

General References: Building Science, Building Envelope and Durability

Books and Research Reports

Allen, E.

Architectural Detailing: Function, Constructability, Aesthetics

New York: John Wiley & Sons

1992

“Describes systematically and in readily usable form the principles by which good architectural details are designed. The principles are laid out in 83 brief but profusely illustrated ‘detail patterns’. The first section examines each of the patterns and illustrates several instances of its use. The latter part demonstrates the execution of these patterns in the design of key details for three different buildings types.”

Available at: BCIT

Allen, E.

How Buildings Work Second Edition

New York: Oxford University Press

1995

“We expect our buildings to do many things: stand up, shelter us from weather, keep us comfortable, provide clean water for drinking and clean air for breathing, dispose of our wastes, give us privacy and security, power everything from tools to toasters, and connect us with the world outside through windows, doors, telephones, and mailboxes. They should be easy to move around in, and should not require excessive expense to maintain. But how does a building do all this? This is the question Edward Allen addresses so engagingly in the completely revised and updated second edition of *How Buildings Work*...this easy-to-read work reveals virtually every secret of a building's function: how it stands up, keeps its occupants safe and comfortable, gets built, grows old, and dies--and why some buildings do this so much better than others.” [This is a very easy to understand and complete primer. If you're having problems understanding the basics of the building envelope as discussed by the experts, read this.]

Available at: BCIT; UBC; VPL

Allen, W.

Envelope Design for Buildings

Oxford: Architectural Press

1997

“Concerned not with the aesthetics of the design, but with the components of a building that actually separate the outside elements from the interior environment, such as the roofs, walls, and basement. Focusing on concepts, processes, and ideas rather than numbers or specific designs, describes old and new materials and how they fit together and react to each other, and the factors involved with design and specification that affect the construction of the building and its ultimate performance in providing shelter and protection.” Chapter headings include the indoor and outdoor climate, the envelope, cavity wall systems, curtain walls, and “timber-framed”

walls for low-rise construction. [Note that this is a British publication and as such has different terms of reference. “Timber framing” is called light wood framing or platform framing in Canada and the United States.]

Available at: BCIT, UBC

ASHRAE

Handbook of Fundamentals

Atlanta: American Society of Heating, Refrigerating and Air Conditioning Engineers

2005

“The ASHRAE Handbook-Fundamentals covers basic principles and data used in the HVAC&R industry. This 2005 edition includes a new chapter 26, Insulation for Mechanical Systems, discusses thermal and acoustical insulation for mechanical systems in residential, commercial, and industrial facilities, including design, materials, systems, and installation for pipes, tanks, equipment, and ducts. Chapter 28, Climatic Design Information, is extensively revised and has expanded table data for each of the 4422 stations listed (USA/Canada/World), more than three times as many stations as in the 2001 edition.”

Available at: BCIT, UBC, VPL

Barrett, Dave

The Renewal of Trust in Residential Construction: Commission of Inquiry into the Quality of Condominium Construction in British Columbia

: Submitted to The Lieutenant-Governor in Council Government of British Columbia.

1998

“A Commission of Inquiry into the Quality of Condominium Construction in British Columbia was appointed by the Minister of Municipal Affairs, through an Order in Council, on April 17, 1998 to review the adequacy of protection, and accountability to, consumers for faulty condominium construction, and to determine the reasons for, and the factors contributing to, faulty construction. The Commission was also asked to recommend any measures needed to ensure consumer protection and accountability for this construction.”

Available at: BCIT, VPL, UBC, HPO,

Barrett, Dave

The Renewal of Trust in Residential Construction: Commission of Inquiry into the Quality of Condominium Construction in British Columbia, Part II

: Submitted to The Lieutenant-Governor in Council Government of British Columbia.

2000

Part II of the June 1998 publication of the same title.

