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2021 BUILDING ENVELOPE SYSTEMS EXAM

Roofing Materials, Systems, and Performance:

Nomenclature

1. Describe the difference between conventional and inverted roofing assemblies.
2. Describe the primary differences between commercial and residential roofing assemblies.
3. Define the following roof types: flat, low slope, sloped, green, vented, unvented.
4. Define the following terms related to roofing defects: standing/ponding water, ridging, blisters, wind scouring, asphalt bleeding.
5. Describe the difference between low-slope and steeper pitched roofs and the various materials typically used in their construction.
6. Describe the various roofing drainage types including: inner (i.e. within the field of the roofing), control flow, dual-outlet, retrofit, perimeter scupper, gutters and general design requirements of each type in terms of location, quantity, flow control, etc.

Components

7. For each of the following roof system components, describe the purpose of the component and the location of the component in a typical roof assembly in a cold climate: structural deck, vapour retarder, air barrier (system), cover board, insulation, separation sheet, attachments/fasteners, membrane, surfacing, flashing, expansion joints, pitch pockets, flashing cones, mechanical curbs.
8. For each of the following roof system components used in a cold climate, identify the materials or products typically used for each: structural decks, vapour retarders, air barriers, cover boards, insulations, separation sheets, attachments/fasteners, membranes, surfacings, flashings, expansion joints, pitch pockets.
9. Explain the difference between the following roofing membranes in terms of application method (e.g. single or multi-ply) and durability: built-up roofing (BUR); modified bitumen (APP, SBS, SEBS); polymer-based thermosets (EPDM, CSPE); and thermoplastics (PVC, CPA, KEE, TPO, CPE).
10. Describe the components of a conventional and inverted roof system and their respective functions.
11. Explain how a "modified" bitumen material is created and how the physical characteristics are improved compared to standard asphalt.
12. 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.
13. 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.

Performance Issues/Defects

14. 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 the system.
15. Discuss the potential issues with installing a new green roof on an existing building (i.e., retrofit, not new construction).
16. 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.
17. Explain why conventional roofs may experience concealed condensation issues.
18. Discuss the need for venting of conventional roofs and how this venting can be established and maintained.

19. Discuss the large temperature differences that roof materials may experience, both seasonally and diurnally, and describe how these large temperature differences can be accommodated in conventional roofing system design.
20. Describe how protected membrane roofs offer the opportunity to increase the durability and service life of the roofing membrane.
21. Describe how a double roof can be constructed when historic buildings are thermally retrofitted.
22. Compare different roof assemblies for thermal and moisture performance.
23. Describe how various local effects (corners and perimeters, interior pressures, openings, parapets) affect wind force and roof component selection.
24. Discuss how wind may affect a roofs durability and service life.
25. 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.
26. Identify causes of interstitial condensation in roofs and how condensation can best be controlled in existing and new buildings.
27. Describe the design considerations when selecting from various drainage mechanisms such as tapered insulations, sloped structure, sumps, and crickets.
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. Discuss what information needs to be gathered/reviewed on-site for useful roof condition assessments.
30. Identify non-destructive and destructive roof testing techniques for both in-situ constructed assemblies and laboratory testing of materials.
31. Discuss why it is important to follow up any non-destructive test with test cut(s).
32. Discuss other factors in roof repair/replacement decisions.
33. 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:

Nomenclature

34. Describe typical Canadian wall structures including: Wood-frame, Steel studs, Concrete block masonry walls, Poured cast-in-place wall.
35. Describe the difference between a 'face-sealed' envelope system and 'pressure-moderated' envelope system.
36. 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.

Components

37. Describe the importance of a continuous air barrier system for walls and a building enclosure.
38. Describe how each of the following component locations within an assembly might differ between a cold-climate configuration and a warm climate configuration: back-up, vapour retarder, air barrier system, sheathing, insulation, water resistant barrier, air gap, cladding.
39. Explain the differences in terms of sustainability considerations (embodied carbon, thermal properties etc) for surfacing materials, cladding, membranes, insulation, air barriers, vapour retarders.

Performance Issues/Defects

40. Discuss the fundamentals of Rainscreen principles.
41. Describe the effects of thermal bridging on building durability and energy performance.
42. Identify causes of interstitial condensation in walls and how condensation can best be controlled in existing and new buildings.
43. Describe how the inter-related environmental forces (i.e., hygrothermal effects; wind-driven rain; and, sun-driven moisture) impact the performance of exterior walls.

44. Describe the impact of the exterior climate on the exterior wall control layers.
45. Describe the design approaches used in exterior walls to control bulk water.
46. Briefly describe the impact of the six climate zones in North America on the long term wetting and drying potential of exterior walls.
47. Describe how the interior climate may affect an exterior wall assembly.
48. Describe the various approaches to managing vapour diffusion through exterior walls.
49. Describe how to determine the drying potential of a wall during the design stage of said assembly.
50. Describe best practice below grade design in residential and commercial applications.
51. Explain the various ways in which frost heave and adfreezing can be controlled for various structures including retaining walls, below grade parking garages and pier foundations.
52. Explain how rainscreen principles can be applied to various wall elements including windows and precast joints.
53. Identify challenges to retrofitting residential and commercial buildings.
54. Identify common simulation tools used to assess window and envelope performance.
55. Describe the methods and tools used to determine the thermal performance of glazing systems.
56. Describe how infrared thermography can be used to detect areas of missing or deficient insulation, air leakage and water penetration in wall systems.
57. 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 and summarize the methodology in performing a facade review on an example building (e.g. a 20-year-old ten-story commercial building).
58. Describe how water testing can be used to evaluate performance for roof and wall systems (when to use, test methods, equipment etc.).
59. Describe how smoke testing can be used to evaluate air barrier systems in-situ.
60. Identify benefits of building enclosure commissioning.

