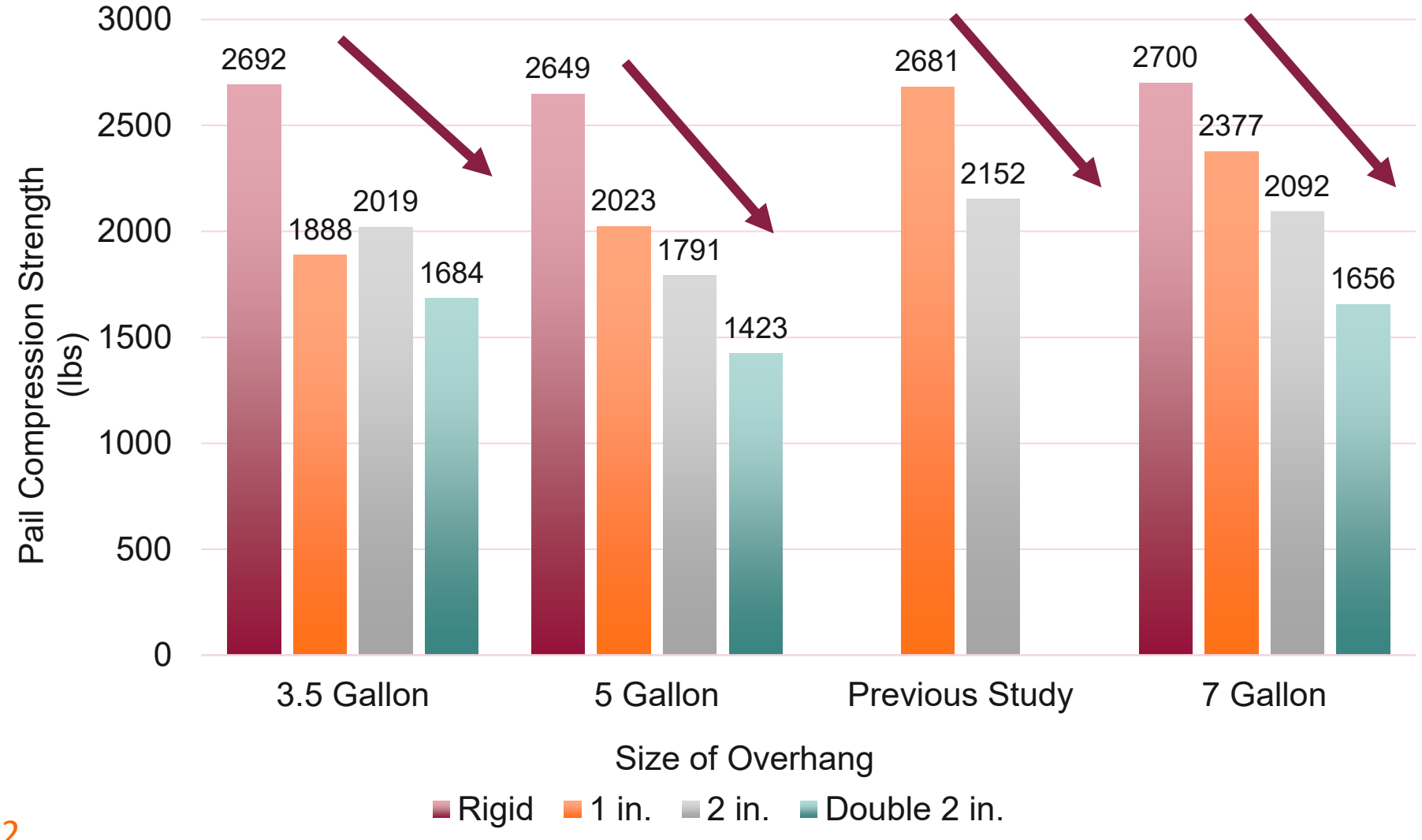
Center of deckboards

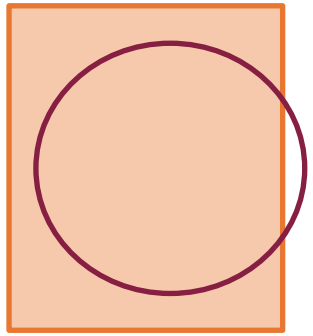
Results: Deckboard Gaps



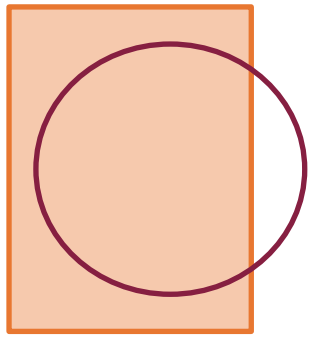
Rigid Deckboard Testing

Results: Pail Overhang

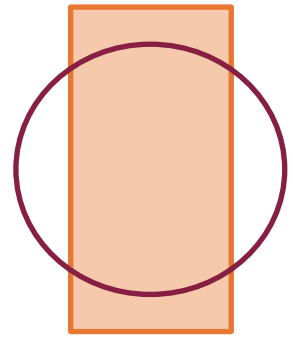




1 in. Overhang

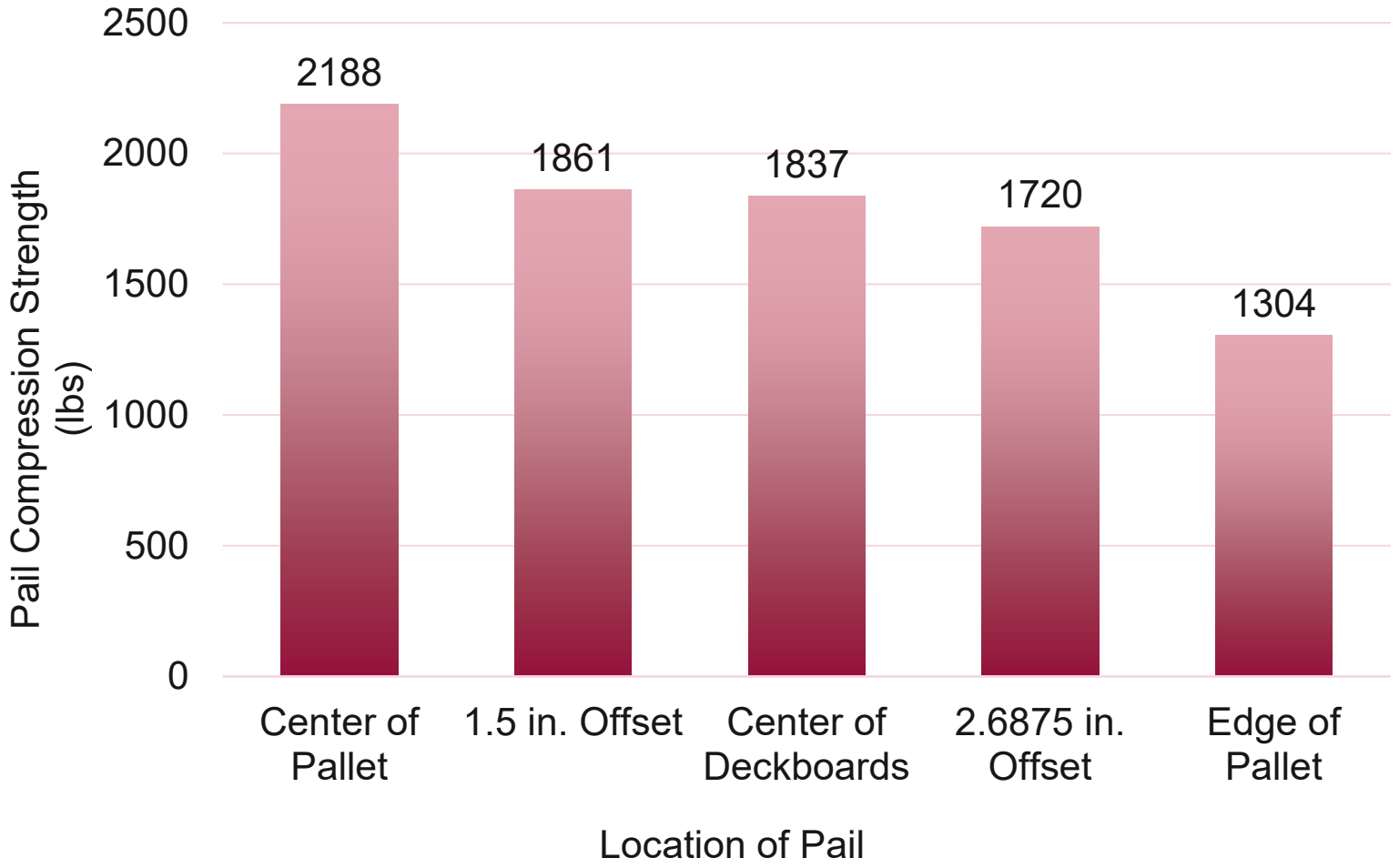


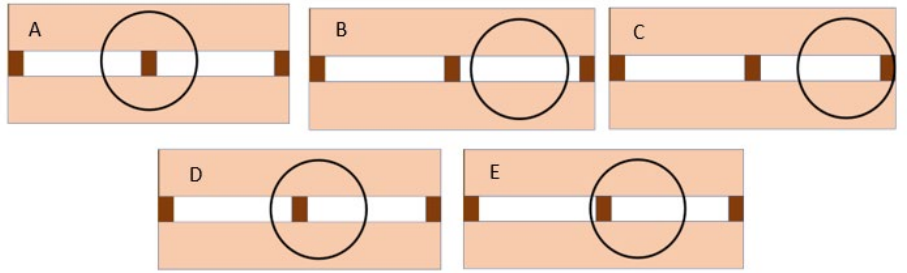
2 in. Overhang



