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Development of national standards for adhesive applied roofing systems

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NRC-CNRC

Institute for
Research in
Construction

Development of National Standards for Adhesive Applied Roofing Systems

Bas A. Baskaran
Suda Molleti

National Research Council of Canada (NRCC)

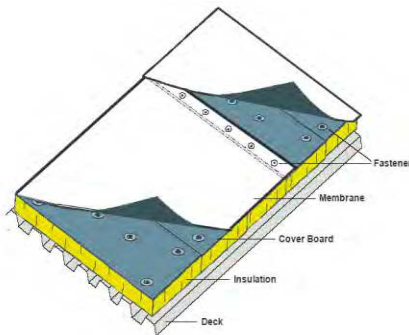


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Council Canada

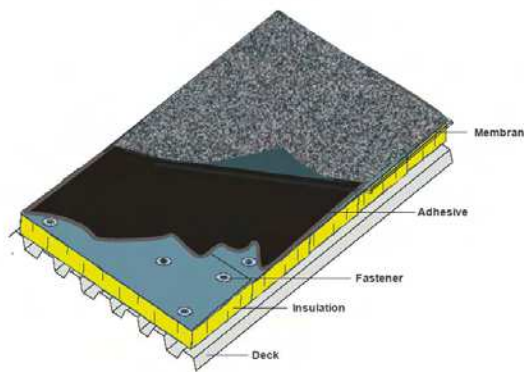
Conseil national
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Canada

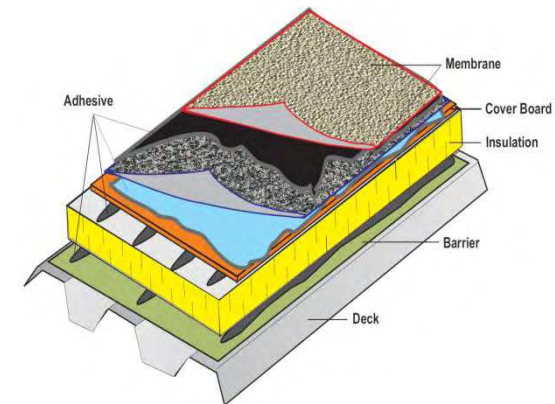
Low-Sloped Roofing Systems



**Mechanically
Attached Roofing System
(MARS)**

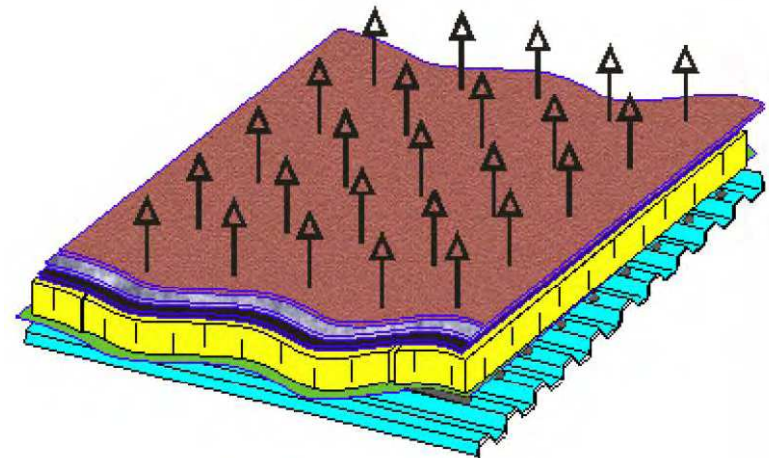
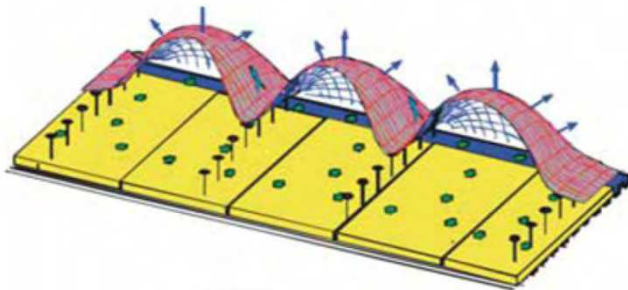


