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### Moisture Defects in Buildings: A SICK BUILDING EPIDEMIC

Cheryl Ciecko, Architect, FALA, LEED AP Dwell Well Institute

AIA Continuing Education Provider



### Moisture Defects: A SICK BUILDING EPIDEMIC

Poor air quality caused by water damage and mold is contributing to increasing health burdens on occupants of buildings...

Professionals and non-professionals alike will gain knowledge and insights to discover, correct and **avoid building defects, errors and omissions that often lead to water damage**, high indoor humidity, mold and poor indoor air quality to confidently build facilities which are durable as well as being wellness supporting environments.





#### CHERYL CIECKO, FALA, LEED AP Architect

Licensed architect, building science, and healthy building consultant providing education and resources to professionals and individuals worldwide.

**Mission:** Create awareness & education to prevent building defects that lead buildings that make occupants sick.



#### **Learning Objectives**

- Recognize causes and sources of water accumulation in building materials with potential health impacts.
- 2. Evaluate the impacts of moisture on all building materials
- 3. Consider the mechanics of moisture movement for building design.
- 4. Recognize moisture related building defects and design solutions to avoid them.

### Moisture Defects: A SICK BUILDING EPIDEMIC

Poor air quality caused by water damage and mold is contributing to increasing health burdens on occupants of buildings...Understanding and applying building science fundamentals along with considerations uniquely related to region, site, structure type, materials and construction coordination is the key to successful building solutions that will be durable and supportive of occupant wellness over time.

Despite building code requirements, common building defects continue to be overlooked in the quest for sustainability, but at the expense of durability and occupant wellness.

Professionals and non-professionals alike will gain knowledge and insights to discover, correct and **avoid building defects**, **errors and omissions that often lead to water damage**, high indoor humidity, mold and poor indoor air quality to confidently build facilities which are durable as well as being wellness supporting environments.



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- 1. Recognize Causes & Sources of Mold...Affect Health
- 2. Impacts of Moisture on Materials
- 3. Mechanics of Moisture Movement
- 4. Review of Defects & Solutions





# CHERYL CIECKO FALA, LEED AP

- Licensed Architect 35+ years
  - B.S. Architecture
  - Master Architecture



- American Lumber Standards Committee
- Mom of 4
- Research Toxin Exposure 20+ years
- Started <u>www.avoidingmold.com</u> in 2016
- Autoimmune Diseases /Lyme
- Thriving...









# INTRODUCTIONS

- Building Construction Industry
- Architects
- Engineers
- Building/Mold Inspectors
- Remediators
- Moisture problem in a building?
- Experienced environmental health impacts?





## 





## Lessons - Toxins are Everywhere

Food Water **EMFs** VOCs **Artificial Light** Chemicals **Cleaning Products** Radon **Air Fresheners** 



Heavy Metals Pesticides Ticks/Mosquitos Parasites Antibiotics/ Vaccines Health supplements Personal Products

# **AIR WE BREATHE**





#### 1. Recognize Causes & Sources of Mold...Affecting Health

- 2. Impacts of moisture on materials
- 3. Mechanics of moisture movement
- 4. Review of defects/solutions





## **Building Mold...**

#### Bacteria comes with mold ...

- 1. Completely concealed/hidden
- 2. Undetectable with the naked eye
- 3. Can have no noticeable smell
- 4. Smells can vary
- 5. Color and texture can vary
- 6. Can be missed by testing
- 7. Toxic dead or alive





http://www.fsec.ucf.edu/en/consumer/buildings/basics/moldgrowth.htm



## **Conditions for Mold Growth?**

- 1. Mold/Fungus Spores
- 2. Oxygen
- 3. Temperature of 30-130 F (most common 40-105 F)
- 4. Nutrient Source
- 5. Moisture















- 1. Recognize causes & sources of mold...affecting health
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### **Materials & Moisture**





NO structural material is immune to moisture damage.

## **NO Material Exempt From MOLD...**















# Moisture + <u>*Dust/Dirt</u> = Mold*</u>



#### **Condensation due to high humidity.**



Stop Mold by Eliminating the Food Source? Mold Proof Materials / Mold Resistant Materials

### **Check the Warranty**

- Limitations
- Exclusions
  - <mark>Water</mark>
  - Dirt/dust
  - High Humidity
- Installation Instructions- 'Clean/Dry'
- Remedy









### **Reasons Buildings Have Mold**

- 1. Unintended consequences
- 2. All buildings are COMPLICATED
- 3. Designed, built by HUMANS
- Qualified ARCHITECTS & other building professionals are NOT involved in home building
- 5. Qualified Contractors in short supply
- 6. Building Codes are overlooked
- 7. Quality work costs Money















