

# Uplift Strength of Clay Tiles Installed on Self-Adhering Roofing Membrane



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# Research Motivation

- Failed tile roof systems key contributors to wind-borne debris

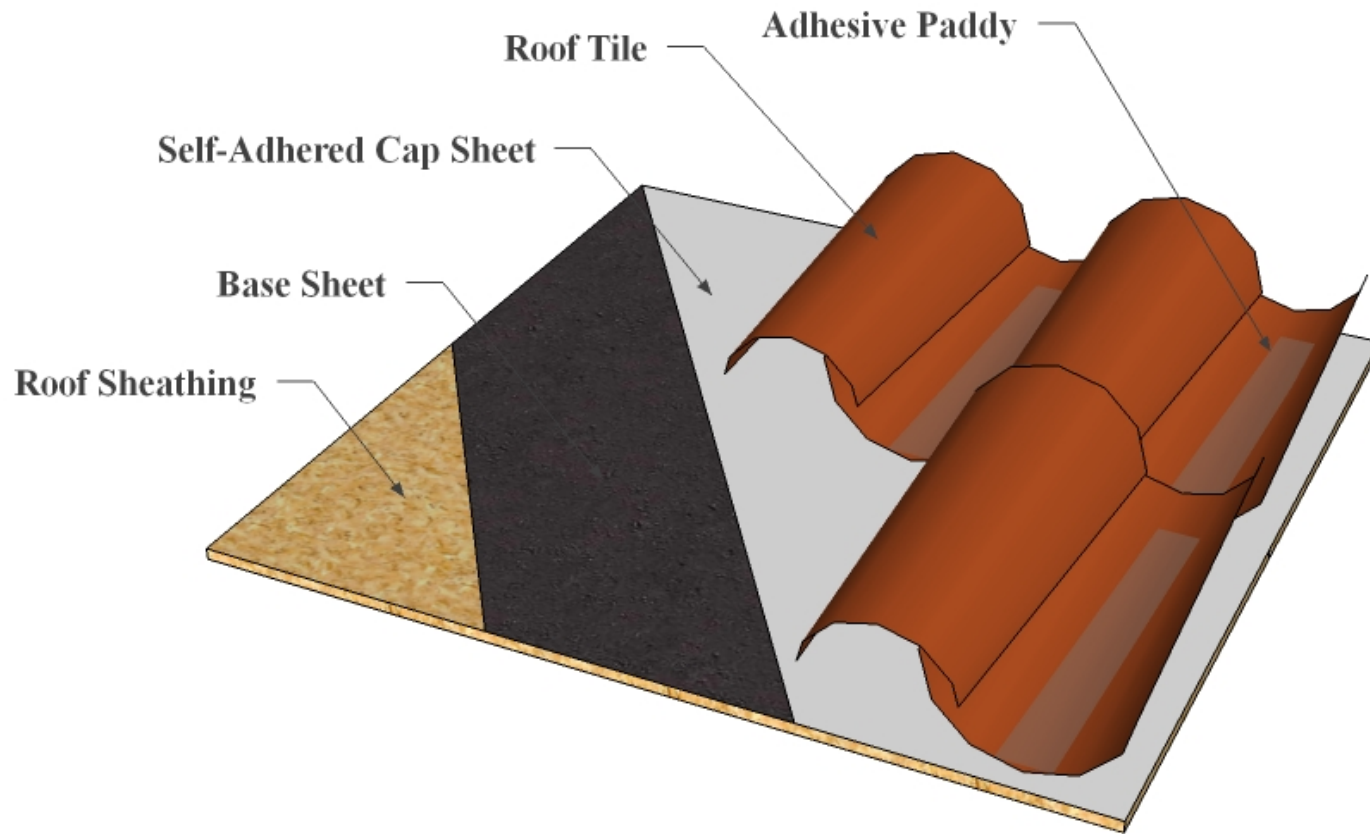


# Research Motivation

- Failure in load path for tile roof systems is key contributor to wind-borne debris
- Typical installation: tile → self-adhered secondary water barrier → nailable base sheet → roof deck.



# Standard Tile Roof Components





# Research Motivation

- Failure in load path for tile roof systems is key contributor to wind-borne debris
- Typical installation: tile → self-adhered secondary water barrier → nailable base sheet → roof deck.
- Tiles are installed with self-adhered membranes, direct to deck, i.e., no nailable base sheet.
- Question: does deck-to-deck self-adhering installation provide adequate uplift performance for clay tile?



# Project Scope

- Develop a test method to evaluate uplift capacity of clay tile roof systems on membrane
- Investigate uplift capacity of tile roof systems with direct-to-deck application
- Compare direct-to-deck application with standard application methods with respect to uplift capacity

# Tile Options

## ➤ Material



Clay



Concrete



Slate



Synthetic

## ➤ Shape



Spanish "S"



