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Wisconsin Contractors Institute

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(Dwelling Contractor Qualifier License)

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Included Inside:

12 Hours of Approved Continuing

Courses and Final Exams

Includes the 4-hour Mandatory Topics Course
(Construction Laws and Codes, Liability and Risk Management, and Construction Contracts)

www.wcitraining.com
wciceu@gmail.com
(262) 409-4282

Frequently Asked Questions

Q Why are you sending me these courses and book for free?

Our mission at Wisconsin Contractors Institute is to make your continuing education a hassle free process. You are not required to take this course. However, you are required to complete 12 hours of continuing education every 2 years. These courses are provided to make your education as easy as possible.

Q How do I complete these courses?

After reading the material, you must complete the final exams (test questions are included throughout the book) with a score of 70% or greater and pay for the course. You can pay online, call us with a credit card or mail a check. There is no charge for retakes on the exam.

Q Do I need to take the 4-hour Mandatory Topics Course?

Yes. As of November 1st, 2022 all Dwelling Contractor Qualifiers must complete 4 hours of continuing education on the following topics: construction laws and codes, liability and risk management, and construction contracts. Any licensee with a renewal date on or after 11/01/2022 must fulfill this new requirement. Please keep in mind that the total number of required CE hours has not changed. DCQs still need to obtain 12 hours of continuing education every 2 years.

Q How do I obtain credit for the course and receivemy certificate of completion?

ONLINE: You can take the tests and pay for the courses online at www.wcitraining.com. The exams online are identical to the exams in the book. Once you pass the course, you can print your certificate immediately.

MAIL: You can fill out the answer sheet (with a pen or pencil) on pages 1-2, and mail it to us with a check payable to Wisconsin Contractors Institute, N16 W23217 Stone Ridge Drive, Suite 290, Waukesha, WI 53188. We will then email your certificate to you (or by mail if no email is provided).

FAX/SCAN: You can call us at (262) 409-4282 with a credit card number and then fax or scan/email your answer sheets to us. We will then email your certificates to you (or by mail if no email is provided).

Q Do you offer any other approved courses?

Yes, we have numerous courses approved by the state of Wisconsin for the Dwelling Contractor Qualifier license. You can see a full listing of the courses at www.wcitraining.com.

Q Do you submit records of my completion/hours to the state of Wisconsin?

Yes, we will directly submit your hours to the state for you.

Q Are these courses approved by the Wisconsin Department of Safety and Professional Services?

Yes, the courses are approved by the state of Wisconsin. The price chart below has the course approval number and expiration date. You can also view the course approval letters on our website.

WCI Wisconsin Contractors Institute

N16 W23217 Stone Ridge Drive, Suite 290
Waukesha, WI 53188

Course Title (Course Approval Number)	Expiration Date	Hours	Price
Construction Laws, Codes, Contracts, Liability & Risk Management for Dwelling Contractor Qualifiers (#22850)	9/28/2027	4 hours	$40
Masonry Construction (#22606)	2/1/2027	3 hours	$30
From the Ground Up: Current Construction Methods and Materials (#22608)	2/1/2027	3 hours	$30
Modular Construction (#22959)	11/9/2027	2 hours	$20
BUY ALL 12 HOURS AND SAVE! ★		**12 hours**	**$99**

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Phone:_____ Email:_____

DCQ License #:_____

***** See instructions on the inside cover page to submit your exams and pay for your course.***

Construction Laws, Codes, Contracts, Liability & Risk Management for Dwelling Contractor Qualifiers

1.	Ⓐ Ⓑ Ⓒ Ⓓ	25.	Ⓐ Ⓑ Ⓒ Ⓓ	49.	Ⓐ Ⓑ Ⓒ Ⓓ	73.	Ⓐ Ⓑ Ⓒ Ⓓ	97.	Ⓐ Ⓑ Ⓒ Ⓓ
2.	Ⓐ Ⓑ Ⓒ Ⓓ	26.	Ⓐ Ⓑ Ⓒ Ⓓ	50.	Ⓐ Ⓑ Ⓒ Ⓓ	74.	Ⓐ Ⓑ Ⓒ Ⓓ	98.	Ⓐ Ⓑ Ⓒ Ⓓ
3.	Ⓐ Ⓑ Ⓒ Ⓓ	27.	Ⓐ Ⓑ Ⓒ Ⓓ	51.	Ⓐ Ⓑ Ⓒ Ⓓ	75.	Ⓐ Ⓑ Ⓒ Ⓓ	99.	Ⓐ Ⓑ Ⓒ Ⓓ
4.	Ⓐ Ⓑ Ⓒ Ⓓ	28.	Ⓐ Ⓑ Ⓒ Ⓓ	52.	Ⓐ Ⓑ Ⓒ Ⓓ	76.	Ⓐ Ⓑ Ⓒ Ⓓ	100.	Ⓐ Ⓑ Ⓒ Ⓓ
5.	Ⓐ Ⓑ Ⓒ Ⓓ	29.	Ⓐ Ⓑ Ⓒ Ⓓ	53.	Ⓐ Ⓑ Ⓒ Ⓓ	77.	Ⓐ Ⓑ Ⓒ Ⓓ	101.	Ⓐ Ⓑ Ⓒ Ⓓ
6.	Ⓐ Ⓑ Ⓒ Ⓓ	30.	Ⓐ Ⓑ Ⓒ Ⓓ	54.	Ⓐ Ⓑ Ⓒ Ⓓ	78.	Ⓐ Ⓑ Ⓒ Ⓓ	102.	Ⓐ Ⓑ Ⓒ Ⓓ
7.	Ⓐ Ⓑ Ⓒ Ⓓ	31.	Ⓐ Ⓑ Ⓒ Ⓓ	55.	Ⓐ Ⓑ Ⓒ Ⓓ	79.	Ⓐ Ⓑ Ⓒ Ⓓ	103.	Ⓐ Ⓑ Ⓒ Ⓓ
8.	Ⓐ Ⓑ Ⓒ Ⓓ	32.	Ⓐ Ⓑ Ⓒ Ⓓ	56.	Ⓐ Ⓑ Ⓒ Ⓓ	80.	Ⓐ Ⓑ Ⓒ Ⓓ	104.	Ⓐ Ⓑ Ⓒ Ⓓ
9.	Ⓐ Ⓑ Ⓒ Ⓓ	33.	Ⓐ Ⓑ Ⓒ Ⓓ	57.	Ⓐ Ⓑ Ⓒ Ⓓ	81.	Ⓐ Ⓑ Ⓒ Ⓓ	105.	Ⓐ Ⓑ Ⓒ Ⓓ
10.	Ⓐ Ⓑ Ⓒ Ⓓ	34.	Ⓐ Ⓑ Ⓒ Ⓓ	58.	Ⓐ Ⓑ Ⓒ Ⓓ	82.	Ⓐ Ⓑ Ⓒ Ⓓ	106.	Ⓐ Ⓑ Ⓒ Ⓓ
11.	Ⓐ Ⓑ Ⓒ Ⓓ	35.	Ⓐ Ⓑ Ⓒ Ⓓ	59.	Ⓐ Ⓑ Ⓒ Ⓓ	83.	Ⓐ Ⓑ Ⓒ Ⓓ	107.	Ⓐ Ⓑ Ⓒ Ⓓ
12.	Ⓐ Ⓑ Ⓒ Ⓓ	36.	Ⓐ Ⓑ Ⓒ Ⓓ	60.	Ⓐ Ⓑ Ⓒ Ⓓ	84.	Ⓐ Ⓑ Ⓒ Ⓓ	108.	Ⓐ Ⓑ Ⓒ Ⓓ
13.	Ⓐ Ⓑ Ⓒ Ⓓ	37.	Ⓐ Ⓑ Ⓒ Ⓓ	61.	Ⓐ Ⓑ Ⓒ Ⓓ	85.	Ⓐ Ⓑ Ⓒ Ⓓ	109.	Ⓐ Ⓑ Ⓒ Ⓓ
14.	Ⓐ Ⓑ Ⓒ Ⓓ	38.	Ⓐ Ⓑ Ⓒ Ⓓ	62.	Ⓐ Ⓑ Ⓒ Ⓓ	86.	Ⓐ Ⓑ Ⓒ Ⓓ	110.	Ⓐ Ⓑ Ⓒ Ⓓ
15.	Ⓐ Ⓑ Ⓒ Ⓓ	39.	Ⓐ Ⓑ Ⓒ Ⓓ	63.	Ⓐ Ⓑ Ⓒ Ⓓ	87.	Ⓐ Ⓑ Ⓒ Ⓓ	111.	Ⓐ Ⓑ Ⓒ Ⓓ
16.	Ⓐ Ⓑ Ⓒ Ⓓ	40.	Ⓐ Ⓑ Ⓒ Ⓓ	64.	Ⓐ Ⓑ Ⓒ Ⓓ	88.	Ⓐ Ⓑ Ⓒ Ⓓ	112.	Ⓐ Ⓑ Ⓒ Ⓓ
17.	Ⓐ Ⓑ Ⓒ Ⓓ	41.	Ⓐ Ⓑ Ⓒ Ⓓ	65.	Ⓐ Ⓑ Ⓒ Ⓓ	89.	Ⓐ Ⓑ Ⓒ Ⓓ	113.	Ⓐ Ⓑ Ⓒ Ⓓ
18.	Ⓐ Ⓑ Ⓒ Ⓓ	42.	Ⓐ Ⓑ Ⓒ Ⓓ	66.	Ⓐ Ⓑ Ⓒ Ⓓ	90.	Ⓐ Ⓑ Ⓒ Ⓓ	114.	Ⓐ Ⓑ Ⓒ Ⓓ
19.	Ⓐ Ⓑ Ⓒ Ⓓ	43.	Ⓐ Ⓑ Ⓒ Ⓓ	67.	Ⓐ Ⓑ Ⓒ Ⓓ	91.	Ⓐ Ⓑ Ⓒ Ⓓ	115.	Ⓐ Ⓑ Ⓒ Ⓓ
20.	Ⓐ Ⓑ Ⓒ Ⓓ	44.	Ⓐ Ⓑ Ⓒ Ⓓ	68.	Ⓐ Ⓑ Ⓒ Ⓓ	92.	Ⓐ Ⓑ Ⓒ Ⓓ	116.	Ⓐ Ⓑ Ⓒ Ⓓ
21.	Ⓐ Ⓑ Ⓒ Ⓓ	45.	Ⓐ Ⓑ Ⓒ Ⓓ	69.	Ⓐ Ⓑ Ⓒ Ⓓ	93.	Ⓐ Ⓑ Ⓒ Ⓓ	117.	Ⓐ Ⓑ Ⓒ Ⓓ
22.	Ⓐ Ⓑ Ⓒ Ⓓ	46.	Ⓐ Ⓑ Ⓒ Ⓓ	70.	Ⓐ Ⓑ Ⓒ Ⓓ	94.	Ⓐ Ⓑ Ⓒ Ⓓ	118.	Ⓐ Ⓑ Ⓒ Ⓓ
23.	Ⓐ Ⓑ Ⓒ Ⓓ	47.	Ⓐ Ⓑ Ⓒ Ⓓ	71.	Ⓐ Ⓑ Ⓒ Ⓓ	95.	Ⓐ Ⓑ Ⓒ Ⓓ	119.	Ⓐ Ⓑ Ⓒ Ⓓ
24.	Ⓐ Ⓑ Ⓒ Ⓓ	48.	Ⓐ Ⓑ Ⓒ Ⓓ	72.	Ⓐ Ⓑ Ⓒ Ⓓ	96.	Ⓐ Ⓑ Ⓒ Ⓓ	120.	Ⓐ Ⓑ Ⓒ Ⓓ

FINAL EXAM ANSWER SHEET

First Name:_____ Last Name:_____ Date:_____

Address:_____ City:_____ State:_____ Zip:_____

Phone:_____ Email:_____

Wisconsin Dwelling Contractor Qualifier Number:_____

***** See instructions on the inside cover page to submit your exams and pay for your course.***

MASONRY CONSTRUCTION

1. Ⓐ Ⓑ Ⓒ Ⓓ	7. Ⓐ Ⓑ Ⓒ Ⓓ	13. Ⓐ Ⓑ Ⓒ Ⓓ	19. Ⓐ Ⓑ Ⓒ Ⓓ	25. Ⓐ Ⓑ Ⓒ Ⓓ
2. Ⓐ Ⓑ Ⓒ Ⓓ	8. Ⓐ Ⓑ Ⓒ Ⓓ	14. Ⓐ Ⓑ Ⓒ Ⓓ	20. Ⓐ Ⓑ Ⓒ Ⓓ	26. Ⓐ Ⓑ Ⓒ Ⓓ
3. Ⓐ Ⓑ Ⓒ Ⓓ	9. Ⓐ Ⓑ Ⓒ Ⓓ	15. Ⓐ Ⓑ Ⓒ Ⓓ	21. Ⓐ Ⓑ Ⓒ Ⓓ	27. Ⓐ Ⓑ Ⓒ Ⓓ
4. Ⓐ Ⓑ Ⓒ Ⓓ	10. Ⓐ Ⓑ Ⓒ Ⓓ	16. Ⓐ Ⓑ Ⓒ Ⓓ	22. Ⓐ Ⓑ Ⓒ Ⓓ	28. Ⓐ Ⓑ Ⓒ Ⓓ
5. Ⓐ Ⓑ Ⓒ Ⓓ	11. Ⓐ Ⓑ Ⓒ Ⓓ	17. Ⓐ Ⓑ Ⓒ Ⓓ	23. Ⓐ Ⓑ Ⓒ Ⓓ	29. Ⓐ Ⓑ Ⓒ Ⓓ
6. Ⓐ Ⓑ Ⓒ Ⓓ	12. Ⓐ Ⓑ Ⓒ Ⓓ	18. Ⓐ Ⓑ Ⓒ Ⓓ	24. Ⓐ Ⓑ Ⓒ Ⓓ	30. Ⓐ Ⓑ Ⓒ Ⓓ

