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2020 Building Envelope Systems Exam Learning Objectives

(All new additions since the 2018 Learning Objectives have been Italicized)

Roofing Nomenclature:

1. Define the following roofing terms: low, flat, sloped, conventional, protected/inverted, hybrid, BUR, modified bitumen, PVC, TPO, EPDM, green, vented, unvented, standing/ponding water, ridging, blisters, wind scouring, asphalt bleeding.
2. For each of the following roof system components, describe the purpose of the component, the location of the component in a typical roof assembly in a cold climate and identify the material or product typically used for each component: structural deck, vapour retarder, air barrier, substrate, cover boards, insulation, separation sheet, attachments, membrane, flashing, expansion joints, surfacing.
3. Describe how each of the above component locations might differ in a predominantly warm climate.

Roofing and Fire:

4. Explain the importance and role of various fire testing agencies/organizations.
5. Describe, in general terms, the Building Code requirements with regards to fire performance criteria

Roofing Materials and Systems:

6. Explain the difference between the following roofing materials in terms of application method and durability: asphalt-based: BUR, mod. Bit., APP, SBS, SEBS; and polymer-based thermosets – EPDM, CSPE and thermoplastics – PVC, CPA, KEE, TPO, CPE.
7. Describe the components of a conventional built-up roof system and their respective functions.
8. Explain how a "modified" bitumen material is created and how the physical characteristics are improved compared to standard asphalt.
9. Explain the difference between thermosets and thermoplastics.
10. Describe how the characteristics and typical applications of the following materials: PVC, TPO, EPDM, CSPE, roof insulations (EPS, XPS), polyiso.
11. Explain the three basic methods to fasten membrane systems (adhered, ballasted and mechanically attached) and compare them with respect to slope limitations, detecting leaks, and the maintenance of system.
12. Discuss design issues for single-ply membranes including reflectivity, soiling of membrane, plasticizer loss and chlorine.
13. Describe how the following materials can be used to waterproof a wall/roof and some limitations of each: bentonite clay, cementitious products, one and two-component liquid-applied membranes, spray foam.
14. Describe the differences between the following types of green roofs: intensive, semi-intensive, extensive, living wall.
15. Describe the purpose and location of each of the following components of a green roof system: root barriers, moisture/water retention mats, drainage mats, aeration mats, irrigation system, borders/curbs, growing medium, growing medium composition.
16. Discuss the potential issues with installing a new green roof on an existing building (i.e., retrofit, not new construction).
17. Discuss green roof design considerations (membrane type, insulation type, redundancy, drainage, soil and vegetation science, modular growing systems, etc.) using ASTM E2400 as a reference.
18. Describe how ice-damming forms on a sloped roof, what design measures can be taken to minimize its formation and what measures can be taken to protect the building when ice-damming inevitably forms despite best efforts
19. *Estimate the hygrothermal performance of various roof systems.*

Wind and Roofing:

20. Employ the various publications (ASCE 7 wind maps, FM tables and data sheets/RoofNav, NBCC/OBC tables) to calculate wind force values for a particular location.
21. Describe how various local effects (corners and perimeters, interior pressures, openings, parapets) affect wind force and roof component selection.
22. Describe the purpose of patio slabs (pavers) and where might they be typically installed on a flat or low-slope roof.
23. Discuss the results of the ASCE, FM and NBCC methods and why they differ.

Roof Drainage:

24. Discuss the importance of draining water away from the roof surface in terms of structural implications, moisture penetration, freeze/thaw, organic growth and accelerated membrane deterioration.
25. Describe the design considerations when selecting from various drainage mechanisms such as tapered insulations, sloped structure, sumps.
26. Describe the various drain types including interior area, perimeter scupper, retrofit, gutters and general design requirements of each type in terms of location, quantity, flow control, etc.
27. Calculate drainage requirements, using the NPC and OBC.

Sustainability in Roofing:

28. Describe sustainability considerations relating to durability (service life of assembly and components, ease of replacement and maintenance of system/components), energy efficiency (embodied capital energy through transport and manufacturing, operational energy and disposal (recycling, reuse, processing), and environmental burden (stormwater runoff, reflectivity, waste generation).
29. Explain the differences in terms of sustainability considerations for surfacing materials, membranes/roof systems, insulations, air barriers, vapour retarders.
30. Explain how design selection can improve durability, energy efficiency, decrease heat island effects, stormwater management

Roof Condition Assessments:

31. Discuss what information needs to be gathered/reviewed on-site for useful roof condition assessments.
32. Identify non-destructive and destructive roof testing techniques for both in-situ constructed assemblies and laboratory testing of materials.
33. Discuss why it is important to follow up any non-destructive test with test cut(s).
34. Explain the CRREL assessment method and why it is useful for large inventory building stock.
35. Calculate Roof Condition Index (RCI) using "ROOFER".
36. Assess replacement/repair strategies using "ROOFER".
37. Discuss other factors in roof repair/replacement decisions.
38. Describe the primary purpose of completing a thermal scan of a roof, the best time(s) to conduct a thermal scan and why.

Wall Systems Basics:

39. *Describe the effects of thermal bridging on building durability and energy performance.*
40. *Describe the difference between a 'face-sealed' envelope system and 'pressure-moderated' envelope system.*
41. Describe how the inter-related environmental forces (i.e., hygrothermal effects; wind-driven rain; and, sun-driven moisture) impact the performance of exterior walls.
42. Identify and describe the six essential elements required by exterior wall systems: air control layer; vapour control layer; thermal control layer; water control layer and drainage; structural integrity; and durability.