Barrel



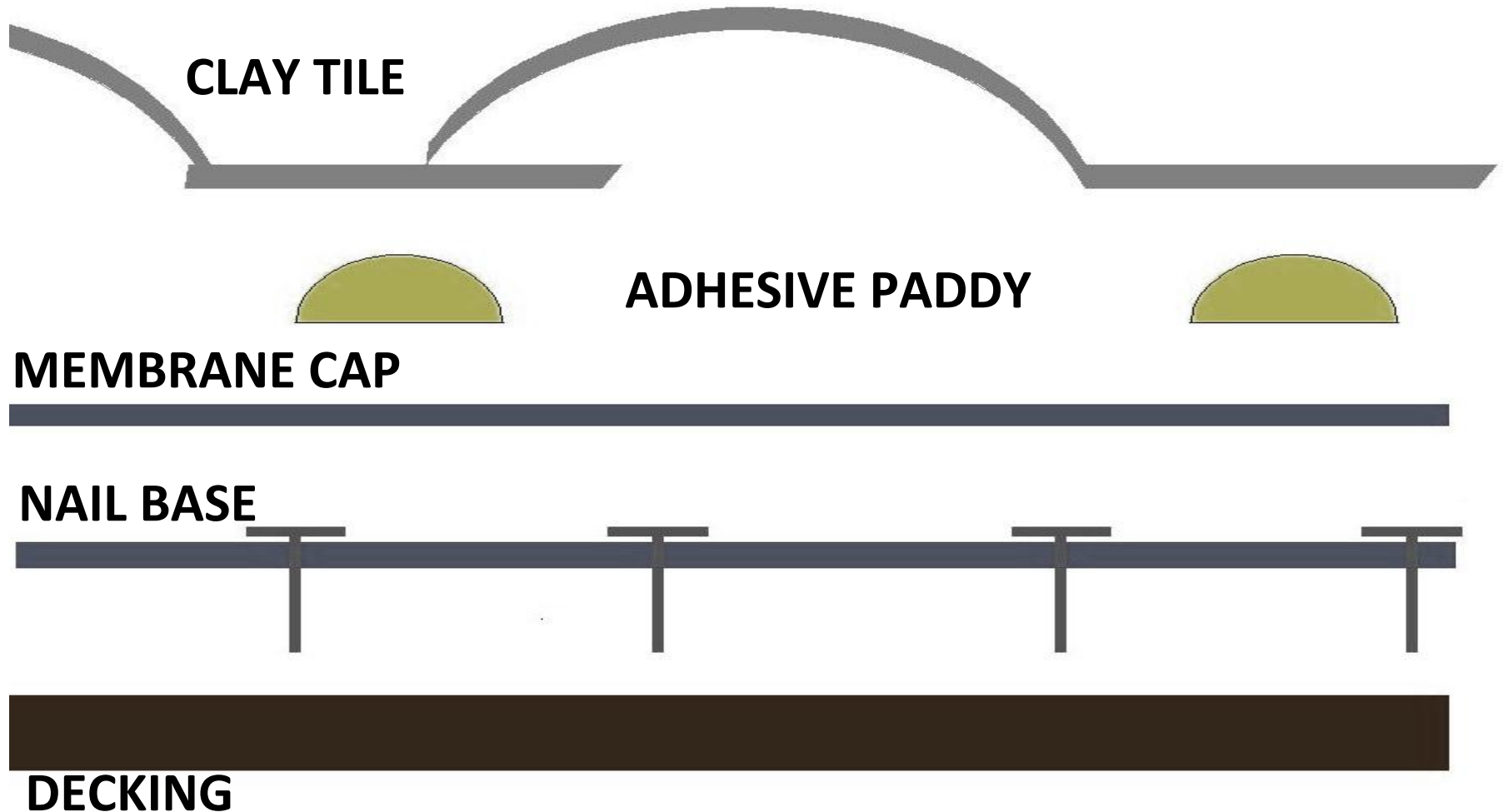
Roman



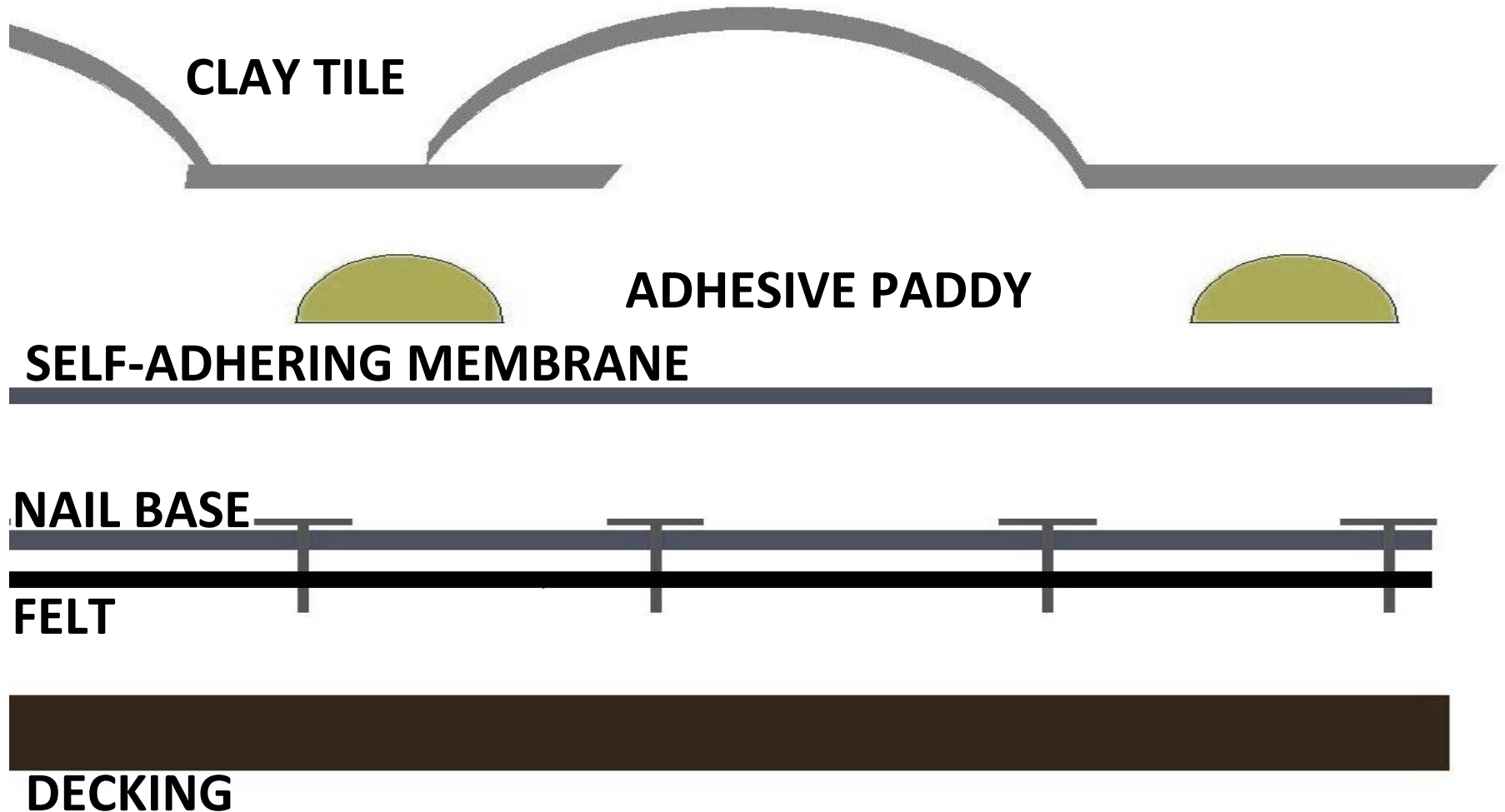
