Engineering Investigation of Common and Uncommon Perils

Presented to:

Cooper & Scully

26th Annual Insurance Workshop

April 5, 2019

NELSON FORENSICS

NELSON FORENSICS

Your questions. Our people. Expert solutions.

LICENSED EXPERTS NATIONWIDE

delivering unparalleled responsiveness and superb quality from 12 strategic locations

WHO WE ARE

Nelson's engineers, architects, and scientists identify damage and develop remediation solutions for buildings, equipment, and other property caused by natural perils, inadequate maintenance and misuse, and design and construction errors.

Nelson is the forensic industry's respected, independent, and objective source for solving its clients' complex problems.

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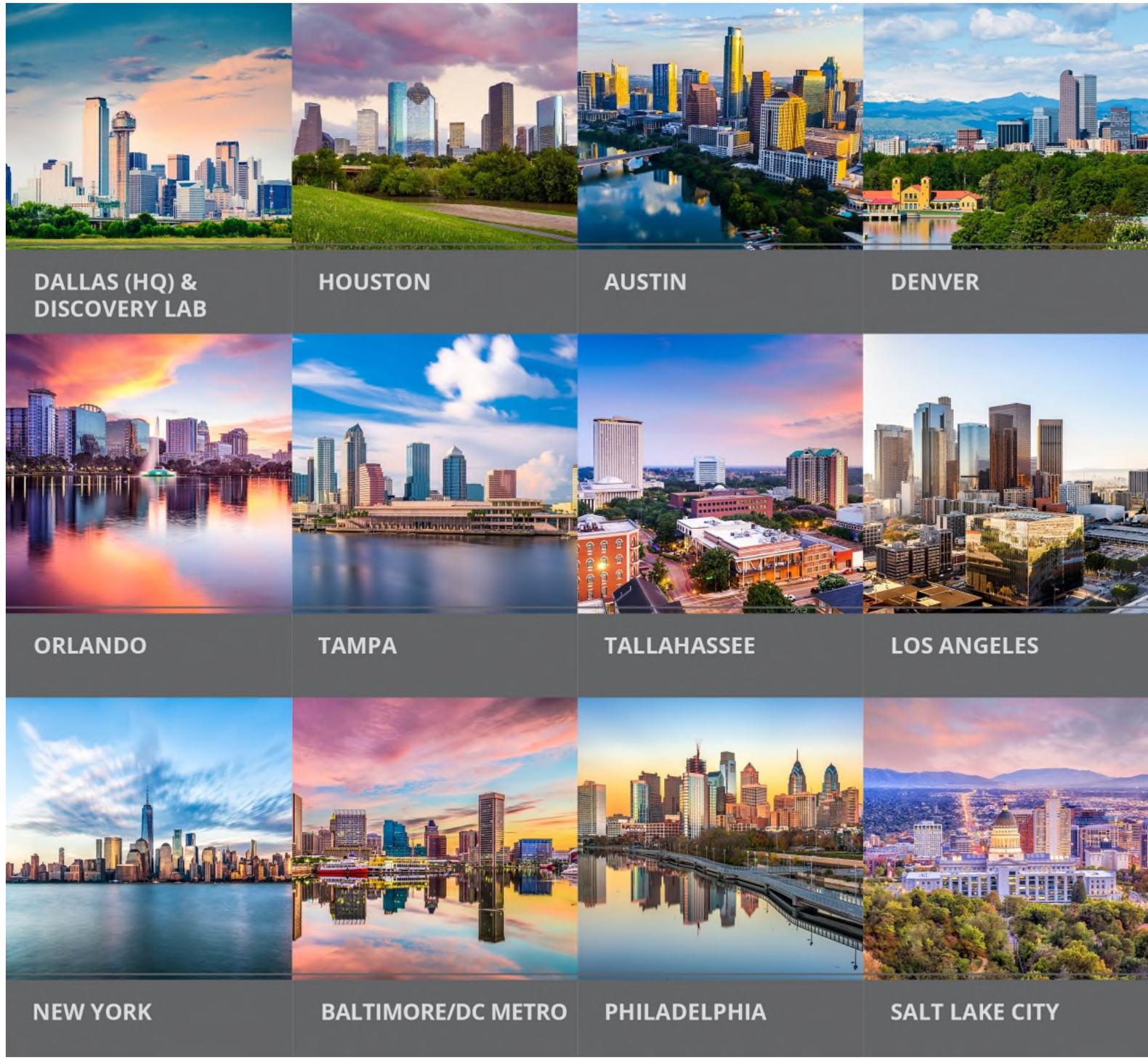
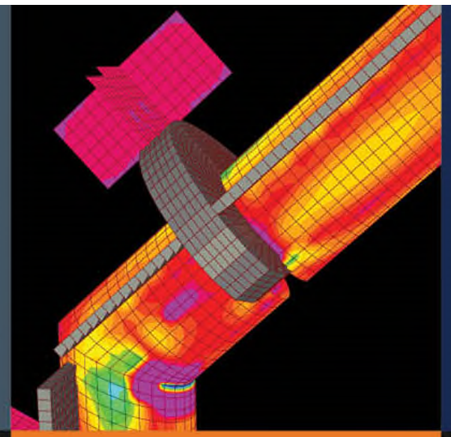
commonperils®



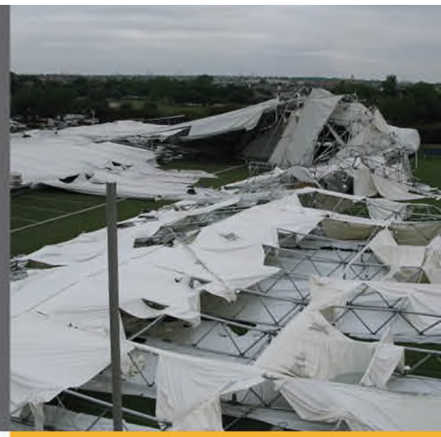
Nelson's professionals deliver exceptional client service; embrace advanced technologies; formulate decisive and independent opinions; and report focused, properly researched, and technically accurate findings.

STRUCTURAL ARCHITECTURAL & CIVIL ENGINEERING

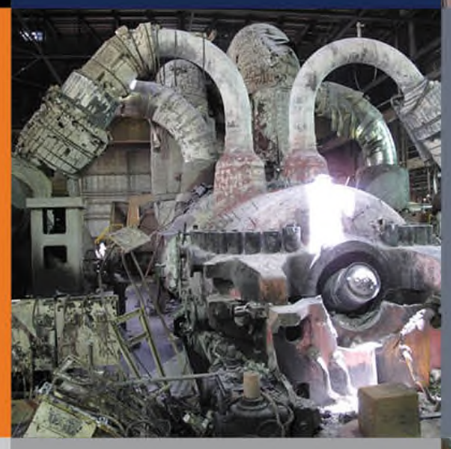


ARCHITECTURE & BUILDING ENVELOPE ASSESSMENT

ROOFING SYSTEM ASSESSMENT



ELECTRICAL ENGINEERING & FIRE INVESTIGATION

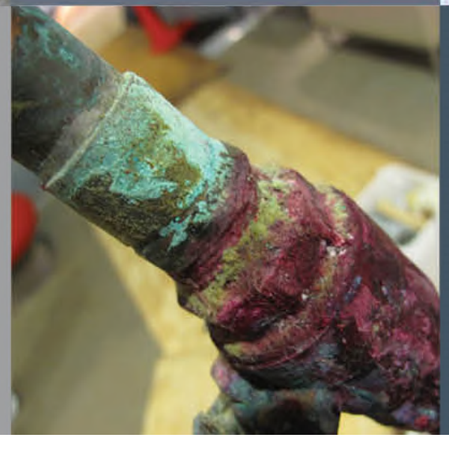


MECHANICAL ENGINEERING

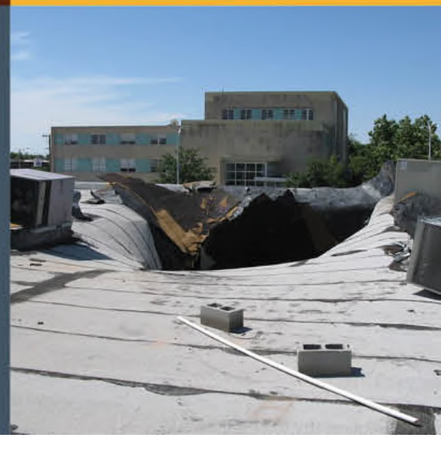
COST ESTIMATING & APPRAISAL

CHEMISTRY & ENVIRONMENTAL SCIENCE

CONSTRUCTION MATERIALS TESTING LABORATORY



MATERIALS SCIENCE



Nelson Discovery Laboratory specializes in developing customized tests to resolve questions of fact in a dispute or for scientific analysis

Roof Sample Testing
- Roof Core Sampling
- Membrane Delamination
- Membrane Desaturation
- Water Column Testing
- Identification of Coal Tar vs. Asphalt Materials
- Identification of TPO vs. PVC Materials
- ASTM Standard Protocols

Water Infiltration Testing
- Determining Areas of Water Penetration
- Evaluate As-Built Conditions On-site
- Mock-up Evaluations

Infrared Imaging
- Electrical Systems and Building Envelopes
- Anomaly Identification
- Moisture Detection
- Certified Thermographers

Aerial Drone Reconnaissance and Photography
- Difficult Access Surveys
- Large and Complex Structures
- Collapse Documentation

Ground Penetrating Radar
- Concrete Evaluation
- Reinforcement and Void Detection
- 3D Imaging of Concealed Conditions

About the Presenter

Licensed Professional and/or Structural Engineer in 42 states, the District of Columbia, and the USVI

M.S. in Civil Engineering – Purdue University

B.S. in Civil Engineering – Purdue University

B.A. in Chemistry – Miami University

CalEMA Safety Assessment Program

Member – ACI, ASCE, ASCE/SEI

Andrew D. Harold, S.E., P.E.
Executive Director of Operations

NELSON FORENSICS

Goals

- Explore methodologies for evaluating damage to buildings which results from any number of perils
- Examine case studies for the investigation of claims related to the following perils:
  - Tornado
  - Hail
  - Fire
  - Hurricane

NELSON FORENSICS

What is a Peril?

A source of danger; something that causes loss, injury, or destruction

Examples of Common Perils (in Texas)?

- Weather (e.g., Hail, Wind, Ice/Snow, Freeze)
- Natural Disaster (e.g., Hurricane, Tornado)
- Foundation Movement
- Collapse
- Fire
- Water Intrusion
- Vehicle Impact
- Mechanical, Electrical, or Plumbing (MEP) Failure
- Design/Construction Defect
- Deterioration

What about Uncommon Perils (in Texas)?

- Earthquake
- Tsunami

Forensic Engineering

The application of engineering principles and methodologies to answer question of fact that may have legal ramifications.

- Randall Noon

Forensic Engineering and Technology

Why Utilize Technical Investigators?

- Targeted Expertise
- Forensic Discipline
- Industry Knowledge

Forensic Investigations

The Scientific Method

- Define the Problem
- Collect Data
  - Document Observed Conditions
    - Photographs
    - Field Sketches/Notes
  - Perform Testing
    - Sampling and Measurements
    - Non-destructive (In Situ) Testing
    - Destructive (Intrusive) Testing
    - Laboratory Analysis of Extracted Samples
- Conduct Research
  - Weather Data
  - Reference Material (e.g., codes, design standards, manufacturer's literature)
- Perform Analysis
  - Explain How/Why the Data Means What It Means
  - Provide a Rational Basis for Conclusions
- Conclusions
  - Grounded in Theory and Practice
- Recommendations