43. Describe the impact of the exterior climate on the exterior wall control layers.
44. Describe the design methods used by exterior walls to control bulk water.
45. Briefly describe the impact of the six climate zones in North America on the long term wetting and drying potential of exterior walls.

Masonry Wall Systems:

46. Identify the key components of typical masonry wall systems including: structural back-up, cavity which includes an air space, insulation, barrier, vapour retarder; and the load bearing or non-load bearing outer wythe.
47. Discuss the factors that contribute to proper planning, design, detailing and construction of masonry wall systems.
48. Compare the differences between solid masonry walls, composite cavity walls, and veneer cladding.
49. Apply and understand best practices and relevant standards as they apply to masonry wall systems.
50. Illustrate how thermal bridging can be minimized by the design and workmanship in masonry walls.
51. Describe how wind load is transferred from the exterior face to the structural back-up.
52. Describe how structural frame creep shortening, dead load deflection, thermal expansion, and masonry moisture expansion affect exterior non-load bearing masonry and design to accommodate these effects through movement control joints.

Precast Concrete Wall Systems:

53. Outline key terminology of precast concrete wall system.
54. Identify the different wall systems, panel components, panel layouts (shapes), limitations, materials and finishes.
55. Describe the manufacturing and installation process for precast concrete wall systems.
56. Describe the differences between single wythe and double wythe precast wall systems.
57. Describe how the joints are a weak aspect of a precast wall system and how their impact can be minimized through drainage, joint profile, and panel anchorage layout.
58. Describe how the materials and finish can impact the colour of precast concrete.
59. Illustrate the differences in the three types of precast concrete anchors: direct and eccentric loading bearing anchors, lateral tie-back anchors and panel to panel anchors.
60. Describe how maintenance issues have an impact on durability of the precast concrete wall systems including: regular inspection to identify damage, joint sealant replacement.

Exterior Insulation and Finish System (EIFS):

61. Identify the composition of exterior insulation and finish systems (EIFS).
52. Contrast the performance of modern EIFS to the original EIFS systems and their failures.
63. Explain the difference between EIFS and stucco.
64. Identify common EIFS assemblies and components as they relate to their moisture management capabilities.
65. Describe the effect of EIFS on the thermal gradient through exterior walls in various new and retrofit configurations.
66. Identify the installation limitations for EIFS.
67. Develop details between EIFS and adjacent cladding components, such as windows, doors and roofing.
68. Identify common deficiencies with EIFS which impact performance and durability.
69. Discuss limitations of installing EIFS at or near grade and ways to accommodate those situations.

Metal and Cementitious Cladding Systems:

69. Describe the differences in installation and performance, advantages and disadvantages between the following cladding systems: composite aluminum cladding panels, preformed and prefinished galvanized steel and aluminum cladding, and cementitious cladding.
70. Describe how thermal clip systems can be used to improve the thermal performance of these systems.

Windows:

71. *Describe the basic components of a window system.*
72. *Describe the effects of window coating and placement of the coatings on window performance.*
73. Describe the different types of operable windows along with their strengths and weaknesses.
74. Determine, with the use of the North American Fenestration Standard (NAFS) - AAMA/WDMA/CSA 101/I.S.2/ A440, the wind pressure, air leakage and water tightness performance levels will be required for the following buildings:
    a. 20 Storey Residential Tower in downtown Hamilton;
    b. 2 Storey Commercial Building in Sudbury; and
    c. Single Storey bungalow in a suburb of Windsor.
75. Explain the benefits and performance issues associated with available window framing component materials (i.e., aluminum, wood, PVC, fiberglass, etc.) and glazing options (single glazed, insulated glass, low e coatings, gas infill, etc..).
76. Describe the window installation process in a single family home and a high-rise residential tower.
77. Discuss when/where tempered glass may be required in windows.

Curtain Wall and Sloped Glazing:

78. Identify the basic components and materials of curtain wall systems.
79. Identify the basic components of structurally-framed sloped glazing systems.
80. Recognize the different types of curtain wall systems (stick framed and unitized) and the variations (standard, custom and structurally glazed) which are possible and how water is managed in each system.
81. Recognize the different types of sloped glazing systems and how water is managed in each system.
82. Explain design considerations (framing materials, methods of glazing, and spandrel infill material choices) and their effects on air leakage, thermal control and vapour resistance performance of the curtain wall systems.

Glazed Wall Systems:

83. Efficiently recognize control layers (air control layer; vapour control layer; thermal control layer; water control layer) for glazed based wall systems.
84. Develop and calculate the properties of an IGU using the WINDOW software.
85. Describe the methods and tools used to determine the thermal performance of glazing systems.
86. Calculate the required venting area for pressure equalized rainscreen.
87. Calculate the overall U-Value of a curtain wall system using the area weighted U-value method.
88. Describe the various components of a window wall system and how a stick built system differs from a factory build system.
89. Describe the difference between a curtain wall and a window wall

Wall Investigations:

90. Describe how infrared thermography can be used to identify areas of missing or deficient insulation, air leakage and water penetration in wall systems.
91. Describe the intent of performing a facade review utilizing the ASTM E2270-03 “Standard Practice for Periodic Inspection of Building Facades for Unsafe Conditions” standard. Summarize the methodology in performing a facade review on a 20-year-old ten-story commercial building.