Available at: VPL, UBC, HPO

Canada Mortgage and Housing Corporation

Best Practice Guide: Wood-Frame Envelopes

Ottawa: Mortgage and Housing Corporation

1999

“Based on the most effective practices used on construction sites across Canada, this

manual/CD-ROM package outlines the essential building science principles for quality wood-frame walls. Created for builders and designers, the kit addresses the need for interior air quality and moisture management necessary because of improved construction techniques, higher levels of insulation and air leakage control introduced in recent years. Practical information on need-to-know topics such as heat and moisture transfer, wood shrinkage and maintenance is combined with 14 best practices on three types of wall assemblies. You'll also get 18 special details for major components such as foundations, window openings and floor cantilevers. Sample specifications on the CD-ROM can easily be customized to your own circumstances.”

Available at: BCIT, UBC, VPL, CMHC

Canada Mortgage and Housing Corporation

Best Practice Guide: Building Technology Wood-Frame Envelopes in the Coastal Climate of British Columbia

Ottawa: Canada Mortgage and Housing Corporation

1999

“This publication/CD-ROM package was produced for builders and designers faced with the unique challenges of wood-frame home construction in B.C.'s coastal areas characterized by a high frequency of wind-driven rain. Endorsed by the Building Envelope Research Consortium and the Canadian Wood Council, you'll gain a better understanding of building science and learn how to construct reliable, durable and economical envelopes. Topics cover the prevention of wood decay; controlling moisture sources; application of the rain-screen principle to cladding; heat flow; most appropriate materials; and developing a building envelope maintenance and renewal plan. The CD-ROM features 53 best practice CAD drawings. Easy-to-use format covers the important principles behind the management of moisture in wood-frame wall systems.”

Available at: BCIT, UBC, VPL, CMHC, HPO

Canada Mortgage and Housing Corporation

Rain Penetration Control: Applying Current Knowledge

Ottawa: Canada Mortgage and Housing Corporation

1999

“This document focuses primarily on rain penetration control in walls and windows. Other wetting mechanisms include condensation and exposure to ground...Following a discussion of several approaches to water penetration in walls, including architectural design, there is a detailed explanation of the rain-screen principle and its application to contemporary buildings. Designers are further challenged to incorporate the Pressure Equalized Rain-Screen (PER) principles...To help design rainscreen curtain walls CMHC developed Rainscreen software. It allows designers to vary the parameters of their rain screen system and graphically see the resulting dynamic pressure distribution on cladding and air barrier (backpan) layers.”

Available at: VPL, CMHC

Canada Mortgage and Housing Corporation

Ice Damming Field Research

Ottawa: Canada Mortgage and Housing Corporation

2001

“Ice damming arises from differential melting and freezing of snow on a roof, and can damage roofing materials and cause water leakage inside the house. This research report documents repairs on residential buildings to address ice damming problems, and examines whether these repairs are successful in eliminating ice dams and their underlying causes.”

Available at: CMHC

Canada Mortgage and Housing Corporation

Research Report: 2001 Building Failures Study

Ottawa: Canada Mortgage and Housing Corporation

2002

“A summary of the most frequent deficiencies reported in 15 high-rise condominiums and a comparison of failure trends.”

Available at: CMHC

Canadian Home Builders’ Association

Canadian Home Builders' Association Builders' Manual

: Ottawa: The Association

2001

“The CHBA builders’ manual summarizes the basic principles and techniques of leading edge home building in Canada. It is not intended to be an exhaustive treatment of building science or design, rather it outlines the fundamental principles of building high quality, energy and resource efficient homes with enough detail to show how they can be applied to the houses that builders are currently building. This manual represents the latest initiative of the Association to inform Canadian builders, as well as practitioners in other countries, of construction techniques resulting in housing which is better built, more comfortable, more energy efficient and more environmentally sensitive than ever before.”

Available at: BCIT

FP Innovations,

Guide for Designing Energy-Efficient Building Enclosures for Wood-Frame Multi-Unit Residential Buildings in Marine to Cold Climate Zones in North America

Vancouver: FP Innovations

2013

This new industry resource was developed by FPInnovations, in partnership with the Homeowner Protection Office, Canadian Wood Council and RDH Building Engineering. The Guide is intended to help architects, engineers, designers and builders improve the thermal performance of building enclosures of wood multi-unit residential buildings. It looks at design and construction best practices and material used to ensure durable performance. As a companion to the Building Enclosure Design Guide of HPO, this Guide expands on the energy efficiency of building enclosures.