Flat



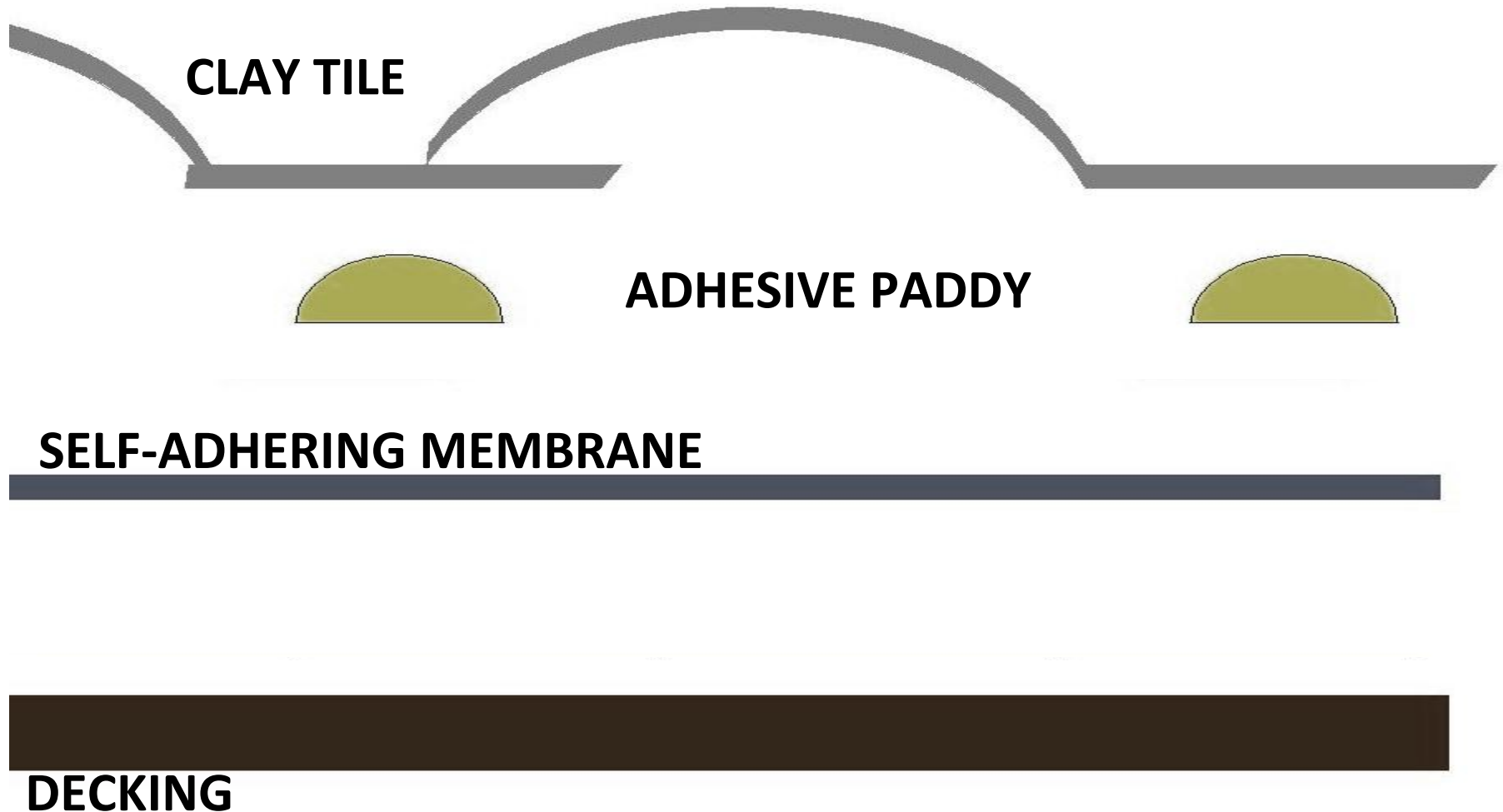
## Two-ply System (Membrane A)