**Fully Bonded Roofing
Systems (FBRS)**



**Adhesive Applied
Roofing Systems
(AARS)**

Roof System Response

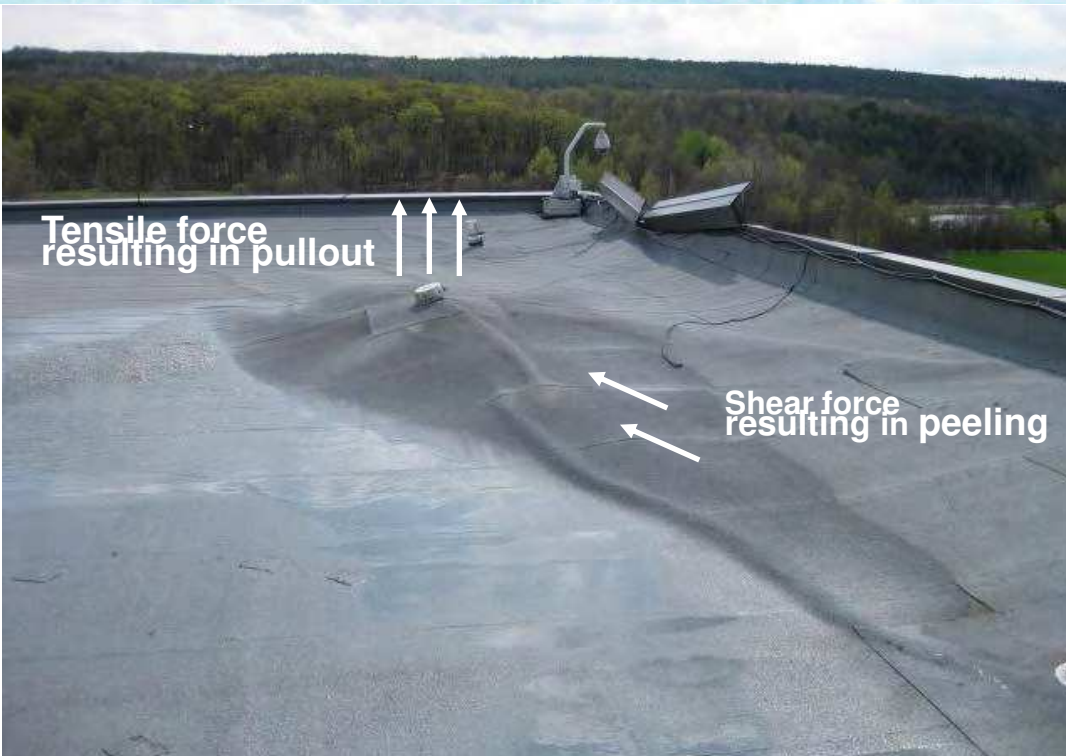


Typical Field Failure of Rigid Systems

NRC-CMRC

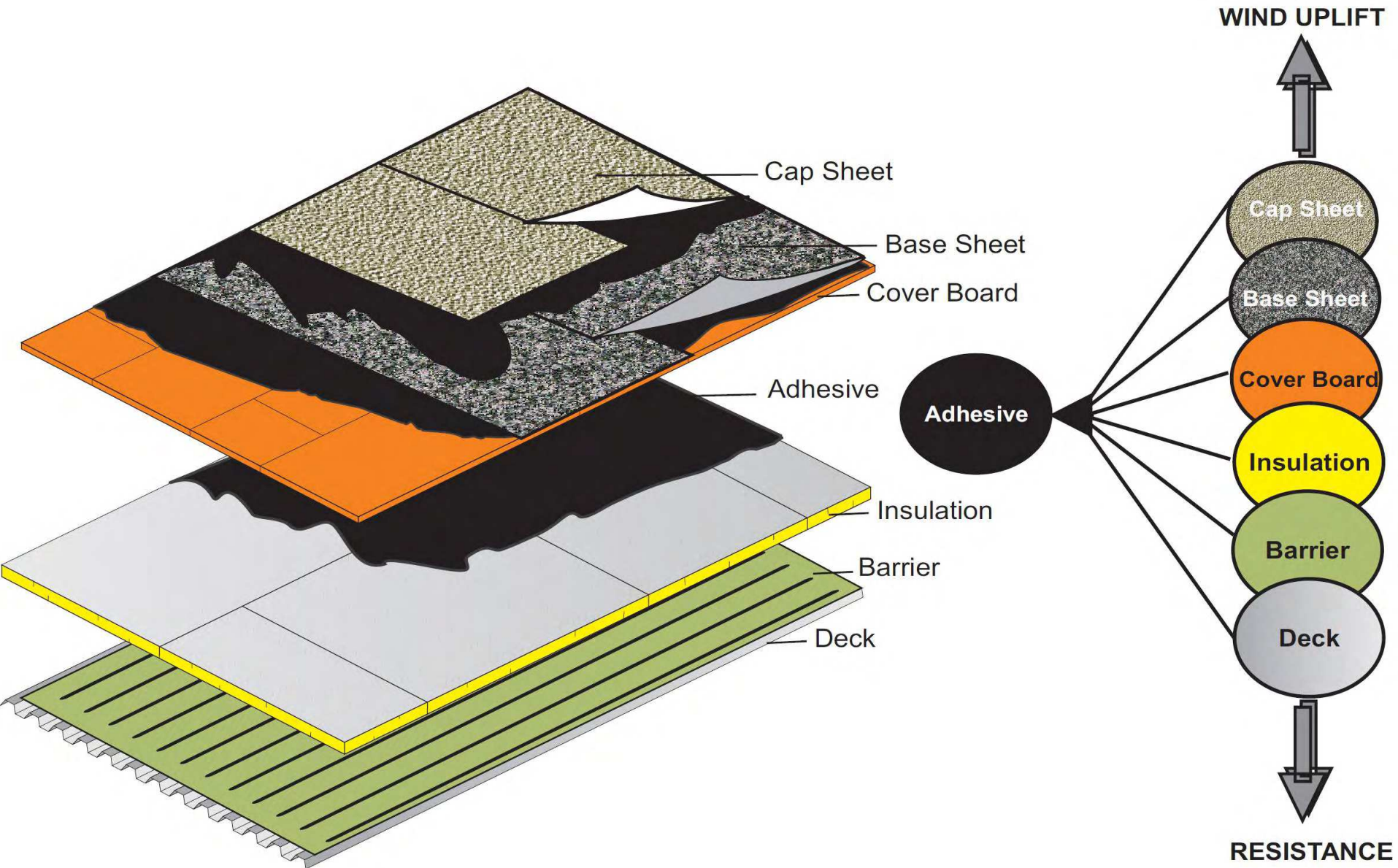


Force Development in AARS



***Wind Induced
Shear and Tensile Forces***

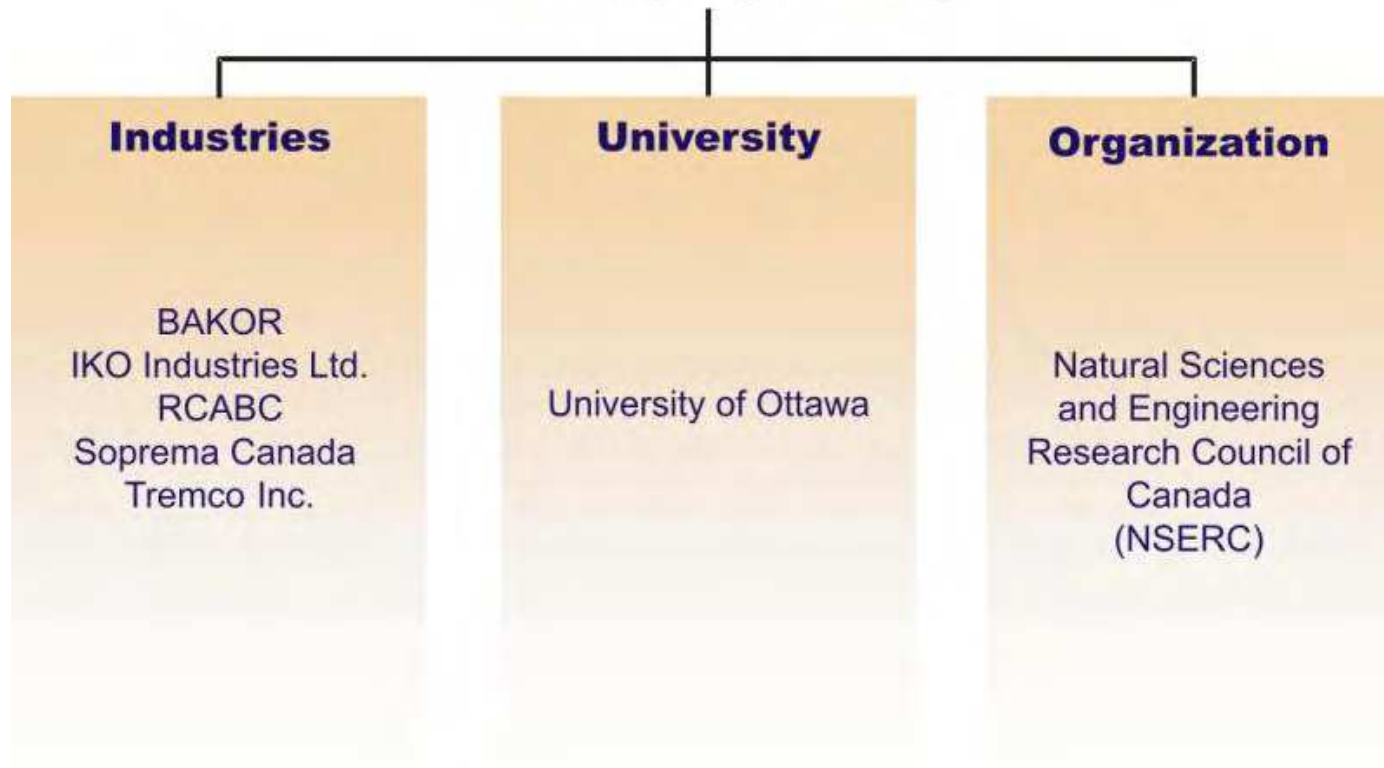
Investigation Objective



Collaborative Research Project

AARS

NRC-CNRC



Research Tasks

Wind Uplift Resistance of Adhesive Applied Low Slope Roofing Systems

Task 1 –Uplift Test

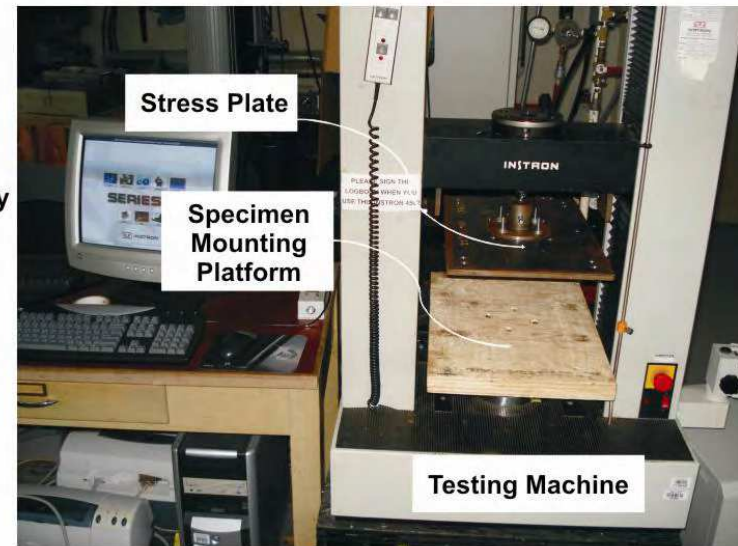
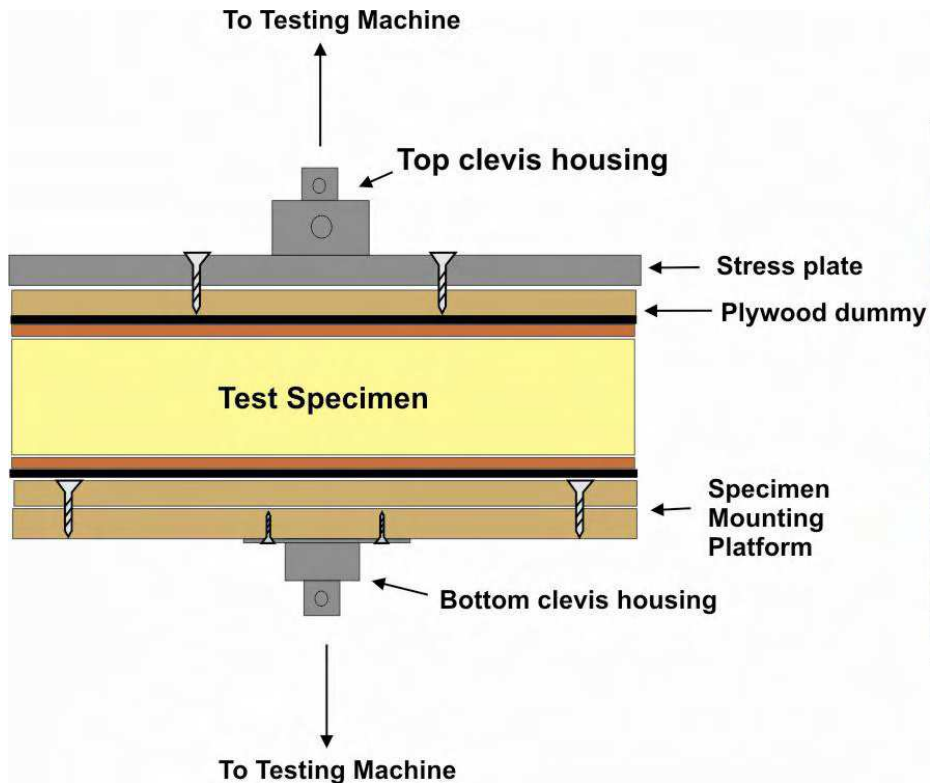
Task 2 –Peel Test

Task 3 – Full Scale Test

Task 4 – Numerical Modelling

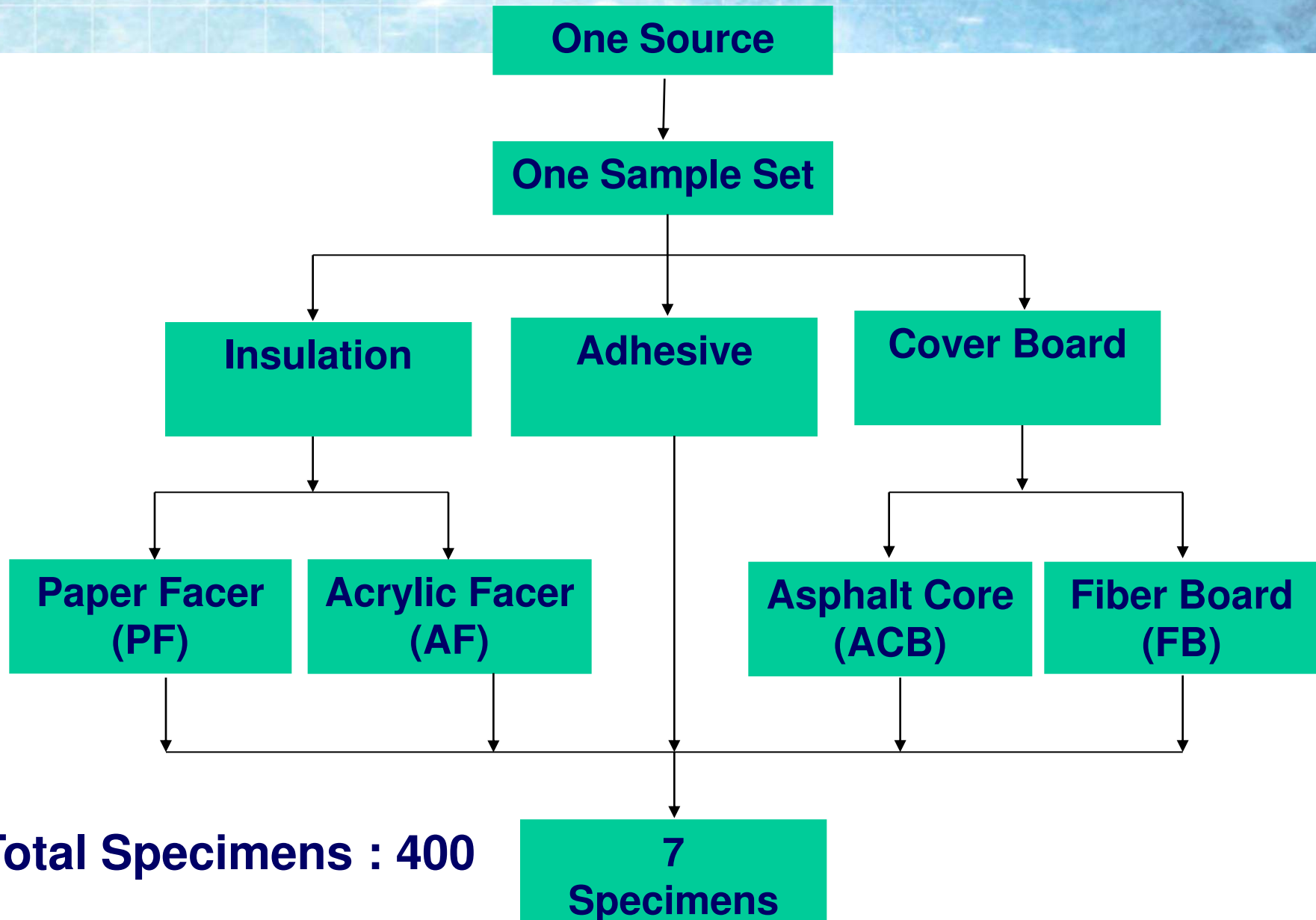
Task 5 – Development of Wind Design Guide