### A seventh child who contracted a mold infection at Seattle Children's Hospital has died



By Nicole Chavez and Rebekah Riess, CNN Updated 6:15 AM ET, Fri February 14, 2020







- 1. Recognize causes & sources of mold...affecting health
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### **Moisture Sources**

#### Exterior:

- Precipitation
- irrigation systems
- water vapor
- groundwater
- Gutters & Downspouts
- Omitted/Poor Flashing









### **Moisture Sources**

#### **Construction Moisture:**

- Concrete
- Masonry & brick
- Grout / Mortar for tile
- Wood materials
- Drywall tape
- Paint











### **Moisture Sources**

#### Interior:

- Building occupants
- Activities







### **Moisture Transport Mechanisms**

- **1. Liquid flow**
- 2. Capillary Action
- 3. Air Movement
- 4. Diffusion





### 1. Moisture – Liquid Flow

#### **Bulk Water**

Movement of water under the *influence of a driving force* 

- Gravity
- Suction caused by air pressure differences







### **Installation Defects**







### **Bulk Water**

#### 5 year old High-End Condo Building Copeland Building Envelope Consulting, Inc.



**New Construction Home 2025** 

### **Air Pressure Differentials are Complicated**

- Air movement caused by thermal differences
- Warmer air less dense than cooler air
- Warm air rises pressure differences
- Cooler air from outside is draw into lower floors



Stack effect

- With warm temperatures the stack effect is reversed
- Hot air enters the upper portion of a cooler building
- Down draft is created.



### **Air Pressure Differentials are Complicated**



Wind effect



Stack effect



### **Air Pressure Differentials are Complicated**





### 2. Moisture – Capillary Action

- Movement of water in **porous materials** resulting from *surface tension forces*.
- Suction in the small space created between two materials.
- 'Rising Damp'







### **Capillary Action Locations**







## **Inward Moisture Drive - Wallpaper Vapor Barrier**





http://buildingscience.com/documents/digests/bsd-108-investigating-and-diagnosing-moisture-problems

### 3. Moisture – Air Movement

• Movement of *water vapor* from *from air flow* thru spaces & materials.





### **Air Pressure Movement**



https://buildingscience.com/sites/default/files/migrate/pdf/BSD-014\_Air%20Flow%20Control\_ed.pdf



https://basc.pnnl.gov/information/building-science-introduction-air-flow

### 4. Moisture - Diffusion

- Movement of water vapor resulting from a vapor pressure difference.
- Through the materials







zoom 🔍 🕨


#### **Moisture Transport Comparison**



Interior temp. 70F, 40% RH

Source: Buildingscience.com



### **Building Science Fundamentals**

Heat moves from

Moisture moves from

- Buildings dry more to the *inside* during warm, humid weather
- Building dry more to the <u>outside</u> during <u>cold, dry weather</u>





# **Objectives**

1. Recognize causes & sources of mold

- 2. Impacts of moisture on materials
- 3. Mechanics of moisture movement

#### 4. Review of DEFECTS & SOLUTIONS





### **Common Building Defects / Solutions**

Drainage
Deflection
Drying
Details

Health impacts growing... Attorney specialists in Building/Construction Defects growing...



# **SITE DESIGN - Ensure Proper Drainage Away**

#### R401.3 Drainage

The slope away required to be 6 inches...within the first 10 feet. (5%)



GRADING METHOD FOR LOT WHERE DWELLING IS LOCATED ON A RIDGE. DRAINAGE SWALES ARE LOCATED AT SIDE YARDS IN AREA OF POSITIVE SLOPES.



https://codes.iccsafe.org/s/IRC2015/part-iii-building-planning-and-construction/IRC2015-Pt03-Ch04-SecR401.3

### **Drain Around Structures With Swales**



- Slope starts at the foundation.
- Avoid flat or low sloped areas adjacent to foundations.
- Check landscaping plans to maintain clearances and slope of subgrade, as well as any finish ground cover.
- Avoid plantings & sprinkler systems adjacent to foundations



# **Maintain Clearances From Soil**



- 1. Maintain proper clearance from soil 8 inches
- 2. Drain away water 5% slope
- 3. Compacted, impermeable soil



IRCFigure R317.1(1)

#### **Attention to SITE DESIGN - Proper Drainage** Ground slopes away from foundation (6 in. per 10 ft) 5% Slope w/low permeability, compacted soil -Fully compacted areas adjacent to the foundation to Low permeability soil promote drainage away. Free-draining back fill material or drainage mat • Free drainage back fill material or a drainage mat to be used BELOW the low perm compacted & sloped soil. **Capillary break** between footing and foundation wal

• Use filter fabric as necessary.