FPInnovations

Pathways to High-performance Housing in British Columbia

Vancouver, BC, Canada: FPInnovations

2014

This guide focuses on design and construction strategies and detailed measures to improve the energy efficiency of homes in British Columbia. It provides guidelines for designers and builders who are interested in the design and construction of single-family and small multi-family buildings that are substantially more energy efficient and lower in environmental impact than traditionally built homes. This guide focuses on design and construction strategies and detailed measures to improve the energy efficiency of homes in British Columbia. It provides guidelines for designers and builders who are interested in the design and construction of single-family and small multi-family buildings that are substantially more energy efficient and lower in environmental impact than traditionally built homes. The guide is based on current building design and construction practices and relevant research. Developed jointly by FPInnovations, the Homeowner Protection Office, BC Hydro, FortisBC and the City of Vancouver, this free 220-page publication is available in PDF format.

Available at: HPO

Homeowner Protection Office,
Building Envelope Guide for Houses
Burnaby: Homeowner Protection Office
2007

This easy-to-use guide provides practical information on the design and construction of the building envelope for new homes constructed in accordance with Part 9 of the 2006 British Columbia Building Code (BCBC) and the 2007 Vancouver Building By-law (VBBL). The Guide recognizes the complex ways that moisture influences building envelope durability and performance in the range of climate zones in British Columbia. It helps builders, designers and trades to put into practice the new Part 9 code provisions, including the new requirement for a rainscreen in the building envelope assembly of houses built in B.C.'s coastal or high moisture index regions.

Homeowner Protection Office,
Compatibility of Fasteners and Connectors with Residential Pressure Treated Wood
Vancouver: Homeowner Protection Office
2011

Best practices for types of fasteners and connectors to be used in contact with treated wood.

Homeowner Protection Office,; RDH Building Engineering Ltd.,
Building Enclosure Design Guide: Wood-Frame Multi-Unit Residential Buildings
Burnaby: Province of British Columbia & Homeowner Protection Office
2011

The Guide is intended for industry professionals involved with the design and construction of building enclosures of multi-unit, wood-frame residential buildings. Described as the industry's most widely accepted reference on building enclosures, it's an invaluable resource for builders, architects, designers, industry educators and others. The Guide explores the latest research, design and construction best practices. It offers practical solutions to ensure high-performance in new multi-unit residential construction. This includes building enclosure design and best practices for wood-frame construction in five and six-storey mid-rise buildings.

Hutcheon, N.B. and G. Handegord

Building Science for a Cold Climate

Ottawa: National Research Council of Canada, Institute for Research in Construction

1995

“Regarded by many as the definitive work on building in cold climates, this 400-plus page book will help you design buildings resilient enough to withstand Canada's harsh winters. The content is essential to understanding cold-climate building practices. The book systematically explains how the fundamental principles of physical science apply to building in Canada. The authors illustrate how various building approaches and materials affect the performance of buildings and their parts. Topics include heat transfer, solar radiation, wind, air leakage and ventilation, and water and buildings. The authors have employed numerous equations and illustrations to complement their information and have included references at the end of each chapter for those who wish to investigate certain areas further. *Building Science for a Cold Climate*, published in 1983 and still highly relevant today, serves as an excellent text for those in training and would be equally at home on the reference shelf of even the most seasoned.” [Although focused on cold climates, the basic building science is equally applicable to the coastal climate of British Columbia. Good source for data.]

Available at: BCIT, VPL, UBC, NRC-IRC

Huth, M. W.