Task 1: Uplift Test : Test Apparatus

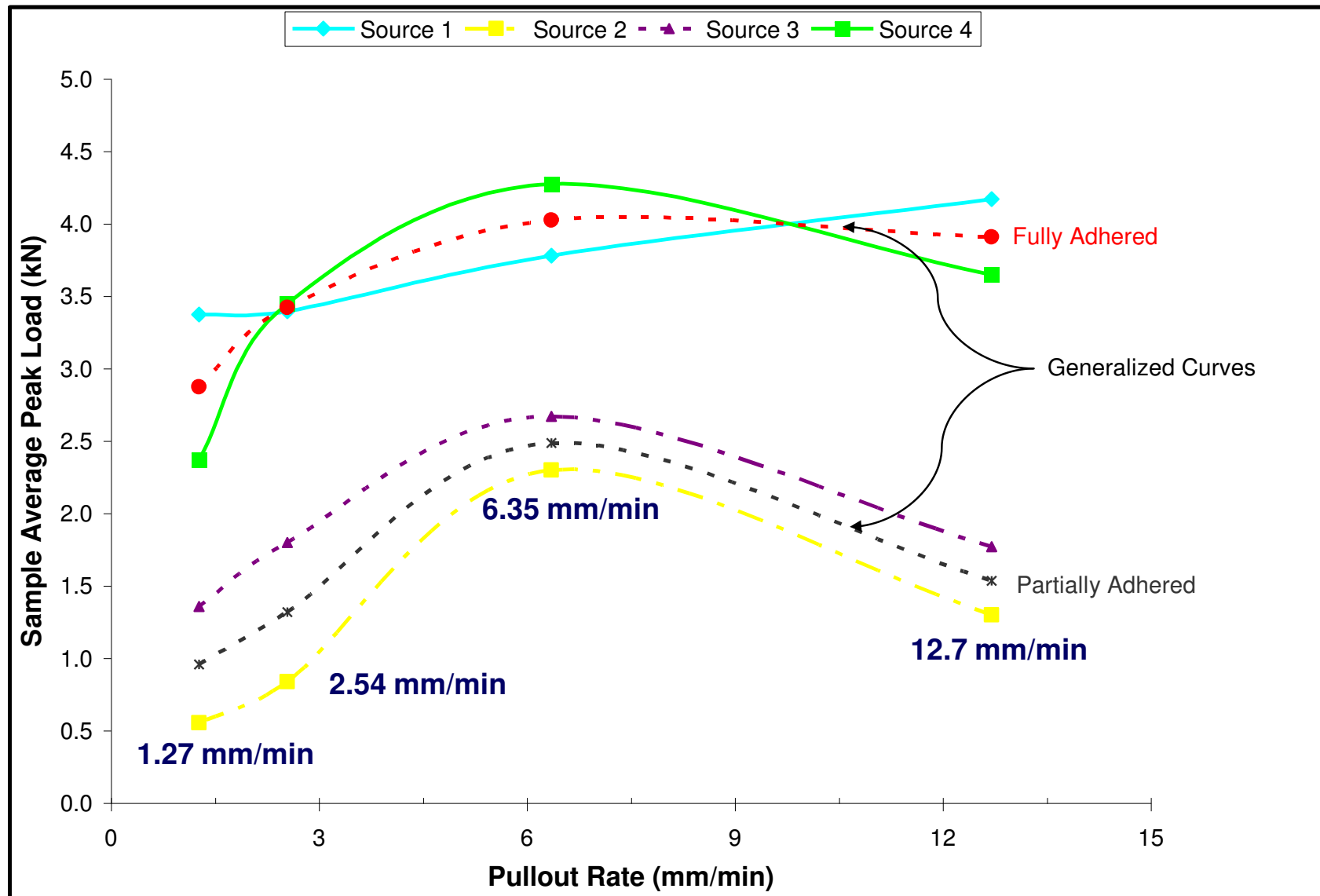


Specimen size: 12" x 18" [300 mm x 450 mm)

Test Matrix

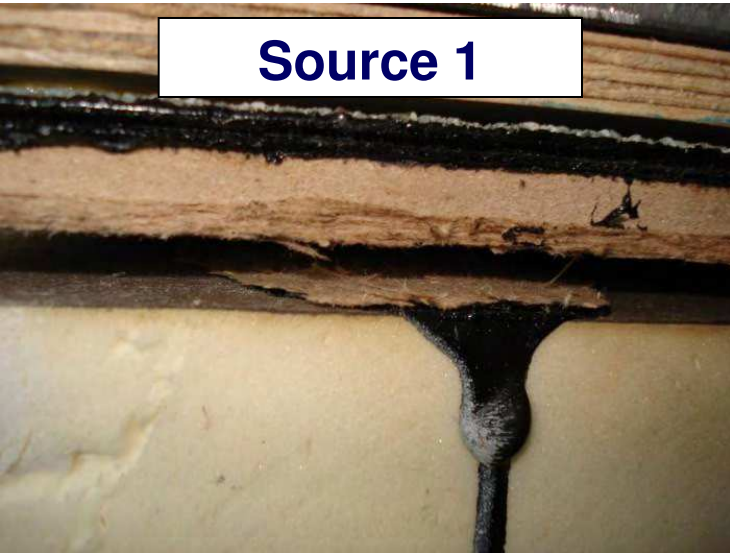


Test Speed



Effect of Material Combinations

Source 1



Source 2



Generalized
Conclusions
about Material
Combinations

?

PF & FB
Failure Planes

FB is almost
universally a
weakest link

Source 3



Source 4



ASTM WK26083 : Standard Test Method for Determining the Uplift Resistance of Adhesive Roofing Systems

ASTM D08.20.37

Standard test method for determining the uplift resistance of adhered roofing systems

This proposed new standard is under consideration for approval with an ASTM International technical committee. This standard has not received all approval required to become an ASTM International Standard. It shall not be reproduced or circulated or quoted, in whole or part, outside of ASTM International activities except with the approval of Chairman of the Committee having jurisdiction and the President of the Society. Copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. All rights reserved.



Designation: D XXXX-XX

WK 26083: Standard Test Method for Determining the Uplift Resistance of Adhered Roofing Systems

1. Scope

1.1 This test method provides a laboratory procedure for determining the uplift resistance of adhered roofing systems under specified conditions of preparation and testing.

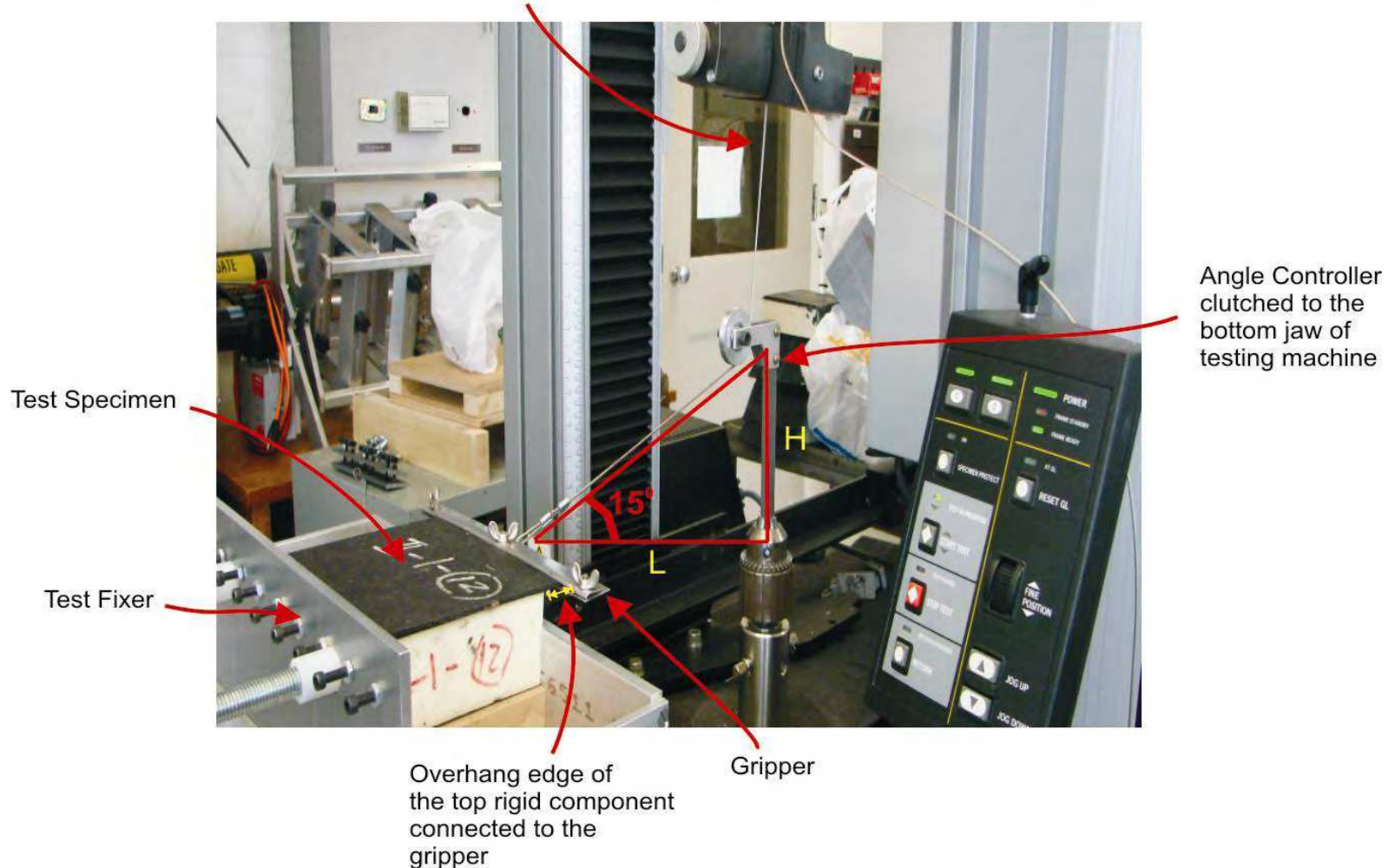
1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