FROM THE GROUND UP

1. Ⓐ Ⓑ Ⓒ Ⓓ	7. Ⓐ Ⓑ Ⓒ Ⓓ	13. Ⓐ Ⓑ Ⓒ Ⓓ	19. Ⓐ Ⓑ Ⓒ Ⓓ	25. Ⓐ Ⓑ Ⓒ Ⓓ
2. Ⓐ Ⓑ Ⓒ Ⓓ	8. Ⓐ Ⓑ Ⓒ Ⓓ	14. Ⓐ Ⓑ Ⓒ Ⓓ	20. Ⓐ Ⓑ Ⓒ Ⓓ	26. Ⓐ Ⓑ Ⓒ Ⓓ
3. Ⓐ Ⓑ Ⓒ Ⓓ	9. Ⓐ Ⓑ Ⓒ Ⓓ	15. Ⓐ Ⓑ Ⓒ Ⓓ	21. Ⓐ Ⓑ Ⓒ Ⓓ	27. Ⓐ Ⓑ Ⓒ Ⓓ
4. Ⓐ Ⓑ Ⓒ Ⓓ	10. Ⓐ Ⓑ Ⓒ Ⓓ	16. Ⓐ Ⓑ Ⓒ Ⓓ	22. Ⓐ Ⓑ Ⓒ Ⓓ	28. Ⓐ Ⓑ Ⓒ Ⓓ
5. Ⓐ Ⓑ Ⓒ Ⓓ	11. Ⓐ Ⓑ Ⓒ Ⓓ	17. Ⓐ Ⓑ Ⓒ Ⓓ	23. Ⓐ Ⓑ Ⓒ Ⓓ	29. Ⓐ Ⓑ Ⓒ Ⓓ
6. Ⓐ Ⓑ Ⓒ Ⓓ	12. Ⓐ Ⓑ Ⓒ Ⓓ	18. Ⓐ Ⓑ Ⓒ Ⓓ	24. Ⓐ Ⓑ Ⓒ Ⓓ	30. Ⓐ Ⓑ Ⓒ Ⓓ

MODULAR CONSTRUCTION

1. Ⓐ Ⓑ Ⓒ Ⓓ	13. Ⓐ Ⓑ Ⓒ Ⓓ	25. Ⓐ Ⓑ Ⓒ Ⓓ	37. Ⓐ Ⓑ Ⓒ Ⓓ	49. Ⓐ Ⓑ Ⓒ Ⓓ
2. Ⓐ Ⓑ Ⓒ Ⓓ	14. Ⓐ Ⓑ Ⓒ Ⓓ	26. Ⓐ Ⓑ Ⓒ Ⓓ	38. Ⓐ Ⓑ Ⓒ Ⓓ	50. Ⓐ Ⓑ Ⓒ Ⓓ
3. Ⓐ Ⓑ Ⓒ Ⓓ	15. Ⓐ Ⓑ Ⓒ Ⓓ	27. Ⓐ Ⓑ Ⓒ Ⓓ	39. Ⓐ Ⓑ Ⓒ Ⓓ	51. Ⓐ Ⓑ Ⓒ Ⓓ
4. Ⓐ Ⓑ Ⓒ Ⓓ	16. Ⓐ Ⓑ Ⓒ Ⓓ	28. Ⓐ Ⓑ Ⓒ Ⓓ	40. Ⓐ Ⓑ Ⓒ Ⓓ	52. Ⓐ Ⓑ Ⓒ Ⓓ
5. Ⓐ Ⓑ Ⓒ Ⓓ	17. Ⓐ Ⓑ Ⓒ Ⓓ	29. Ⓐ Ⓑ Ⓒ Ⓓ	41. Ⓐ Ⓑ Ⓒ Ⓓ	53. Ⓐ Ⓑ Ⓒ Ⓓ
6. Ⓐ Ⓑ Ⓒ Ⓓ	18. Ⓐ Ⓑ Ⓒ Ⓓ	30. Ⓐ Ⓑ Ⓒ Ⓓ	42. Ⓐ Ⓑ Ⓒ Ⓓ	54. Ⓐ Ⓑ Ⓒ Ⓓ
7. Ⓐ Ⓑ Ⓒ Ⓓ	19. Ⓐ Ⓑ Ⓒ Ⓓ	31. Ⓐ Ⓑ Ⓒ Ⓓ	43. Ⓐ Ⓑ Ⓒ Ⓓ	55. Ⓐ Ⓑ Ⓒ Ⓓ
8. Ⓐ Ⓑ Ⓒ Ⓓ	20. Ⓐ Ⓑ Ⓒ Ⓓ	32. Ⓐ Ⓑ Ⓒ Ⓓ	44. Ⓐ Ⓑ Ⓒ Ⓓ	56. Ⓐ Ⓑ Ⓒ Ⓓ
9. Ⓐ Ⓑ Ⓒ Ⓓ	21. Ⓐ Ⓑ Ⓒ Ⓓ	33. Ⓐ Ⓑ Ⓒ Ⓓ	45. Ⓐ Ⓑ Ⓒ Ⓓ	57. Ⓐ Ⓑ Ⓒ Ⓓ
10. Ⓐ Ⓑ Ⓒ Ⓓ	22. Ⓐ Ⓑ Ⓒ Ⓓ	34. Ⓐ Ⓑ Ⓒ Ⓓ	46. Ⓐ Ⓑ Ⓒ Ⓓ	58. Ⓐ Ⓑ Ⓒ Ⓓ
11. Ⓐ Ⓑ Ⓒ Ⓓ	23. Ⓐ Ⓑ Ⓒ Ⓓ	35. Ⓐ Ⓑ Ⓒ Ⓓ	47. Ⓐ Ⓑ Ⓒ Ⓓ	59. Ⓐ Ⓑ Ⓒ Ⓓ
12. Ⓐ Ⓑ Ⓒ Ⓓ	24. Ⓐ Ⓑ Ⓒ Ⓓ	36. Ⓐ Ⓑ Ⓒ Ⓓ	48. Ⓐ Ⓑ Ⓒ Ⓓ	60. Ⓐ Ⓑ Ⓒ Ⓓ

Wisconsin Contractors Institute

CONSTRUCTION LAWS, CODES, CONTRACTS, LIABILITY & RISK MANAGEMENT FOR DWELLING CONTRACTOR QUALIFIERS

4 Hours

Course Approval Number: 22850

FOR MORE INFORMATION:

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Liability and Risk Management

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CONSTRUCTION LAWS AND CODES

Design Criteria

CHAPTER SPS 321

CONSTRUCTION STANDARDS

Subchapter II — Design Criteria

SPS 321.02 Loads and materials.

Every dwelling shall be designed and constructed in accordance with the requirements of this section.

(1) DESIGN LOAD. Every dwelling shall be designed and constructed to support the actual dead load, live loads and wind loads acting upon it without exceeding the allowable stresses of the material. The construction of buildings and structures shall result in a system that provides a complete load path capable of transferring all loads from point of origin through the load–resisting elements to the foundation.

COMMENTARY ON THE CODE

321.02 Load Paths

Individual structural members need their load paths analyzed all the way to grade for adequate load transfer. This may require additional wall studs or joist bay blocking below point loads. If such supports have a header in them, typically separate structural analysis must be provided to properly size this header and those supporting jamb columns.

(a) *Dead loads*. Every dwelling shall be designed and constructed to support the actual weight of all components and materials. Earth–sheltered dwellings shall be designed and constructed to support the actual weight of all soil loads.

COMMENTARY ON THE CODE

321.02 (1) (a) Dead Load of Insulation

To avoid ceiling gypsum board sag or related problems, attic insulation dead load should not exceed gypsum board manufacturer's recommended capacity. This is especially true today where thick attic insulation and 24-inch truss spacing are common.

Attic insulation materials vary in density and thermal properties. Therefore, the total weight per installed R-value will vary depending on type, installation method and manufacturer of insulation product.

(b) *Live loads*.

1. 'Floors and ceilings.' Floors and ceilings shall be designed and constructed to support the minimum live loads listed in Table 321.02. The design load shall be applied uniformly over the component area.

2. 'Snow loads.' Roofs shall be designed and constructed to support the minimum snow loads listed on the zone map. The loads shall be assumed to act vertically over the roof area projected upon a horizontal plane.

TABLE 321.02-1

COMPONENT	LIVE LOAD (pounds per sq. ft.)
Floors	40
Garage Floors	50
Exterior Balconies, Decks, Porches	40
Ceilings (with storage)	20
Ceilings (without storage)	5

COMMENTARY ON THE CODE

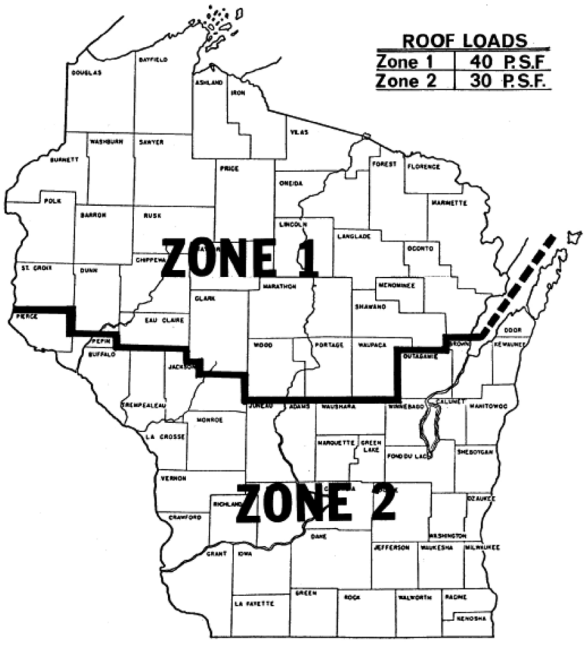
321.02 (1) (b) 2. Live Load - Snow

Exterior balconies or decks should be designed to withstand 40 PSF as the critical live load. The effect of drifting or sliding snow on a roof should be considered as a matter of good design practice. However, the UDC only requires a 30 or 40 PSF snow load applied uniformly to roofs. In complex roofs with side by side low-high portions or flat roofs below sloped upper roofs, a designer may want to consider potentially higher snow loads in the low roof areas where sliding or drifting snow may collect.

(c) *Wind loads.* Dwellings shall be designed and constructed to withstand either a horizontal and uplift pressure of 20 pounds per square foot acting over the surface area or the wind loads determined in accordance with ASCE 7–05, Minimum Design Loads for Buildings and Other Structures.

Note: ***ASCE 7–05 allows for substantial reduction from 20 psf as applied to the surface area.***

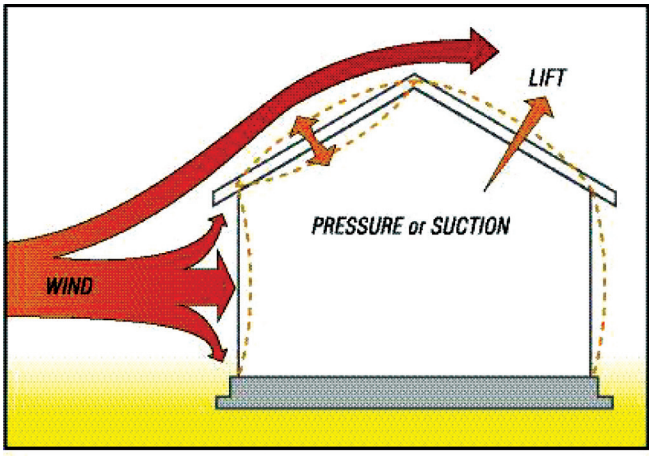
FIGURE 321.02 ZONE MAP FOR ROOF LOADS



COMMENTARY ON THE CODE

321.02(1)(c) Wind Design

Lateral wind forces can cause a building to rack, slide, or overturn, as well as uplift. All of these potential movements need to be addressed by the building design.



Racking:
When wind blows against the side of the structure exerting a lateral force that causes it to lean over (rack) to one side.

Sliding:
When wind blows against the side of the structure exerting a lateral force, causing it to slide off of its foundation.

Overturning:
When the structure is anchored in place to limit racking or sliding, the lateral force of the wind causes the structure to rotate or overturn.

Assessment Questions

1. **The construction of buildings and structures shall result in a system that provides a complete load path capable of transferring all loads from point of origin through the load−resisting elements to the _____.**
   (a) roof
   (b) load-bearing walls
   (c) foundation
   (d) floor

2. **Floors shall be designed and constructed to support the minimum live load of _____ pounds per sq. ft.**
   (a) 5
   (b) 20
   (c) 40
   (d) 50

3. **Ceilings (without storage) shall be designed and constructed to support the minimum live load of _____ pounds per sq. ft.**
   (a) 5
   (b) 20
   (c) 40
   (d) 50

4. **Structures built in Zone 2 have a roof load of _____ p.s.f.**
   (a) 20
   (b) 30
   (c) 40
   (d) 50

(2) METHODS OF DESIGN. All dwellings shall be designed by the method of structural analysis or the method of accepted practice specified in each part of this code.

Note: ***See ch. NR 116, rules of the department of natural resources, for special requirements relating to buildings located in flood plain zones. Information regarding the elevation of the regional flood may be obtained from the local zoning official.***

(3) STRUCTURAL STANDARDS.

(a) *General.* Design, construction, installation, practice and structural analysis shall conform to the following nationally recognized standards.

(b) *Wood.*

1. Except as provided in subd. 1. a. and b., structural lumber, glue−laminated timber, timber pilings and fastenings shall be designed in accordance with the "National Design Specification for Wood Construction" and the "Design Values for Wood Construction," a supplement to the National Design Specification for Wood Construction.

   a. Section 2.2.5.3. The cumulative effects of short−time loads, such as snow, shall be considered in determining duration of load. For snow load, no greater duration of load factor than 1.15 shall be used.

   b. Section 4.1.7. The provisions of this section shall also apply to reused lumber. Reused lumber shall be considered to have a duration of load factor of 0.90.

2. Span tables for joists and rafters printed in ch. SPS 325 Appendix A or approved by the department may be used in lieu of designing by structural analysis.

3. Sawn lumber that is not graded in accordance with the standards under subd. 1., shall use the NDS published allowable design stresses for the lumber species using grade number 3 when used for studs, stringers, rafters or joists and may use grade number 1 when used for beams, posts or timbers.

(c) *Structural steel.* The design, fabrication, and erection of structural steel for buildings shall conform to Specification for Structural Steel Buildings and the provisions of the accompanying commentary as adopted under Table 320.24−3.

(d) *Concrete.* Plain, reinforced or prestressed concrete construction shall conform to the following standards:

1. ACI Standard 318, Building Code Requirements for Structural Concrete.

2. ACI Standard 332, Residential Code Requirements for Structural Concrete.

Note: ***Concrete construction in one− and two−family dwellings should meet the standards established in ACI 332. Construction means, materials, or methods not addressed in ACI 332 should meet the standards established in ACI 318.***

(e) *Masonry.* The design and construction of masonry shall conform to the following standards:

1. ACI 530, Building Code Requirements for Masonry Structures.

2. ACI 530.1, Specification for Masonry Structures.

(f) *Engineered structural components.* Engineered structural components shall be used in accordance with structural analysis or with load tables supplied by the manufacturer, provided those load tables were developed using structural analysis or load testing.