Masonry Wall Systems:

Nomenclature

61. Compare the differences between solid masonry walls, composite cavity walls, and veneer cladding.

Components

62. Identify the key components of typical masonry wall systems including: structural back-up, cavity which includes an air space, insulation, barrier, vapour retarder,ties; and the load bearing or non-load bearing outer wythe.

Performance Issues/Defects

63. Discuss the factors that contribute to proper planning, design, detailing and construction of masonry wall systems.
64. Describe the best practices and relevant standards as they apply to masonry wall systems.
65. Illustrate how thermal bridging can be minimized by the design and workmanship in masonry walls.
66. Describe how wind load is transferred from the exterior face to the structural back-up system.
67. 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.
68. Discuss how to mitigate the risk of freeze thaw deterioration for masonry when designing a new or retrofit wall system with masonry.
69. Describe how to test for the common deterioration mechanisms associated with masonry wall systems.

Metal and Cementitious Panelized Cladding Systems:

Nomenclature

70. Outline key terminologies of precast concrete wall systems, including: structural wythe, aesthetic wythe, insulation, anchors, joints, drainage.
71. Describe the manufacturing and installation process for precast concrete wall systems.
72. Describe the differences between single wythe and double wythe precast wall systems.
73. Outline key terminologies of metal panel systems, including: liner panel, aesthetic/finish panel, gaskets, joints, anchors, drainage.
74. Describe the manufacturing and installation process for metal panels.

Components

75. Identify the different wall systems, panel components, panel layouts (shapes), limitations, materials and finishes.
76. 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.
77. 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.

Performance Issues/Defects

78. Describe the air, heat and moisture control mechanisms in panelized wall systems.
79. Describe, recognize and test for the common deterioration mechanisms associated with metal and cementitious panelized cladding systems.
80. Explain the importance of joint design in the precast concrete wall system.
81. Describe how thermal clip systems can be used to improve the thermal performance of these systems.
82. 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.
83. Describe how the materials and finish can impact the colour of precast concrete.
84. Describe how maintenance issues have an impact on durability of the precast concrete wall systems including: regular inspection to identify damage, joint sealant replacement.
85. Understand, describe, recognize and test for the common deterioration mechanisms associated with precast concrete wall systems.

Exterior Insulation and Finish Systems (EIFS):

Nomenclature

86. Name the composition of exterior insulation and finish systems (EIFS) layers.
87. Understand the difference between face-sealed, drained, and ventilated EIFS.

Components

88. Identify common EIFS assemblies and components as they relate to their heat, air and moisture management capabilities.

Performance Issues/Defects

89. Contrast the performance of modern EIFS to the original EIFS systems and their failures.
90. Explain the difference between EIFS and stucco.
91. Describe the effect of EIFS on the thermal gradient through exterior walls in various new and retrofit configurations.

92. Identify the installation limitations for EIFS.
93. Develop details between EIFS and adjacent cladding components, such as windows, doors and roofing.
94. Identify common deficiencies with EIFS which impact performance and durability.
95. Discuss limitations of installing EIFS at or near grade and ways to accommodate those situations.
96. Describe how to test for the common deterioration mechanisms associated with EIFS.
97. Describe how a drained EIFS system works.
98. Assess the rain-screen principles in EIFS application.

Windows:

Nomenclature

99. Describe the difference between fixed and operable windows.
100. Describe different operable window styles: awning, hopper, horizontal & vertical sliders, casement, tilt and turn.

Components

101. Describe the basic components of a window system.
102. Describe the effects of window coating and placement of the coatings on window performance.
103. Describe how the control layers (air control layer; vapour control layer; thermal control layer; water control layer) are achieved for window systems.
104. 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..).
105. Discuss when/where tempered glass may be required in windows.
106. Discuss the relative effects of thermal performance of spacers and window frames, and how they interact together.

Performance Issues/Defects

107. Describe the different types of operable windows along with their strengths and weaknesses.
108. 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 in various locations and building types.
109. Describe how the window installation process varies between a single family home and a high-rise residential tower.
110. Understand the importance of key window installation parameters (drainage, air barrier continuity, thermal continuity, operability, security) and optimize these parameters during design.
111. Discuss the benefits and drawbacks of inwards versus outward opening operable windows.
112. Describe the differences between various window installation approaches (e.g. punched, ribbon, strip).

Curtain Wall, Window Wall and Sloped Glazing:

Nomenclature

113. Describe the differences and similarities between curtain wall, window wall and sloped glazing systems.

Components

114. Identify the basic components and materials of curtain wall systems.
115. Identify the basic components of structurally-framed sloped glazing systems.

116. Describe how the control layers (air control layer; vapour control layer; thermal control layer; water control layer) are achieved for curtain wall, window wall and sloped glazing systems.

117. Describe how a stick built system differs from a unitized system.

Performance Issues/Defects

118. Discuss 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.

119. Discuss the different types of sloped glazing systems and how water is managed in each system.

120. 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.

121. Describe the differences between curtain wall and window wall and how these affect relative performance.

122. Calculate the required venting area for pressure moderated rainscreen.

123. Describe the key detail areas most likely to fail in terms of water penetration, air leakage, thermal and structural.

124. Calculate the overall U-Value of a glazing system using the area weighted U-value method.