- **Specimen size:**
12" x 18"
(300 mm x 450 mm)
- **Test speed:**
0.25"/min
(6.25 mm/min)

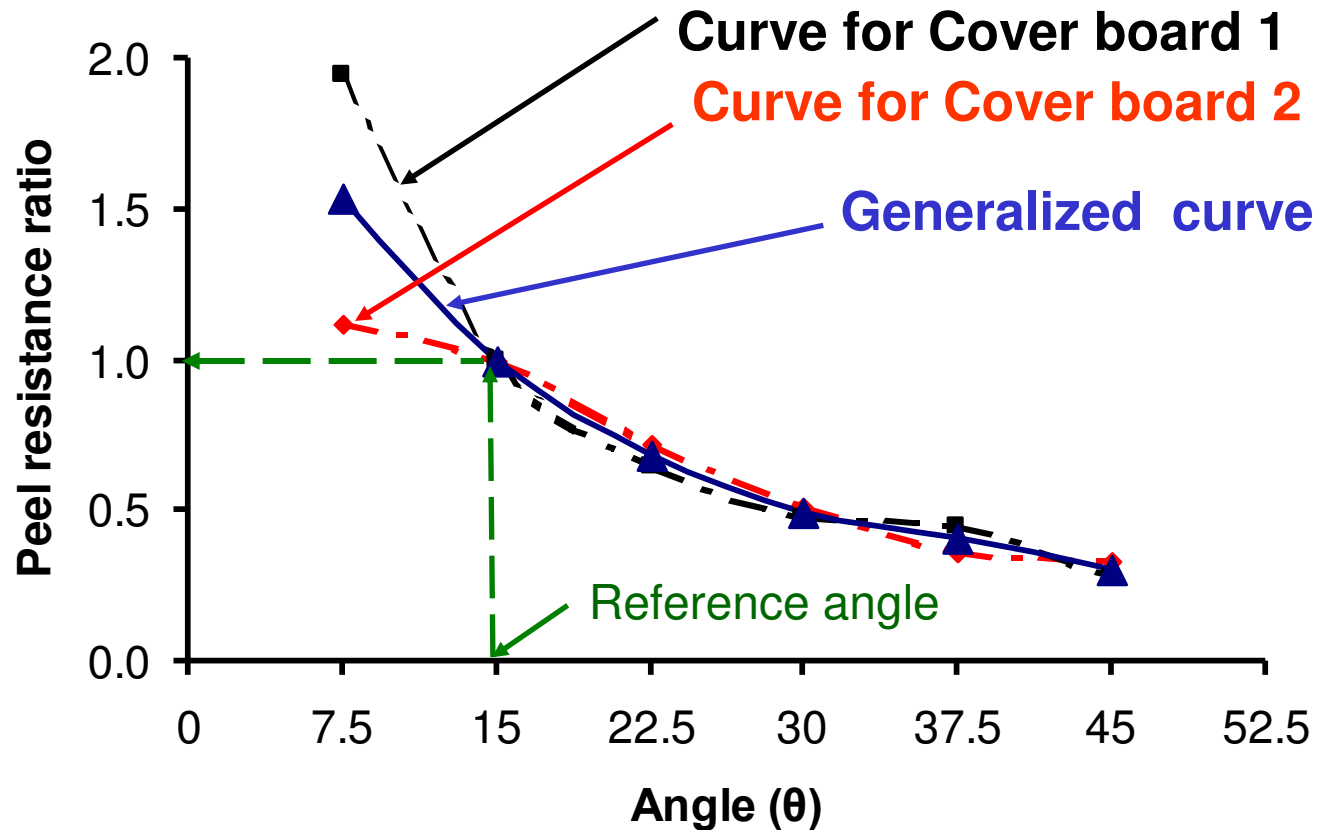
Task 2: Peel Test

Steel wire of the gripper clutched into the upper jaw of the testing machine



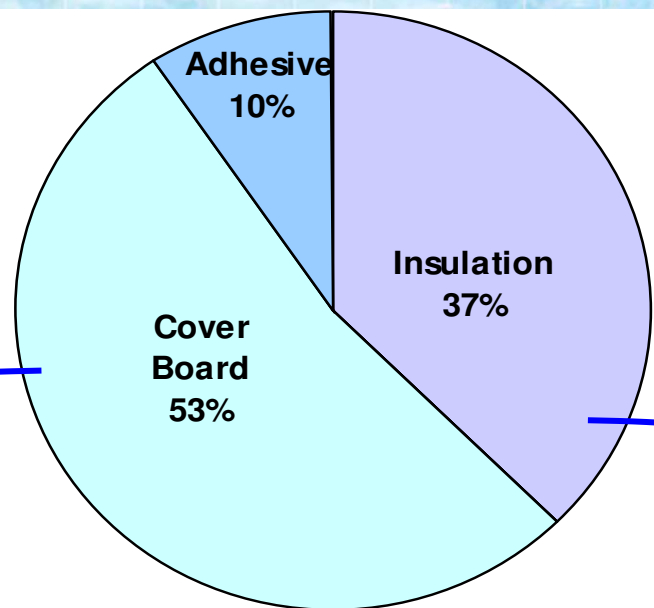
Specimen size is 6" x 6" (150 mm x 150 mm)

Test Peel Angle

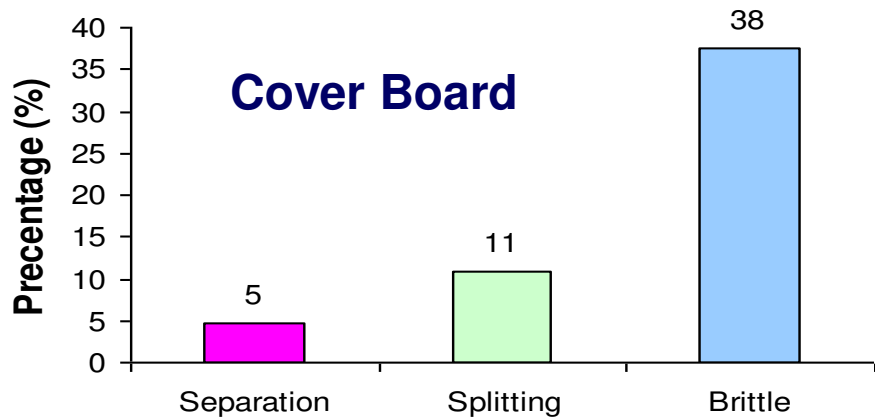
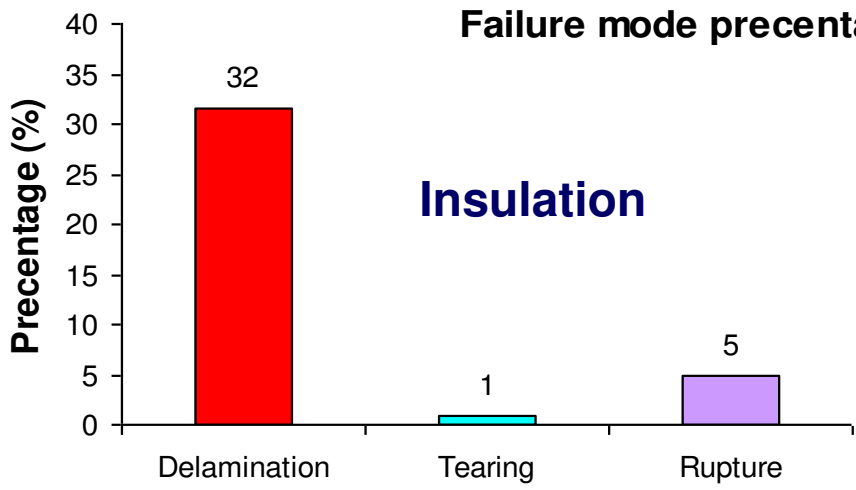


Proposed angle = 15°

Failure Mode Distribution



Failure mode precentage for component



Failure Modes



Facer Delamination



Facer Tearing



Adhesive Failure

Total Specimens: 532

ASTM WK26082 : Standard Test Method for Determining the Peel Resistance of Adhered Roofing Systems

ASTM D08.20.37

Standard test method for determining the peel resistance of adhered roofing components

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Designation: D XXXX-XX

WK 26082: Standard Test Method for Determining the Peel Resistance of Adhered Roofing Components

1. Scope

1.1 This test method provides a laboratory procedure for determining the peel resistance strength of fully adhered roofing components when peeled at 15° angle under specified conditions of preparation and testing.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