Understanding Construction Drawings

Clifton Park, NY: Thomson Delmar Learning

2005

“Updated to the 2003 International Building and Residential Codes, the fourth edition of *Understanding Construction Drawings* continues to highlight a range of real construction projects - from residential dwellings to commercial structures. This enhanced edition takes a detailed approach to reading construction drawings by providing thorough coverage that builds the foundation for a broad understanding of the entire construction process, beginning with a simple duplex home that focuses readers on the fundamentals of views, lines, basic dimensioning, and symbols. Next, coverage of a multi-level single family home goes into more depth in orienting and cross-referencing drawings. The third section explores multifamily construction and is accompanied by more complex drawings for practice and more advanced interpretations. The final portion of the book introduces readers to elements of commercial construction, including structural steel, masonry, and reinforced concrete. A set of drawings accompanies each building so that readers can apply important skills and gain a real-world understanding of construction drawings.”

Available at: BCIT

Johnson, G.F.

Alberta Building Envelope Failure Analysis

Edmonton: Alta: Alberta Municipal Affairs

1991

“The walls, in particular, and building envelopes in general, of less than twenty year old medium and high rise residential buildings in Alberta have shown a marked reduction in performance. The principal objective of this study was to develop recommendations and strategies which, when

applied to the design, construction and maintenance of envelopes of the subject building categories, will significantly reduce the incidence of envelope failure and will result in a minimum cost, maximum benefit relationship in instances where envelope repair is required.” [According to the author, Gary Johnson, this study shows that envelope failures are not a recent, nor a strictly British Columbia problem.]

Available at: VPL

Kesik, T. J.

Canadian Wood-Frame House Construction

Ottawa: Canada Mortgage and Housing Corporation

2005

“The updated version for the latest National Building Code contains new illustrations, sizing tables, planning notes and tips on healthy housing to improve indoor air quality and reduce environmental impact. An indispensable tool for builders, renovators and do-it-yourselfers, covering everything from site excavation to completion. Topics include: concrete work, footings and foundations; framing all parts of the house; roof sheathings; exterior finishes, trims and millwork; plumbing, heating and wiring; vapour and air barriers; insulation, fire and sound control; ventilation; interior wall and ceiling finishes, floor coverings; stairs, eaves, chimneys, and much more.”

Available at: BCIT, UBC, VPL, CMHC

Latta, J.K.

Windows and Roofs for the Canadian Climate: A Summary of the Current Basis for Selection and Design

Ottawa: National Research Council of Canada, Division of Building Research

1979

“This text brings together the Canadian Building Digests, Building Science Seminars, and other publications relating to the design of building enclosures in Canada. Serving as a building science primer the information is still valid today.”

Available at: VPL, UBC, NRC-IRC

Lewis G. Harriman, III, and Joseph W. Lstiburek

The ASHRAE Guide for Buildings in Hot & Humid Climates

: ASHRAE

2009

“The expanded second edition of The ASHRAE Guide for Buildings in Hot and Humid Climates triples the size of this popular reference, adding information on building enclosures, dehumidification, sustainability, mold avoidance, energy reduction, and much more—all tightly focused on the needs of owners, architects, and engineers who build and manage buildings in hot and humid climates. The book includes six chapters that discuss critical crosscutting issues for architecture, engineering, and building management along with eleven chapters of detailed and practical solutions to everyday problems in each area. This expanded second edition provides a richly illustrated summary of the state of the art in building science, moisture management, and techniques for reducing energy consumption in hot and humid climates, all based on real-world

field experience as well as on recent ASHRAE research.”

Lsiburek, J.

Builder's Guide to Structural Insulation Panels (SIPs) for all Climate

: Building Science Press

2008

This builder's guide addresses construction in all hygro-thermal regions with extreme to low rain exposure zones for building enclosures and mechanical systems suited for a Class II interior climate - that is an interior climate that is temperature controlled, vapor pressure moderated and air pressure moderated. In other words houses, apartments, condominiums, townhouses, and manufactured housing. Information on specialized enclosures such as pools, spas and ski lodges in extreme climates can be found in the Appendices.

Lstiburek, J.