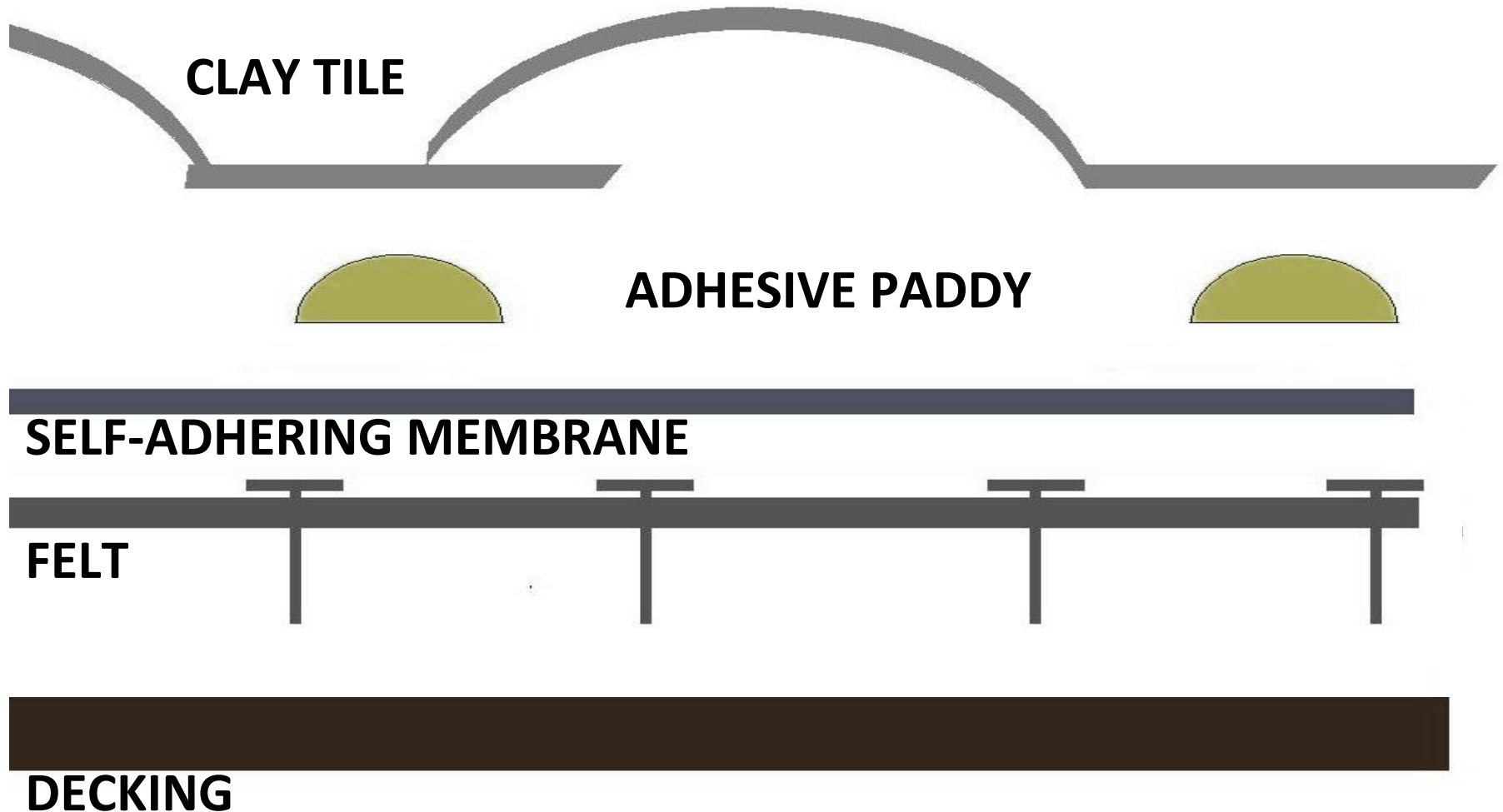
# Two-ply System with felt (Membrane A)



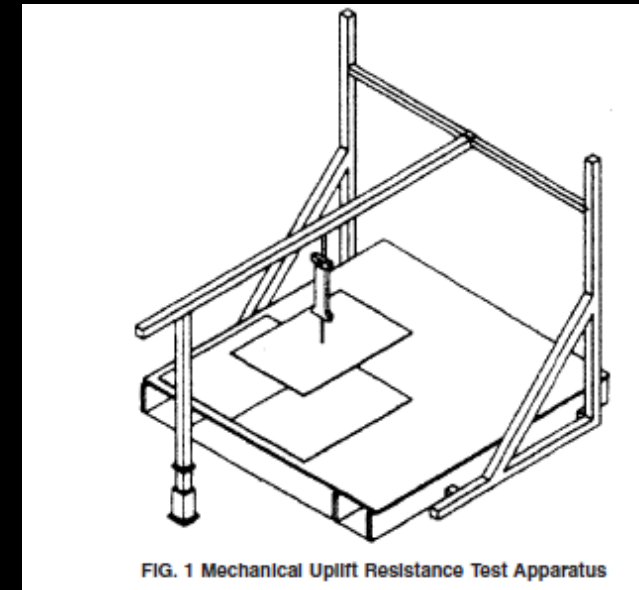
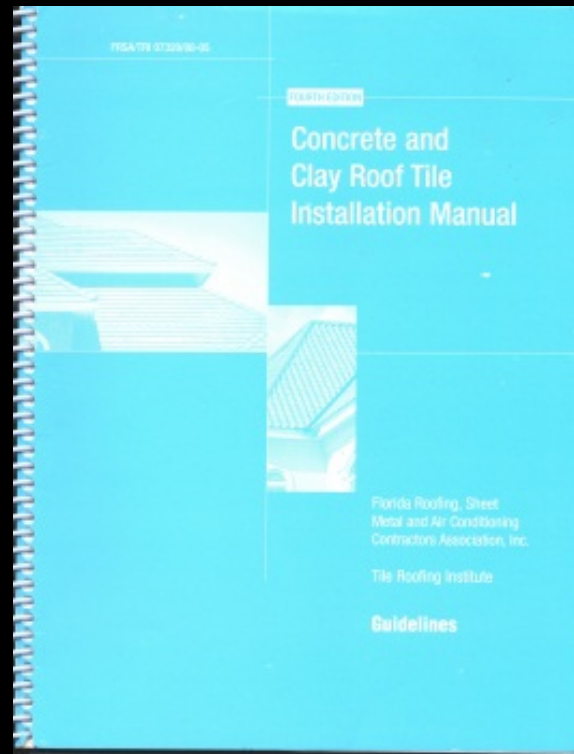
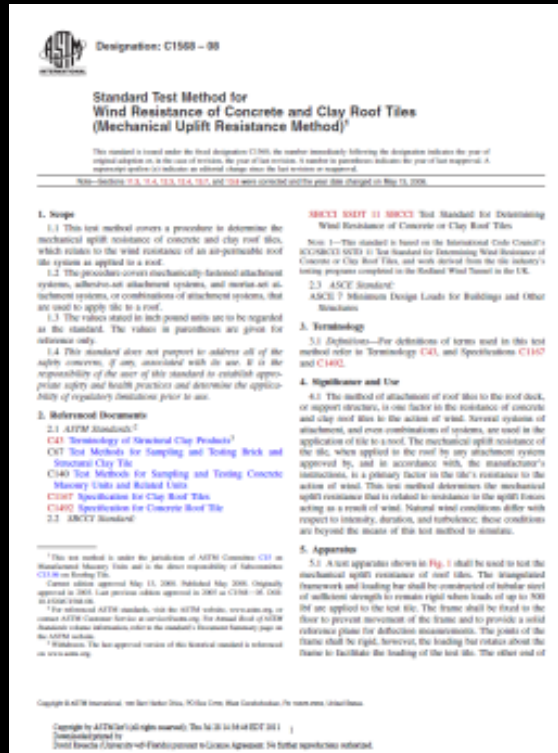
# Single-ply direct-to-deck (membranes B,C,D)