Types of Forensic Testing

Non-Destructive

Destructive

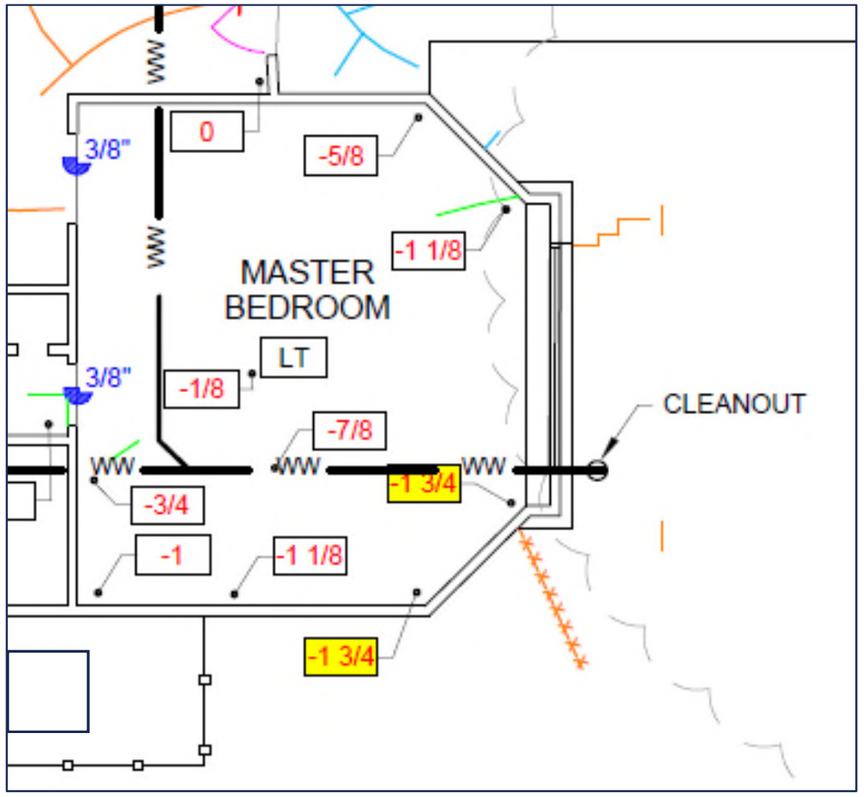
Non-Destructive Testing

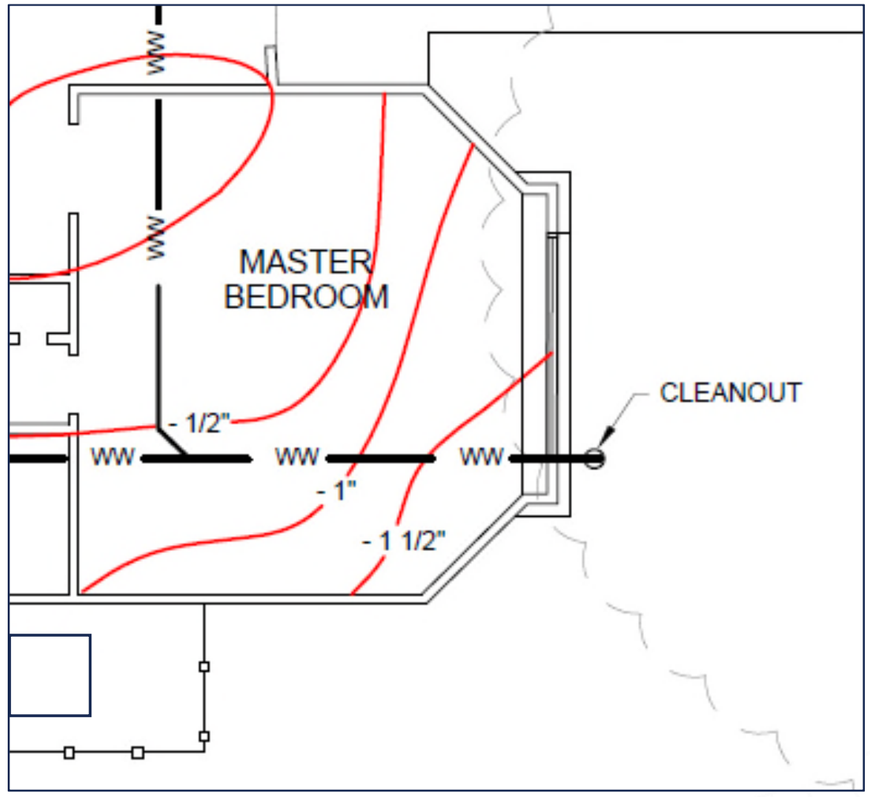
- Visual Observation and Sampling
- Photographs (Onsite and Aerial)
- Detailed Distress Survey
- Elevation or Plumbness Surveys
- Moisture Testing
- Infrared (Thermography)
- Water Spray Testing (Building Envelope)

Non-Destructive Testing

Broom Lines Remaining from Crack Mapping Survey

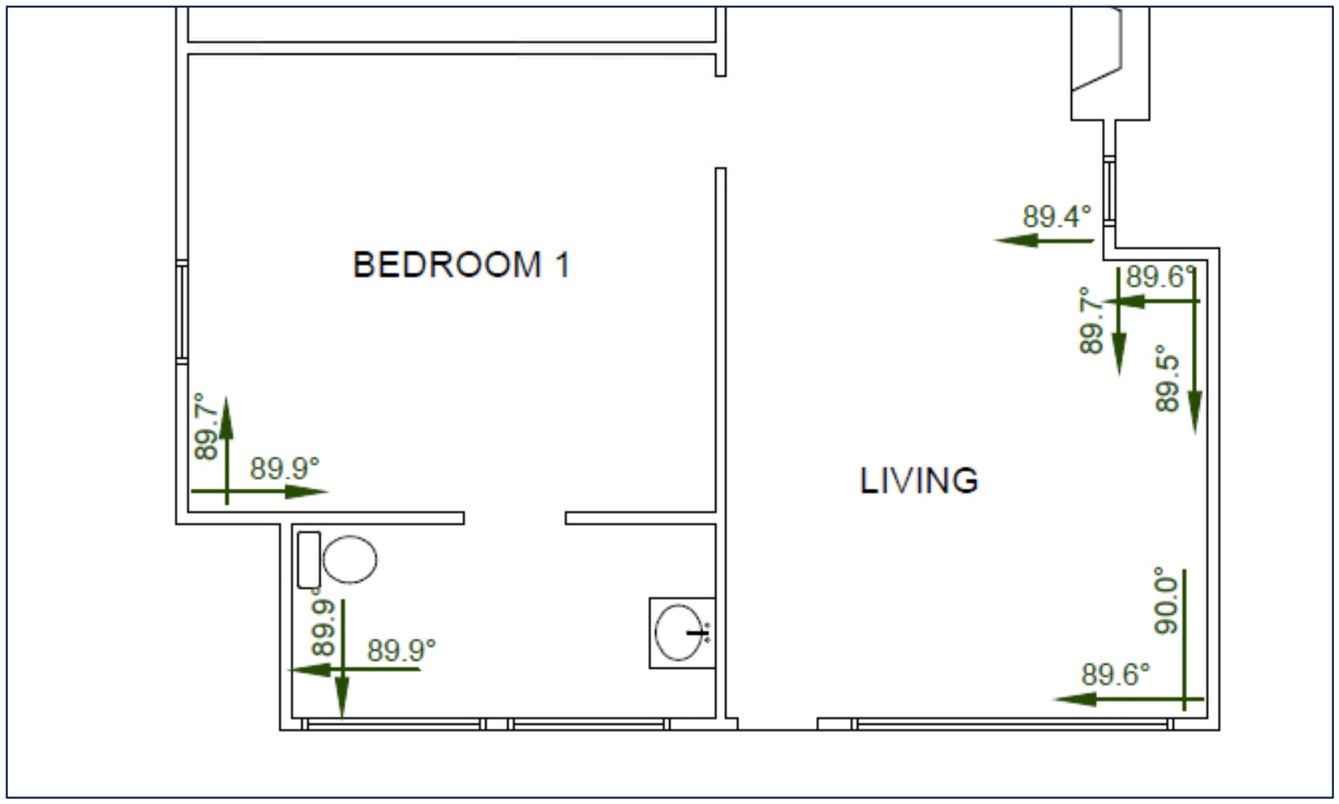
Non-Destructive Testing





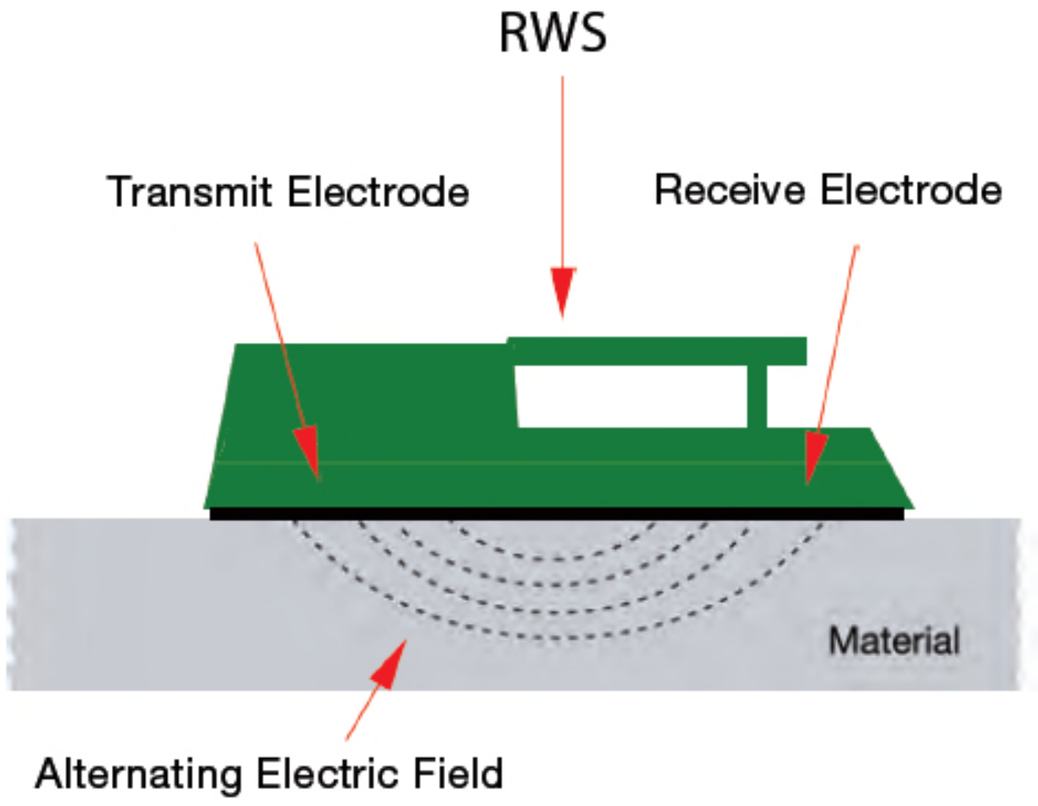
Distress and Elevation Surveys

Non-Destructive Testing



Plumbness
Survey

Non-Destructive Testing Tools

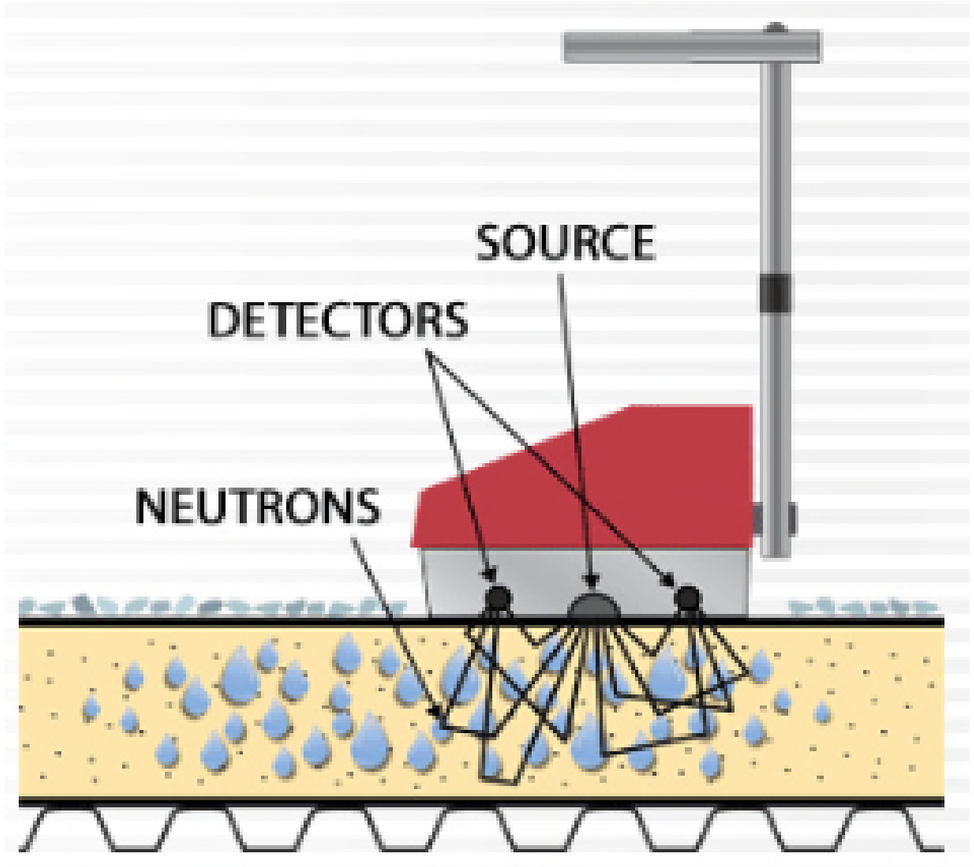


Electrical Capacitance (Impedance) Testing

Non-Destructive Testing Tools

Electrical Capacitance (Impedance) Testing

Non-Destructive Testing Tools



Nuclear Hydrogen Detection

Non-Destructive Testing Tools

Infrared Thermography

Non-Destructive Testing Tools

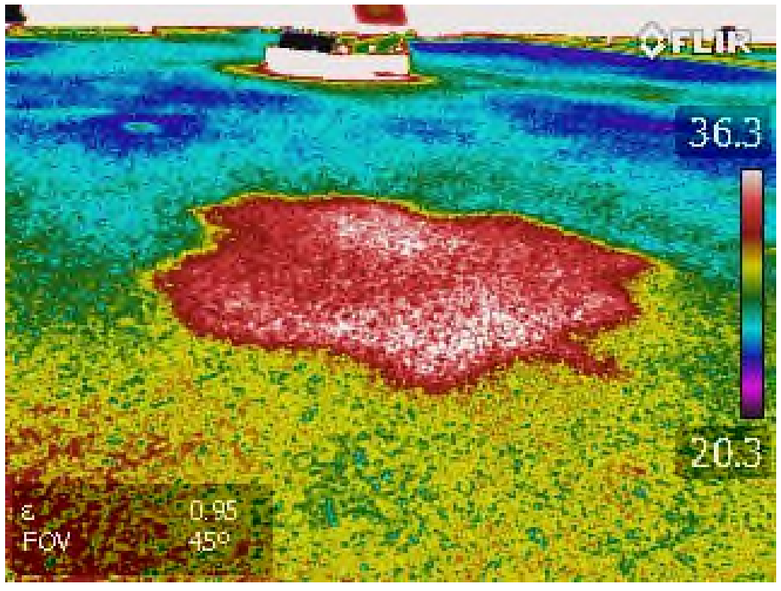
Designation: C1153 – 10

Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging[1]