(g) *Whole logs.* Dwellings constructed of whole logs shall conform to ICC 400, Standard on the Design and Construction of Log Structures.

Note: ***This standard requires the minimum log diameter to be 8 inches.***

(h) *Fasteners.*

1. All building components shall be fastened to withstand the dead load, live load, snow load, and wind load.

2. Fasteners shall comply with the schedule listed in Table 321.02−2.

Note: ***Other fastening methods may be allowed if engineered under s. SPS 321.02(3).***

COMMENTARY ON THE CODE

321.02 (1) (d) Fasteners

The fastener schedule in table 321.02-2 presents one means of showing adequate fastening to meet the code in most typical designs with sawn lumber. However, it may not be sufficient for certain designs, especially those using engineered lumber that can handle greater spans and loads that those assumed in the appendix fastener table. Be sure to verify that the fasteners provided will adequately transfer the greater loads that required special lumber.

(4) ALTERNATE MATERIALS AND STANDARDS. No part of this code is intended to prohibit or discourage use of alternate, equivalent materials or standards; or the construction of innovative dwellings such as a dwelling built below ground, a geodesic dome, a concrete house, a fiberglass house, or any other nonconventional structure.

Note: ***Examples of materials addressed by this subsection include structural insulated panels that are used in accordance with the manufacturer's instructions or structural analysis, and cold−formed steel framing complying with AISI S230 Standard for Cold-Formed Steel Framing — Prescriptive Method for One and Two Family Dwellings.***

TABLE 321.02-2

MINIMUM FASTENER SCHEDULE TABLE

Other interior and exterior panel products and finishes installed per manufacturer requirements. For engineered connectors, use manufacturer's specified fasteners.

DESCRIPTION OF BUILDING MATERIALS/CONNECTION	NUMBER AND TYPE OF FASTENER[1 2 3]
FLOOR FRAMING	
Joist to joist, face nailed over support	3–8d
Joist to sill or girder, toe nail	3–8d
Band or rim joist to joist, end nail	3–16d
Band or rim joist to sill or top plate	2–16d at 16" o.c.
Bridging to joist, toe nail each end	2–8d
Bridging to joist, toe nail each end	10d at 32" o.c. at top and bottom and staggered and two at ends and at each splice
Built–up girder and beams, side–loaded	16d at 16" o.c. at top and bottom and staggered and two at ends and at each splice
Ledger strip to beam, face nail	3–16d each joist
Joist on ledger to beam, toe nail	3–8d
WALL FRAMING	
Sole plate to joist or blocking, face nail	2–16d at 16" o.c.
Top or sole plate to stud, end nail	2–16d
Stud to sole plate, toe nail	3–8d or 2–16d
Doubled studs, face nail	10d at 24" o.c.
Doubled studs, face nail	10d at 24" o.c.
Doubled top plates, minimum 24–inch offset of end joints, face nail in lapped area	8–16d
Top plates, laps and intersections, face nail	2–10d
Continuous header, two pieces	16d at 16" o.c. along each edge
Continuous header to stud, toe nail	4–8d
1" corner brace to each stud and plate, face nail	2–8d or 2 staples, 1¾"
Built–up corner studs	10d at 24" o.c.
ROOF/CEILING FRAMING	
Ceiling joists to plate, toe nail	3–8d
Ceiling joist, laps over partitions, face nail	3–10d
Ceiling joist to parallel rafters, face nail	3–16d

Rafter to plate, toe nail (maximum 6 rafter span, engineered connector for longer)	2–16d
Roof rafters to ridge, valley or hip rafters, toe nail	4–16d
Roof rafters to ridge, valley or hip rafters, face nail	3–16d
Collar ties to rafters, face nail	3–8d
BOARDS AND PLANKS	
1" x 6" subfloor or less to each joist, face nail	2–8d or 2 staples, 1¾"
Wider than 1" x 6" subfloor toe to each joist, face nail	3–8d or 4 staples 1¾"
2" subfloor to joist or girder, blind and face nail	2–16d
1" x 6" roof or wall sheathing to each bearing, face nail	2–8d or 2 staples, 1¾"
1" x 8" roof or wall sheathing to each bearing, face nail	2–8d or 3 staples, 1¾"
Wider than 1" x 8" roof sheathing to each bearing, face nail	3–8d or 4 staples, 1¾"
2" planks	2–16d at each bearing

PANEL SHEATHING			
MATERIAL	**FASTENER**	**SPACING OF FASTENER**	
		EDGES	**INTERMEDIATE SUPPORTS**
Engineered wood panel for subfloor and roof sheathing and wall corner wind bracing to framing			
5/16" to 1/2"	6d common or deformed nail or staple, 1½"	6"	12" [4]
5/8" to 3/4"	8d smooth or common, 6d deformed nail, or staple, 14 ga. 1¾"	6"	12" [4]
7/8" to 1"	8d common or deformed nail	6"	12"
1⅛" to 1¼"	10d smooth or common, or 8d deformed nail	6"	12"
Combination subfloor/ underlayment to framing			
3/4" or less	6d deformed or 8d smooth or common nail	6"	12"
7/8" to 1"	8d smooth, common or deformed nail	6"	12"
1⅛" to 1¼"	10d smooth or common or 8d deformed nail	6"	12"

MATERIAL	FASTENER	SPACING OF FASTENER	
		EDGES	INTERMEDIATE SUPPORTS
Wood panel siding to framing			
1/2″ or less	6d corrosion–resistant siding and casing nails	6″	12″
5/8″	8d corrosion–resistant siding and casing nails	6″	12″
1/2″ structural cellulosic fiberboard sheathing	1½″ galvanized roofing nail; 8d common nail; staple 16 ga., 1½″ long	3″	6″
25/32″ structural cellulosic fiberboard sheathing	1¾″ galvanized roofing nail; 8d common nail; staple 16 ga., 1¾″ long	3″	6″
1/2″ gypsum sheathing[5]	1½″ galvanized roofing nail; 6d common nail; staple galvanized 1½″ long; 1¼″ screws, Type W or S	4″	8″
5/8″ gypsum sheathing[5]	1¾″ galvanized roofing nail; 8d common nail; staple galvanized 1⅝″ long; 1⅝″ screws, Type W or S	7″	7″

1 *All nails are smooth – common, box or deformed shank except where otherwise stated.*
2 *Nail is a general description and may be T-head, modified round head or round head.*
3 *Staples are 16-gauge wire, unless otherwise noted, and have a minimum 7/16″ o.d. crown width.*
4 *Staples shall be spaced at not more than 10″ o.c. at intermediate supports for floors.*
5 *Apply vertically 4′ x 8′ or 4′ x 9′ panels.*

Assessment Questions

5. According to section (3) Structural Standards (b) Wood, reused lumber shall be considered to have a duration of load factor of _____.

(a) 0.80

(b) 0.90

(c) 1.00

(d) 1.10

6. According to section (3) Structural Standards (b) Wood, for snow load, no greater duration of load factor than _____ shall be used.

(a) 0.90

(b) 1.05

(c) 1.10

(d) 1.15

7. According to section (3) Structural Standards (b) Wood, sawn lumber that is not graded in accordance with the standards under subd. 1., shall use the NDS published allowable design stresses for the lumber species using grade number _____ when used for studs, stringers, rafters or joists and may use grade number 1 when used for beams, posts or timbers.

(a) 1

(b) 2

(c) 3

(d) 4

8. According to section (3) Structural Standards (b) Wood, sawn lumber that is not graded in accordance with the standards under subd. 1., shall use the NDS published allowable design stresses for the lumber species using grade number _____ when used for beams, posts or timbers.

(a) 1

(b) 2

(c) 3

(d) 4

9. All building components shall be fastened to withstand the dead load, along with which of the following? live load, snow load, and wind load.

(a) live load

(b) snow load

(c) wind load

(d) all of the above

10. What number and type of fastener should be used for floor framing when "bridging to joist, toe nail each end"?

(a) 3–8d

(b) 2–8d

(c) 3–16d

(d) 3–16d each joist

11. What number and type of fastener should be used for wall framing for "continuous header to stud, toe nail" connections?

(a) 8–16d

(b) 16d at 16" o.c. along each edge

(c) 10d at 24" o.c.

(d) 4–8d

12. For panel sheathing, when using combination subfloor / underlayment to framing of 7/8" to 1", which of the following fasteners should be used?

(a) 8d smooth, common or deformed nail

(b) 6d deformed or 8d smooth or common nail

(c) 10d smooth or common or 8d deformed nail

(d) 6d corrosion−resistant siding and casing nails

SPS 321.03 Exits. Exits, doors and hallways shall be constructed as specified in this section.

(1) EXITS FROM THE FIRST FLOOR.

(a) Except as allowed under par. (h), every dwelling unit shall be provided with at least 2 exit doors accessible from the first floor.

(b) At least one of the exits shall discharge to grade and may not go through a garage. This exit may include interior or exterior stairs.

Note*: Under this paragraph, only one of the two exit doors that are addressed in par. (a) is required to exit directly to grade.*

(c) Any exit that does not comply with par. (b) may discharge to an outside balcony that complies with sub. (8).

(d) Any exit that does not comply with par. (b) may discharge into an attached garage provided the garage has an exit door that discharges to grade. An overhead garage door may not be used as an exit door.

(e) Except as allowed under pars. (f) and (h), the 2 required exit doors shall be separated by at least the greater of the following distances:

1. One−third the length of the longest diagonal of the floor in plan view, exclusive of an attached garage.

2. 20 feet.

Note*: See ch. SPS 325 Appendix A for examples of exit separation design.*

(f) 1. First floor levels that do not meet the separation requirements under par. (e), shall have at least one egress window complying with sub. (6) on that floor level.

2. An egress window to comply with subd. 1. shall be separated from at least one door on the first floor by one of the distances under par. (e).

3. If first floor levels that do not meet the separation requirements under par. (e) contain one or more sleeping rooms, each sleeping room shall have at least one egress window complying with sub. (6).

(g) 1. The exit separation distance required under par. (e) shall be calculated or measured as a straight line from the midpoint of one doorway to the midpoint of the other doorway.

2. For exiting through an attached garage, the separation distance shall be measured using the door connecting the garage and the dwelling. Distance within the garage shall be ignored.

(h) 1. Dwellings consisting of no more than a first floor with a maximum floor area of 400 square feet and a loft area not exceeding half of the first floor area, shall be provided with at least one exit door leading directly to the exterior and at least one egress window that complies with sub. (6).

2. a. Dwellings that meet the size restrictions under subd. 1., are not required to meet the exit separation requirements under par. (e) or (f).

b. If a dwelling that meets the size restrictions under subd. 1., has more than one room on the first floor, the door and the egress window shall be located in different rooms.

3. One of the exit doors required in par. (a) may be omitted for a dwelling unit that has one or more egress windows on the first floor. If there are bedrooms, each must have a window that complies with sub. (6).

COMMENTARY ON THE CODE

321.03(1) Acceptable First Floor Exits

Question: Is it acceptable to use a ground floor exit door to help satisfy the requirement for two exits from a first floor?

Answer: Yes, assuming the two floors are connected with a stairway and the other requirements are met. In this situation, the exit separation distance would be measured from the middle of the first floor exit door to the middle of the top of the stairway on the first floor.

Question: Are first floor bedrooms required to have egress windows?

Answer: No. The code indicates two exits are required from the first floor; however, if two exits do not serve the first floor or their separation requirements of 321.03(1)(e) are not met, then any first floor bedroom would require egress windows.

Assessment Questions

13. Except as allowed under par. (h), every dwelling unit shall be provided with at least ___ exit door(s) accessible from the first floor.

(a) 2
(b) 1
(c) 3
(d) 0

14. True or false? An overhead garage door may be used as an exit door.

(a) True
(b) False

15. The 2 required exit doors shall be separated by at least the greater of the following distances: One−third the length of the longest diagonal of the floor in plan view, exclusive of an attached garage, or _____ feet.

(a) 15
(b) 20
(c) 25
(d) 30

16. First floor levels that do not meet the separation requirements under par. (e), shall have at least _____ egress window(s) complying with sub. (6) on that floor level.

(a) 1
(b) 2
(c) 3
(d) no egress windows are required

17. If first floor levels that do not meet the separation requirements under par. (e) contain one or more sleeping rooms, each sleeping room shall have at least _____ egress window(s) complying with sub. (6).

(a) 3
(b) 2
(c) 1
(d) no egress windows are required

18. Dwellings consisting of no more than a first floor with a maximum floor area of _____ square feet and a loft area not exceeding half of the first floor area, shall be provided with at least one exit door leading directly to the exterior and at least one egress window that complies with sub. (6).

(a) 550

(b) 500

(c) 450

(d) 400

COMMENTARY ON THE CODE

321.03(2) Second Floor Bedroom Egress

Question: If one of the second floor bedrooms has a code-compliant exit door out of the bedroom onto a deck or balcony, can the requirement for egress windows in the other second floor bedrooms be waived?

Answer: Yes, but only if the hardware on the bedroom door, which leads to the second exit is incapable of being locked from the hallway that serves as the exit path from these other bedrooms.

See section 320.07 for 'EXIT' definition.

(2) EXITS FROM THE SECOND FLOOR.

(a) At least 2 exits shall be provided from the second floor. At least one of the exits shall be a stairway or ramp and lead to the first floor or discharge to grade. The second exit may be via a stairway or ramp that discharges to grade, or to a balcony which complies with sub. (8), or to a deck that complies with s. SPS 321.225 and that is no more than 15 feet above the grade below.

(b) Windows that comply with sub. (6) may be provided in each second floor bedroom — or in another location on the second floor if there are no bedrooms on that floor — in lieu of the second exit from that floor.

(c) Where the second floor of a building is the lowest floor level in a dwelling unit, as in an up−and−down duplex, no exit from the unit may go through another dwelling unit or other party's occupancy on the first floor.

(3) EXITS ABOVE THE SECOND FLOOR.

(a) Except as provided under pars. (b) and (c), each habitable floor above the second floor shall be provided with at least 2 exits that meet all of the following requirements:

1. The exits shall be stairways or ramps that lead to the second floor or discharge to grade.
2. The exits shall be located such that an exit is accessible to the second floor if another exit is blocked.

(b) A second stairway or ramp exit is not required for habitable areas on a third floor that meet all of the following requirements:

1. The habitable area consists of a single room.

   Note: ***Non−habitable areas, such as closets and bathrooms may be partitioned off.***

2. The room is not used for sleeping.
3. The habitable area has a floor area of 400 square feet or less.
4. There is at least one egress window meeting the requirements of sub. (6) in the habitable area.