Building's Guide to Cold Climates

Westfor, MA: Building Science Corporation

2004

“The North American Cold Climate edition of the Builder's Guide is augmented to provide the building industry with the latest and best practical information on how to apply building science principles to structures as systems in colder regions. A concise, graphically rich technical manual, it contains over 150 detailed illustrations showing the latest details and techniques to effectively implement energy and resource efficient residential construction with revised sections on: Foundations, Walls, Roofs and an expanded discussion of Vapour Barriers, Additional Appendixes plus a newly added Glossary of Terms. The new guide embodies much of what is now known about building homes that are affordable, durable, energy efficient, healthy, safe, comfortable and environmentally responsible.”

Available at: BCIT

Lstiburek, J.

Building's Guide to Hot-dry/Mixed-dry Climates

Westfor, MA: Building Science Corporation

2004

“The North American Hot-Dry/ Mixed-Dry Climate edition of the Builder's Guide now provides the building industry with the latest and best practical information on how to apply building science principles to structures as systems with revised sections on: Foundations, Walls, Roofs and an expanded discussion of Vapor Barriers, Additional Appendixes plus a newly added Glossary of Terms.”

Available at: BCIT

Lstiburek, J.

Building's Guide to Mixed-humid Climates

Westfor, MA: Building Science Corporation

2005

“The North American Mixed Climate edition of the Builder's Guide now provides the building

industry with the latest and best practical information on how to apply building science principles to structures as systems in mixed-humid "temperate" climate regions."
Available at: BCIT

Lstiburek, J.

Building's Guide to Hot/humid Climates

Westfor, MA: Building Science Corporation

2005

"The Builder's Guide will provide the building industry with the latest and best practical information on how to apply building science principles to structures as systems in hot-humid climate regions."

Available at: BCIT

Lstiburek, J.

H2NØ

: Building Science Press

2008

"H2NØ is a book about HVAC-Heating, Ventilating, and Air Conditioning with an emphasis on moisture control-how mechanical systems might help or hinder keeping buildings dry. It talks about hardware, the components that make up our air conditioning systems. And it talks about fundamentals-thermodynamics, heat transfer, refrigeration, psychrometrics, load calculations-the underlying sciences. Air conditioning is at once fairly simple yet widely misunderstood. H2NØ peels away layers of myths and old wives' tales, revealing the 80% that most everyone should understand, and high lighting the 20% that your HVAC professional had better understand. H2NØ is written for people who do not work in the HVAC trades or professions, but are interested in the health and comfort of buildings and their occupants. That would include architects, contractors, owners, facility managers, and students pursuing careers in these professions. And we should not forget the people who are running businesses and institutions-teachers, preachers, doctors and nurses, merchants, manufacturers, suppliers, executives, and perhaps most important of all homeowners-who are chronically confounded by their air conditioning systems."

Mathis, R. Christopher

Insulating Guide

: Building Science Press

2007

"This Guide provides builders and contractors with a variety of proven techniques for properly insulating a home. Part I represents general insulating and air sealing principles applicable to almost any construction project. Part II provides specific recommendations and best practices for many common residential construction details - from the foundation to the roof. While this Guide does not address every possible insulating system or air sealing technique, it does provide jobsite-proven examples for builders seeking to achieve superior levels of energy efficiency. The details shown have been built by numerous builders in a wide variety of successful beyond-code projects across the country. The insulating and air sealing principles and practices presented here are intended to be immediately applicable to almost any residential construction project."

Employing these techniques will help builders minimize their risk of callbacks while maximizing the likelihood of achieving superior levels of energy efficiency and overall home performance."

Monteyne, D. and J. O'Connor

Wood-Frame Construction Practice in North America: An Annotated Bibliography

Vancouver: Forintek Canada Corporation

2000

"This document is a list and review of 170 current published materials and web sites that deal with the design and construction of most types of wood buildings in North America, including both light and heavy timber framing. The focus is the structural use of wood rather than exterior or interior finishing, millwork, shingles, or other such components, although many books in this list cover all these topics. This bibliography also includes some items on related issues such as material properties, building systems, wood use, sustainable design, indoor air quality, new products, marketing, research, and testing. Most of the listings are recent, generally limited to those published since 1980, and largely restricted to publications originating within North America. Commentary provided for each item includes a description of the content and intended audience, as well as an opinion regarding quality of the document and its likely effectiveness in influencing the practice of wood design and construction. The literature search was aimed at materials targeted to architects, engineers, professional builders, and owner-builders/clients. This exercise is one step in examining how these specifiers get their information about wood and wood construction, and what is the nature and quality of that information. Also included is a brief history of wood building in North America."