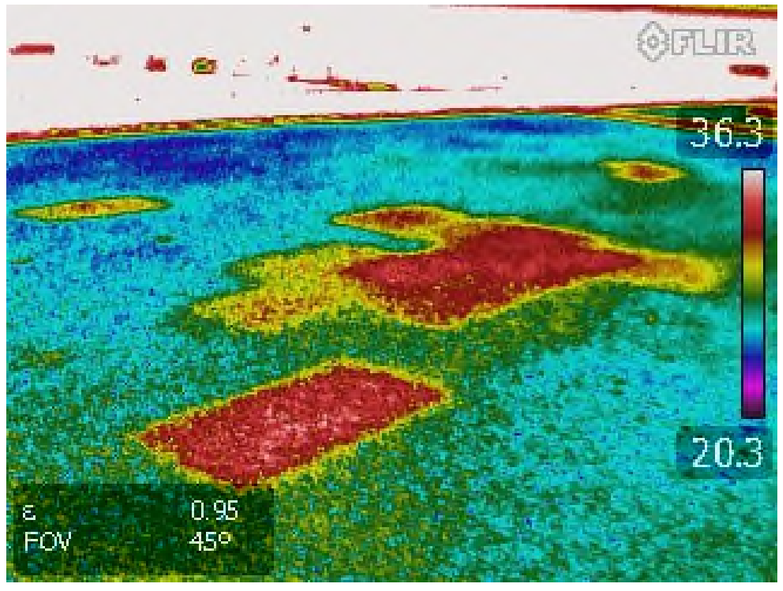
Table 1 – General Site Conditions for Infrared Roof Survey

Time of Survey	6:00 PM
Wind Velocity	8 mph
Outside Temperature	51 °F
Weather During Survey	Clear
Weather 24 hrs Prior to Survey	Sunny/Clear
Roof Surface Condition at Time of Survey	Dry

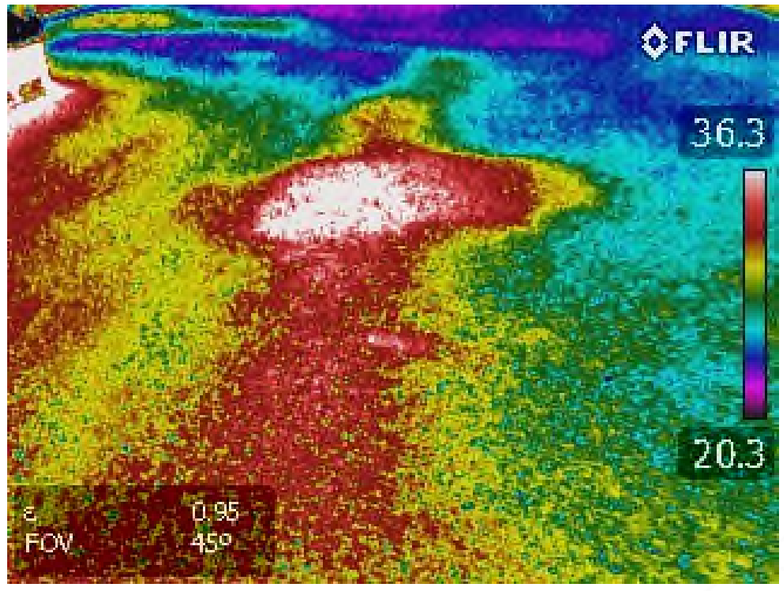
Non-Destructive Testing Tools



Isolated Anomaly

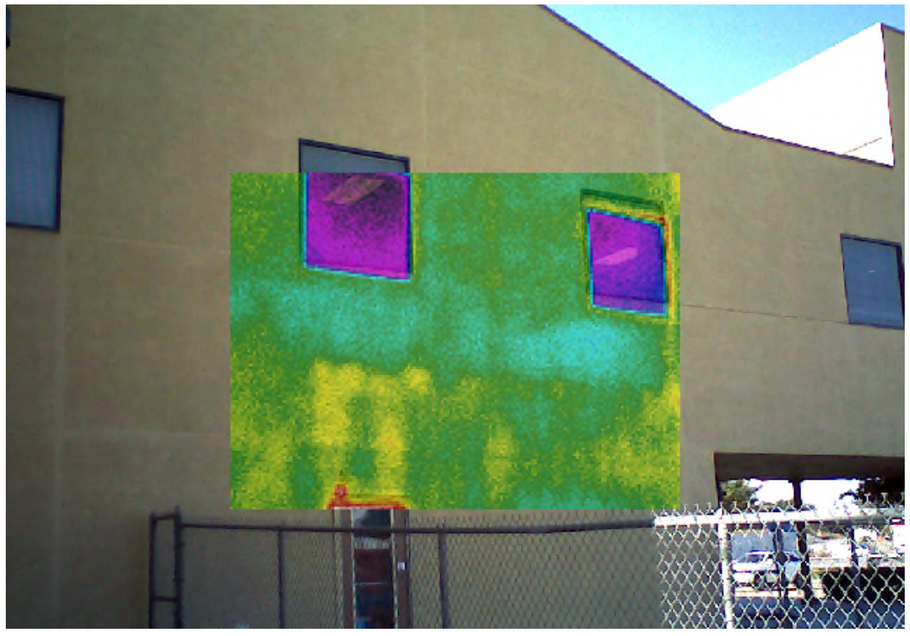


Various Anomalies

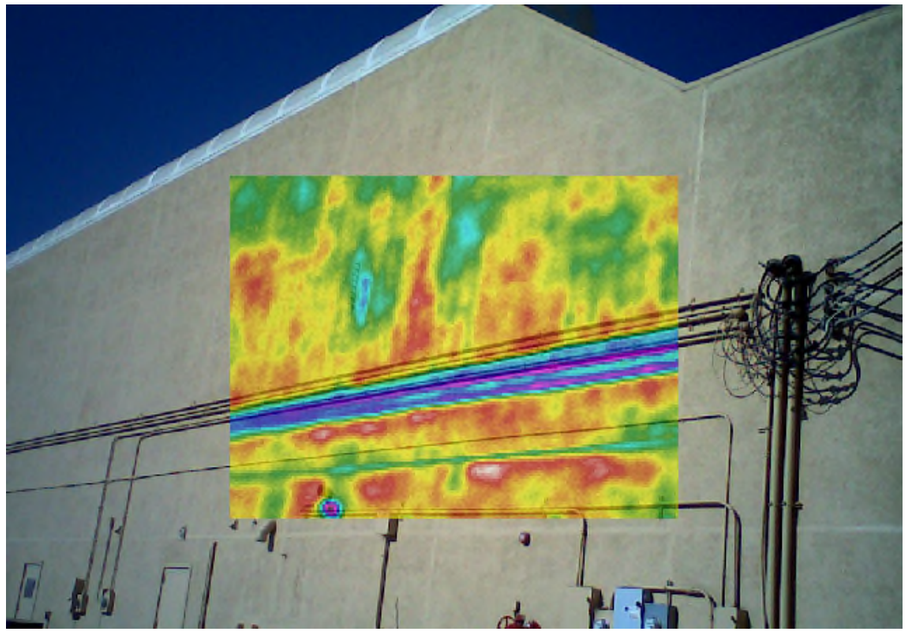


Possible Moisture Source

Non-Destructive Testing Tools



Weak Anomalies



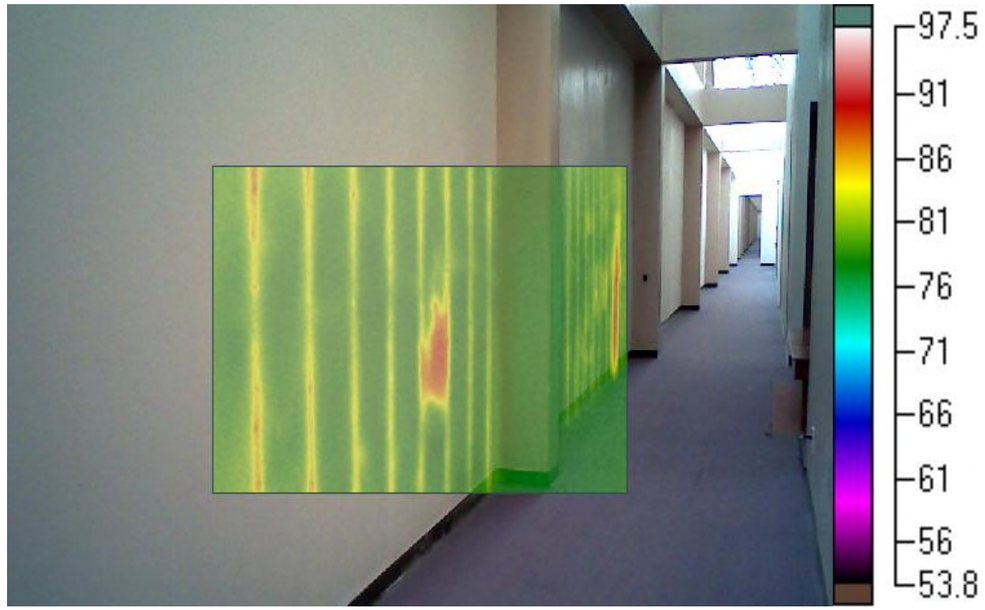
Strong Anomalies

Non-Destructive Testing Tools

Infrared Image

Corresponding Visible Light Image

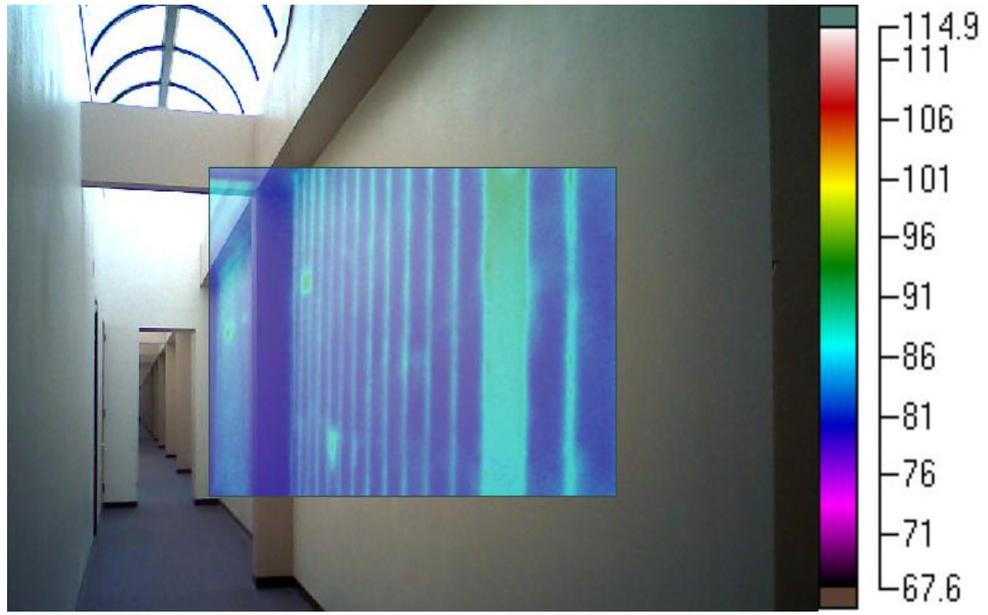
Non-Destructive Testing Tools



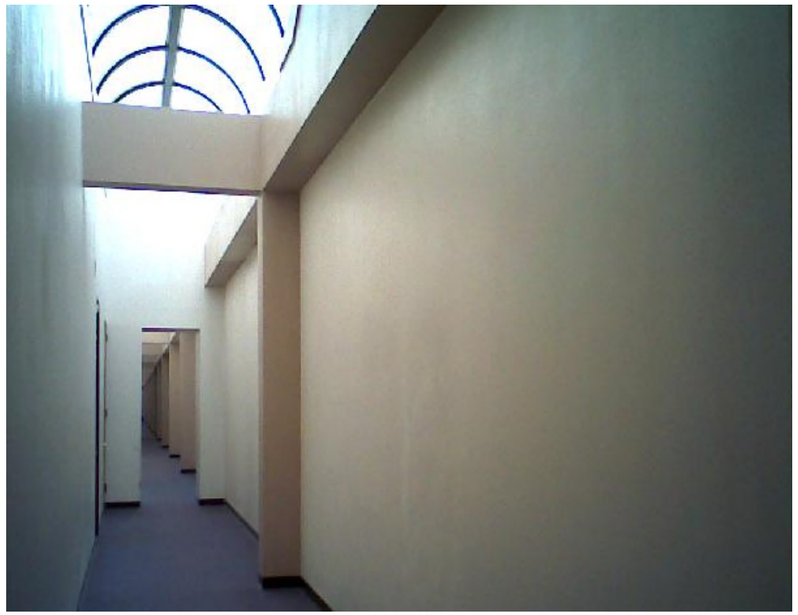
Infrared Image at Exterior Wall

Corresponding Visible Light Image

Non-Destructive Testing Tools



Infrared Image at Interior Wall



Corresponding Visible Light Image

Additional Examples of Non-Destructive Testing

- Moisture/Vapor Emission
- Hardness
- Ultrasonic
- Structural Analysis
- Load Testing
- Ground Penetrating Radar (GPR)
- Soil Sampling and Testing
- Water Origin and Quality
- Mold
- Asbestos

Destructive or Non-Destructive?