(c) A second stairway or ramp exit is not required for habitable areas on a third floor that meet all of the following requirements:

1. The dwelling is fully sprinklered in accordance with NFPA 13R or NFPA 13D.

2. If a required exit includes an attached garage, the garage shall be sprinklered.

COMMENTARY ON THE CODE

321.03(3) Acceptable Exits Above the Second Floor

Small third floor rooms specified under s. SPS 321.03 (3) (b) require only one stairway or ramp that leads to the second floor or lower in the dwelling. If the dwelling is fully sprinklered, only one exit is required from the third floor. Otherwise, only stairways or ramps to the second floor or grade are acceptable to meet the two exit requirements. If an exterior stair is used, access to it from the third floor shall be with a door and if the stairway terminates at the second floor, then there must be a door leading back into the dwelling or a code-compliant egress balcony to complete the exit path.

(4) EXITS FROM LOFTS.

(a) At least one stairway exit shall be provided, to the floor below, for a loft exceeding 400 square feet in area.

(b) At least one stairway or ladder exit shall be provided to the floor below for a loft, 400 square feet or less, in area.

COMMENTARY ON THE CODE

321.03(4) Exits from Lofts

A code-complying loft is not subject to the exiting requirements of the other subsections of this section. In other words, a loft open to a first-floor or second-floor below, only requires a single stairway or ladder (depending on area) to satisfy exiting. A loft bedroom or loft level would not require an egress window but would require natural light and ventilation the same as any other habitable space.

(5) EXITS FROM BASEMENTS AND GROUND FLOORS.

(a) *General.* Except as provided in par. (b), all basements and ground floors shall be provided with at least one exit of the following types:

1. A door to the exterior of the dwelling.

2. A stairway or ramp that leads to the floor above.

(b) *Basements and ground floors used for sleeping.*

1. Basements and ground floors used for sleeping shall be provided with at least 2 exits.

2. The exits shall be located as far apart as practical.

3. The exits may not be accessed from the same ramp or stairway.

4. In addition to the exit type required under par. (a), the second exit from a basement or ground floor used for sleeping shall be one of the following types:

   a. A door to the exterior of the dwelling.

   b. A stairway or ramp that leads to the floor above.

   c. A stairway that leads to a garage provided the garage has an exit door other than the overhead door.

d. An egress window that complies with sub. (6), located in each bedroom.

(6) WINDOWS USED FOR EXITING. Windows which are installed for exit purposes shall comply with the requirements of this subsection.

(a) The window shall be openable from the inside without the use of tools or the removal of a sash. If equipped with a storm or screen, it shall be openable from the inside.

(b) 1. The nominal size of the net clear window opening shall be at least 20 inches by 24 inches irrespective of height or width. Nominal dimensions shall be determined by rounding up fractions of inches if they are ½–inch or greater or rounding down fractions of inches if they are less than ½–inch.

2. No portion of the window, including stops, stools, meeting rails and operator arms, shall infringe on the required opening.

(c) The area and dimension requirements of par. (b) may be infringed on by a storm window.

(d) 1. For any window used for exiting, the lowest point of clear opening shall be no more than 60 inches above the floor.

2. If the lowest point of clear opening is more than 46 inches above the floor, a permanent platform or fixture shall be installed such that a flat surface at least 20 inches wide and 9 inches deep is located no more than 46 inches directly below the clear opening.

3. The topmost surface of the platform or fixture shall be no more than 24 inches above the floor.

4. The topmost surface of the platform or fixture shall support a live load of at least 200 pounds.

5. A stair used for the sole purpose of reaching the top of the platform or fixture is exempt from the requirements of s. SPS 321.04.

(e) 1. An egress window with any point of clear opening below adjacent grade shall be provided with an areaway in accordance with this section.

2. The width of the areaway shall be at least equal to the width of the window.

3. The areaway shall be a minimum of 36 inches measured perpendicular from the outer surface of the below–grade wall.

4. If the bottom of the areaway is more than 46 inches below adjacent grade or the top of the areaway enclosure, the areaway shall be provided with a ladder or stair to aid egress. Stairs used to comply with this section are exempt from the requirements of s. SPS 321.04.

5. a. Ladders or other stairs used to comply with subd. 4. may infringe on the required area of the areaway by a maximum of 6 inches.

b. Ladder rungs shall have a minimum inside width of at least 12 inches and shall project at least 3 inches from the wall behind the ladder.

c. Ladder rungs shall be able to support a concentrated load of 200 pounds.

d. Ladder rungs shall have a maximum rise of 12 inches between rungs and shall extend to within 12 inches of exterior grade.

6. The areaway shall be constructed such that water entering the areaway does not enter the dwelling.

(f) An egress window under a deck or porch shall discharge through a clear path of at least 36 inches in height and 36 inches in width, and no more than 15 feet in length, to a yard or open space.

Note: ***Under this paragraph, there is no maximum height above grade for an egress window. Similarly, egress windows are not prohibited from discharging to a roof, regardless of the slope of the roof.***

COMMENTARY ON THE CODE

321.03(6) Bedroom Exit Windows

Question: Can egress windows be located in sitting or dressing areas of a master bedroom suite?

Answer: This section requires egress windows in some bedrooms. However, it does not specify the location of the window within the bedroom itself. A sitting room or area located in an alcove of a master bedroom is an acceptable location for the bedroom egress window. The alcove can be considered part of the bedroom if there are no doors obstructing communication between the two areas.

Assessment Questions

19. At least ____ exit(s) shall be provided from the second floor.

(a) 1
(b) 2
(c) 3
(d) 4

20. True or false? Where the second floor of a building is the lowest floor level in a dwelling unit, as in an up–and–down duplex, the exit from the unit may go through another dwelling unit or other party's occupancy on the first floor.

(a) True
(b) False

21. Except as provided under pars. (b) and (c), each habitable floor above the second floor shall be provided with at least _____ exit(s).

(a) 1
(b) 2
(c) 3
(d) no exits are required

22. A second stairway or ramp exit is not required for habitable areas on a third floor that meet which of the following requirements?

(a) The dwelling is fully sprinklered in accordance with NFPA 13R or NFPA 13D.
(b) If a required exit includes an attached garage, the garage shall be sprinklered.
(c) The first exit door is a swing–type door at least 80 inches high by 36 inches wide.
(d) Both a and b are correct

23. Which of the following is an acceptable exit for a loft exceeding 400 square feet in area?

(a) Stairway
(b) Ladder
(c) Egress window
(d) All of the above

24. Basements and ground floors used for sleeping shall be provided with at least _____ exit(s).

(a) 1
(b) 2
(c) 3
(d) As many as practically possible

25. Windows which are installed for exit purposes shall have a net clear window opening with the nominal size of at least ____ inches by ____ inches irrespective of height or width.

(a) 20 inches by 24 inches

(b) 20 inches by 20 inches

(c) 18 inches by 20 inches

(d) 12 inches by 12 inches

26. For any window used for exiting, the lowest point of clear opening shall be no more than _____ inches above the floor.

(a) 50

(b) 55

(c) 60

(d) 40

27. An egress window under a deck or porch shall discharge through a clear path of at least 36 inches in height and 36 inches in width, and no more than _____ feet in length, to a yard or open space.

(a) 12

(b) 13

(c) 14

(d) 15

(7) DOORS USED FOR EXITING.

(a) Doors used for exiting from a dwelling shall meet the following dimensions:

1. At least one exit door shall be a swing−type door at least 80 inches high by 36 inches wide.

2. Except as allowed under subds. 3. and 4., other required exit doors shall be at least 76 inches high by 32 inches wide.

3. Where double doors are used as a required exit, each door leaf shall provide a clear opening at least 30 inches wide and be at least 76 inches high.

4. Where sliding doors are used as a required exit, the clear opening shall be at least 29 inches wide and be at least 76 inches high.

(b) All exit doors shall be openable from the interior without the use of a key.

(8) BALCONIES.

(a) Balconies shall be made of concrete, metal or wood which is treated, protected or naturally decay−resistive in accordance with s. SPS 321.10.

(b) Balconies shall be provided with guards in accordance with s. SPS 321.04 (3).

(c) Balconies which are required for exit purposes shall also comply with all of the following requirements:

1. The balcony guard shall terminate no more than 46 inches above the floor level of the balcony.

2. The floor level of the balcony shall be no more than 15 feet above the grade below.

3. The floor of the balcony shall have minimum dimensions of 3 feet by 3 feet. The guard and its supports may infringe on the dimensions of the required area no more than 4.5 inches.

COMMENTARY ON THE CODE

321.03(8) Balconies

Balconies not used for a required exit purposes may be greater than 15 feet above grade. All guards for balconies more than 24" above grade are required to comply with SPS 321.04(3) regarding height, in-fill or spindle and rail spacing requirements.

(9) SPLIT LEVEL DWELLINGS. In determining the exit requirement in a split level dwelling, all levels that are to be considered a single story shall be within 5 feet of each other.

COMMENTARY ON THE CODE

321.03(9) Split Level Dwellings

This section allows floor levels within 5 feet vertically of each other to be considered one floor level for exiting purposes.

Any combined floor levels must all be within 5 feet of each other. In other words, a floor level that is between two other floor levels, separated by more than 5 feet, does not make all three levels into one even if exiting is from the middle level. However, the middle level may be combined with only one of the other levels.

(10) TWO−FAMILY DWELLINGS. In a 2−family dwelling, each dwelling unit shall be provided with exits in compliance with this section.

(11) EXITS TO COURTYARDS. No exit may discharge to a courtyard having a perimeter that is entirely enclosed by exterior building walls or other obstructions that prevent pedestrian passage.

Assessment Questions

28. Doors used for exiting from a dwelling shall meet the following dimensions: At least one exit door shall be a swing−type door at least _____.

(a) 85 inches high by 36 inches wide

(b) 80 inches high by 36 inches wide

(c) 80 inches high by 32 inches wide

(d) 85 inches high by 32 inches wide

29. Where double doors are used as a required exit, each door leaf shall provide a clear opening at least _____ high.

(a) 30 inches wide and be at least 76 inches

(b) 30 inches wide and be at least 72 inches

(c) 24 inches wide and be at least 76 inches

(d) 24 inches wide and be at least 72 inches

30. Balconies shall be made of which of the following?

(a) Concrete

(b) Metal

(c) Wood which is treated, protected or naturally decay-resistive

(d) Any of the above

31. Balconies which are required for exit purposes shall have a floor level no more than _____ feet above the grade below.

(a) 20

(b) 18

(c) 15

(d) 25

32. In determining the exit requirement in a split level dwelling, all levels that are to be considered a single story shall be within _____ feet of each other.

(a) 5

(b) 6

(c) 7

(d) 8

SPS 321.035 Interior circulation.

(1) DOORS AND OPENINGS. All doors and openings to the following areas shall be at least 80 inches high and provide either a net clear opening width of 30 inches or be a 32−inch door:

(a) Except as provided under pars. (b) and (c), all entrances into common use areas.

(b) At least 50% of the bedrooms.

(c) 1. At least one full bathroom, including doors or openings to a sink, toilet and tub or shower. If this bathroom is accessible only through a bedroom, the bedroom door shall meet the minimum width requirements of this section.

2. If one or more full bathrooms are provided on the first floor, the bathroom meeting the requirements under this section shall be on the first floor.

Note: ***This section does not require a full bathroom on the first floor.***

(2) HALLWAYS.

(a) Except as allowed under par. (b), the clear width of hallways shall be at least 36 inches.

(b) The following are allowed to infringe on the required clear width of a hallway:

1. Door hardware and finish trim.

2. Handrails may infringe into the minimum width of a hallway up to 4½ inches on each side.

3. Heating registers may infringe into the minimum width of a hallway up to 4½ inches and no part of the register may be more than 38 inches above the floor.

4. Ducts, pipes, light fixtures, structural features, and corner treatments that are within 84 inches of the floor may infringe into the minimum width of a hallway by a maximum of 4½ inches on each side.

5. Unlimited infringements are allowed in a hallway more than 84 inches above the floor.

(3) KITCHENS.

(a) There shall be at least 30 inches of clearance between a wall, a permanently−installed kitchen island, permanently−installed kitchen cabinets and the following kitchen appliances, if provided:

1. A range, cook top or oven.

2. A sink, refrigerator or freezer.

(b) Measurements shall be taken from the face of the wall, island, cabinet or appliance, ignoring knobs and handles.

Note: ***See ICC/ANSI A117.1 chapter 10 for more guidelines relating to doors and accessible routes. Under that standard, doors must be at least 80−inches in height and provide a minimum net clear opening of 31¾−inches in width in order to provide accessibility for people with disabilities.***

COMMENTARY ON THE CODE

321.035(3) Clearance Between Cabinets & Appliances

The required 30 inches of clearance between major appliances and islands, walls or built-in cabinets, is measured to the face of the cabinets, not including countertop nosings.

Assessment Questions

33. All doors and openings to which of the following areas shall be at least 80 inches high and provide either a net clear opening width of 30 inches or be a 32–inch door?

(a) Entrances to common use areas

(b) 50% of bedrooms

(c) At least one full bathroom

(d) All of the above

34. Except as allowed under par. (b), the clear width of hallways shall be at least _____ inches.

(a) 30

(b) 32

(c) 36

(d) 34

35. Handrails may infringe into the minimum width of a hallway up to _____ inches on each side.

(a) 4½

(b) 5

(c) 5½

(d) 5¾

36. There shall be at least _____ inches of clearance between a wall and a permanently–installed kitchen island.

(a) 24

(b) 32

(c) 30

(d) 36

SPS 321.04 Stairways and elevated areas.

(1) SCOPE.

(a) *General.* Except as provided under par. (b), the following stairways shall conform to the requirements of this section.

1. Every interior and exterior stairway attached to, or supported by any part of the structure covered under this code.

2. Tub access stairs, unless they are an integral part of an approved plumbing product.

(b) *Exceptions.* The following stairways are not required to comply with the requirements of this section:

1. Stairways leading to non–habitable attics or crawl spaces.

2. Non–required stairways connecting the basement directly to the exterior of the structure without communicating with any other part of the structure.

COMMENTARY ON THE CODE

Non-required Stairs

Although stairways to attics and crawlspaces are not covered by the code, other non-required stairs, such as a second stairway from the first floor to a basement, are covered. Stairways are a major location of deaths and serious injuries in the home. Statistics from the U.S. Consumer Product Safety Commission (CPSC) show that one in four people will be injured and seek hospital treatment due to an injury related to stairways sometime in their lives. In 1994, the number of injuries from stairs, ramps, landings and floors was 1,879,029. This was an increase over the previous year by 11 percent (200,000-plus injuries), and was roughly equivalent to 19 percent of the total number of injuries reported in all categories for that same year.