Available at: BCIT, Forintek Canada Corporation

Ontario New Home Warranty Program and the Ministry of Municipal Affairs and Housing

High-Rise Residential Construction Guide

Toronto: Ontario New Home Warranty Program

1995

"This handbook seeks to avoid the problems experienced in "high-rise" development of the condominium units enrolled under the Ontario New Homes Warranty Program. Details of every element of the building from foundations and parking garages to roof anchors are included as well as a checklist."

Available at: VPL

RDH Building Engineering Ltd.,

Energy Consumption and Conservation in Mid- and High-Rise Residential Buildings in British Columbia

Burnaby: Homeowner Protection Office

2012

The main objectives of this research were to review and assess the effects of building enclosure improvements on the space conditioning energy use in typical mid- and high-rise multi-unit residential buildings in the Lower Mainland of British Columbia and Victoria, and to develop better strategies that take into account enclosure repairs, energy conservation and greenhouse gas emissions. Contributing partners to this project include: CMHC, HPO, BC Hydro, Fortis BC, City of

Vancouver and RDH Building Engineering.

Roppel, Patrick ; Cianfrone, Christian and Norris, Neil

Building Envelope Thermal Bridging Guide

Vancouver, BC, Canada: BC Hydro Power Smart

2014

This guide explores how the building industry in British Columbia can meet the challenges of reducing energy use in buildings, in part by effectively accounting for the impact of thermal bridging. Most practitioners will find PART 1 and Appendices A and B to be most useful. PART 1 outlines how to effectively account for thermal bridging. Appendices A and B provide a catalog of common building envelope assemblies and interface details, and their associated thermal performance data. Researchers and regulators will be interested in PART 2 and PART 3, and Appendices C to E. They contain the cost-benefit analysis, and discussion on significance and further insights, of using this guide to mitigate thermal bridging in buildings. Co-funded by BC Hydro Power Smart, the Canadian Wood Council, Fortis BC, FPInnovations and the Homeowner Protection Office, this guide was prepared by engineering firm Morrison Hershfield Ltd. in conjunction with key stakeholders, partners and industry advisors.

Available at: HPO

Rose, W. B.

Water in Buildings: An Architect's Guide to Moisture and Mold

Hoboken, N.J.: John Wiley & Sons

2005

“This practical guide illuminates an essential understanding of the ‘whys’ of moisture problems, including valuable information on how water behaves and how its performance can be anticipated and managed in building design. With a special emphasis on water's role in creating mold, an issue of growing concern and liability, *Water in Buildings* offers the most up-to-date information on rainwater management, below-grade water management, foundations, wall and roof construction, mechanical systems, moisture, and more. This guide features: -Clear explanations of how water interacts with building materials and equipment -An in-depth exploration of the paths of leaks -Numerous case studies on such well-known structures as Mount Vernon, Independence Hall, and Wingspan (Frank Lloyd Wright) -Numerous descriptive drawings and photographs.”

Available at: BCIT

Ruddick, J.N.R

Field Investigations on the Application of ACQ Treated Wood and Use of Metal Fasteners and Connectors in Residential Construction

Vancouver: Homeowner Protection Office

2006

“Chromated Copper Arsenate (CCA) treated lumber has been phased out for most exterior residential applications and is being replaced with Alkaline Copper Quaternary (ACQ). The copper levels in the ACQ treated wood are significantly greater than in the CCA treated wood, which increases the risk of galvanic corrosion on metal fasteners, connectors and anchors. Manufacturer guidelines and related literature suggest appropriate metal hardware be used with ACQ treated wood. A field

survey was carried out at a sample of building sites in the Lower Mainland region to determine whether compatible metal components are specified and used, and whether there is an indication of premature corrosion of metal components. Research partners include HPO and the Technical Research Committee of the Canadian Home Builders Association of BC who assisted in identifying builders to participate in the field survey.”