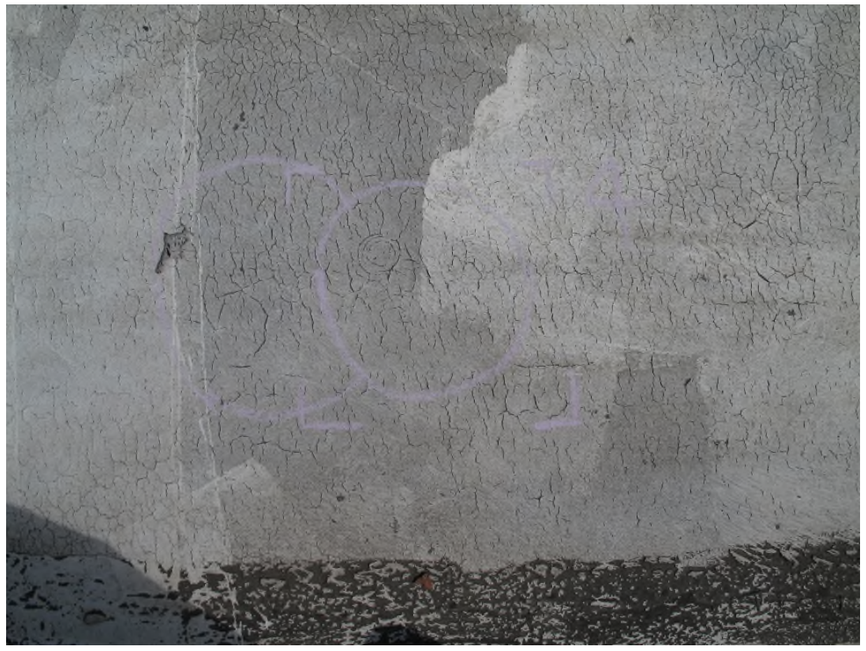
Non-Destructive

Destructive

Examples of Destructive Testing

- Moisture Probe
- Roof Coring and Sampling
- Wall (Veneer) and Finish Removal
- Concrete/Masonry Probe
- Concrete Coring
- Water Spray Testing
- Load Testing

Destructive Testing



Roof Coring and Sampling

Destructive Testing

Exterior Veneer Removal

Destructive Testing

Water Spray Testing

Testing Summary

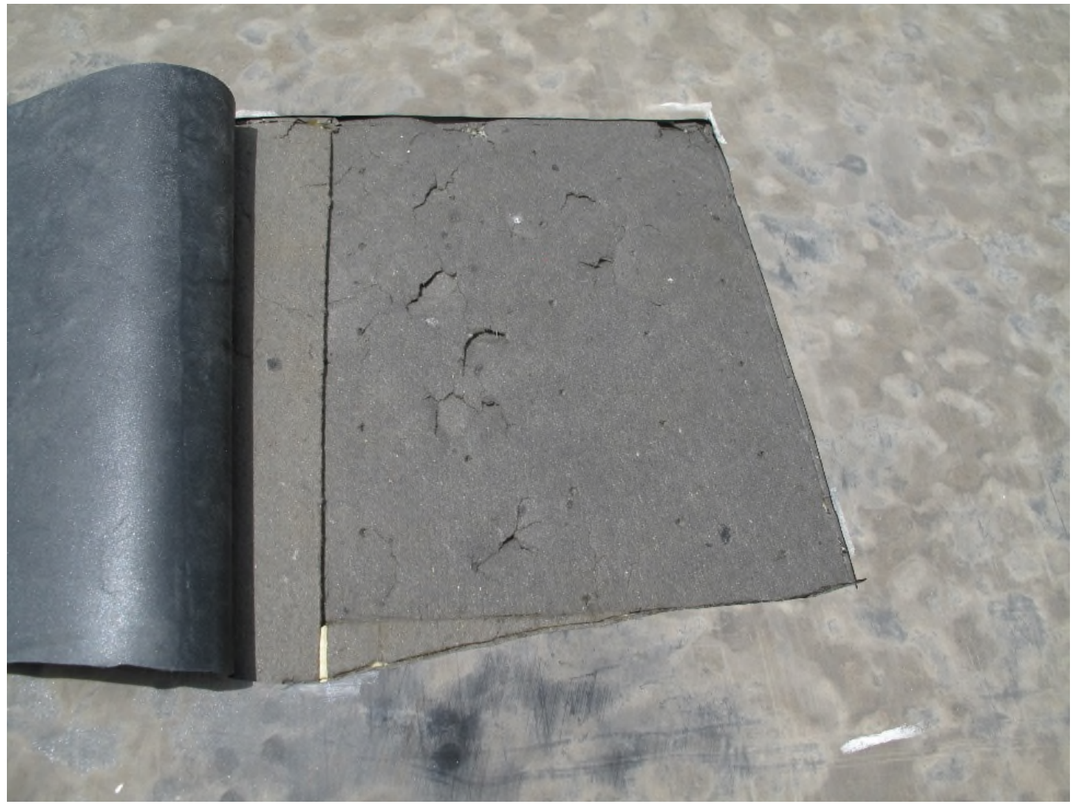
- Gather the Data Necessary to:
  - Test Hypotheses
  - Objectively Support Conclusions
- Data Collection May Need to be Altered or Augmented Depending Upon Findings
- Focus Should be on Objectivity, Sound Technique, and Reproducibility
- Available Documents are also Data to be Used in Forming Conclusions

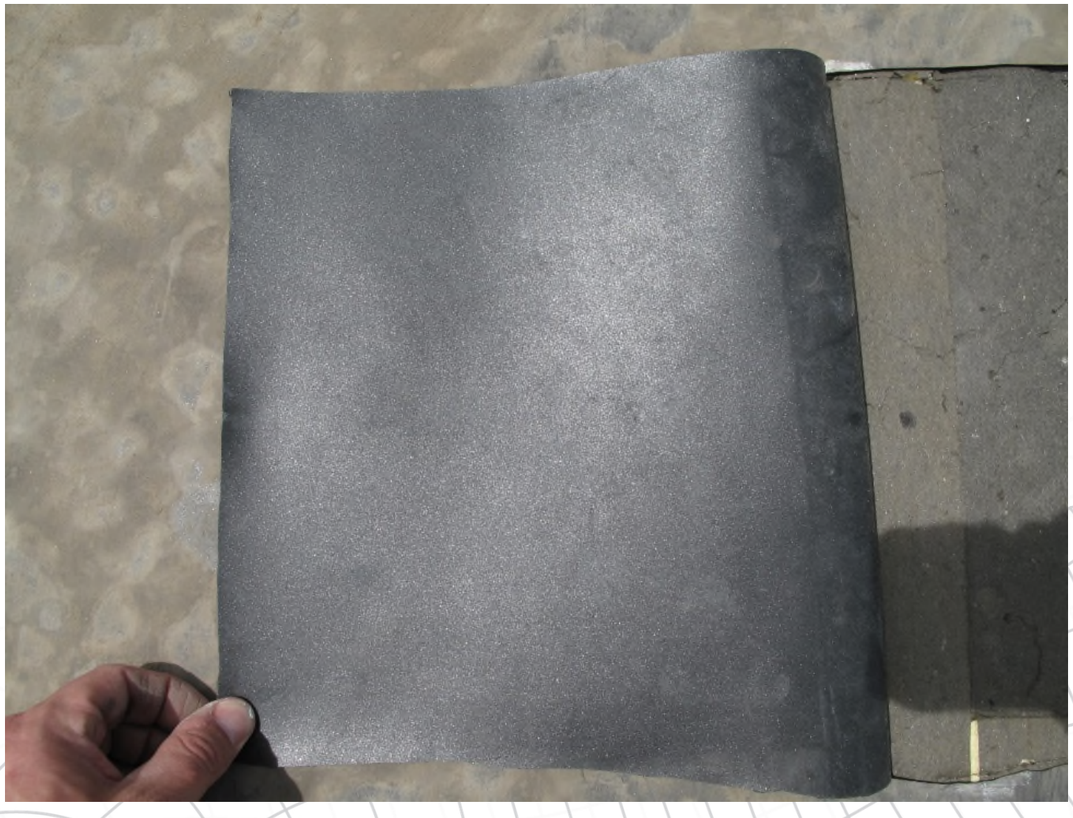
Case Study: Hail

Office, Warehouse, & Distribution Facility –
Englewood, CO

Case Study: Hail

Case Study: Hail





Case Study: Hail

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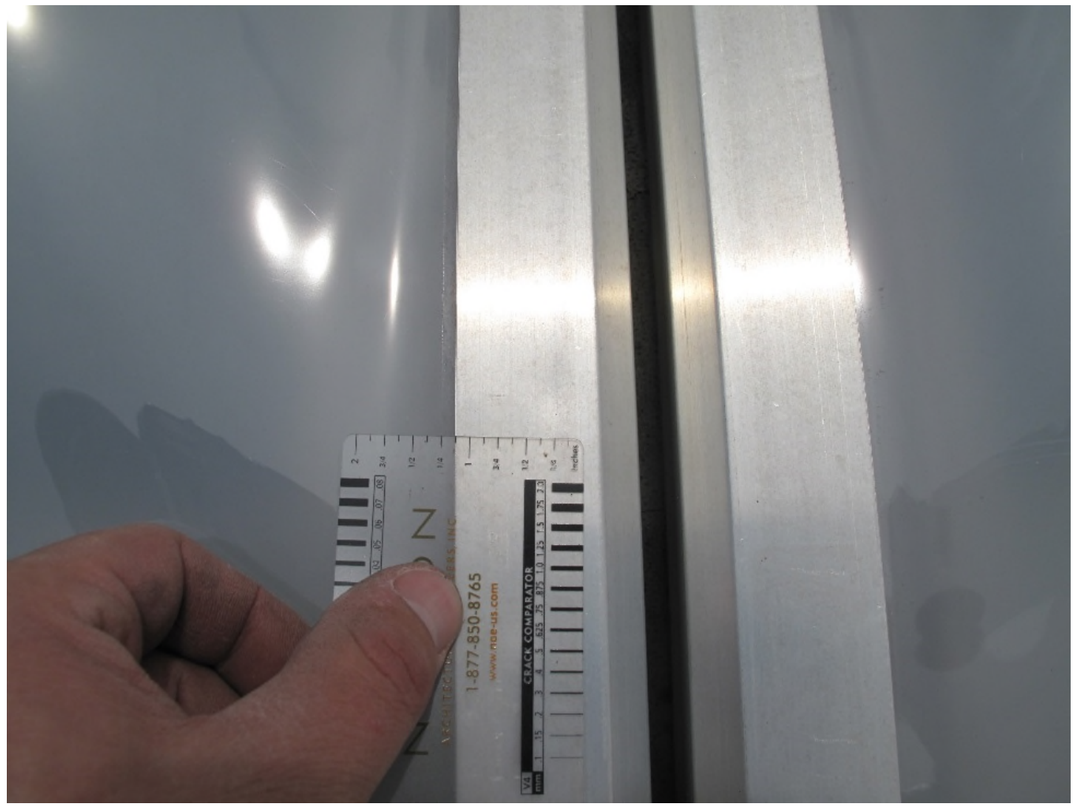
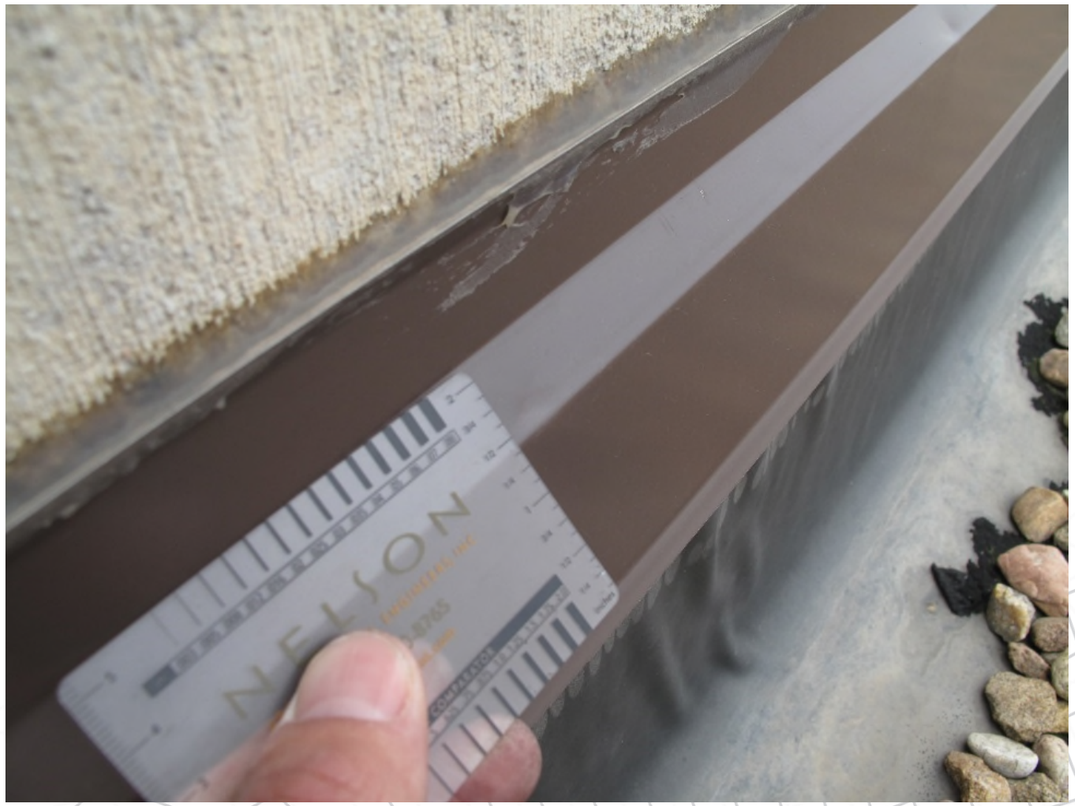