The CPSC also estimates that the cost of home injuries in 1994 was $94.3 billion. The cost directly related to injuries from stairs, ramps, landing and floors was $17.5 billion.

Similarly, a study prepared for the U.S. National Bureau of Standards estimated that stair riser/tread dimensions are factors in nearly 50 percent of all stair-related injuries in the home.

321.04(1)(b)2. Exterior Stairs to Basements

Question: Do bulkhead-type doors and stairways need to be code complying?

Answer: No, they must be code complying only if they are used AS AN EXIT, not if they are used as a service or non-required stairway. However, if they are required for egress, then verify the following items:

- **landings,**
- **handrails,**
- **stairway width,**
- **headroom, and**
- **stair treads and risers.**

In the case of bulkhead-type doors and stairs:

- **The headroom height may be measured with the doors open, since the stairway is only usable if the doors are opened; and**
- **A landing is not required at the head of the stairway since this is considered an interior stairway protected from the weather. However, a landing is required at grade outside the door.**

Regarding the door(s), they must meet the exit door requirements if this is a required exit. That means it must be a 32" wide leaf if there is a single door or two 30" openings if there are double doors. If this is not a required exit, then no minimum width applies. Door headroom, at the bottom of stairs, would have to be in compliance with the required stairway headroom.

(2) DETAILS.

(a) *Width.*

1. Except for spiral staircases under subd. 2., stairways shall measure at least 36 inches in width. Handrails and associated trim may project a maximum of 4.5 inches into the required width at each side of the stairway. The minimum clear width at and below the handrail, including at treads and landings, may not be less than 31.5 inches where a handrail is installed on one side, and 27 inches where handrails are provided on both sides.

2. Spiral staircases shall be at least 26 inches wide measured from the outer edge of the supporting column to the inner edge of the handrail.

(b) *Riser height.*

1. a. Except for spiral staircases under subd. 2., risers may not exceed 8 inches in height measured vertically from tread to tread.

   b. At the top and bottom of a flight, measurement shall be taken from the top of the nosing to the finished floor surface unless the finished surface is carpeting, in which case measurement shall be made to the hard surface below the carpeting.

2. Risers in spiral staircases may not exceed 9.5 inches in height measured vertically from tread to tread.

(c) *Tread depth.*

1. 'Rectangular treads.' Rectangular treads shall have minimum tread depth of 9 inches measured horizontally from nosing to nosing.

2. 'Spiral staircase treads.' Spiral staircase treads shall have a minimum tread depth of 7 inches from nosing to nosing measured at a point 12 inches from the outer edge of the center column.

3. 'Winder treads in series.' Two or more winder treads may be placed immediately adjacent to each other anywhere in a stairway provided both of the following conditions are met:

   a. The winder treads shall have a minimum tread depth of 7 inches measured at a point 12 inches from the narrow end of the tread.

b. The depth of the immediately adjoining winder treads shall be equal at a point 12 inches from the narrow end of the tread or inside face of spindles or balusters.

c. Winder treads may not be used on a straight stairway.

4. 'Individual winder treads.'

a. An individual winder tread may be placed between rectangular treads or at the end of a flight of rectangular treads provided the tread depth is at least 9 inches, when measured at a distance of 12 inches from the narrow end of the tread or from the inside face of the wall.

b. There may be more than one individual winder tread in a stairway.

c. Winder treads may not be used on a straight stairway.

(d) *Headroom.*

1. Stairways shall be provided with a minimum headroom clearance of 76 inches measured vertically from a line parallel to the nosing of the treads to the ceiling, soffit or any overhead obstruction directly above that line.

2. The headroom clearance shall be maintained over an intermediate landing.

3. The headroom clearance shall be maintained over a landing that is at the top or bottom of a stairway for a minimum distance of 36 inches in the direction of travel of the stairway.

(e) *Uniformity.*

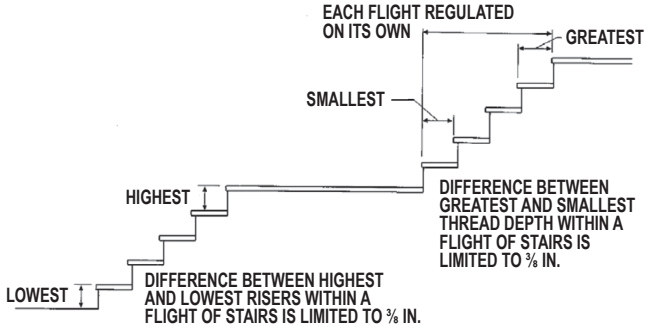
1. Within a stairway flight, the greatest tread depth may not exceed the smallest tread depth by more than 3/8 inch and the greatest riser height may not exceed the smallest riser height by more than 3/8 inch.

2. The allowed variation in uniformity under subd. 1. may not be used to exceed the maximum riser height under par. (b) or to decrease the minimum tread depth under par. (c).

COMMENTARY ON THE CODE

321.04(2)(e)1. Tread Height and Depth Uniformity

Within a stairway flight, the greatest tread depth may not exceed the smallest tread depth by more than 3/8 inch and the greatest riser height may not exceed the smallest riser height by more than 3/8 inch. Once an intermediate landing occurs, a new flight starts and new riser and tread dimensions may be used.



(f) *Open risers.* Stairways with open risers shall be constructed to prevent the through−passage of a sphere with a diameter of 4 inches or larger between any 2 adjacent treads.

(g) *Walking surface.* The walking surface of stair treads and landings shall be a planar surface that is free of lips or protrusions that could present a tripping hazard.

Assessment Questions

37. Which of the following stairways are NOT required to comply with the requirements of SPS 321.04 Stairways and elevated areas?

(a) Stairways leading to non−habitable attics.

(b) Stairways leading to crawl spaces.

(c) Non−required stairways connecting the basement directly to the exterior of the structure without communicating with any other part of the structure.

(d) All of the above

38. Except for spiral staircases under subd. 2., stairways shall measure at least _____ inches in width.

(a) 26

(b) 36

(c) 28

(d) 40

39. Spiral staircases shall be at least _____ inches wide measured from the outer edge of the supporting column to the inner edge of the handrail.

(a) 24

(b) 36

(c) 26

(d) 28

40. Except for spiral staircases under subd. 2., risers may not exceed _____ inches in height measured vertically from tread to tread.

(a) 8

(b) 9

(c) 10

(d) 12

41. Rectangular treads shall have minimum tread depth of _____ inches measured horizontally from nosing to nosing.

(a) 7

(b) 9

(c) 12

(d) 8

42. Spiral staircase treads shall have a minimum tread depth of 7 inches from nosing to nosing measured at a point _____ inches from the outer edge of the center column.

(a) 9

(b) 8

(c) 12

(d) 7

43. Stairways shall be provided with a minimum headroom clearance of _____ inches measured vertically from a line parallel to the nosing of the treads to the ceiling, soffit or any overhead obstruction directly above that line.

(a) 60

(b) 80

(c) 72

(d) 76

44. Within a stairway flight, the greatest tread depth may not exceed the smallest tread depth by more than 3/8 inch.

(a) 1/8

(b) 1/4

(c) 3/8

(d) 3/16

45. Stairways with open risers shall be constructed to prevent the through−passage of a sphere with a diameter of _____ inches or larger between any 2 adjacent treads.

(a) 4

(b) 5

(c) 6

(d) 7

(3) HANDRAILS AND GUARDS.

(a) *General.*

1. A flight of stairs with more than 3 risers shall be provided with at least one handrail for the full length of the flight.

2. Guards shall be provided on all open sides of stairs consisting of more than 3 risers and on all open sides of areas that are elevated more than 24 inches above the floor or exterior grade.

Note*: A handrail provided at 30 to 38 inches above the tread nosing meets the height requirement for a guard on a stairway.*

3. a. Except as provided in subd. 3. b., guards shall be constructed to prevent the through−passage of a sphere with a diameter of 4⅜ inches, when applying a force of 4 pounds.

b. The triangular area formed by the tread, riser and bottom rail shall have an opening size that prevents the through−passage of a sphere with a diameter of 6 inches, when applying a force of 4 pounds.

c. Rope, cable, or similar materials used in guard infill shall be strung with maximum openings of 3½ inches with vertical supports a maximum of 4 feet apart.

Note*: In some cases, the vertical supports could be simple cable stays that offer vertical support to the rope or cable span. Structural posts must be supplied to provide the rail with the minimum 200 pound load resistance, as well as to resist the tensile loads exerted by the tightened rope or cable.*

4. a. Handrails and guards shall be designed and constructed to withstand a 200 pound load applied in any direction.

b. Handrail or guard infill components, balusters and panel fillers shall withstand a horizontally applied perpendicular load of 50 pounds on any one−foot−square area.

c. Glazing used in handrail or guard assemblies shall be safety glazing.

5. Exterior handrails and guards shall be constructed of metal, decay resistant or pressure−treated wood, or shall be protected from the weather.

(b) *Handrails.*

1. 'Height.'

a. Handrails shall be located at least 30 inches, but no more than 38 inches above the nosing of the treads, except as provided in subds. 1. b. to d. Measurement shall be taken from the hard structural surface beneath any finish material to the top of the rail. Variations in uniformity are allowed only when a rail contacts a wall or newel post or where a turnout or volute is provided at the bottom tread.

b. A volute, turnout, or starting easing that does not comply with subd. 1. a. may extend over the lowest tread.

c. Transition fittings on handrails may extend above the 38−inch height limit.

d. Where handrail fittings or bendings are used to provide a continuous transition between flights, or at winder treads, or from a handrail to a guard, or at the start of a flight, the height at the fittings or bendings may exceed 38 inches.

2. 'Clearance.' The clearance between a handrail and the wall surface shall be at least 1½ inches.

3. 'Winders.'

   a. Except as provided under subd. 3. b., the required handrail on winder stairs shall be placed on the side where the treads are wider.

   b. Where all winder treads in a flight have a depth of at least 9 inches from nosing to nosing measured at a point 12 inches from the narrow end of the tread, the required handrail may be located on either side of the stairway.

4. 'Projection.' Handrails and associated trim may project into the required width of stairs and landings a maximum of 4½ inches on each side.

5. 'Size and configuration.' Handrails shall be symmetrical about the vertical centerline to allow for equal wraparound of the thumb and fingers.

   a. Handrails with a round or truncated round cross sectional gripping surface shall have a maximum whole diameter of 2 inches.

   b. Handrails with a rectangular cross sectional gripping surface shall have a maximum perimeter of 6¼ inches with a maximum cross sectional dimension of 2⅞ inches.

   c. Handrails with other cross sections shall have a maximum cross sectional dimension of the gripping surface of 2⅞ inches with a maximum linear gripping surface measurement of 6¼ inches and a minimum linear gripping surface of 4 inches.

Note*: See ch. SPS 325 Appendix A for further information on handrail measurement.*

6. 'Continuity.' Handrails shall be continuous for the entire length of the stairs except in any one of the following cases:

   a. A handrail may be discontinuous at an intermediate landing.

   b. A handrail may have newel posts.

   c. A handrail may terminate at an intermediate wall provided the lower end of the upper rail is returned to the wall or provided with a flared end, the horizontal offset between the 2 rails is no more than 12 inches measured from the center of the rails, and both the upper and lower rails can be reached from the same tread without taking a step.

(c) *Guards.*

1. 'Application.'

   a. All openings between floors, and open sides of landings, platforms, balconies or porches that are more than 24 inches above grade or a floor shall be protected with guards.

   b. The requirements under subd. 1. a. apply where insect screens are the only means of enclosure or protection for a surface that is more than 24 inches above grade or a floor.

   c. For exterior applications, the 24 inch vertical measurement shall be taken from the lowest point within 3 feet horizontally from the edge of the deck, landing, porch or similar structure.

   d. This paragraph does not apply to window wells, egress wells, and retaining walls.

2. 'Height.' Guards shall extend to at least 36 inches above the floor or to the underside of a stair handrail complying with s. SPS 321.04 (3) (b). Measurement shall be taken from the hard structural surface beneath any finish material to the top of the guard.

3. 'Opening size.' Guards shall be constructed to prevent the through−passage of a sphere with a diameter of 4⅜ inches, when applying a force of 4 pounds.

(4) LANDINGS.

(a) *Intermediate landings.*

1. A level intermediate landing shall be provided in any stairway with a height of 12 feet or more.

2. Intermediate landings that connect 2 or more straight flights of stairs, or 2 flights of stairs at a right angle, shall be at least as wide as the treads and shall measure at least 36 inches in the direction of travel.

3. Curved or irregular landing shall have a radius of at least 36 inches.

4. Curved or irregular landings shall have a minimum straight line measurement of 26 inches between the nosing of the 2 connecting treads measured at a point 18 inches from the narrow end of the landing measured along the nosing of the 2 treads.

(b) *Landings at the top and base of stairs*. A level landing shall be provided at the top and base of every stairs except as provided in par. (d). The landing shall be at least as wide as the treads and shall measure at least 3 feet in the direction of travel.

(c) *Doors at landings*. Except as provided in subds. 1. to 3. And par. (d), level landings shall be provided on each side of any door located at the top or base of a stair, regardless of the direction of swing. In the following exceptions, a stairway between a dwelling and an attached garage, carport or porch is considered to be an interior stair:

1. A landing is not required between the door and the top of interior stairs if the door does not swing over the stairs.

2. A landing is not required between the door and the top of an interior stairs of 1 or 2 risers regardless of the direction of swing.

3. A landing is not required between a sliding glass door or an in−swinging glass door and the top of an exterior stairway of 3 or fewer risers.

(d) *Exterior landings*.

1. The exterior landing, platform, or sidewalk at an exterior doorway shall be located a maximum of 8 inches below the interior floor elevation, be sloped away from the doorway at a minimal rate that ensures drainage, and have a length of at least 36 inches in the direction of travel out of the dwelling.

2. The landing at the base of an exterior stair shall be sloped away from the stair at a minimal rate that ensures drainage.

COMMENTARY ON THE CODE

321.04(4)(d) Exterior Landings

This section would allow exterior landings at grade to be turf, gravel or other stable material as long as it sloped away from the dwelling.

Assessment Questions

46. A flight of stairs with more than ____ riser(s) shall be provided with at least one handrail for the full length of the flight.