Available at: HPO

Rumbarger J. and R. J. Vitullo

Architectural Graphic Standards for Residential Construction

New York: John Wiley & Sons

2003

“Created exclusively for professionals working in residential design and construction, this guide combines key information culled from the tenth edition of Architectural Graphic Standards with all-new material on residential design. This special volume provides thousands of standard architectural details and guidelines and is an easy reference for anyone designing or constructing a residential project. In step with current practices, this volume includes the latest guidelines for: 1) Energy efficiency, 2) Accessibility, 3) HVAC and indoor air quality, and 4) Green construction.”

Available at: BCIT

Said, N.M.

Moisture Measurement Guide for Building Envelope Applications

Ottawa: for Research in Construction, National Research Council Canada

2004

“This document reviews literature and describes moisture measurement methods for field monitoring applications of building envelopes with emphasis on continuous monitoring applications. Example measurements and guidance on applications of moisture measurement methods are also presented. Reviewed measurement methods are grouped according to measurement principles (resistance-, voltage-, capacitance-, microwave-, or thermal-based methods). Resistance and voltage-based sensors are most suitable for continuous monitoring applications. They can be readily connected to a data logging system. Voltage-based moisture sensors are usually used to measure time-of-wetness of surfaces. Their main weakness is durability, which can be quite short in outdoor applications. Resistance-based sensors are used to monitor changes in wetness level within materials as well as time-of-wetness of surfaces. They are durable and can be fabricated in-house. Their challenge is for an instrumentation system that can measure a wide range of electrical resistance from few ohms to several hundred M ohms. Alternatively, electric resistances can be measured indirectly in terms of voltage using a half-bridge electric circuit.”

Available at: NRC-IRC

Schittch, C.

In Detail, Building Skins: Concepts, Layers, Materials

Munich: Institut für International Architektur-Dokumentation GmbH

2001

“In recent years the facades of a building have become increasingly significant due to

unconventional choices of materials and the use of innovative technology. More and more the external surfaces are being perceived and designed as an integral part of the building...Focusing on the choice of materials and their application, the aesthetic qualities and the technical possibilities are presented in carefully selected international examples.”

Available at: Book retailers

Straube J. and E. Burnett

Building Science for Building Enclosures

Westfor, MA: Building Science Corporation

2005

“This book is intended for the building professional: the engineer, architect or technical specialist involved in the design, construction, operation, maintenance, repair, and renovation of buildings. The focus is on predicting and understanding the heat, air, and moisture response of the building enclosure, i.e., walls, windows, roofs, below-grade construction. The text moves from the fundamental physics to more practical applications for all climate regions, including worked example calculations of heat flow, vapor diffusion and air leakage condensation through building enclosures.”

Available at: BCIT, HPO

Structural Engineering Institute, American Society of Civil Engineers

Guideline for Condition Assessment of the Building Envelope

Reston, Va.: American Society of Civil Engineers

2000

“This Standard provides a guideline and methodology for assessing the condition and performance of existing building envelope systems and components, and identifying problematic and dysfunctional elements. As the adaptive reuse, rehabilitation, and improvement of existing buildings have assumed a more prominent role... the ability to accurately assess the conditions of a building is imperative. The condition of the building envelope is most important since failures can result in safety and health problems, as well as structural damage. Proper evaluation of the building envelope is often the first step toward stabilization and rehabilitation of the building. This Standard is a compilation of basic information, procedures, and references, and will be an asset to the investigator developing a logical approach to the assessment of the building envelope in order to focus on fundamental defects rather than outward symptoms.”