Case Study: Hail

Case Study: Hail

Case Study: Hail

Case Study: Hail

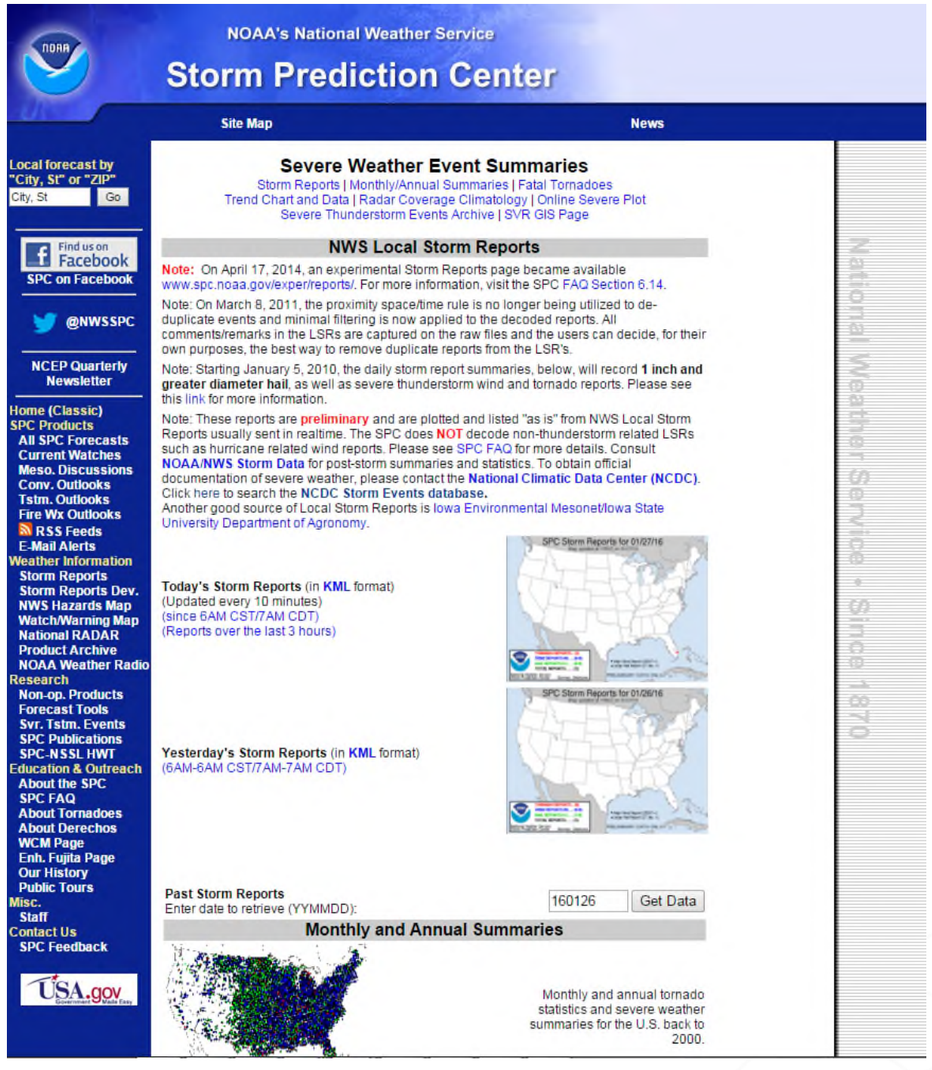
Case Study: Hail

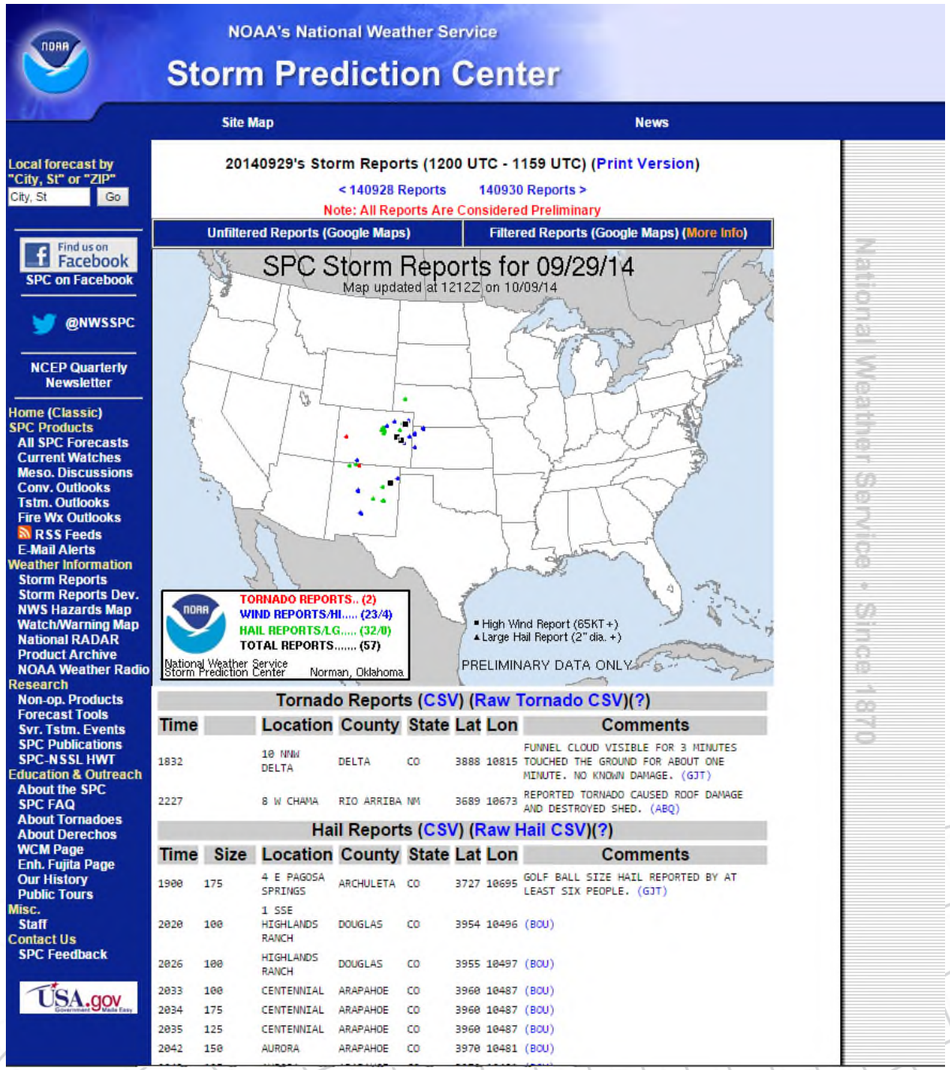
Weather Data

- NOAA (NCEI, SPC, NWS)
- Weather Stations
- Purchased Reports
  - CompuWeather
  - CoreLogic
  - Verisk Climate
- News/Media Outlets

Source: Reppenhagen, May 8, 2017

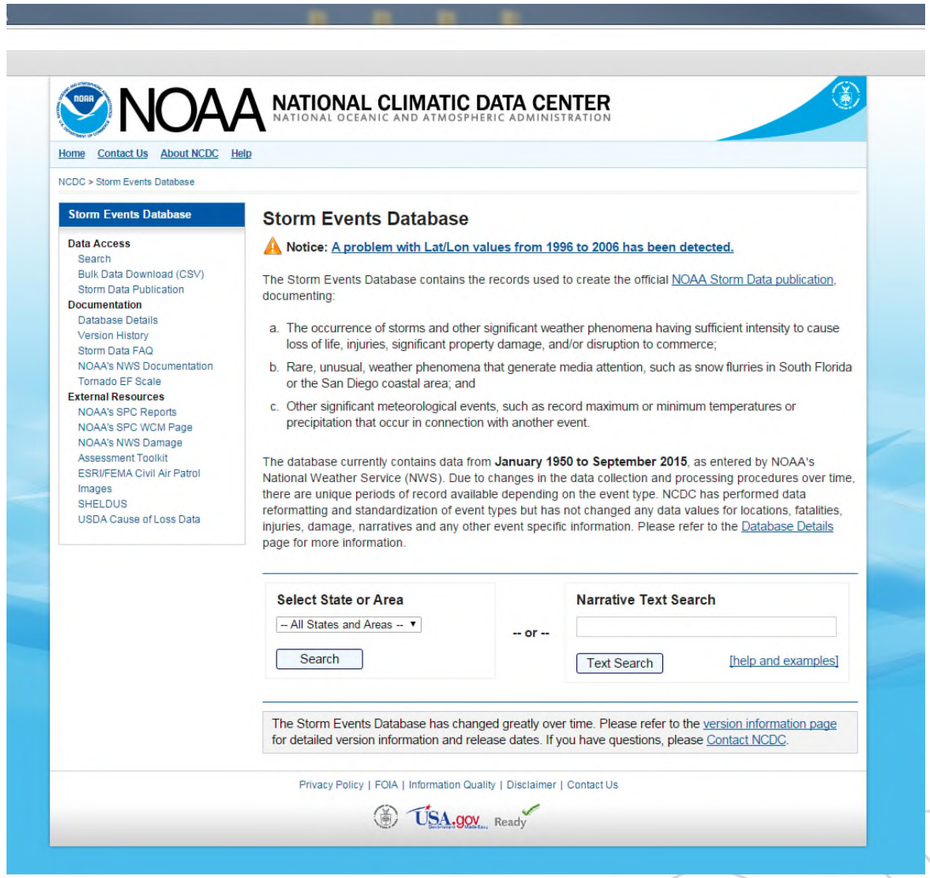
Case Study: Hail





http://www.spc.noaa.gov/climo/online/

Case Study: Hail



http://www.ncdc.noaa.gov/stormevents

Case Study: Wind

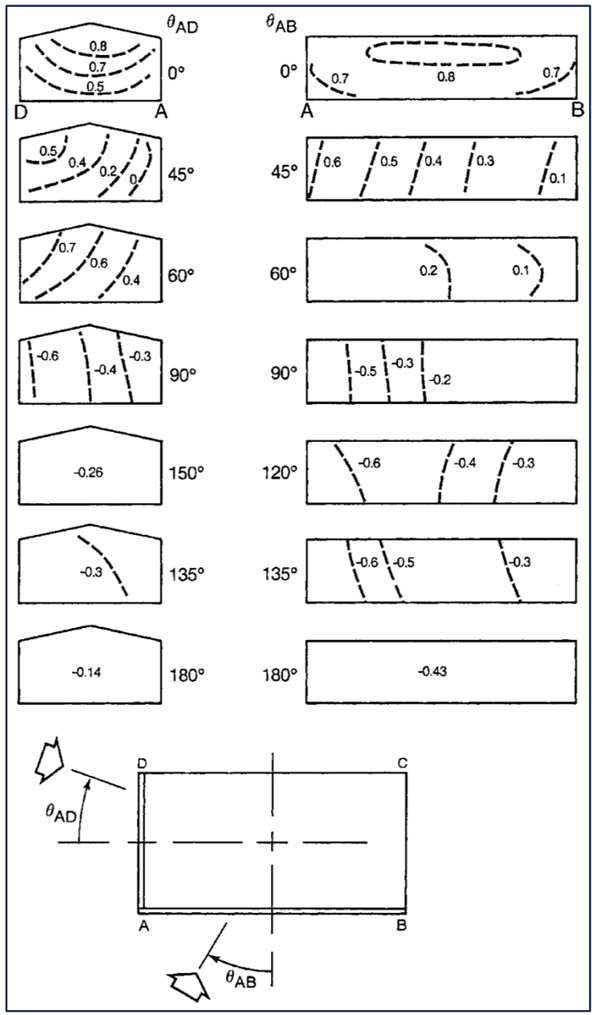


Figure 5 – Local Pressure Coefficients for Walls of Low-Rise Building with Varying Wind Direction (Holmes 1986)