(a) 1
(b) 2
(c) 3
(d) 4

47. Except as provided in subd. 3. b., guards shall be constructed to prevent the through−passage of a sphere with a diameter of 4⅜ inches, when applying a force of ____ pounds.

(a) 4
(b) 5
(c) 6
(d) 7

48. Rope, cable, or similar materials used in guard infill shall be strung with maximum openings of 3½ inches with vertical supports a maximum of _____ feet apart.

(a) 7

(b) 6

(c) 5

(d) 4

49. Handrails and guards shall be designed and constructed to withstand a _____ pound load applied in any direction.

(a) 100

(b) 125

(c) 200

(d) 175

50. Handrails shall be located at least 30 inches, but no more than _____ inches above the nosing of the treads, except as provided in subds. 1. b. to d.

(a) 40

(b) 38

(c) 42

(d) 36

51. The clearance between a handrail and the wall surface shall be at least _____ inch(es).

(a) 1½

(b) 1

(c) 2

(d) 1¾

52. Handrails with a round or truncated round cross sectional gripping surface shall have a maximum whole diameter of _____ inch(es)

(a) 1

(b) 1.5

(c) 2

(d) 2.5

53. True or false? A handrail must be continuous through an intermediate landing.

(a) True

(b) False

54. Which of the following shall be protected with guards?, and open sides of landings, platforms, balconies or porches that are more than 24 inches above grade or a floor shall be protected with guards

(a) All openings between floors.

(b) Open sides balconies that are more than 24 inches above grade.

(c) Open sides of landings that are more than 24 inches above a floor.

(d) All of the above

55. Guards shall be constructed to prevent the through−passage of a sphere with a diameter of _____ inches, when applying a force of 4 pounds.

(a) 4⅜

(b) 4⅛

(c) 4

(d) None of the above

56. A level intermediate landing shall be provided in any stairway with a height of ____ feet or more.

(a) 9

(b) 10

(c) 11

(d) 12

57. A curved or irregular landing shall have a radius of at least _____ inches

(a) 24

(b) 32

(c) 34

(d) 36

58. True or false? A landing is not required between the door and the top of interior stairs if the door does not swing over the stairs.

(a) True

(b) False

59. A landing is not required between a sliding glass door or an in−swinging glass door and the top of an exterior stairway of ____ or fewer risers.

(a) 3

(b) 4

(c) 5

(d) None of the above

60. The exterior landing, platform, or sidewalk at an exterior doorway shall be located a maximum of _____ inches below the interior floor elevation, be sloped away from the doorway at a minimal rate that ensures drainage, and have a length of at least 36 inches in the direction of travel out of the dwelling.

(a) 12

(b) 10

(c) 8

(d) 4

LIABILITY AND RISK MANAGEMENT

Home Improvement Trade Practices

CHAPTER ATCP 110

HOME IMPROVEMENT PRACTICES

COMMENTARY ON THE CODE

Wisconsin's home improvement law, Wis. Adm. Code ch. ATCP 110, protects consumers contracting for improvements including:

- **basements**
- **sidewalks**
- **patios/decks**
- **driveways**
- **swimming pools**
- **porches**
- **terraces**
- **garages**
- **heating**
- **home alarm systems**
- **landscaping**
- **water softeners**
- **floor coverings**
- **air conditioning**

ATCP 110.01 Definitions.

(1) "Buyer" means either of the following persons who is a party or prospective party to a home improvement contract:

(a) The owner of residential or noncommercial property to which the home improvement contract pertains.

(b) The tenant or lessee of residential or noncommercial property to which the home improvement contract pertains if the tenant or lessee is or will be obligated to make a payment under the home improvement contract.

(2) "Home improvement" means the remodeling, altering, repairing, painting, or modernizing of residential or non−commercial property, or the making of additions thereto, and includes, but is not limited to, the construction, installation, replacement, improvement, or repair of driveways, sidewalks, swimming pools, terraces, patios, landscaping, fences, porches, garages, basements and basement waterproofing, fire protection devices, heating and air conditioning equipment, water softeners, heaters and purifiers, wall−to−wall carpeting or attached or inlaid floor coverings, and other changes, repairs, or improvements made in or on, attached to, or forming a part of, the residential or non−commercial property. The term extends to the conversion of existing commercial structures into residential or non−commercial property. "Home improvement" does not include the construction of a new residence or the major renovation of an existing structure.

(2m) "Major renovation of an existing structure" means a renovation or reconstruction contract where the total price of the contract is more than the assessed value of the existing structure at the time the contract is initiated.

(3) "Residential or non−commercial property" means a structure used, in whole or in part, as a home or place of residence by any natural person, whether or not a single or multi−unit structure, and that part of the lot or site on which it is situated and which is devoted to the residential use of the structure, and includes all appurtenant structures. The term extends to all other existing non−commercial structures and the immediate premises on which they are situated even though they are not used for residential purposes.

(4) "Home improvement contract" means an oral or written agreement between a seller and an owner, or a seller and a tenant or lessee, of residential or non−commercial property, or a seller and a tenant or lessee if the tenant or lessee is to be obligated for the payment of home improvements made in, to, or upon such property, and includes all agreements under which the seller is to perform labor or render services for home improvements, or furnish materials in connection therewith.

(5) "Seller" means a person engaged in the business of making or selling home improvements and includes corporations, partnerships, associations, and any other form of business organization or entity, and their officers, representatives, agents, and employees.

(6) "Warranty" means any warranty or guarantee made with respect to labor, services, products, or materials provided under a home improvement contract. "Warranty" includes a seller's warranty and a manufacturer's product warranty.

Assessment Questions

61. "_____" means the owner of residential or noncommercial property to which the home improvement contract pertains.

(a) Seller

(b) Warranty

(c) Buyer

(d) Tenant

62. The definition of "Home improvement" does NOT include which of the following?

(a) The construction of a new residence.

(b) The major renovation of an existing structure.

(c) The conversion of existing commercial structures into residential or non−commercial property.

(d) Both a and b

63. "Major renovation of an existing structure" means

(a) A renovation or reconstruction contract where the total price of the contract is more than the assessed value of the existing structure at the time the contract is initiated.

(b) A renovation or reconstruction contract where the total price of the contract is more than 50% of the assessed value of the existing structure at the time the contract is initiated.

(c) A renovation or reconstruction contract where the total price of the contract is more than 85% of the assessed value of the existing structure at the time the contract is initiated.

(d) A renovation or reconstruction contract where the total price of the contract is less than the assessed value of the existing structure at the time the contract is initiated.

64. True or false? A "Home improvement contract" can be either an oral or a written agreement between a seller and an owner?

(a) True

(b) False

65. "Seller" means a person engaged in the business of making or selling home improvements and includes which of the following?

(a) Corporations

(b) Partnerships

(c) Associations

(d) All of the above

66. "_____" means any guarantee made with respect to labor, services, products, or materials provided under a home improvement contract.

(a) Major renovation of an existing structure

(b) Home improvement

(c) Warranty

(d) None of the above

ATCP 110.02 Prohibited trade practices. No seller shall engage in the following unfair methods of competition or unfair trade practices:

(1) MODEL HOME REPRESENTATIONS. Misrepresent or falsely state to a prospective buyer that the buyer's residential or non−commercial property is to serve as a "model" or "advertising job", or use any other prospective buyer lure to mislead the buyer into believing that a price reduction or other compensation will be received by reason of such representations.

(2) PRODUCTION AND MATERIAL REPRESENTATIONS. Misrepresent directly or by implication that products or materials to be used in the home improvement:

(a) Need no periodic repainting, finishing, maintenance, or other service.

(b) Are of a specific or well−known brand name, or are produced by a specific manufacturer or exclusively distributed by the seller.

(c) Are of a specific size, weight, grade, or quality, or possess any other distinguishing characteristics or features.

(d) Perform certain functions or substitute for, or are equal in performance to, other products or materials.

(e) Meet or exceed municipal, state, federal, or other applicable standards or requirements.

(f) Are approved or recommended by any governmental agency, person, form, or organization, or that they are the users of such products or materials.

(g) Are of sufficient size, capacity, character, or nature to do the job expected or represented.

(h) Are or will be custom−built or specially designed for the needs of the buyer.

(i) May be serviced or repaired within the buyer's immediate trade area, or be maintained with replacement and repair parts which are readily available.

(3) BAIT SELLING.

(a) Offer or represent specific products or materials as being for sale, where the purpose or effect of the offer or representation is not to sell as represented but to bait or entice the buyer into the purchase of other or higher priced substitute products or materials.

(b) Disparage, degrade, or otherwise discourage the purchase of products or materials offered or represented by the seller as being for sale, by statements or representations in conflict with other claims or representations made with respect to such products and materials, to induce the buyer to purchase other or higher priced substitute products or materials.

(c) Refuse to show, demonstrate, or sell products or materials as advertised, offered, or represented as being for sale.

(e) Fail to have available a quantity of the advertised product sufficient to meet reasonably anticipated demands.

(f) Misrepresent that certain products or materials are unavailable or that there will be a long delay in their manufacture, delivery, service, or installation in order to induce a buyer to purchase other or higher priced substitute products or materials from the seller.

(4) IDENTITY OF SELLER.

(a) Deceptively gain entry into the prospective buyer's home or onto the buyer's property under the guise of any governmental or public utility inspection, or otherwise misrepresent that the seller has any official right, duty, or authority to conduct an inspection.

(b) Misrepresent that the seller is an employee, officer, or representative of a manufacturer, importer, or any other person, firm, or organization, or that such person, firm, or organization will assume some obligation in fulfilling the terms of the contract.

(c) Misrepresent the status, authority, or position of the sales representative in the organization he or she represents.

(d) Misrepresent that the seller is licensed, bonded, or insured. If the seller represents that the seller is licensed, bonded, or insured, the seller shall provide the buyer with a written statement specifically describing the type of license, bond, or insurance that the seller possesses.

Assessment Questions

67. No seller shall misrepresent to a prospective buyer that the buyer's residential property is to serve as a "model" to mislead the buyer into believing that (a) _____ will be received by reason of such representations.

(a) faster completion time
(b) price reduction
(c) improved materials
(d) none of the above

68. No seller shall misrepresent directly or by implication that products or materials to be used in the home improvement need no periodic _____.

(a) repainting
(b) finishing
(c) maintenance
(d) all of the above

69. No seller shall misrepresent directly or by implication that products or materials to be used in the home improvement meet or exceed municipal, state, _____, or other applicable standards or requirements.

(a) international
(b) customary
(c) federal
(d) none of the above

70. No seller shall misrepresent directly or by implication that products or materials to be used in the home improvement are of sufficient _____, capacity, character, or nature to do the job expected or represented.

(a) size
(b) color
(c) shape
(d) all of the above

71. No seller shall misrepresent directly or by implication that products or materials to be used in the home improvement may be serviced or repaired within the buyer's immediate _____.

(a) jurisdiction
(b) shopping center
(c) trade area
(d) none of the above

72. No seller shall _____ the purchase of products or materials offered or represented by the seller as being for sale, by statements or representations in conflict with other claims or representations made with respect to such products and materials, to induce the buyer to purchase other or higher priced substitute products or materials.

(a) disparage

(b) degrade

(c) discourage

(d) all of the above

73. No seller shall misrepresent that certain products or materials are unavailable or that there will be a long delay in their manufacture, delivery, service, or installation in order to induce a buyer to purchase _____.

(a) higher priced substitute products or materials from the seller.

(b) cheaper substitute products or materials from the seller.

(c) lower quality substitute products or materials from the seller.

(d) all of the above

74. If the seller represents that the seller is licensed, bonded, or insured, the seller shall provide the buyer with a(n) _____ statement specifically describing the type of license, bond, or insurance that the seller possesses.

(a) oral

(b) written

(c) hand-written

(d) all of the above

(5) GIFT OFFERS. Offer or advertise any gift, free item, or bonus without fully disclosing the terms or conditions of the offer, including expiration date of the offer and when the gift, free item, or bonus will be given, or fail to comply with the terms of such offer.

(6) PRICE AND FINANCING.

(a) Misrepresent to a prospective buyer that an introductory, confidential, close−out, going out of business, factory, wholesale, or any other special price or discount is being given, or that any other concession is made because of materials left over from another job, a market survey, or test, or any other reason.

(b) Misrepresent that any person, firm, or organization, whether or not connected with the seller, is especially interested in seeing that the prospective buyer gets a bargain, special price, discount, or any other benefit or concession.

(c) Misrepresent or mislead the prospective buyer into believing that insurance or some other form of protection will be furnished to relieve the buyer from obligations under the contract if the buyer becomes ill, dies, or is unable to make payments.

(d) Misrepresent or mislead the buyer into believing that no obligation will be incurred because of the signing of any document, or that the buyer will be relieved of some or all obligations under the contract by the signing of any document.

(e) Request the buyer to sign a completion slip or certificate, or make final payment on the contract before the home improvement is completed in accordance with the terms of the contract.

(f) Fail to disclose that the offered or contract price does not include delivery or installation, or that other requirements must be fulfilled by the buyer as a condition to the performance of labor, services, or the furnishing of products or materials at the offered or contract price.

(g) Misrepresent that the down payment or any other sum constitutes the full amount the buyer will be obligated to pay.

(h) Misrepresent or fail to disclose to a buyer, before the buyer enters into a home improvement contract, the existence or amount of any financing charges, interest service charges, credit investigation costs, building or installation permit fees, or other costs or charges to be paid by the buyer.

(i) Fail to disclose that the home improvement contract, promissory note, or other evidence of indebtedness may be assigned or sold to a financial institution or any other third party.

(j) Advise or induce the buyer to inflate the value of the buyer's property or assets, or to misrepresent or falsify the buyer's true financial position in order to obtain credit.

(k) Increase or falsify the contract price, or induce the buyer by any means to misrepresent or falsify the contract price or value of the home improvement for financing purposes or to obtain additional credit.

(L) Where the buyer requests lien waivers under s. ATCP 110.025 (2), fail to give or furnish to the buyer lien waivers in writing from all contractors, subcontractors, and material suppliers at, or prior to, the time final payment is made on the home improvement contract.

(m) Where partial payments are required at various stages in the performance of the contract, and the buyer requests lien waivers under s. ATCP 110.025 (2), fail to give or furnish to the buyer lien waivers in writing from all contractors, subcontractors, and material suppliers for the proportionate value of all labor, services, and products or materials furnished or delivered as of the time partial payment is made.

(n) Fail to provide notice to a buyer as required under s. ATCP 110.025 (1), before the buyer enters into a home improvement contract, that the buyer is entitled to receive written lien waivers.