- Specimen size: **150 x 150 mm**
- Test position: **Edge**
- Test angle: **15°**
- Peeling rate: **25.4 mm/min**

Task 3: Full Scale Test

- 1. Development of a load cycle**
- 2. Implementing the load cycle on full scale test mockups**

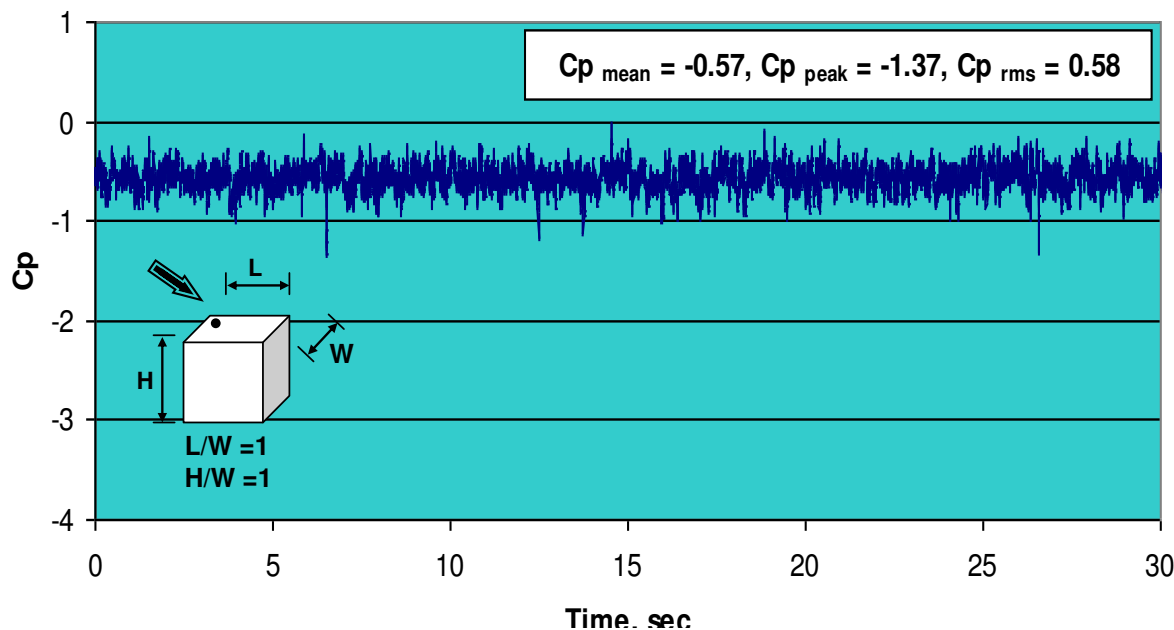
Development of a load cycle : Wind Tunnel Study



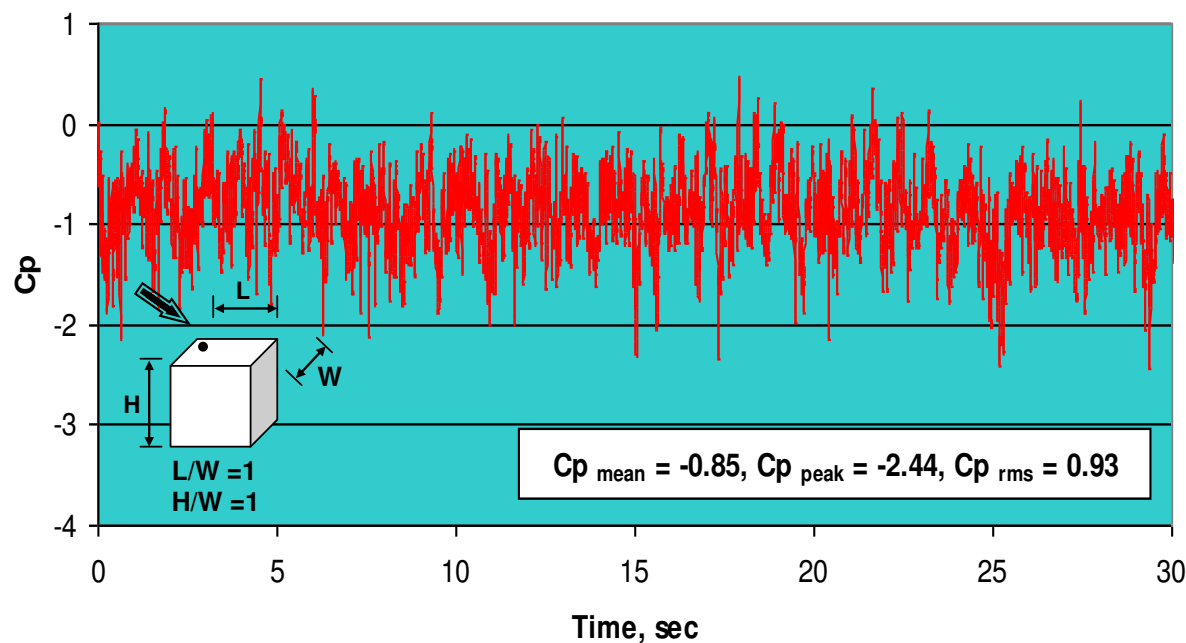
Models Information	Description
Test Condition	Open Exposure
Building Height	6 m, 12 m and 18 ft
Model roof aspect ratio	0.5, 1 and 2
Wind angle	0 and 45 degrees