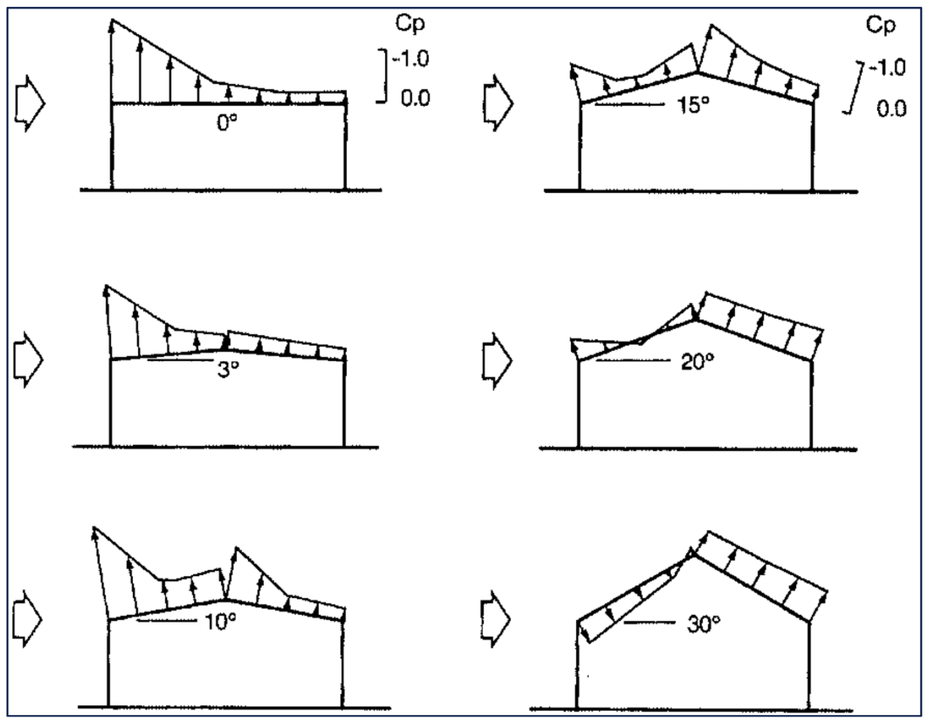


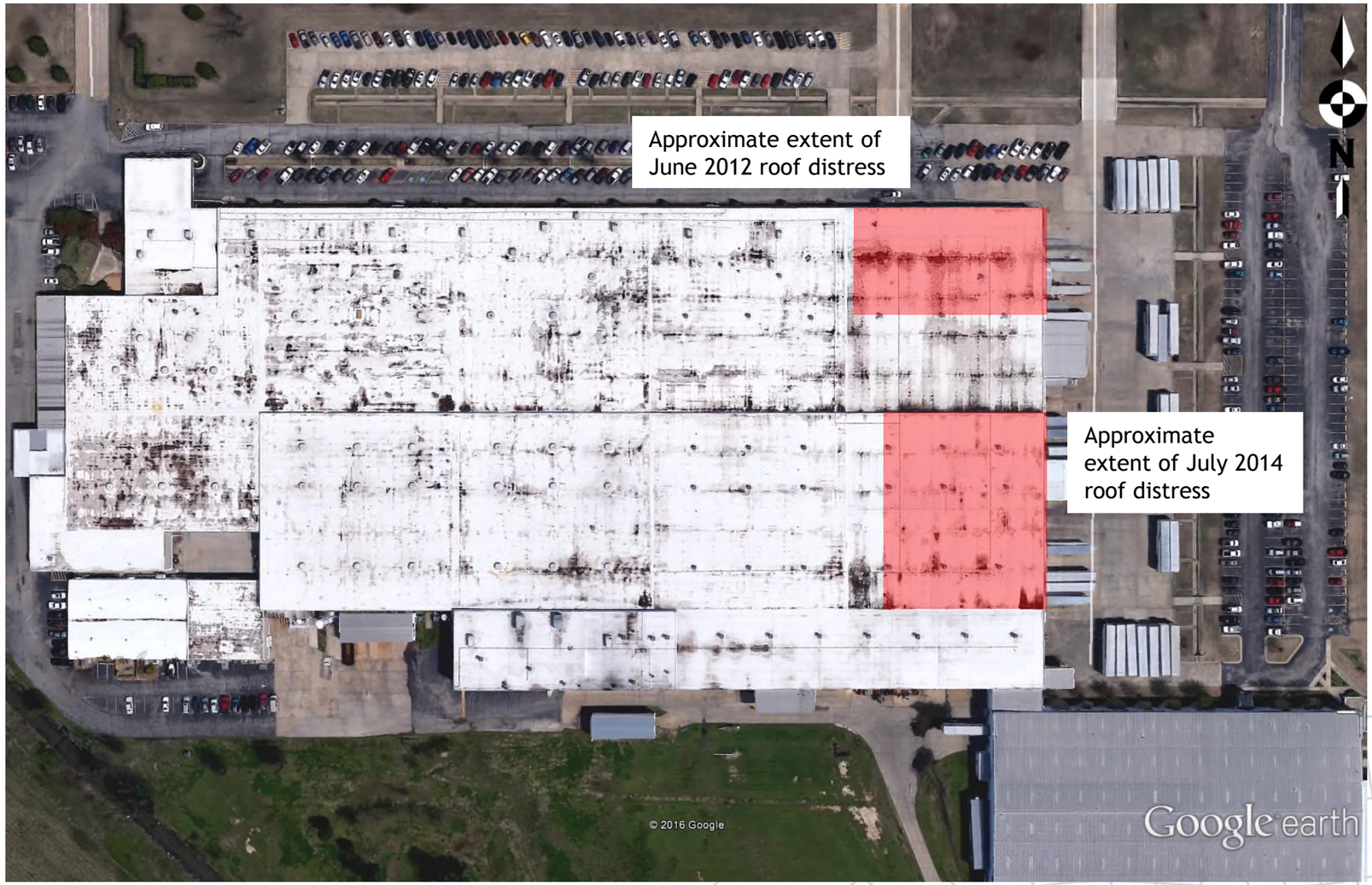
Figure 8 – Local Roof Pressure Coefficients for Roof of Low-Rise Buildings (Holmes 1986)

2001 ASHRAE Fundamentals Handbook

Case Study: Wind

Office, Manufacturing, Warehouse, & Distribution Facility – Northeast Arkansas

Case Study: Wind



Case Study: Wind

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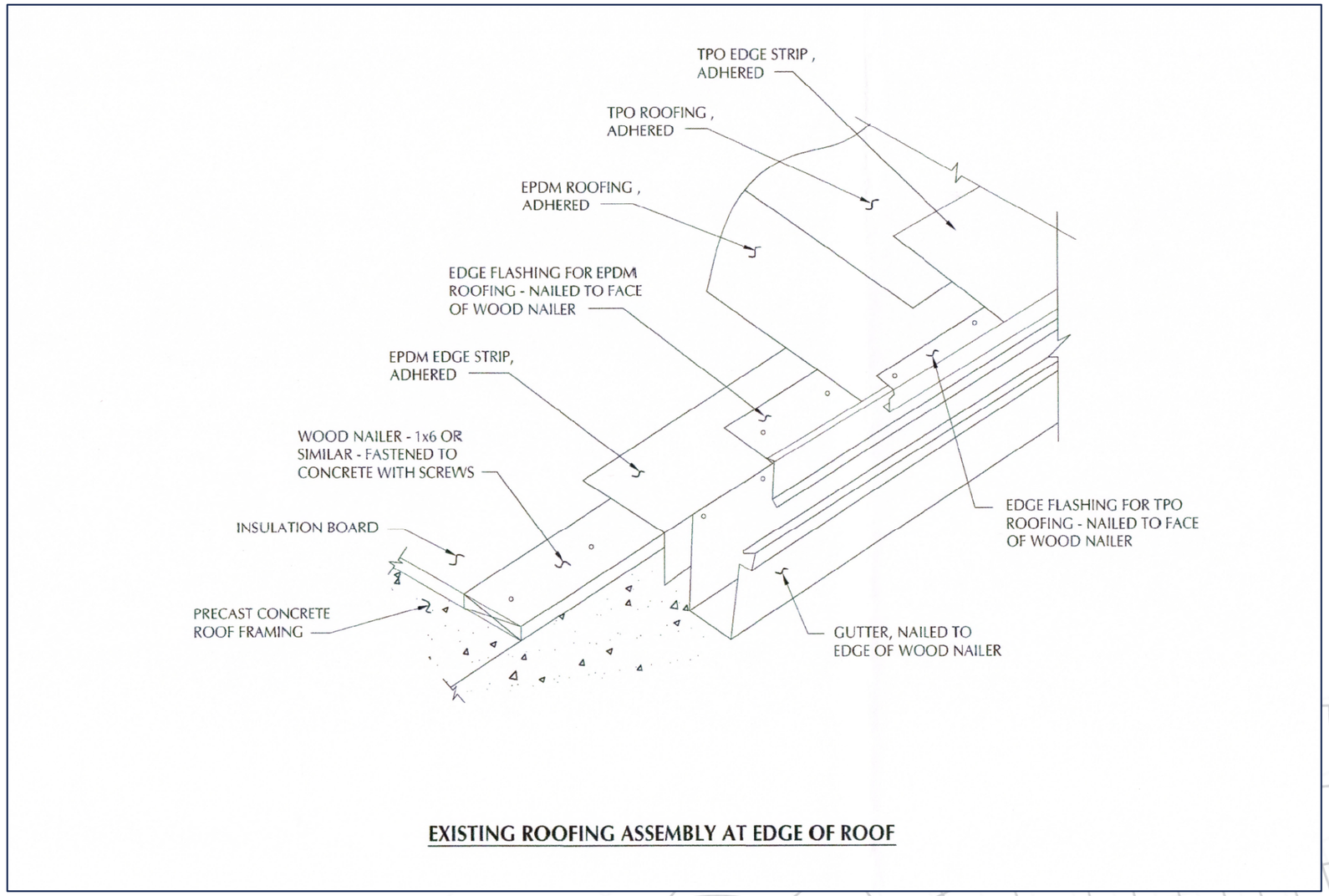
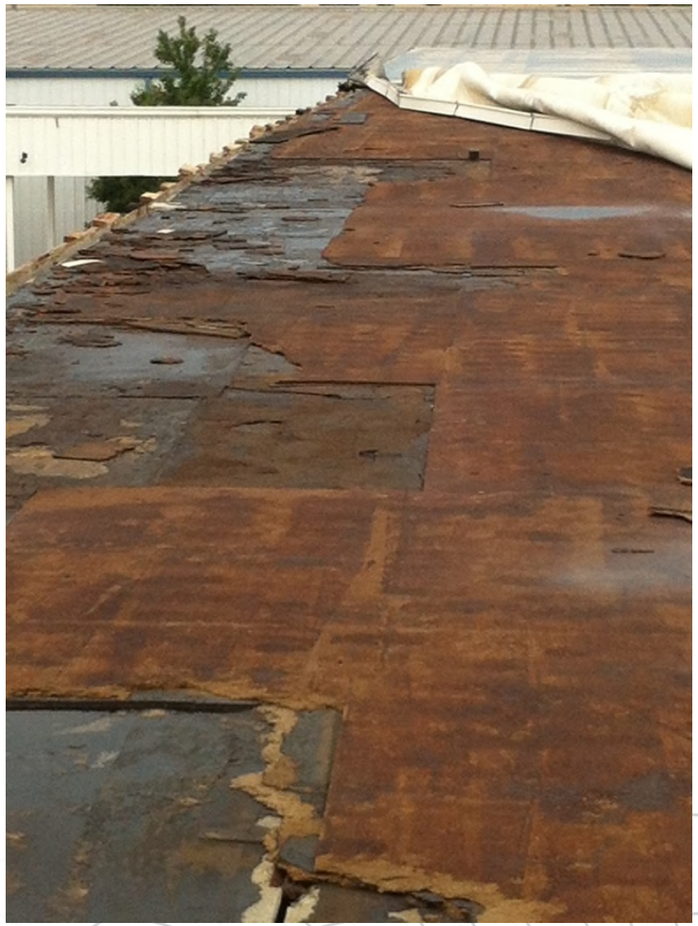