(o) Misrepresent that the seller is the only person who can provide financing for the home improvement contract.

Assessment Questions

75. No seller shall offer or advertise any gift, free item, or bonus without fully disclosing which of the following?

(a) terms or conditions of the offer

(b) expiration date

(c) when the gift, free item, or bonus will be given

(d) all of the above

76. No seller shall misrepresent to a prospective buyer that a _____ is being given because of materials left over from another job, a market survey, or test, or any other reason.

(a) special price

(b) discount

(c) tax break

(d) both a and b

77. No seller shall misrepresent or mislead the prospective buyer into believing that _____ or some other form of protection will be furnished to relieve the buyer from obligations under the contract if the buyer becomes ill, dies, or is unable to make payments.

(a) bonds

(b) insurance

(c) legal clauses

(d) government funds

78. True or false? The seller may request the buyer to make final payment on the contract before the home improvement is completed in accordance with the terms of the contract.

(a) True

(b) False

79. No seller shall fail to provide notice to a buyer as required under s. ATCP 110.025 (1), before the buyer enters into a home improvement contract, that the buyer is entitled to receive _____.

(a) written lien waivers

(b) additional credit from financial institutions

(c) insurance

(d) none of the above

80. True or false? The seller is the only person who can provide financing for the home improvement contract.

(a) True

(b) False

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(7) PERFORMANCE.

(a) Deliver materials, begin work, or use any other tactic to pressure the buyer into a home improvement contract, or make any claim or assertion that a binding contract has been agreed upon where no final agreement or understanding exists.

(b) Solicit or accept any payment for home improvement materials or services which the seller does not intend to provide according to the terms of the home improvement contract, or which the seller has reason to believe will not be provided according to the terms of the contract.

(8) INTERFERENCE WITH COMPETITORS.

(a) Make false derogatory statements concerning any competitor, the competitor's equipment, products or materials, workmanship, performance, reputation or responsibility, or attempt to or induce the breach of any existing home improvement contract between a prospective buyer and a competitor, or interfere with or obstruct the performance of any home improvement contract by a competitor.

(b) Misrepresent that the work of a competitor was performed by the seller.

(c) Misrepresent that the seller's products, materials, or workmanship are equal to or better than those of a competitor.

(d) Use or imitate the trade−marks, trade names, labels, or other distinctive marks of a competitor.

(9) SALES REPRESENTATIONS.

(a) Misrepresent or mislead the buyer into believing that a purchase will aid or help some public, charitable, religious, welfare, or veteran's organization, or any other person, group, or organization, or misrepresent the extent of such aid or assistance.

(b) Fail to make any statement of fact, qualification, or explanation if the omission of such statement, qualification, or explanation causes an advertisement, announcement, statement, or representation to be false, deceptive, or misleading.

(c) Misrepresent that the customer's present equipment, material, product, home, or a part thereof, is dangerous or defective, or in need of repair or replacement.

(10) MISAPPROPRIATION OF BUYER'S PREPAYMENTS. Use any home improvement contract payment, received from a buyer prior to the completion of a home improvement, for any purpose other than to provide materials or services for the home improvement.

(11) MISREPRESENTATIONS; GENERAL. Make any false, deceptive, or misleading representation in order to induce any person to enter into a home improvement contract, to obtain or keep any payment under a home improvement contract, or to delay performance under a home improvement contract.

Assessment Questions

81. No seller shall _____, or use any other tactic to pressure the buyer into a home improvement contract.

(a) deliver materials

(b) begin work

(c) both a and b

(d) none of the above

82. No seller shall make false derogatory statements concerning any competitor, and which of the following?

(a) any competitor's equipment

(b) any competitor's products or materials

(c) any competitor's workmanship

(d) all of the above

83. No seller shall use or imitate the _____, or other distinctive marks of a competitor.

(a) trade−marks

(b) trade names

(c) labels

(d) all of the above

84. No seller shall use any home improvement contract payment, received from a buyer prior to the completion of a home improvement, for any purpose other than to _____.

(a) obtain building permits

(b) provide materials or services for the home improvement

(c) acquire building insurance

(d) provide written liens

ATCP 110.09 Basement waterproofing practices.

(1) DECLARATION OF POLICY. Basement water problems and particularly those arising from poor drainage or high water tables are often difficult to correct without a thorough analysis of causative factors and the performance of extensive and costly waterproofing services. The effectiveness of such services, unlike many other services, cannot readily be determined until heavy rains or other conditions responsible for basement water problems occur. In the performance of basement waterproofing services certain methods or processes have been used at substantial cost to the consumer which are ineffective, inadequate, or unsuitable for the correction of basement water problems. Guarantees, if given, may often be vague, ambiguous, or unenforceable against the seller, or otherwise made without reasonable expectancy of performance on the part of the seller to the detriment of the buyer. These and other abuses in the sale of basement waterproofing services are contrary to the public interest and are unfair trade practices and unfair methods of competition prohibited under s. 100.20, Stats.

COMMENTARY ON THE CODE

A leaky basement is one of the most frustrating problems a homeowner can face. Water problems are often difficult and can be costly to correct, but expensive waterproofing is not always the answer.

Services offered to some consumers have been ineffective or inadequate for the correction of basement water problems. Guarantees given by some contractors are vague and confusing.

(2) DEFINITIONS.

(a) "Advertising" means any oral, written, printed, or graphic statement or representation made in connection with the solicitation or sale of basement waterproofing services.

(b) "Basement waterproofing" means the use or application of materials or processes for the prevention or control of water leakage or flow through the basement walls or flooring into the interior portion of a basement.

(c) "Engineer's analysis" means a written report from a professional engineer registered in the state of Wisconsin containing an analysis of soil conditions, water tables or pressure, and other factors or conditions affecting the existence and correction of basement water problems, and an opinion as to the probability that the process and the particular substances or materials which are to be used in the performance of basement waterproofing services will or will not cure the basement water problem or have a significant waterproofing effect.

(d) "Pressure pumping" means a basement waterproofing process by which a substance is injected into the ground adjacent to the basement walls or beneath the basement foundation or floor by pipes or other conduits for the purpose of protecting or sealing the basement walls, foundation, or floors against water penetration.

(e) "Seller's analysis" is a written statement by the seller of the causes and conditions responsible for the buyer's basement water problem and the specific processes and materials to be used in correcting the problem.

(f) "Guarantee" means any promise, made by or on behalf of the seller in connection with the sale of basement waterproofing services, which provides that the seller's services, materials, or workmanship are defect free or will meet a specified level of performance over a specified period of time, or which provides that the seller will correct, repair, service, replace, make refunds for, or otherwise remedy any systems, problems, defects, or malfunctions that relate to or arise out of basement waterproofing services. The term includes service contracts or agreements made by or on behalf of the seller in connection with a basement waterproofing contract under which the seller provides or agrees to perform, over a fixed or extended period of time, basement waterproofing inspection, maintenance, or repair services, whether or not a separate or additional charge is made for such services.

Assessment Questions

85. "_____" is a written statement by the seller of the causes and conditions responsible for the buyer's basement water problem and the specific processes and materials to be used in correcting the problem.

(a) Guarantee
(b) Engineer's analysis
(c) Seller's analysis
(d) Advertising

86. "_____" means the use or application of materials or processes for the prevention or control of water leakage or flow through the basement walls or flooring into the interior portion of a basement.

(a) Basement waterproofing
(b) Engineer's analysis
(c) Pressure pumping
(d) Guarantee

(3) PROHIBITED PRACTICES. No seller of basement waterproofing services, products, or materials shall engage in the following unfair trade practices or unfair methods of competition:

(a) Make or offer to make any guarantee with respect to basement waterproofing services unless the guarantee meets the requirements of sub. (4), and is furnished to the buyer in writing with a seller's analysis prior to final execution of any contract.

(b) Make any guarantee the seller knows or reasonably ought to know cannot be performed or which exceeds the period of time the seller or other persons obligated under the guarantee may be able to honor or perform under the guarantee.

(c) Submit a seller's analysis to the buyer which the seller knows or reasonably ought to know is founded on incorrect facts or conclusions.

(d) Enter into a basement waterproofing contract which provides, in whole or in part, for the performance of services which the seller knows or reasonably ought to know are unnecessary or will not materially serve to correct the buyer's basement water problem, unless such unnecessary or noncorrective services are separately and distinctly identified and enumerated in the seller's analysis, or an amendment thereto, provided to the buyer prior to execution of a basement waterproofing contract.

(e) Advertise basement waterproofing services in a manner which explicitly states or otherwise suggests or implies that such services will be guaranteed, unless they are in fact guaranteed and a copy of the guarantee is furnished to the buyer in connection with any basement waterproofing contract.

(f) Advertise that basement waterproofing services of the seller are or will be effective unless the seller is experienced in and uses basement waterproofing methods generally recognized as being effective for the prevention or control of basement water problems in the basement waterproofing industry.

(g) Sell basement waterproofing services using the pressure pumping method unless the need or effectiveness of such method is established in a seller's analysis verified by an engineer's analysis furnished to the buyer prior to the sale, and the work is guaranteed as provided under sub. (4).

(h) Advertise basement waterproofing services using the pressure pumping process without disclosing in the advertisement that an engineer's analysis recommending this process is required as a condition to the use thereof, and must be furnished to the buyer before a contract is signed.

(i) Enter into any contract for basement waterproofing services which does not contain all agreements, promises, or representations made with respect to such services, and which is not in writing and signed by the buyer and seller.

(j) Fail to provide, in all instances where the seller's basement waterproofing services are not guaranteed, the following disclaimer, which shall be set forth on the face of the contract, separate and apart from all other contract provisions, and in bold face type: "THE BASEMENT WATERPROOFING SERVICES PROVIDED BY THIS CONTRACT ARE NOT GUARANTEED."

COMMENTARY ON THE CODE

Sellers of basement waterproofing services are required to do the following under Wis. Admin. Code § ATCP 110.09:

- **Provide buyers with a "seller's analysis" which describes the water problem and the specific methods and material to be used in correcting it before finalizing any contract.**
- **Provide all guarantees in writing.**
- **Before advertising the usage of effective methods, the seller must have experience in using the method and the method must be generally recognized by the industry.**
- **Basement waterproofing services using a pressure pumping method can be sold only if the need or effectiveness of this method is established by the waterproofing company, verified by an engineer's analysis, and provided to the buyer prior to the sale.**

(4) GUARANTEES.

(a) All guarantees shall be furnished to the buyer in writing prior to the final execution of any contract and include the name and address of the seller or person responsible for performance under the guarantee. Guarantees shall be considered part of the basement waterproofing contract and any breach in the terms or conditions thereof shall entitle the buyer to a full refund of money paid under the contract, less the value of benefits actually derived from the performed services. The burden of establishing any benefit to the buyer shall be on the seller.

(b) All guarantees shall be set forth in clear and explicit terms and shall fully guarantee that the work or services to be performed will effectively prevent or control the basement water problem they were designed or intended to prevent or control for the period of time specified in the guarantee. Basement dampness may be excluded from the guarantee if agreed to by the buyer in writing and the guarantee or contract contains the following statement in bold face type: "THE GUARANTEE PROVIDED HEREIN DOES NOT COVER DAMPNESS ON THE BASEMENT WALLS—IT DOES COVER ANY WATER LEAKAGE OR FLOW."

(c) All guarantees shall contain a provision that any remedial work or services to be performed under the guarantee shall begin within 45 days and be completed within 6 months after notice by the buyer to the seller of any failure of the waterproofing services under the contract. Notice of any claim by the buyer under the guarantee shall be deemed actual notice if mailed by certified mail to the seller's address as set forth in the guarantee.

(5) SELLER'S ANALYSIS. Sellers of basement waterproofing services shall prepare and furnish to the buyer a signed copy of the seller's analysis prior to the final execution of any basement waterproofing contract.

Assessment Questions

87. No seller of basement waterproofing services, products, or materials shall engage in which of the following?

(a) Make any guarantee which exceeds the period of time the seller may be able to honor or perform under the guarantee.

(b) Submit a seller's analysis to the buyer which the seller reasonably ought to know is founded on incorrect facts or conclusions.

(c) Enter into a basement waterproofing contract which provides, in whole or in part, for the performance of services which the seller knows are unnecessary.

(d) All of the above

88. No seller of basement waterproofing services, products, or materials shall fail to provide, in all instances where the seller's basement waterproofing services are not guaranteed, which of the following disclaimers?

(a) THE BASEMENT WATER-PROOFING SERVICES PROVIDED BY THIS CONTRACT ARE NOT GUARANTEED

(b) THE PRESSURE PUMPING SERVICES PROVIDED BY THIS CONTRACT ARE NOT GUARANTEED

(c) THE ENGINEER'S ANALYSIS PROVIDED BY THIS CONTRACT ARE NOT GUARANTEED

(d) THE BASEMENT WATER-PROOFING SERVICES PROVIDED BY THIS CONTRACT ARE NOT COVERED BY INSURANCE

89. All guarantees shall be furnished to the buyer _____ prior to the final execution of any contract and include the name and address of the seller or person responsible for performance under the guarantee.

(a) verbally

(b) in writing

(c) electronically

(d) all of the above

90. All guarantees shall contain a provision that any remedial work or services to be performed under the guarantee shall begin within _____ days after notice by the buyer to the seller of any failure of the waterproofing services under the contract.

(a) 15

(b) 30

(c) 45

(d) 6

Home Improvement Trade Practices

ATCP 110.023 Substituting products or materials; altering the written contract.

(1) No seller may substitute products or materials for those specified in the home improvement contract, or for those which the seller represented would be used in the home improvement, without the prior consent of the buyer. Except as provided in sub. (2), if a written home improvement contract is required under s. ATCP 110.05 (1) or the buyer signs a written contract, the buyer's consent under this paragraph shall also be in writing.

Note: ***According to s. 137.15 (3), Stats., "If a law requires a record to be in writing, an electronic record satisfies that requirement in that law."***

(2) VERBAL AUTHORIZATION. The seller may act on alterations to the contract that are verbally authorized by the buyer, if all the following conditions are met:

(a) The alteration does not represent any additional cost to the buyer.

(b) The alteration does not represent a decrease in the value of the materials used or the services provided.

(c) The seller maintains documentation of the following:

1. The manner in which the buyer communicated the authorization for the alteration. In this subdivision, "manner" means face−to−face discussion, phone call, or some other method of communicating.
2. The name of the buyer who authorized the alteration.
3. The date and time that the buyer authorized the alteration.
4. A description of the alteration.

(d) The seller must report any alterations documented pursuant to par. (c) to the buyer before final payment is accepted.