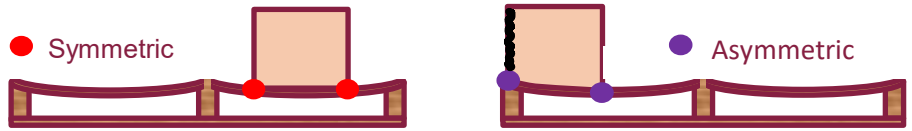
Double 2 in. Overhang

Results: Location Effect



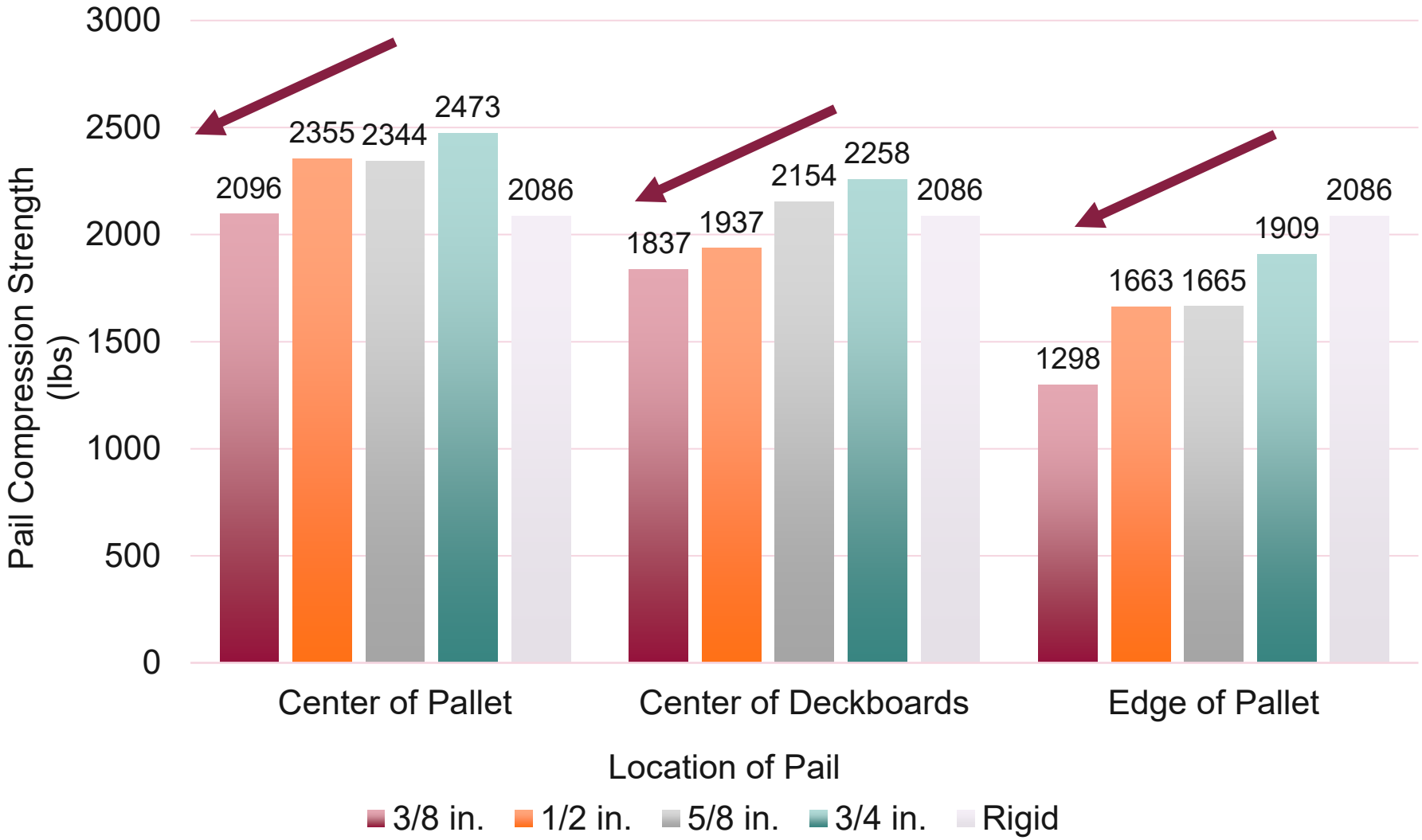


Locations that were tested

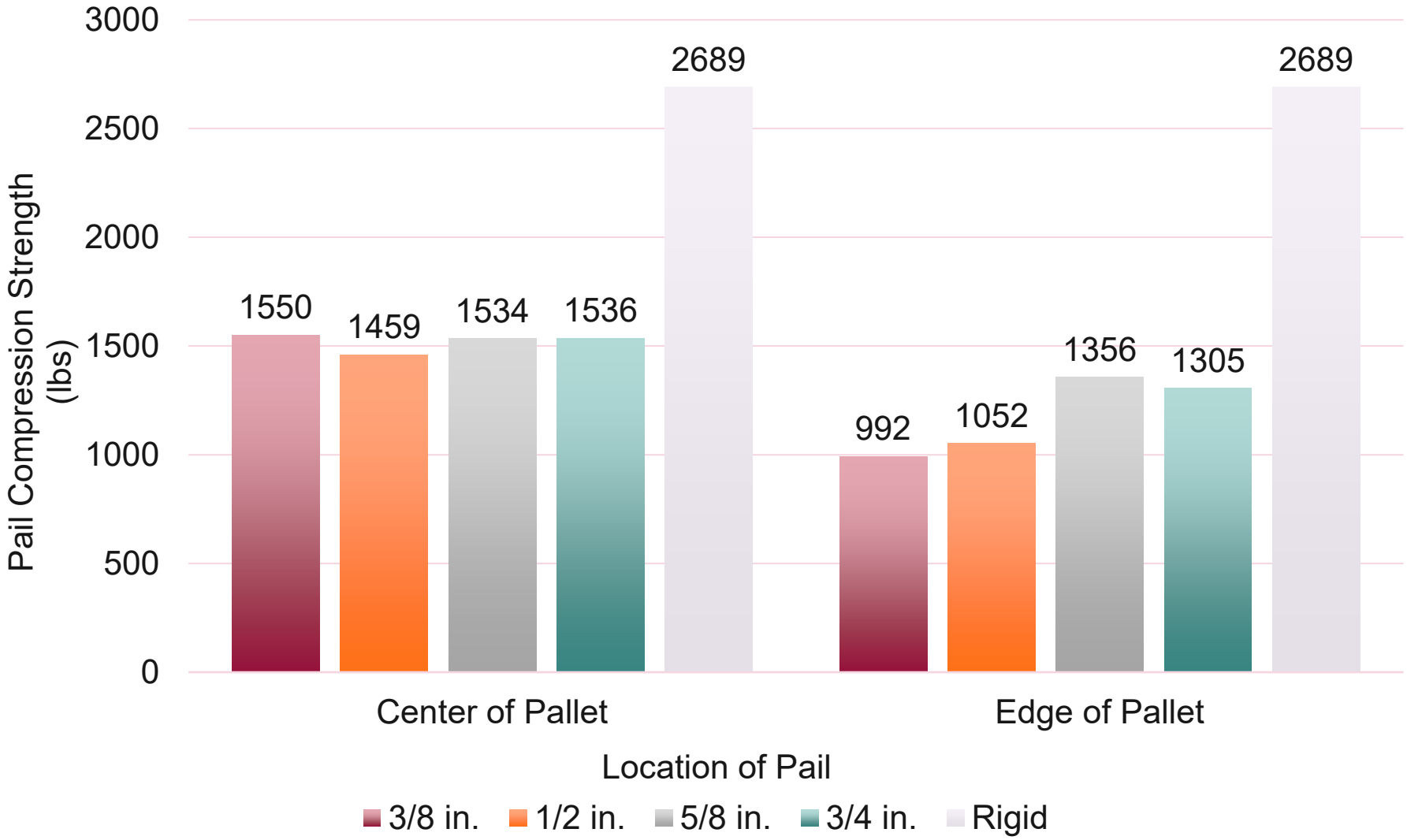


Symmetric vs. Asymmetric Loading

Results: Stiffness Testing & Effect of Location



Results: Stiffness Testing & Effect of Location with Overhang



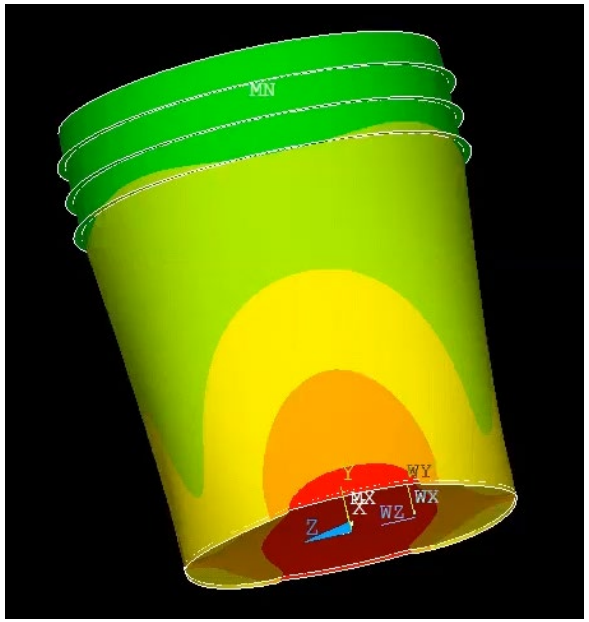
Conclusions

Conclusions

- Increasing the size of the pallet gap and overhang significantly reduces the strength of plastic pails
- The location of the pail on the pallet has a significant effect on the pail strength
- Compression strength of pails decreased as much as 40% at the edge of the pallet
- Thickness of the pallet top deckboard has a statistically significant effect on the compression strength of the plastic pails
- When the thickness of the pallet top deck decreases, the compression strength of the pail decreases as much as 47%
- Deckboard stiffness effect related the location of the pail on the pallet

Future of Plastic Pail Work

- Developing a finite element model of plastic pails on pallet to predict interactions
- Continuing to investigate the effect of supported base (relationship between % of supported base and compression strength)
- Data and model will be integrated into the NWPCA software, Pallet Design System



Finite Element Example

Acknowledgements

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Thank you for your attention

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