LONGEVITY OF STRUCTURES

and

FUNCTIONING BUILDING ENCLOSURES

LEE DUNHAM, PE SE
PRINCIPAL
OAC SERVICES, INC.
LONGEVITY OF STRUCTURES AND FUNCTIONING BUILDING ENCLOSURES

2019 SeaBEC Symposium
Museum of Flight
May 14, 2019

LET’S TALK ABOUT:
• Changes in building enclosure performance over time
  *Relative longevity examined through forensics*
• Designing / constructing building enclosures in a changing industry
• What can we do better?
Engineers and architects at OAC have investigated 1,500+ building enclosure failures over the last two decades in the Pacific Northwest.

In a 2018 study, data from 140 of these buildings were analyzed to highlight trends in failures over time.
APPARENT DECLINE IN BUILDING LONGEVITY
RELATIVE LONGEVITY TRENDS

Years in service until failure in % of building age

Year Born


OIL Embargo
Energy Code
Condo Act
Rainscreen
Recession
Air Barriers
DRAINAGE & DRYING BEHIND CLADDING

4-story, traditional stucco, Seattle (1984)
DRAINAGE & DRYING BEHIND CLADDING

4-story, traditional stucco (marblecrete), Seattle (1979)
TRENDS IN FAILURE CAUSE

- Material: 30%
- Design: 29%
- Installation: 41%
RELATIVE FREQUENCY OF FAILURE MODE
RELATIVE FREQUENCY OF FAILURE CAUSE
DESIGN ISSUES

- Resistant to Weather
- Breathing, Drainage & Drying
- Constructability
- Simple Design and Detailing
- Simple to Maintain
- Quality Control
DESIGN BREATHING & DRYING

- Unvented roof
- Imperfect vapor retarder
- Under-deck insulation
- Condensation damage at wood sheathing and framing
- Diminished air quality
INSTALLATION
SIMPLE
QUALITY
CONTROL

- Highrise residential
- Built in 2008
- Investigation 2013
- Post-tensioned construction
- Tendon tails/grease caps
MATERIAL ISSUES

- Compatibility
- Material Knowledge – Risks and Rewards
- Durability / Time Tested
- Temperature & Moisture Application Window
- Storage
UNDERSTANDING OF MATERIAL BEHAVIOR

• Alternative cements (slag, fly ash)

• Benefits and risks – know both

• Proactively deal with risky behavior

• Ex: compensating admixtures
DURIBILITIY
MUST BE PART OF THE SUSTAINABILITY EQUATION
INDUSTRY CHANGES AFFECTING PERFORMANCE

• Change in the Definition of “Failure”
• Impact of Changing Code Requirements
• Availability of Skilled Labor
• Rate of Innovation
• Fragmented / Specialized Industry Groups
• Interaction of Design / Manufacturing / Installation
EVOLUTION OF CONSTRUCTION INDUSTRY

LAST 100 YEARS
(according to Dunham)

1919
- buildings get more complicated
- schedules get tighter
- owner
- design
- installation & material
- "true craftsmanship"

2019
- "fragmentation and self-preservation"
WHAT CAN WE DO BETTER?
DESIGN FOR DURABILITY
this requires knowledge of material behavior + the formulation of constructible details that make maintenance simple
INTERACTION OF DESIGN, MANUFACTURING & INSTALLATION

10 – 15 YEAR FORENSIC FEEDBACK LOOP NEEDS TO BE REDUCED
WHAT CAN WE DO BETTER?

Increase QA/QC
For Designers, Contractors, Owners, Code officials & Material Suppliers

Decrease building enclosure failures
WHAT CAN WE DO BETTER?

- Communicate often and effectively
- Learn from failures quicker (feedback loop)
- Anticipate risk and potential misuse
- Educate across disciplines
Let’s continue the conversation…

Lee Dunham, PE SE
OAC Services, Inc

ldunham@oacsvcs.com
linkedin.com/in/leedunhamPESE
oacsvcs.com

OAC Services, Inc.
STUDY CONTRIBUTORS

Grace Wong
Architect & Engineer, PE RA, LEED AP BD+C

Christian Gorry, Associate Engineer & BE Specialist, PE RRC

David Bates, Associate Senior Architect, AIA, CSI

With the support of OAC’s Forensic Architecture & Engineering Building Enclosure Team