Available at: Structural Engineering Institute

Trechsel, H. R. and M. Bomberg

Moisture Control in Buildings: The Key Factor in Mold Prevention 2nd Edition

: ASTM International

2009

“Twenty-eight comprehensive chapters focus on the major issues involved in the process of moisture resistive construction. This one-of-a-kind publication provides the latest and most important information relating to moisture problems in buildings. Three new chapters have been added to make this the ultimate publication on moisture control: 1. Details and Practice discusses design details suitable for preventing moisture problems in service. • 2. Quality Management in

Design and Construction discusses the need for and application of quality control and management during design and construction for preventing moisture problems in service. • 3. Towards Development of Methods for Assessment of Moisture-Originated Damage looks to the future. The latest edition is divided into four parts: 1. Fundamentals—addresses moisture transfer, condensation, and evaporation. 2. Applications—discusses the technologies that affect the moisture balance in buildings and the techniques used to determine the suitability of materials, components, systems, and structures. 3. Construction Principles and Recommendations—covers new and existing commercial and high buildings, new and existing residential buildings, and manufactured and historic buildings. 4. Implementation—discusses implementation mechanisms.” Available at: BCIT

Articles

Abdelouhab, Malya; Collignan, Bernard; Allard, Francis. 2010. Experimental study on passive Soil Depressurisation System to prevent soil gaseous pollutants into building. *Building and Environment* 11: 2400-2406
Available at: BCIT, UBC

Abuku, Masaru; Fukushima, Akira; Tsukidate, Tsukasa; Iba, Chiemi; Watanabe, Hirofumi; Ogawa, Akihiro. 2012. Periodic alternation between intake and exhaust of air in dynamic insulation: A preliminary study. *5th International Building Physics Conference (IBPC) Kyoto, Japan*

Aburas, H.. 2011. Off-Site Construction in Saudi Arabia: The Way Forward. *Journal of Architectural Engineering* 4: 122-124
Available at: BCIT, UBC

Acquaye, A. A., A. P. Duffy . 2010. Input-output analysis of Irish construction sector greenhouse gas emissions. *Building and Environment* 45(3): 784-791
Available at: BCIT, UBC

Adriaenssens, S.; Ney, L.; Bodarwe, E.; Williams, C.. 2012. Finding the Form of an Irregular Meshed Steel and Glass Shell Based on Construction Constraints. *Journal of Architectural Engineering* 3: 206-213
Available at: BCIT, UBC

Akimoto, T., S.-i. Tanabe, et al. 2010. Thermal comfort and productivity - Evaluation of workplace environment in a task conditioned office.. *Building and Environment* 45(3): 704-710
Available at: BCIT, UBC

Al-ajmi, F. F. and D. L. Loveday. 2010. Indoor thermal conditions and thermal comfort in air-conditioned domestic buildings in the dry-desert climate of Kuwait.. *Building and Environment* 45(3): 704-710
Available at: BCIT, UBC

Al-Homoud, Mohammad S. . 2009. Envelope thermal design optimization of buildings with intermittent occupancy. *Journal of Building Physics* 33(1): 65-85

Available at: UBC

Alderson, Caroline R.; Savage, Beth L.; Matta, Charles; Kam, Calvin; Weber, Anne E.. 2010. Government Policy and Practice: Digital Conservation and Landscape Renewal. *APT Bulletin* 4: 11-17

Available at: UBC

Aldous, F.. 2010. Developing an Exterior Enclosure Commissioning Plan. *Proceedings of Thermal Performance of Exterior Envelopes of Whole Buildings XI Florida, USA*

Available at: Public Libraries of B.C., ASHRAE

Aldous, Fiona. 2010. Developing an Exterior Enclosure Commissioning Plan. *Thermal Performance of the Exterior Envelopes of Whole Buildings XI International Conference Clearwater Beach, Florida*

Allen, G. and L. Falkenhagen. 2005. Living with bad design: an owner's perspective. *Building Envelope Forum Online Newsletter, September*

Allen, David S.; Pennisi, Bob; Norman, Rick. 2011. Building Development: High Performance Teamwork for High Performance Buildings. *ASHRAE Transactions* 1: 222-229

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