**Filter fabric** 

Coarse gravel (no fines)

Perimeter drain sy

### **Capillary Break - Footing/Foundation Wall**

- Site drainage away
- Exterior waterproofing
- Capillary break between footing & foundation wall
- Min. 10mil vapor barrier
- Capillary Break / course gravel
- Vapor barrier attached to all openings & walls up 6 " approx.
- Insulation between slab & foundation wall





# **Slab Edge Capillarity**





http://buildingscience.com/documents/digests/bsd-108-investigating-and-diagnosing-moisture-problems

# **Extend Downspouts**













NO free draining gravel at the surface near foundation!

### **Slab Foundation**

- Site drainage away
- Exterior waterproofing
- Capillary break between footing & foundation wall
- Min. 10ml vapor barrier
- Capillary Break / course gravel
- Concrete slab over VB



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Do not place ducts under slab.

Use solid drainpipes with mechanical traps in the floor.

If gravel bed is omitted, use a drainage mat to connect submembrane airspace to depressurization system.

Fill joint with sealant

Reinforce slab and use concrete with low water/cement ratio to reduce cracking

connects sub slab space to depressurization

Bond beam, cap block, or filled upper course of masonry wall

# **Common Building Defects / Solutions**

Drainage
Deflection
Drying
Details



### **Follow the WATER**







### **Design With Overhangs**





#### No Overhangs = No Protection

### **Roof Drainage**







#### **Drainage Planes - Reversed Shingled**





#### **Wall Drainage Defects**







### **Attention to Proper Shingling**







# **Roof Drainage & Gutters**





https://basc.pnnl.gov/resource-guides/step-and-kick-out-flashing-roof-wall-intersections#quicktabs-guides=7 https://www.jlconline.com/training-the-trades/kickout-flashing-required-by-code-yet-often-overlooked\_o







https://basc.pnnl.gov/resource-guides/step-and-kick-out-flashing-roof-wall-intersections#edit-group-cad https://basc.pnnl.gov/resource-guides/step-and-kick-out-flashing-roof-wall-intersections#edit-group-description

## **Common Building Defects / Solutions**

Drainage
Deflection
Drying
Details



# **Design the HVAC with Building Design**

NO ducts or mechanical equipment in unconditioned spaces!





**Avoid HVAC being an after-thought!** 



#### **Exhaust / Venting Locations - Follow the Air**





#### Avoid exhaust outlets in soffits!





What is Attic Black Mold and W... checkthishouse.com



Ventilation Won't Prevent Attic Mo... healthyindoors.com



Attic Black Mold | How to Preve... checkthishouse.com







Mold in Attics - Why s certifiedinspections.c



What it is and ...

Attic Mold 101 - ATMOX atmox.com



1044 H. R. M. C. M. C 800 × 600

Soffit vent chutes | Quigley Attic Mol... quigleyatticmold.com



What Causes Mold Growt... murphyinspect.com



Blocked soffit vents 050 | 0 quigleyatticmold.com



### Just Say NO!





#### **Condition Crawlspaces & Basements**



Provide dedicated dehumidification!

118 3 4 3

#### Flooring as Vapor Barrier Mold - Slabs & Above Crawl Spaces





#### Vapor Barriers/Retarders & Below Grade Walls

No interior vapor barrierOnly vapor OPEN insulation







https://buildingscience.com/documents/digests/bsd-103-understanding-basements

#### **Moisture Trapped Behind Vapor Barriers**







### **Spray Foam - Vapor Barrer**





#### Air Gaps in Spray Foam - Mold on Surfaces FL





### **Common Building Defects / Solutions**

Drainage
Deflection
Drying
Details

Health impacts growing... Attorney specialists in Spray Foam Defects growing also!



### **Details Overlooked**







#### **Seal Wall Penetrations**





#### Spaced Deck-Ledger Detail


# Summary





### **Always Consider the Root Cause...**

#### **Symptoms**

- High humidity
- Poor indoor air quality
- Sick building occupants

#### The solution is rarely:

Whole house dehumic Whole house air purit re ERVs or HRVs







### **Conditions for Mold Growth?**

- 1. Mold/Fungus Spores
- 2. Oxygen
- 3. Temperature of 30-130 F (most common 40-105 F)
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## 5. Moisture





### **Mold Food... Moisture = Humidity**





### Design for Moisture Management is the beginning...

#### **Reinforce through:**

- Proper construction
- Quality assurance
- <u>Commissioning</u> of the building enclosure.
- Also... ongoing inspection and maintenance
  - Ensure performance is sustained









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## LEARN MORE

Building Well to Avoid Mold, Water Damage, and Toxins



### Find Online Programs, Masterclasses, and Resources



AvoidingMold.com | CherylCiecko.com