# Single-ply on felt (membranes B,C,D)



# Standard Protocols for Tile Roofs



ASTM C1568 – Standard Test Method for Wind Resistance of Concrete and Clay Roof Tiles

FRSA - Concrete and Clay Roof Tile Installation Manual

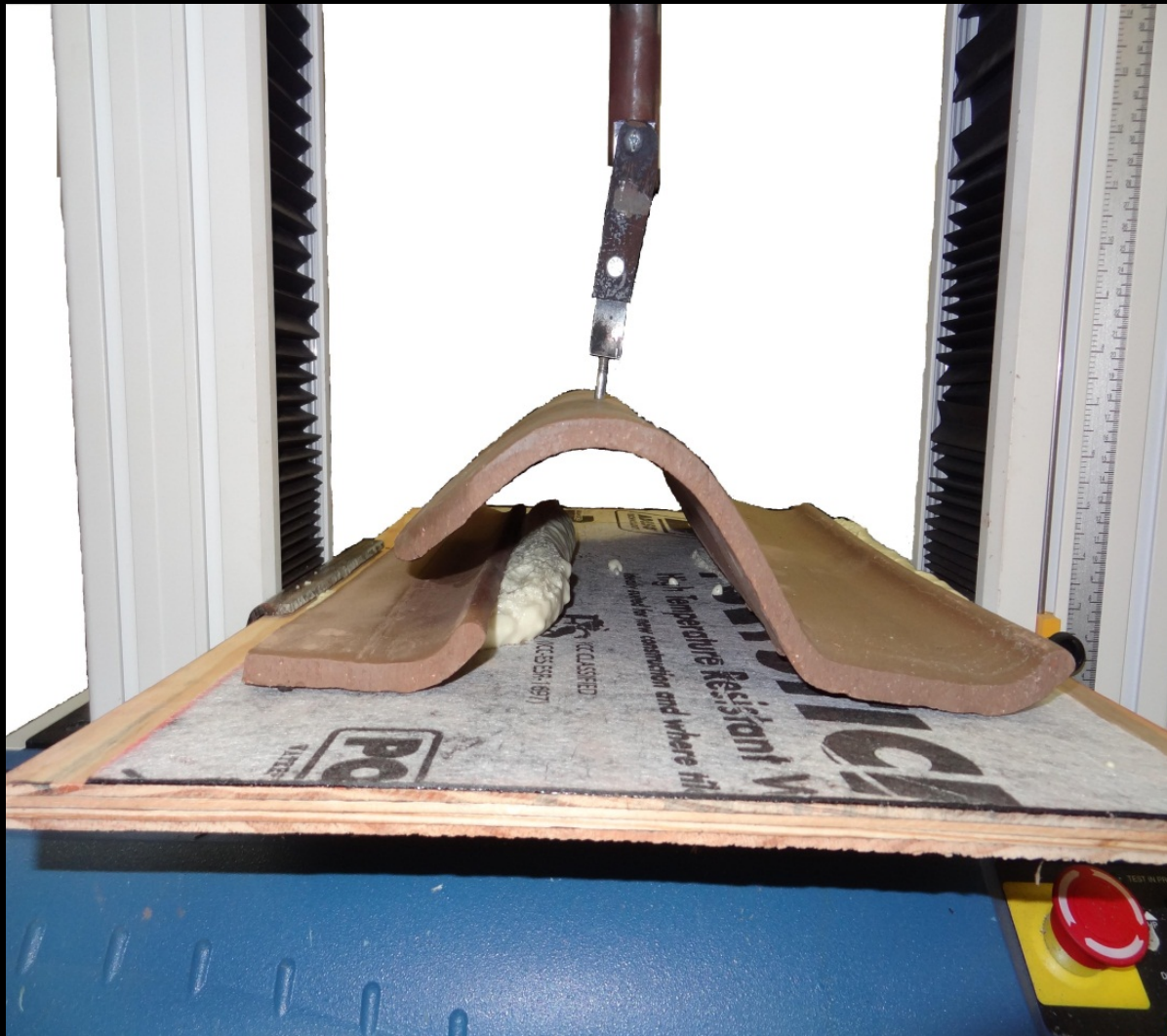
ASTM C1568 Test Setup

- TAS No. 101-95 – Test Procedure for Static Uplift Resistance of Mortar or Adhesive Set Tile Systems
- RAS No. 120 – Mortar and Adhesive Set Tile Application
- RAS No. 113 – Standard Requirements for Job Site Mixing of Roof Tile Mortar