Typical Cp Time History

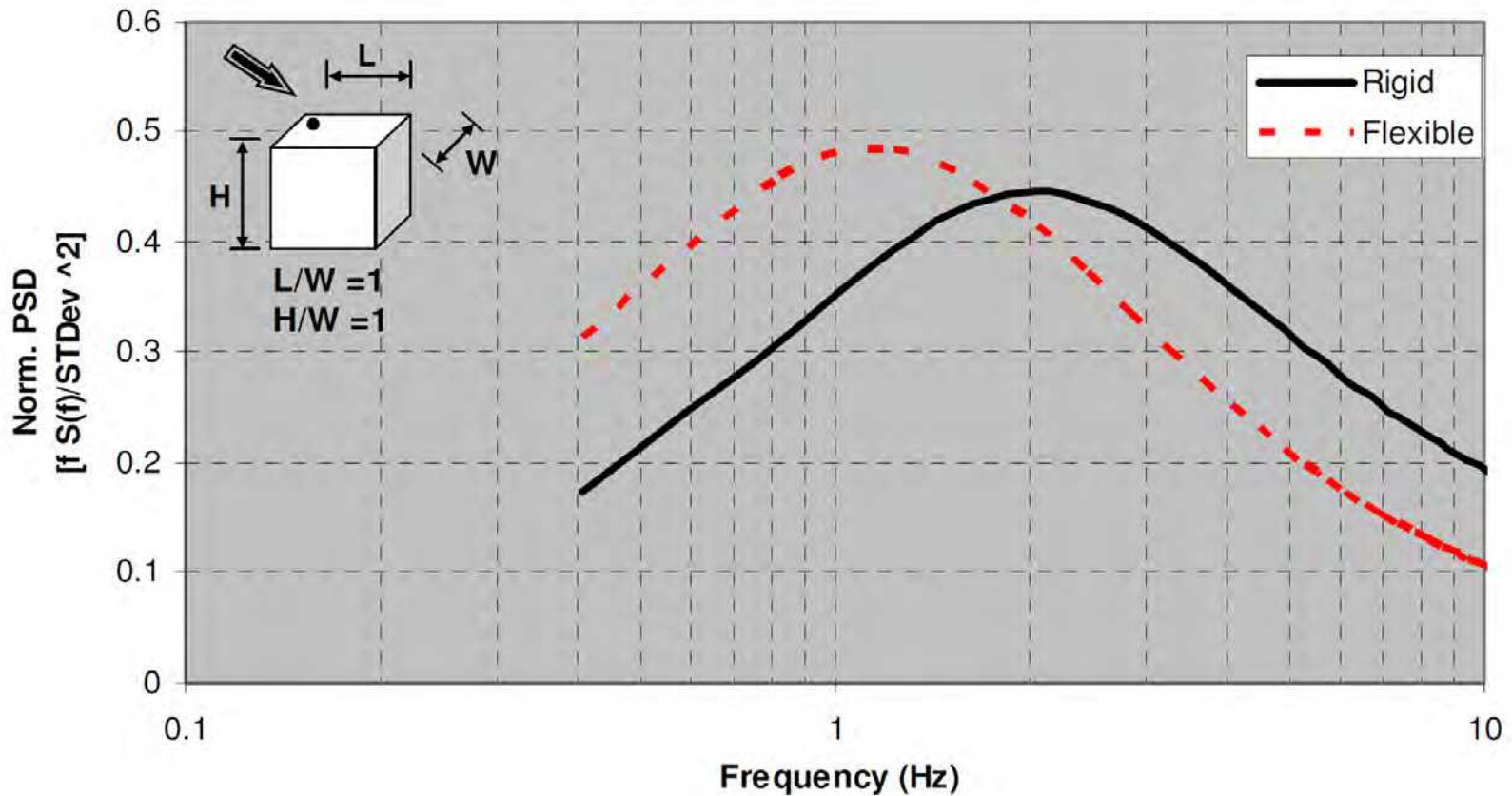
Rigid Roof Model



Flexible Roof Model

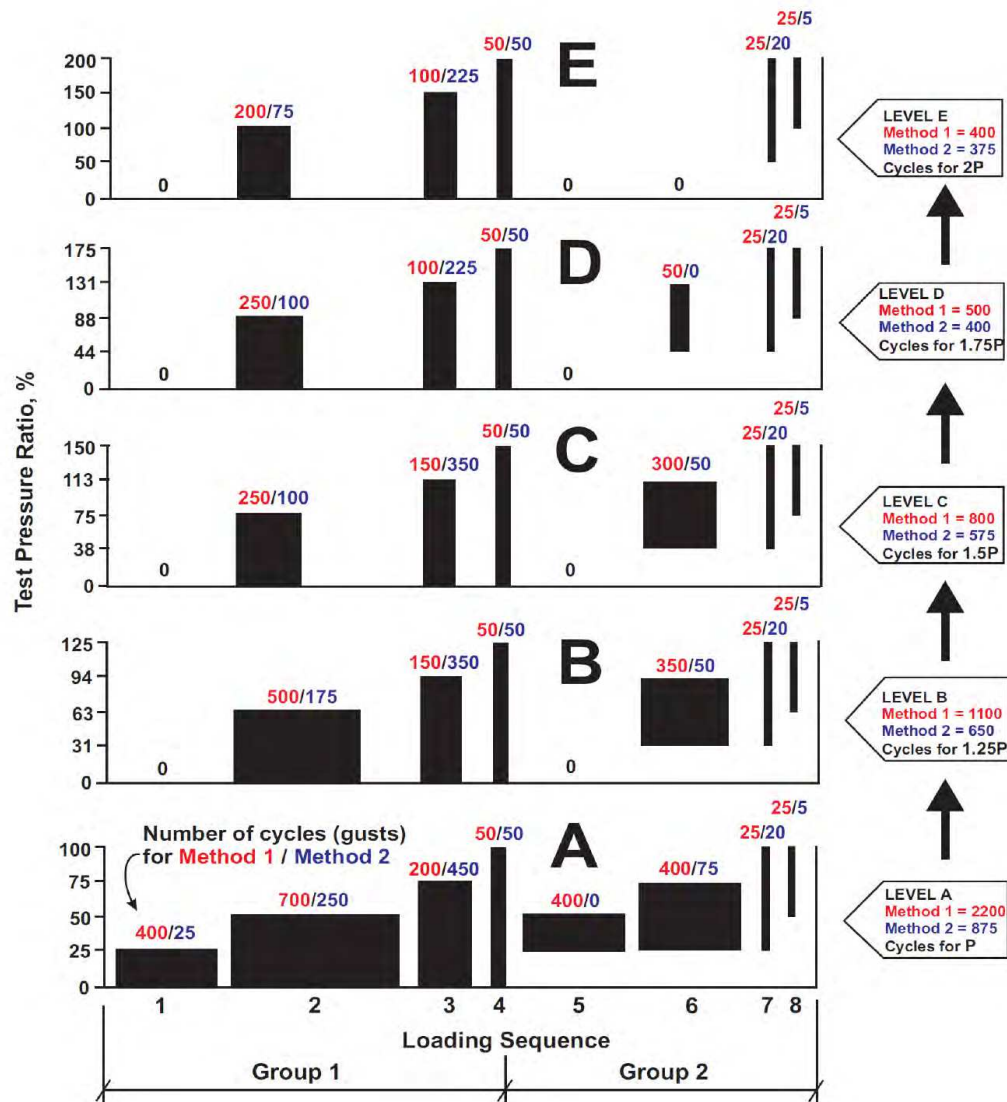


Power Spectra of System response



**Typical Power Spectra Response at the Corner Zone
for $H/W = 1$ and $L/W = 1$**

Dynamic load cycle



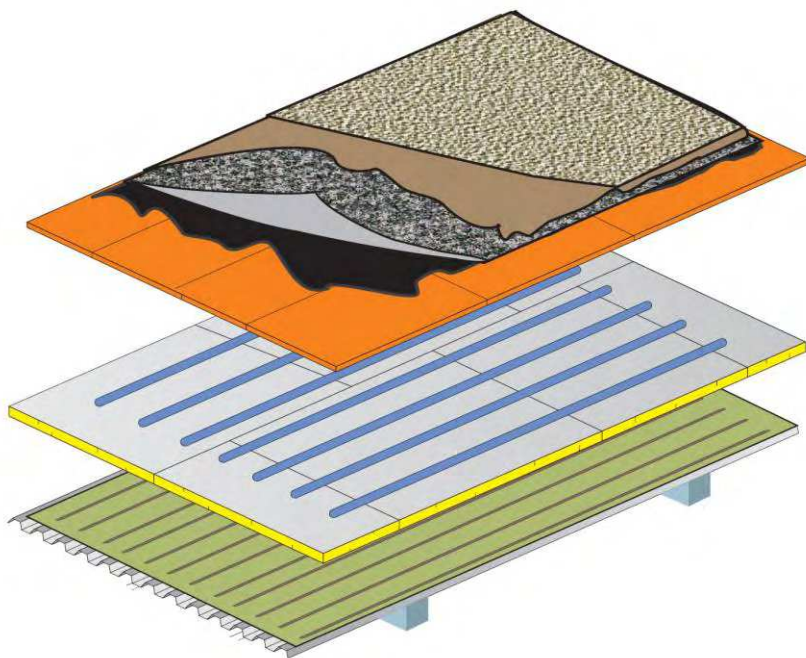
New- CSA load cycle
(Flexible & Rigid Roof)

Full Scale Investigations

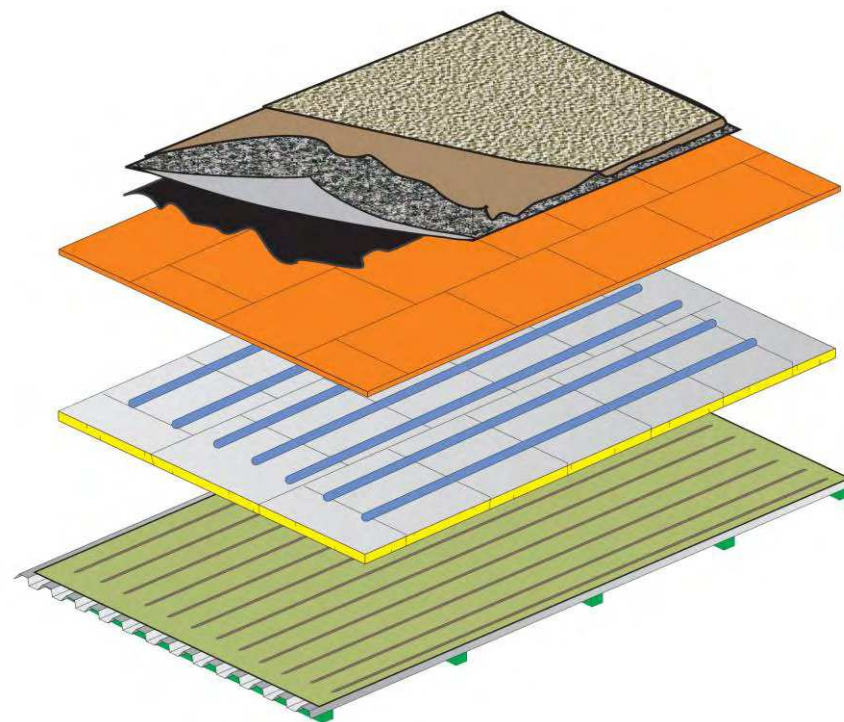
- ✓ **Fabricated & tested 30 full scale AARS mock-ups with different roof component configurations**
 - **2 types of cover board**
 - **2 types of facer insulation**
- ✓ **Investigated AARS common failure modes**
- ✓ **Evaluated the wind uplift performance under static vs dynamic loading condition**

Test Specimen Size

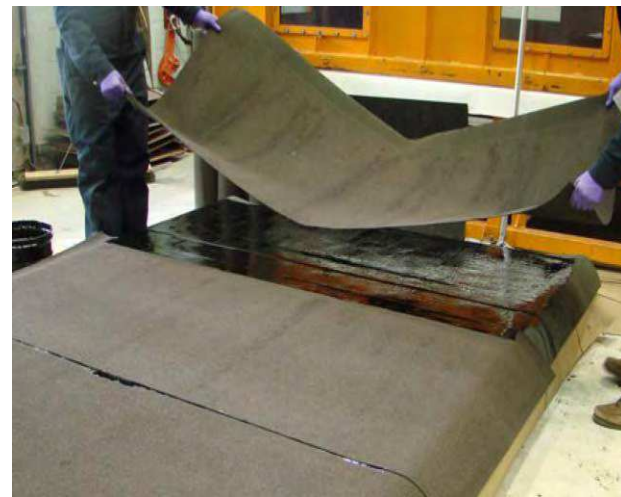
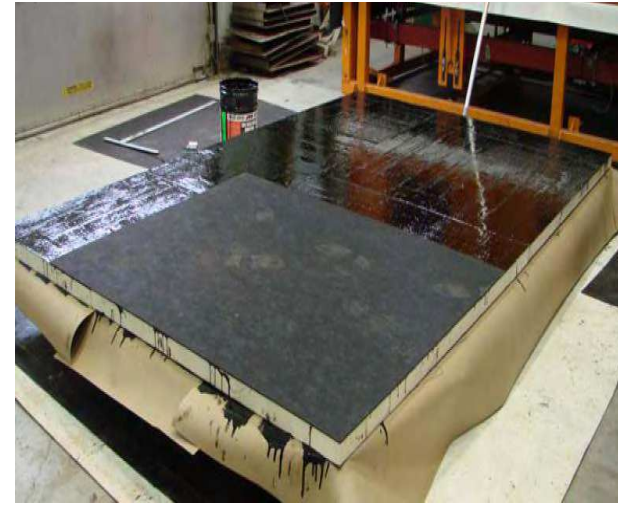
Full-scale: 8 ft x 10 ft