EXISTING ROOFING ASSEMBLY AT EDGE OF ROOF

Case Study: Wind

Photographs by Others

Case Study: Wind



Photographs by Others

Case Study: Wind

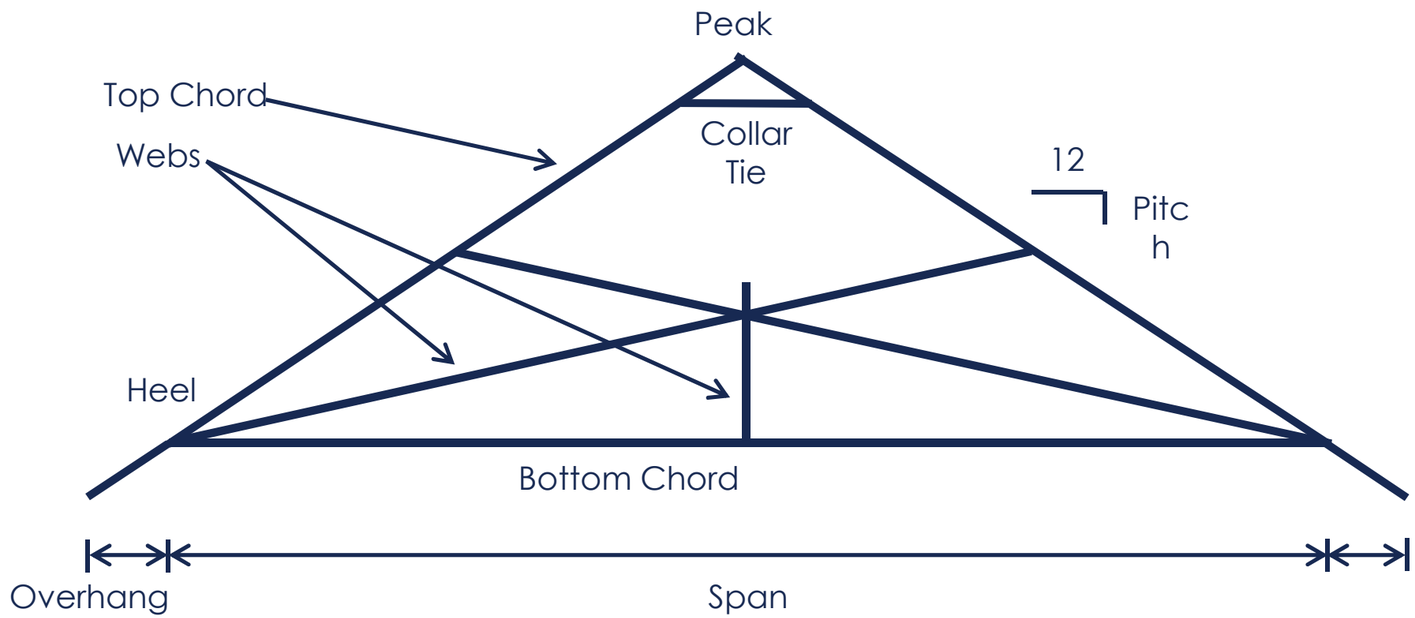
Photographs by Others

Case Study: Snow

Church – Pocatello, ID

Case Study: Snow

Case Study: Snow



Line Diagram of a Typical Roof Truss

Case Study: Snow

Truss Details

- Approximately 36’ span w/ 2’ overhangs
- 8:12 pitch (i.e., vertical rise: horizontal run)
- 24” on center spacing
- 2x6 chords and webs, 1x8 collar ties
- 5/8” diameter bolt at visible web-to-chord connections
- Nailed collar tie connections and splices

Case Study: Snow

Case Study: Snow

Case Study: Snow

Case Study: Snow

Weather Data – NCEI (formerly NCDC)

- Snow data from 1950 – present
- Only events with reported property damage
  - 3” – 5” in October 2007
  - 2” – 4” in November 2011
  - 3” – 7” in November 2014
- Wind data from 1950 – present
  - Multiple events with 58 – 81 mph wind speeds between 1989 - present

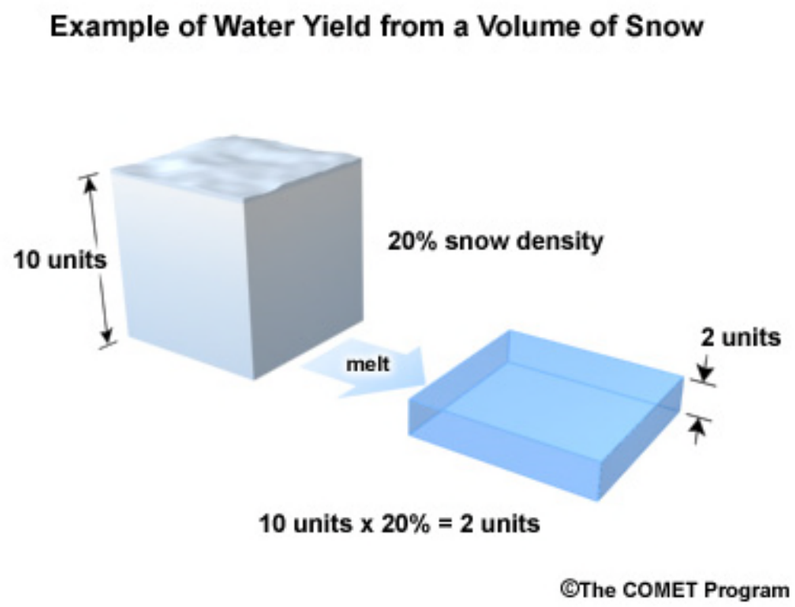
Case Study: Snow

Snow:Water Equivalent

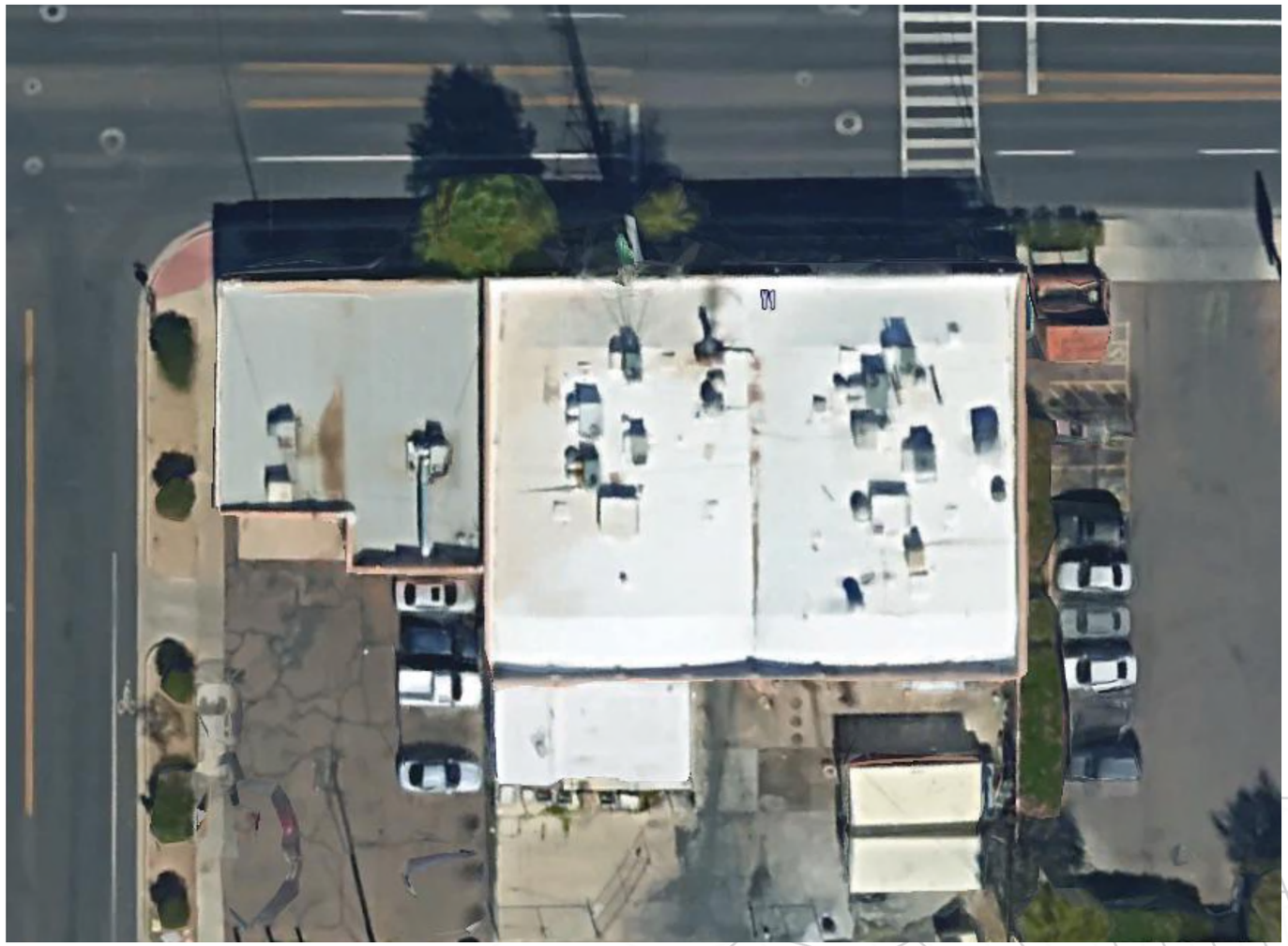
- Heavy: 1:1 – 9:1
- Average: 9:1 – 15:1
- Light: > 15:1

(Roebber et al. 2003)

7" of wet snow (5:1) weighs approximately 7 psf.



Case Study: Fire



Mexican Grocery and Restaurant – Phoenix, AZ (Google Earth Pro 2016)

Case Study: Fire

Case Study: Fire

Case Study: Fire

Case Study: Fire

Case Study: Fire

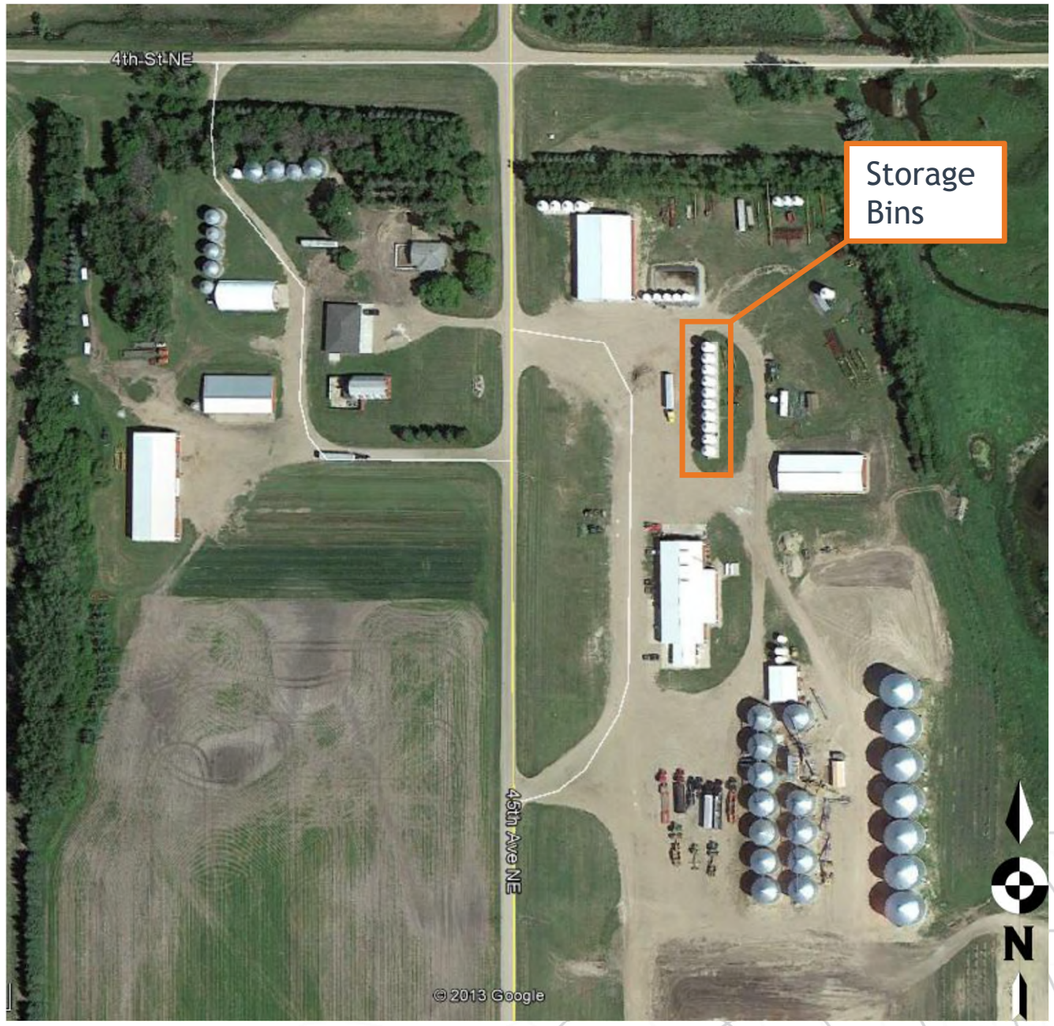
Case Study: Fire

Case Study: Fire

Case Study: Fire

Case Study: Fire

Case Study: Collapse



Storage Bin Failure Analysis – North Dakota (Google Earth 2014)

Case Study: Collapse

Case Study: Collapse

Case Study: Collapse

Case Study: Collapse

Case Study: Collapse

Case Study: Collapse

Case Study: Collapse

Case Study: Collapse

Figure 2. Typical flow pattern and problem with bulk granular materials such as grains.