# Test Setup

- Spanish “S” tile
- 2 deck types
- 4 membrane systems
- Foam adhesive & mortar



Instron 3367 Test Machine  
1.0 in. per min. at tile center

# Test Matrix

	Sheathing Type		Membrane Type					Adhesive Type		#
SAMPLE	PLYWOOD	OSB	30#	Type A	Type B	Type C	Type D	FOAM	MORTAR	Samples
1	X			X				X		30
2	X		X	X				X		20
3	X			X					X	20
4		X		X				X		20
5		X	X	X				X		20
6	X				X			X		20
7	X		X		X			X		20
8		X			X			X		20
9		X	X		X			X		20
10	X					X		X		15
11	X		X			X		X		15
12	X						X	X		20
13	X		X				X	X		20
14	X						X		X	20
Total										280

# Material Properties

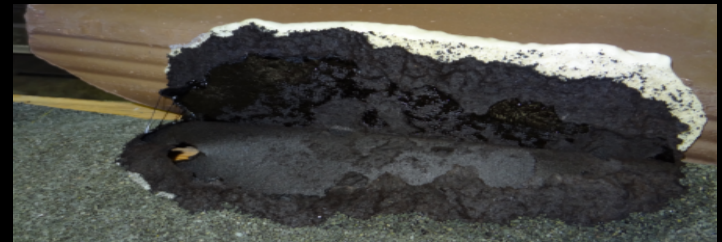
Underlayment Type	Product	Thickness	Top Surface	Fastener	Fastener Pattern
Membrane A	Cap Sheet	59.1mils	Permanent Film	Nails	(2) Staggered Rows 18" O.C.
	Base Sheet	157.5mils	Granular Mineral	Self-adhered	n/a
Membrane B	Cap Sheet	80mils	Polyester Fabric	Self-adhered	n/a
Membrane C	Cap Sheet	100mils	Ceramic Granules	Self-adhered	n/a
Membrane D	Cap Sheet	55.9mils	Polyester Fabric	Self-adhered	n/a
Felt	30# Felt	40.5mils	Smooth	Nails	12" O.C.

# Analyzing Testing Results

- Peak Failure - failure mechanism at Peak Load, causing decrease in capacity
- Secondary: other observed failure mechanisms
  - Adhesive Failure (to tile, within adhesive, or to cap sheet)
  - Membrane Failure (cohesive or adhesive)
  - Membrane tearout around nail