Full-scale: 12 ft x 24 ft

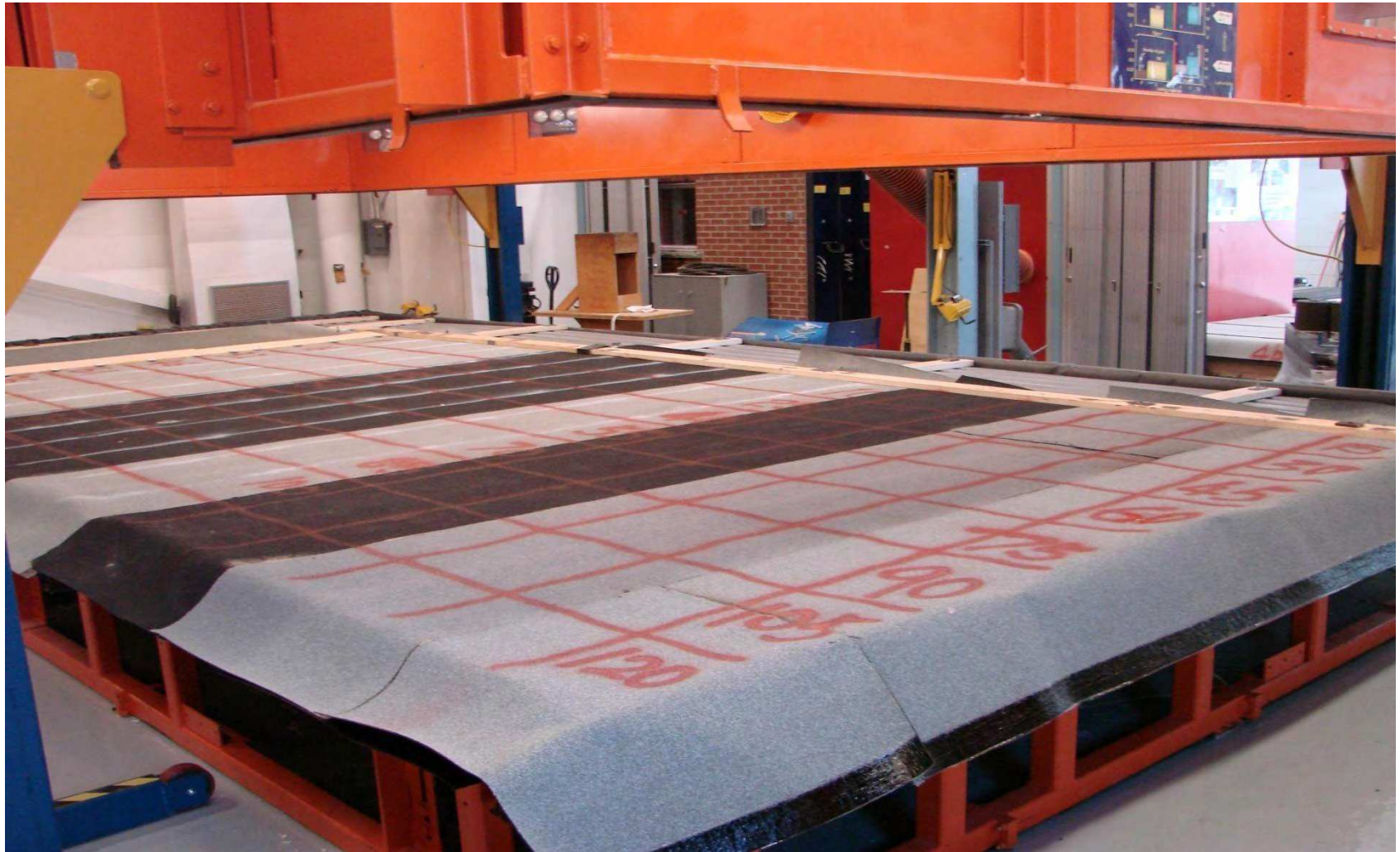


Test Specimen Construction



Installation of Test Specimen in the Testing Table –DRF - XL

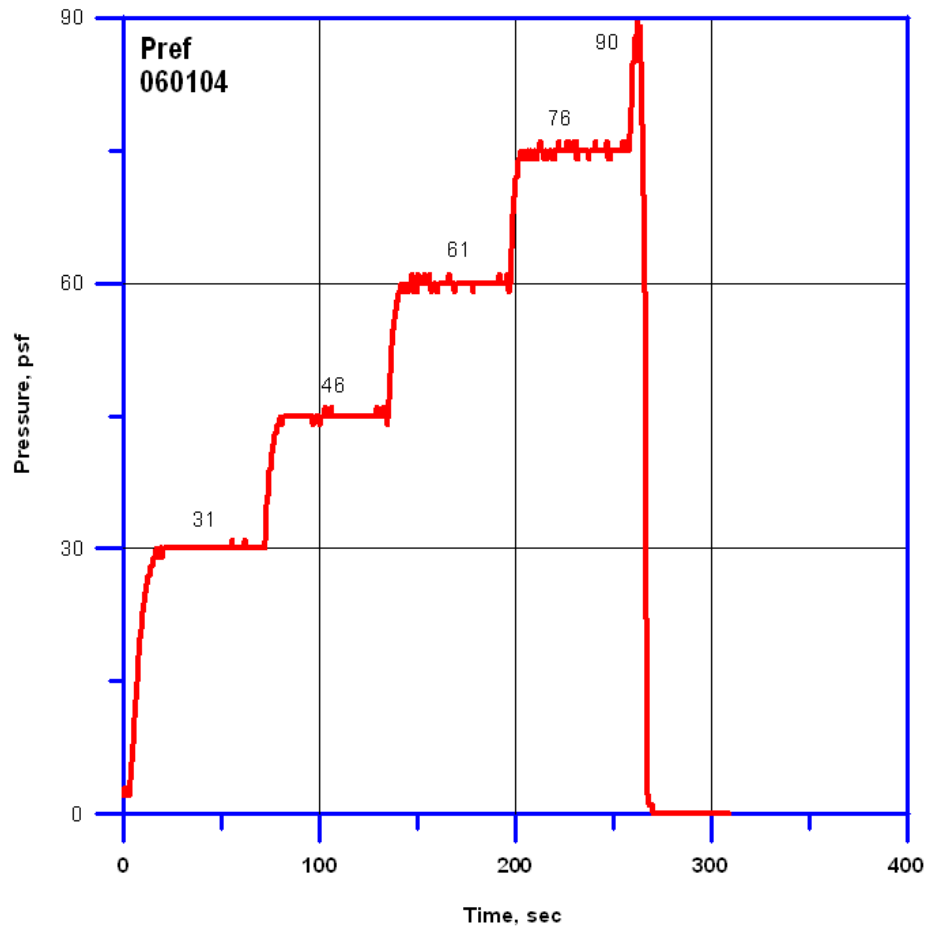
NRC-CNRC



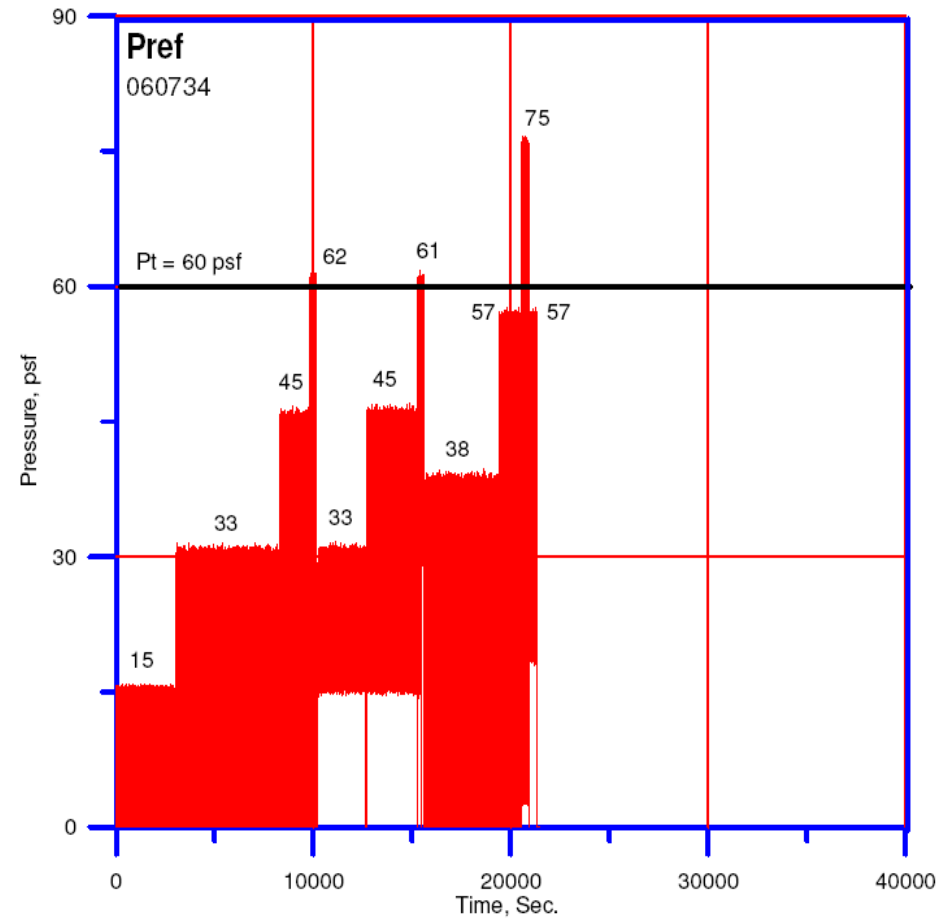
Static Vs Dynamic

(Typical Pressure Time History)