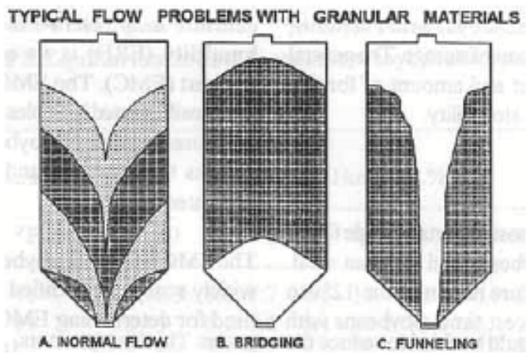
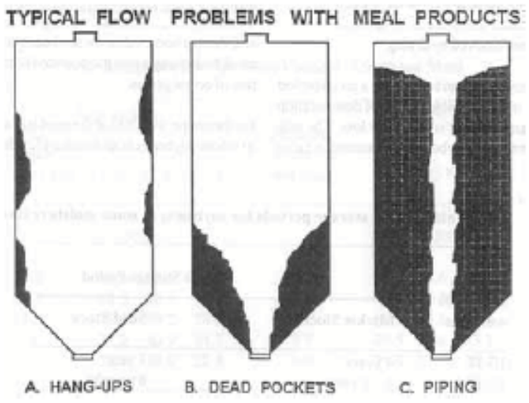
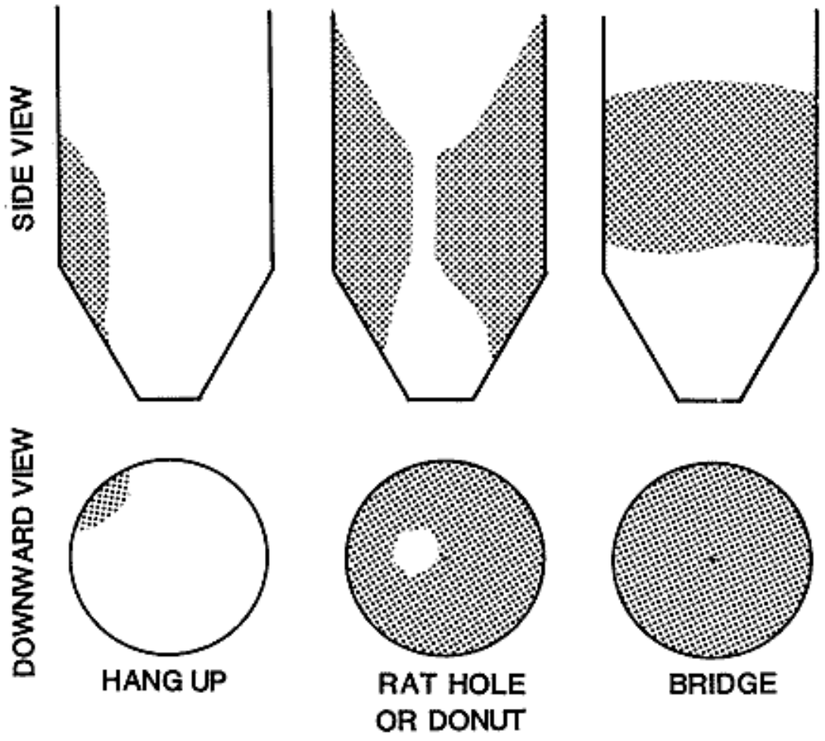


Figure 3. Typical bulk flow problems with meal products during discharge from hopper-bottom silos.





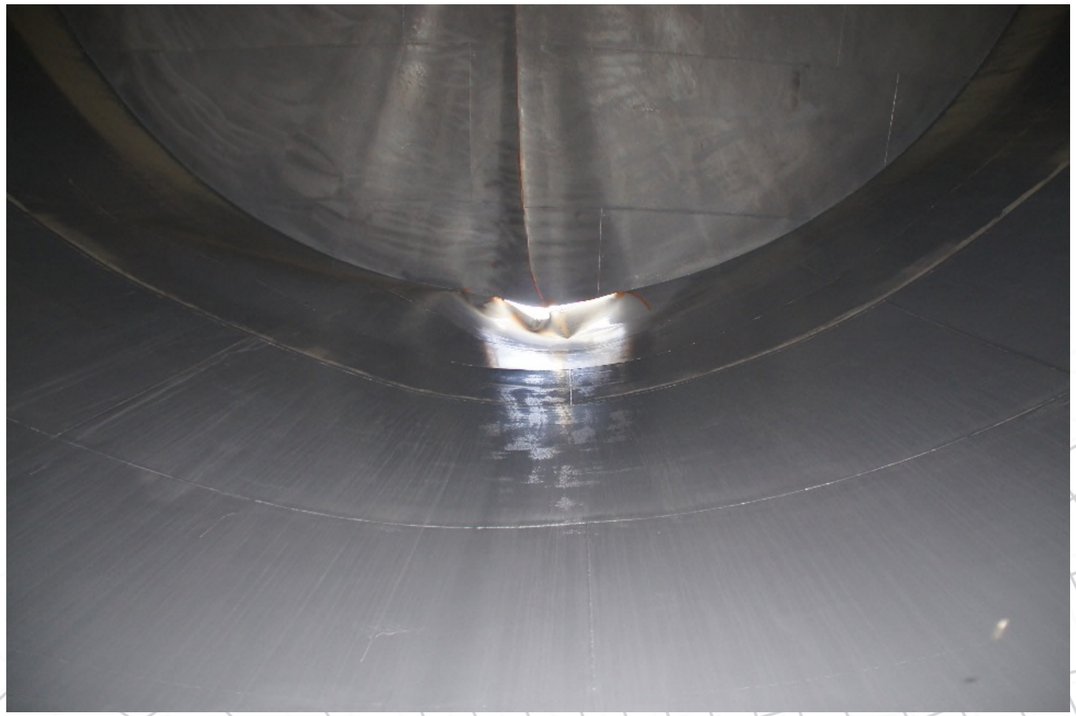
Case Study: Defect

Making Facility – Northern California

Case Study: Collapse

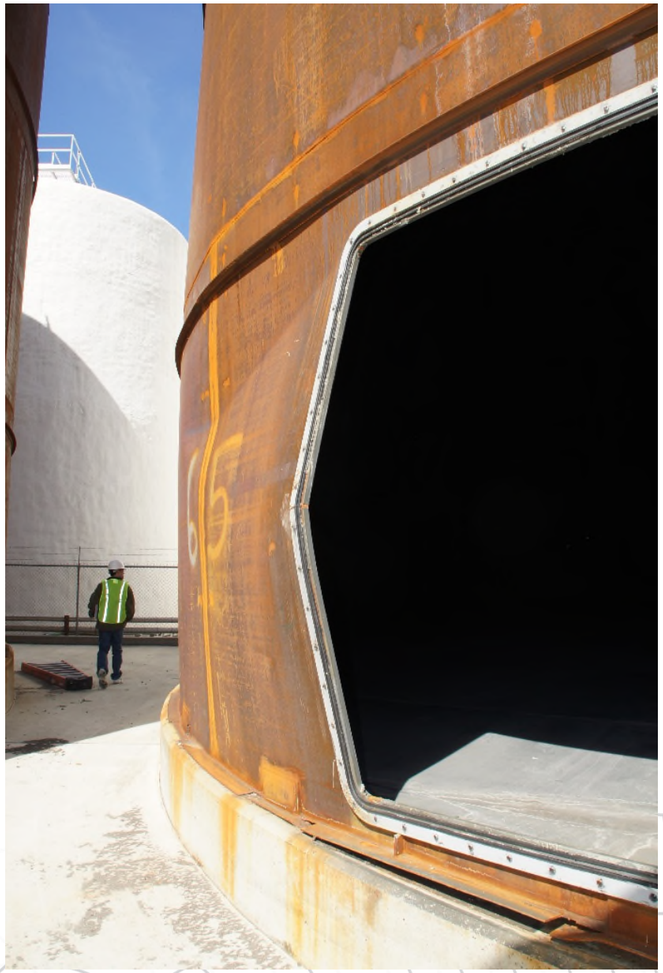
Photographs by Others

Case Study: Collapse



Photographs by Others

Case Study: Collapse



Photographs by Others

Case Study: Collapse

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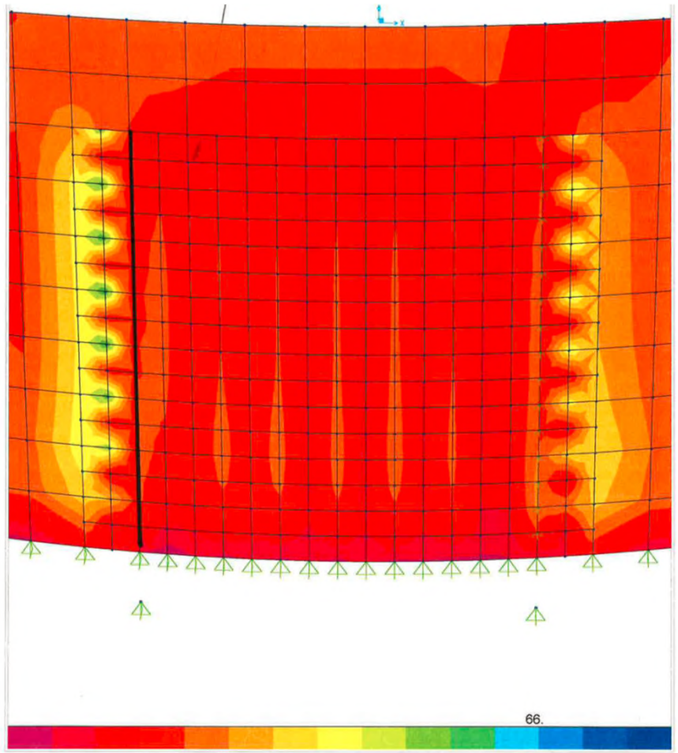
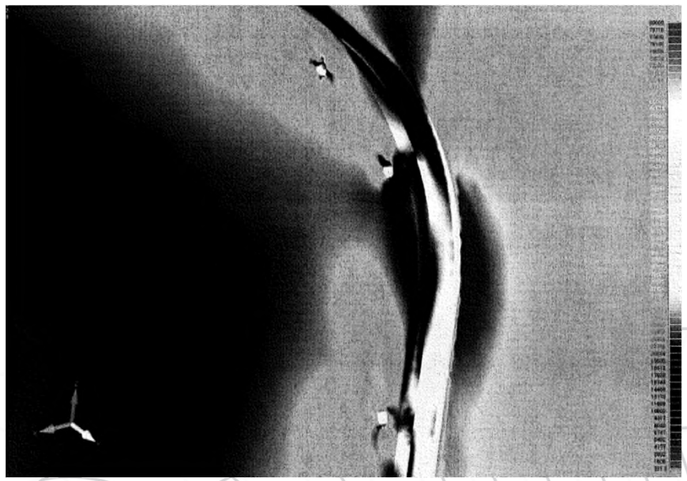
Case Study: Collapse

Photographs by Others

Case Study: Collapse





Results of FEA Analysis by Others

Case Study: Collapse

Case Study: Collapse

Case Study: Collapse

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Case Study: Collapse

Summary

- Forensic engineering investigations can assist in providing resolution for claims or disputes
- A typical scope - determine extent, causation, and/or responsibility; provide recommendations for remediation
- A proper investigation uses the scientific method to *objectively* solve a problem
- A rational basis should be established for conclusions via a properly substantiated analysis

Thank you!

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