Adhesive Failure

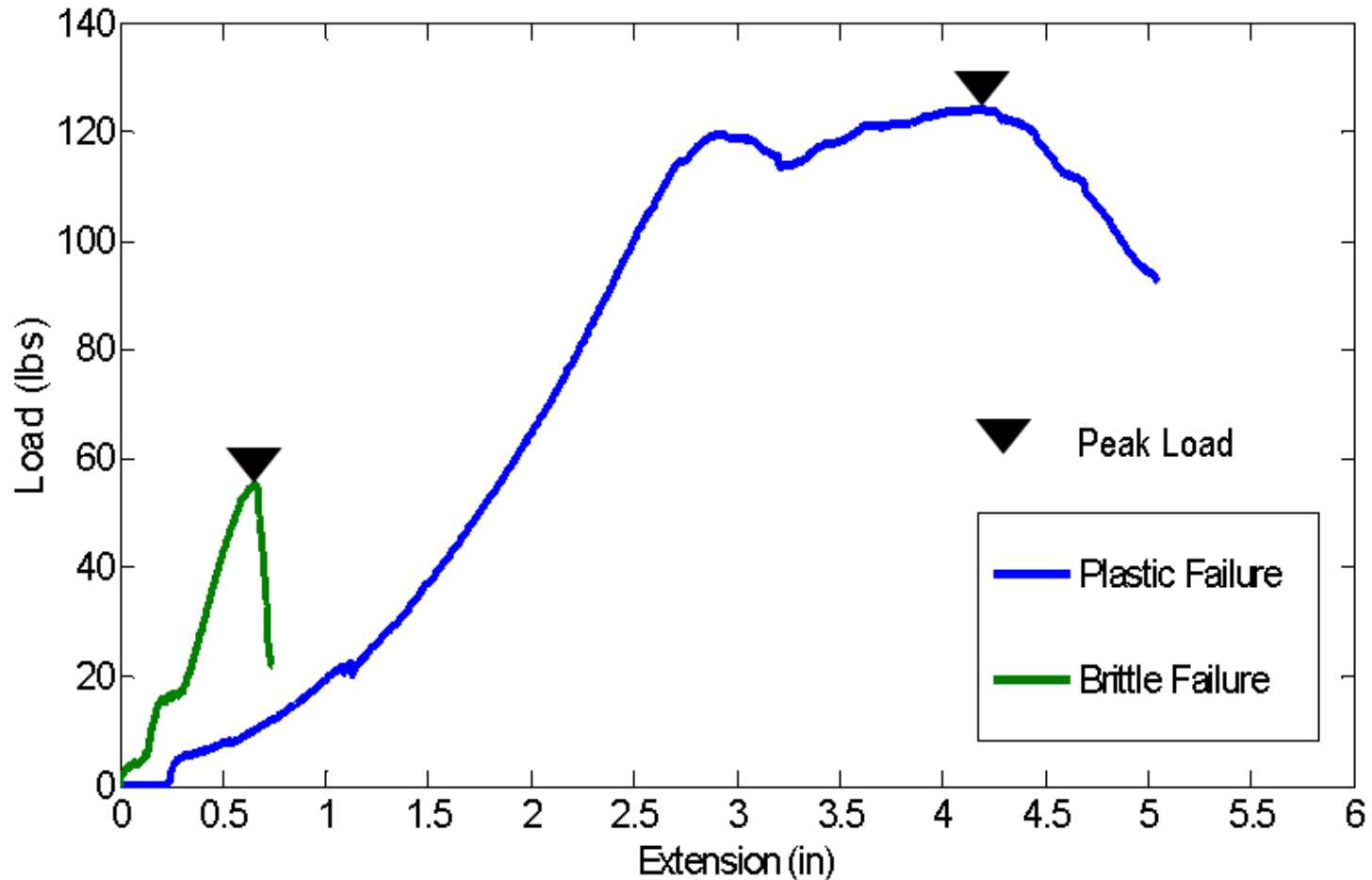


Membrane Failure



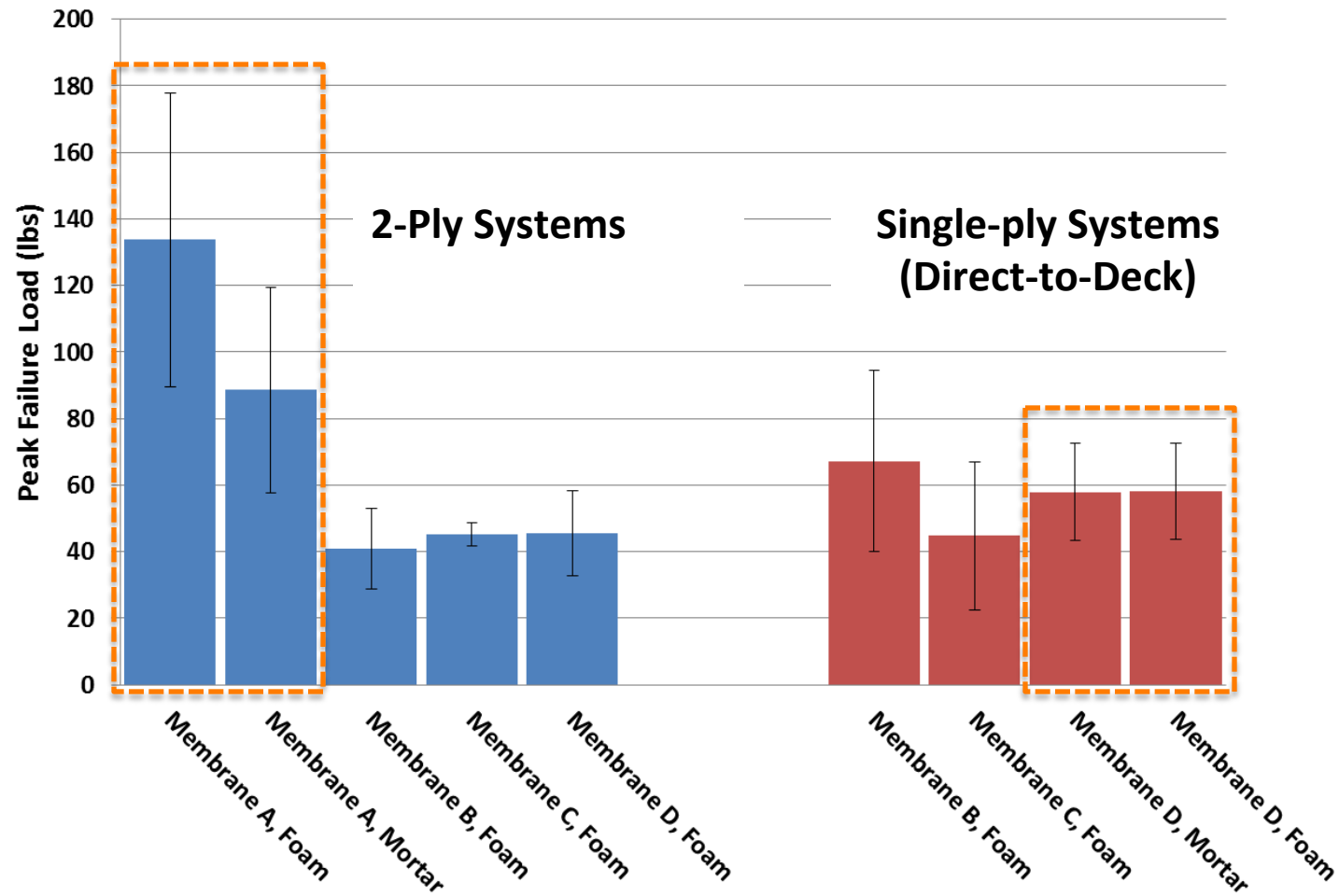
Membrane tearout around nail

# Plastic vs Brittle Failure





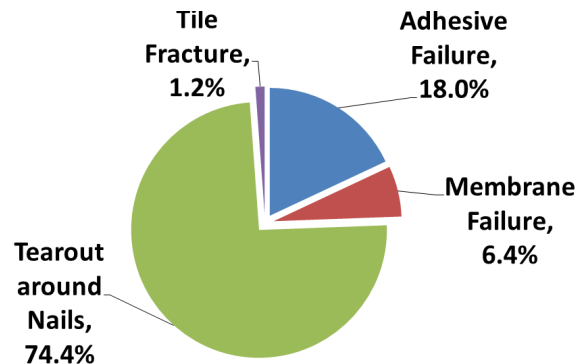
# Results – Failure Loads



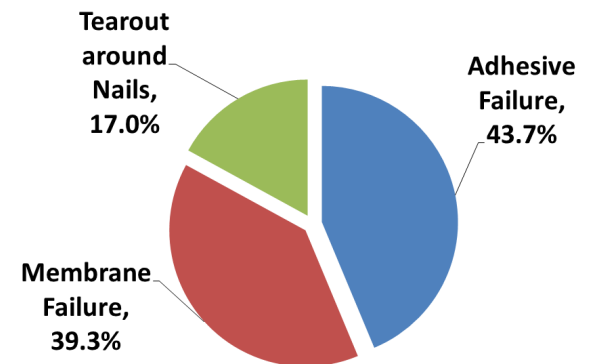
# Results – Failure Types

## 2-Ply Systems

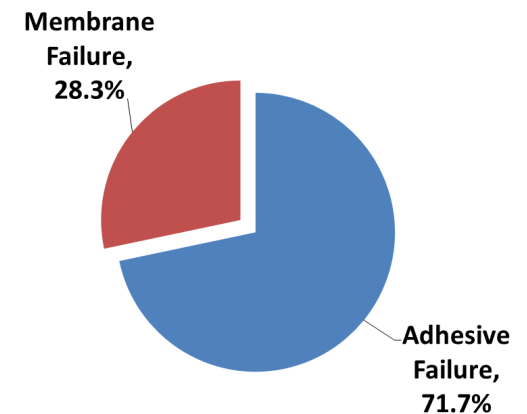
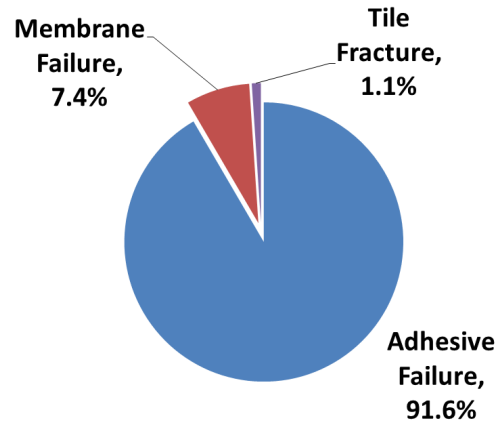
### Primary



### Secondary



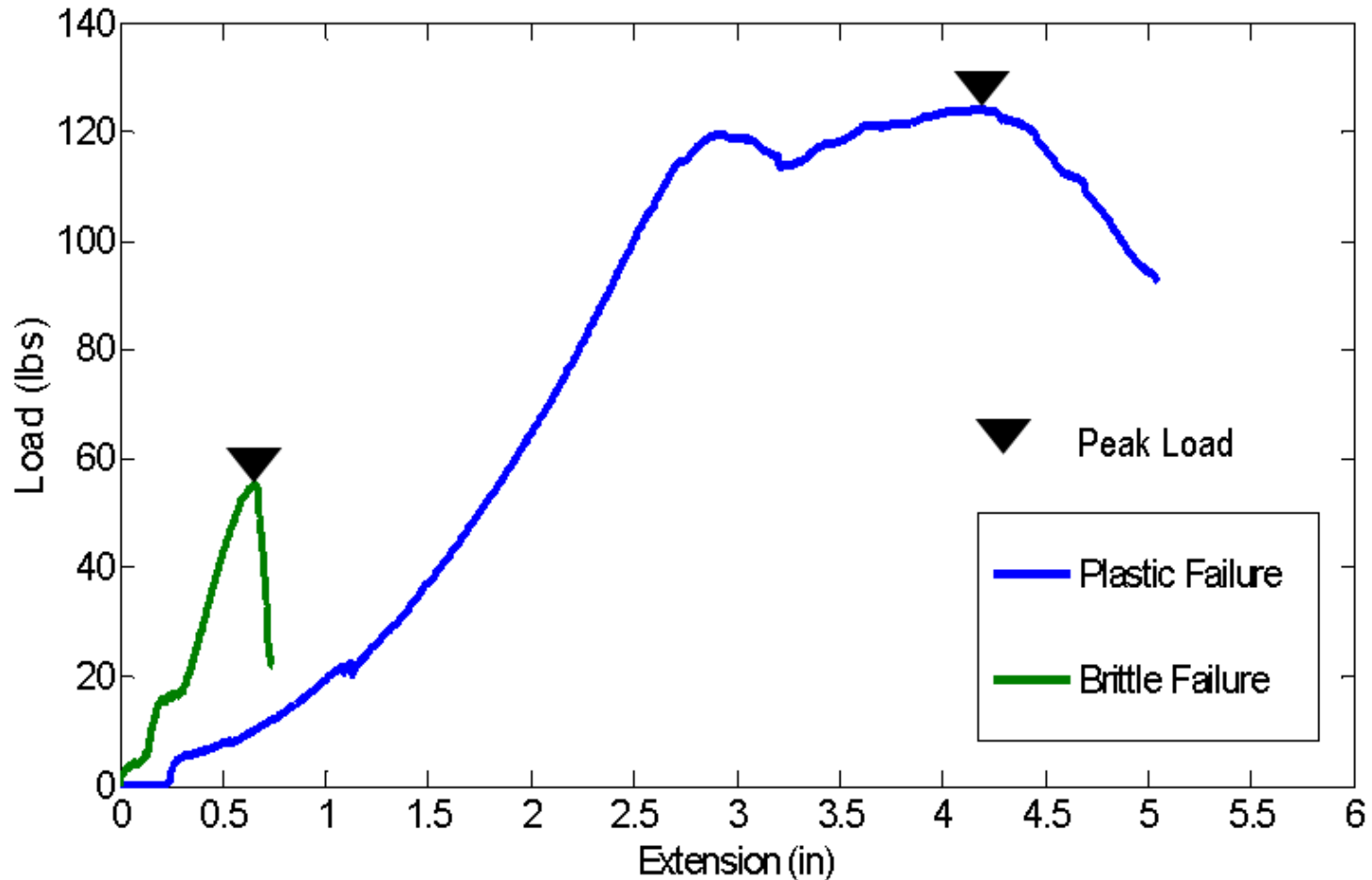
## Single-ply (Direct-to-Deck)



# Conclusions

- Peak failure loads for nail base systems versus direct-to-deck systems similar in membranes from Manufacturers B, C and D
- Brittle failures in direct-to-deck application as opposed to plastic failures in systems with nail base
- Primary failure mechanisms change between standard and direct-to-deck systems

# Plastic vs Brittle Failure



# Summary

- Limitations of the results
  - Withdrawal rate (slow, controlled) vs. sudden impact wind load
  - Static, monotonic increasing load vs. dynamic wind action
  - Atypical boundary conditions (isolated tile, discontinuous membrane) to establish conservative capacity
- Roof corner design pressure  $\sim 60\text{psf}$  at  $140\text{ mph} = \sim 80\text{ lb}$
- Failure may not be controlled by suction
- Future tests recommended using dynamic open jet using simulated hurricane wind speed



➤ Thank you for your time and attention

➤ Questions/Comments?

➤ Contact Information

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