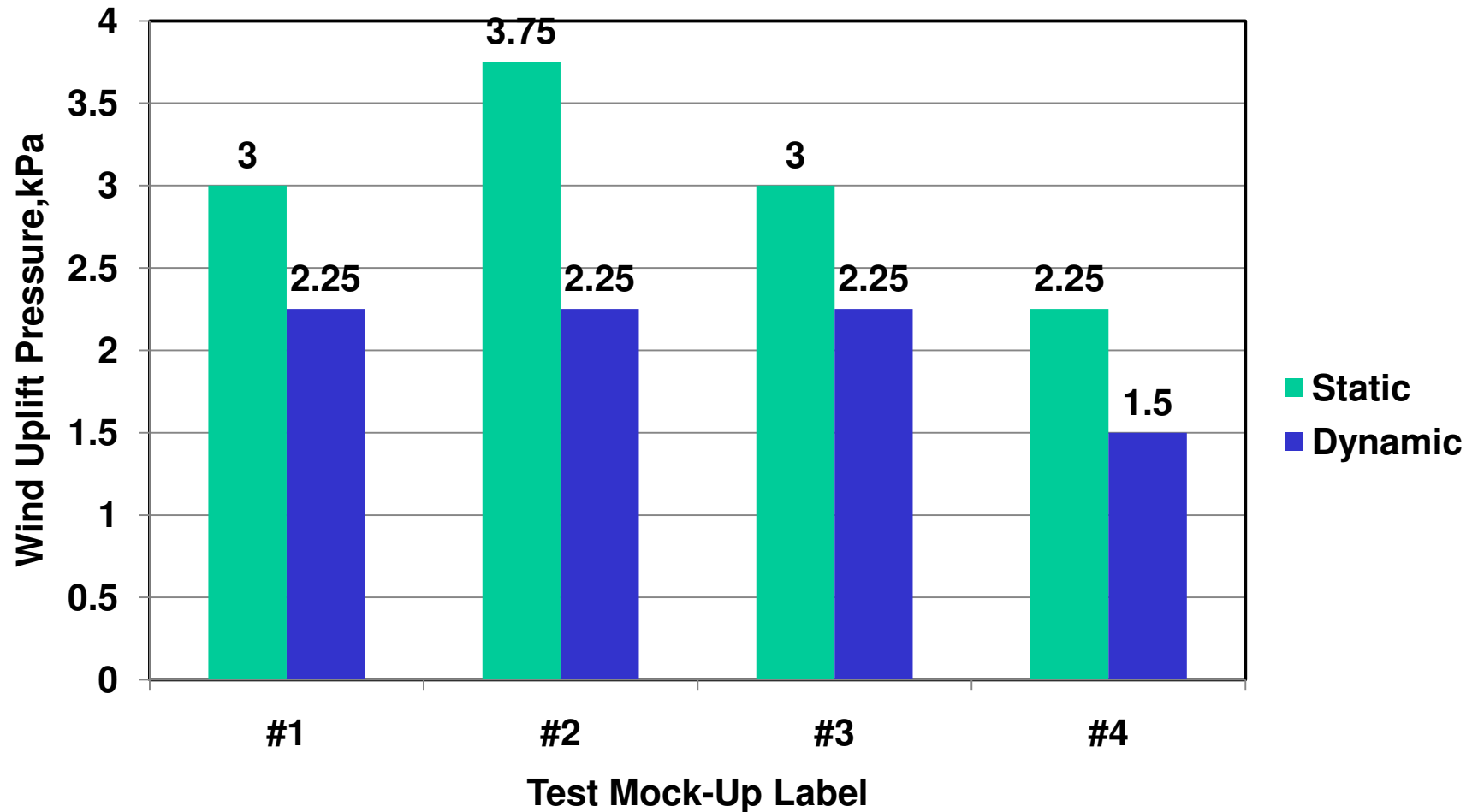
Static



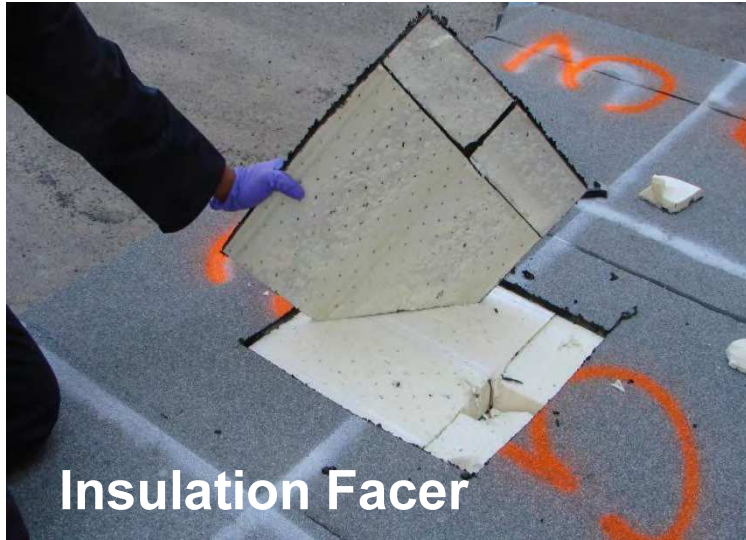
Dynamic



Static Vs Dynamic

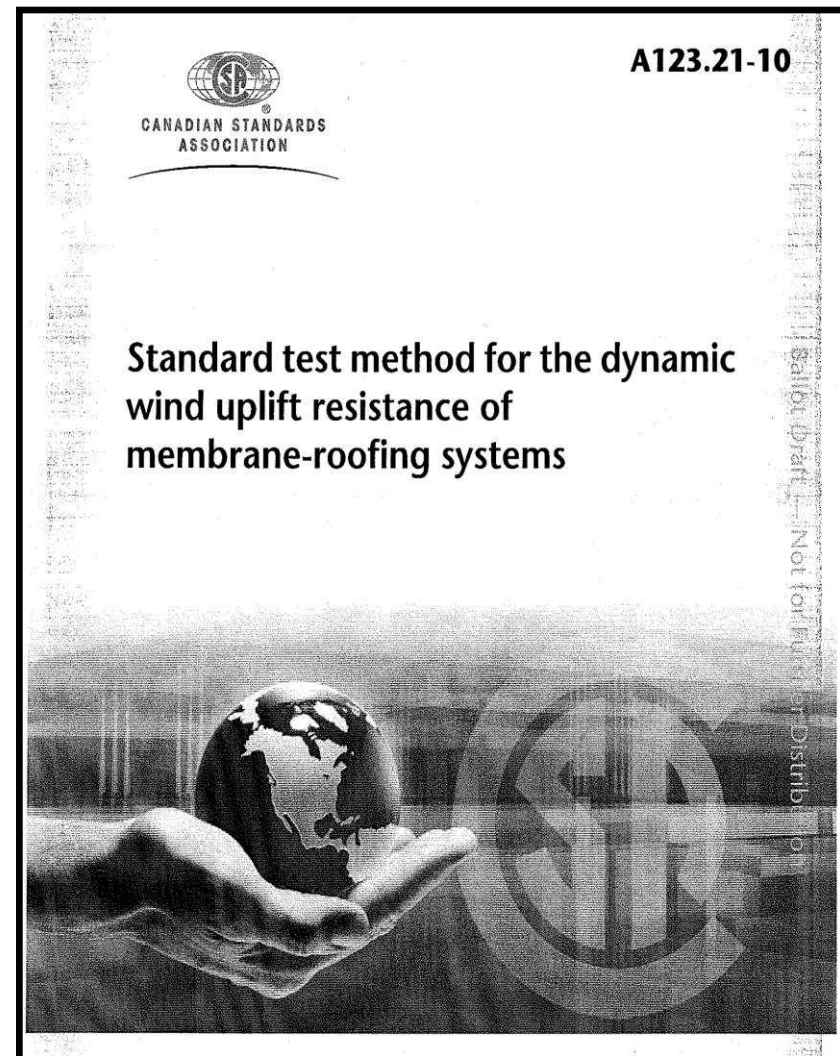
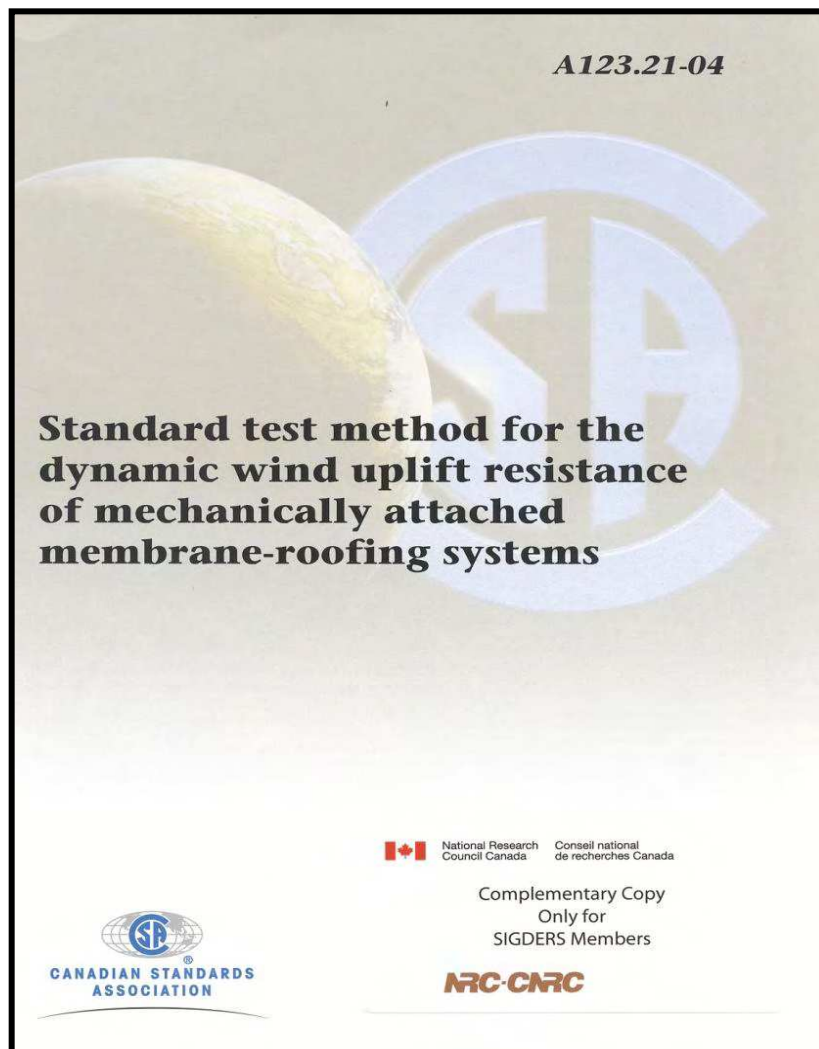


Failure Modes



Updated Version of CSA A123.21-04

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Conclusion

ASTM D08.20.37

Standard test method for determining the uplift resistance of adhered roofing systems

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Designation: D XXXX-XX

WK 26083: Standard Test Method for Determining the Uplift Resistance of Adhered Roofing Systems

1. Scope

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ASTM D08.20.37

Standard test method for determining the peel resistance of adhered roofing components

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Designation: D XXXX-XX

WK 26082: Standard Test Method for Determining the Peel Resistance of Adhered Roofing Components

1. Scope

1.1 This test method provides a laboratory procedure for determining the peel resistance strength of fully adhered roofing components when peeled at 15° angle under specified conditions of preparation and testing.

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A123.21-10



Standard test method for the dynamic wind uplift resistance of membrane-roofing systems



Standard Draft - Not for Distribution