Assessment Questions

91. No seller may substitute products or materials for those specified in the home improvement contract, or for those which the seller represented would be used in the home improvement, without the _____.

(a) addition of insurance

(b) provision of a written lien

(c) prior consent of the buyer

(d) all of the above

92. The seller may act on alterations to the contract that are verbally authorized by the buyer, if which of the following conditions are met?

(a) The alteration does not represent any additional cost to the buyer.

(b) The alteration does not represent a decrease in the value of the materials used or the services provided.

(c) The seller must report any alterations documented pursuant to par. (c) to the buyer before final payment is accepted.

(d) All of the above

93. The seller may act on alterations to the contract that are verbally authorized by the buyer, if the seller maintains documentation of which of the following?

(a) The manner in which the buyer communicated the authorization for the alteration.

(b) The name of the buyer who authorized the alteration.

(c) The date and time that the buyer authorized the alteration.

(d) All of the above

ATCP 110.025 Lien waivers.

(1) A seller shall provide notice to buyer that buyer may request written lien waivers from all contractors, subcontractors, and material suppliers at, or prior to, the time any payment is made on the home improvement contract. Notice shall be provided before the buyer and seller enter into a home improvement contract. The notice shall meet the following requirements:

(a) The notice shall be in writing and consist of the following, verbatim statement:

Notice of Consumer's Right to Receive Lien Waivers

If a consumer requests lien waivers, a seller of home improvement services must provide lien waivers from all contractors, subcontractors, and material suppliers. This Wisconsin law protects consumers from having liens filed against their property. Lien waivers prevent the filing of a lien on your home in the event that a contractor does not pay suppliers or subcontractors.

For more information about home improvement law, contact the Wisconsin Consumer Protection Bureau at 1−800−422−7128 or www.datcp.wi.gov.

(b) The notice shall be provided as a separate document, written in a clear and conspicuous font, in a format that the buyer can retain.

(c) The seller shall retain evidence of the buyer's acknowledgement of receipt of the notice.

(2) Upon request from the buyer, the seller shall provide the buyer with lien waivers in writing from all contractors, subcontractors, and material suppliers for the proportionate value of all labor, services, and products or materials furnished or delivered as of the time payment is made. Unless the buyer specifies that the lien waiver request applies only to the final payment, the seller shall provide lien waivers at the time any partial payments are made.

COMMENTARY ON THE CODE

Home improvement contractors by law must give the buyer a "Notice of Consumer's Right to Receive Lien Waivers" before the buyer and seller enter into a home improvement contract. The notice shall inform the buyer that the buyer may request lien waivers from all contractors, subcontractors, and material suppliers at, or prior to, the time any payment is made on the home improvement contract.

When any payment is made – especially final payment – consumers have the option to get lien waivers from the contractor.

Contractors must provide the lien waivers if a buyer requests them. The following case study explains why lien waivers are so important to consumers:

CASE STUDY

Mr. Jones signed a contract with ABC Contractors for the construction of an addition to his home. When the work was done, Jones paid the contracted price and started enjoying his new addition.

A month later, he received a "Notice of Intent to File Claim for Lien" from the lumberyard where ABC Contractors obtained building materials in the mail.

What happened? Although Jones had paid his bill, ABC Contractors did not pay the lumberyard. The law allows a subcontractor or supplier of materials to place a lien on the property where the work was done if the contractor does not pay his bills. This can happen even if the homeowner has paid the contract in full.

To protect against this, buyers should be given completed "waiver of lien" forms by the contractor and each subcontractor anytime payment is made. These forms should be signed by the contractor and every other person supplying materials or labor covered by the payment.

Assessment Questions

94. Notice that buyer may request written lien waivers from all contractors, subcontractors, and material suppliers shall be provided _____ the buyer and seller enter into a home improvement contract.

(a) before

(b) after

(c) either of the above

(d) none of the above

95. True or false? The seller shall retain evidence of the buyer's acknowledgement of receipt of the notice.

(a) True

(b) False

96. Unless the buyer specifies that the lien waiver request applies only to the _____, the seller shall provide lien waivers at the time any partial payments are made.

(a) first payment

(b) final payment

(c) building insurance

(d) security bonds

ATCP 110.027 Delay in contract performance.

(1) A seller must give the buyer timely notice of any impending delay in the home improvement contract performance if performance will be delayed beyond a deadline specified in the home improvement contract. The notice shall specify any reasons for the delay and shall specify new proposed deadlines by which the seller will begin and complete the work. If a written home improvement contract is required under s. ATCP 110.05 (1) or the buyer signs a written contract, no change in performance deadlines is effective unless the buyer agrees in writing to the change.

Note: ***According to s. 137.15 (3), Stats., "If a law requires a record to be in writing, an electronic record satisfies that requirement in that law."***

(2) Notwithstanding sub. (1), a seller shall not be responsible for delays in contract performance if the seller can demonstrate any of the following:

(a) The delay was caused by actions or inactions of the buyer.

(b) The delay was caused by a destructive act of nature such as tornado, flood, or fire.

(c) The delay was caused by disruptive civil disorder such as a strike, hostile action, or war.

Assessment Questions

97. If a written home improvement contract is required under s. ATCP 110.05 (1) or the buyer signs a written contract, no change in performance deadlines is effective unless the buyer agrees _____ to the change.

(a) orally

(b) in writing

(c) both a and b are correct

(d) electronically

98. A seller shall not be responsible for delays in contract performance if the seller can demonstrate which of the following:

(a) The delay was caused by actions or inactions of the buyer.

(b) The delay was caused by a destructive act of nature such as tornado, flood, or fire.

(c) The delay was caused by disruptive civil disorder such as a strike, hostile action, or war.

(d) All of the above

ATCP 110.03 Building permits.

(1) Before a buyer enters into a home improvement contract, the seller shall inform the buyer of all building or construction permits that are required for the home improvement. Except as provided in sub. (4), no seller may start work under a home improvement contract until all required state and local permits have been issued.

(2) Where midpoint or final inspections are required under state laws or local ordinances, copies of inspection certificates shall be furnished to the buyer when construction is completed and before final payment is due or the signing of a completion slip is requested of the buyer.

(3) Pursuant to sub. (2), if the state or local inspector who completed the inspection does not issue an inspection document, the seller may provide a summary of the inspection to the buyer. The summary shall include the inspector's name, the date of the inspection, and inspection number or some other way to identify the inspection in the state or local building inspection database.

(4) Notwithstanding sub. (1), if the home improvement contract includes subprojects, no seller may start work on any subproject of a home improvement contract that requires state or local permits until all permits required for that subproject have been issued.

Assessment Questions

99. True or false? Sellers may start work under a home improvement contract before all required state and local permits have been issued.

(a) True

(b) False

100. Where midpoint or final inspections are required under state laws or local ordinances, copies of inspection certificates shall be furnished to the _____.

(a) inspector

(b) building official

(c) buyer

(d) insurance company

101. If the state or local inspector who completed the inspection does not issue an inspection document, the seller may provide a summary of the inspection to the buyer. The summary shall include which of the following?

(a) The inspector's name

(b) The date of the inspection

(c) The inspection number

(d) All of the above

ATCP 110.04 Warranties.

(1) A seller shall give a buyer a copy of every written warranty made with respect to labor, services, products, or materials furnished in connection with a home improvement. If a seller makes any oral warranty, the seller shall document that warranty in writing and give a copy to the buyer. The seller shall provide all warranty documents to the buyer at the time the buyer enters into a home improvement contract, except that a manufacturer's product warranty may be provided at any of the following times:

(a) At the time the buyer enters into a home improvement contract.

(b) At the time the product is installed.

(c) At the conclusion of the project, if specified in the contract.

(2) If a seller warrants any labor, service, product, or material furnished in connection with a home improvement, the warranty shall be clear and specific and shall clearly specify all of the following:

(a) Any warranty conditions or exclusions.

(b) Any limitations on the scope or duration of the warranty.

(c) The time period within which the seller will perform the seller's warranty obligations after the buyer makes a valid warranty claim.

(3) No seller may give any warranty which the seller does not intend to honor in full, or which the seller has reason to believe will not be honored in full.

Assessment Questions

102. A seller shall give a buyer a copy of every written warranty made with respect to which of the following?

(a) Labor

(b) Services

(c) Products or materials

(d) All of the above

103. True or false? If a seller makes any oral warranty, the seller shall document that warranty in writing and give a copy to the buyer.

(a) True

(b) False

104. The seller may provide a manufacturer's product warranty at which of the following times?

(a) At the time the buyer enters into a home improvement contract.

(b) At the time the product is installed.

(c) At the conclusion of the project, if specified in the contract.

(d) All of the above

ATCP 110.05 Home improvement contract requirements.

(1) The following home improvement contracts and all changes in the terms and conditions thereof, shall be in writing:

(a) Contracts requiring any payment of money or other consideration by the buyer prior to completion of the seller's obligation under the contract.

(b) Contracts which are initiated by the seller through face–to– face solicitation away from

the regular place of business of the seller, mail or telephone solicitation away from the regular place of business of the seller, mail or telephone solicitation, or handbills or circulars delivered or left at places of residence.

(2) If sub. (1) requires a written home improvement contract or the buyer signs a written contract, the written contract shall be signed by all parties and shall clearly, accurately and legibly set forth all material terms and conditions of the contract, including:

(a) The name and address of the seller, including the name and address of the sales representative or agent who solicited or negotiated the contract for the seller.

(b) A description of the work to be done and the principal products and materials to be used or installed in performance of the contract. The description shall include, where applicable, the name, make, size, capacity, model, and model year of principal products or fixtures to be installed, and the type, grade, quality, size, or quantity of principal building or construction materials to be used. Where specific representations are made that certain types of products or materials will be used, or the buyer has specified that certain types of products or materials are to be used, a description of such products or materials shall be clearly set forth in the contract.

(c) The total price or other consideration to be paid by the buyer, including all finance charges. If the contract is one for time and materials the hourly rate for labor and all other terms and conditions of the contract affecting price shall be clearly stated.

(d) The dates or time period on or within which the work is to begin and be completed by the seller.

(e) A description of any mortgage or security interest to be taken in connection with the financing or sale of the home improvement.

(f) A statement of any guarantee or warranty with respect to any products, materials, labor, or services made by the seller or which are required to be furnished to the buyer under s. ATCP 110.04 (1).

(g) A description or identification of any other document which is to be incorporated in or form part of the contract.

(3) Before the seller begins work or receives any payment under a written home improvement contract, the seller shall provide the buyer with a copy of the contract.

(4) Where a representation is made that insurance or some other form of protection will be provided, the contract shall clearly state the terms, conditions, and limitations thereof, as well as the name and address of the insurer or the person who is furnishing such protection, if different from the seller. A copy of the insuring or protection agreement, declarations page, or some other document that shows evidence of insurance or other protection shall be furnished to the buyer before final payment is due under the contract.

(5) If a person other than the seller is to act as the general contractor or assume responsibility for performance of the contract, the name and address of such person shall be disclosed in the oral or written contract, except as otherwise agreed, and the contract shall not be sold or assigned without the written consent of the buyer.

(6) Before a buyer enters into a written home improvement contract prepared or offered by the seller, the seller shall determine if the buyer is able to read and understand the contract. If the buyer is blind or unable to read the contract, the written contract shall be read and explained to the buyer by a third party designated by the buyer and having no connection with the seller. If a language other than English is primarily used in contract negotiations, the written contract shall be both in English and in the language used to negotiate the contract.

(7) Liquidated damages for breach of contract by the buyer if made a part of the contract shall not exceed 10% of the contract price.

(8) If the buyer is required to sign a note, the amount and terms of the note shall correspond exactly with those stated in the oral or written contract.

COMMENTARY ON THE CODE

Do not rely on oral agreements. It is wise to request a written contract in all situations. The contract serves as a statement that the contractor knows exactly what services the buyer wants performed.

Make sure the contract contains:

- The name and address of the salesperson, as well as the company name and address (not just a post office box number).
- A full description of the job. Again, do not rely on oral agreements.
- A detailed list of materials to be used including the name, brand, size, models, performance capacity of the items, and the quantity of materials to be used.
- The total price, plus finance charges.
- A starting and completion date, to prevent the job from going on indefinitely.
- A statement explaining any warranties on materials, labor or services. Be sure you understand any exceptions or limitations.

If any payment is required before the work is done, a written contract is required by the law.

Assessment Questions

105. True or false? Contracts requiring any payment of money or other consideration by the buyer prior to completion of the seller's obligation under the contract shall be in writing.

(a) True

(b) False

106. True or false? Contracts which are initiated by the seller through face–to– face solicitation away from the regular place of business of the seller shall either be an oral agreement or in writing.

(a) True

(b) False

107. _____ the seller begins work or receives any payment under a written home improvement contract, the seller shall provide the buyer with a copy of the contract.

(a) Before

(b) After

(c) Both a and b are correct

(d) None of the above

108. Liquidated damages for breach of contract by the buyer if made a part of the contract shall not exceed _____% of the contract price.

(a) 20%

(b) 15%

(c) 10%

(d) 5%

109. If the buyer signs a written contract, the written contract does NOT need to include which of the following:

(a) The name and address of the sales representative who solicited or negotiated the contract.

(b) The total price or other consideration to be paid by the buyer.

(c) A statement which prevents the job from going on indefinitely

(d) A description of the materials to be used or installed.

110. If the buyer is blind or unable to read the contract, the written contract shall be read and explained to the buyer by _____.

(a) An attorney

(b) A third party designated by the buyer and having no connection with the seller

(c) The seller

(d) All of the above

111. If a language other than English is primarily used in contract negotiations, the written contract shall be in _____.

(a) English

(b) The language used to negotiate the contract

(c) Both English and the language used to negotiate the contract

(d) Latin

ATCP 110.06 Preservation of buyer's claims and defenses.

(1) Every assignee of a home improvement contract takes subject to all claims and defenses of the buyer or successors in interest.

Note*: Under this section, where the seller assigns the debt to a finance company before completing the contract and then fails to complete the contract, the finance company is subject to the same claims and defenses the buyer has against the contractor.*

(2) No seller shall enter into any home improvement contract wherein the buyer waives the right to assert against the seller or any assignee any claim or defense the buyer may have against the seller under the contract.

(3) No seller shall use any promissory note or instrument, other than a check, in connection to a home improvement contract unless it bears the following statement in contrasting bold−face type: "This is a home improvement instrument and is non−negotiable. Every holder takes subject to claims and defenses of the maker or obligor."

(4) Every holder or transferee of a negotiable instrument executed in violation of this section, who knew or should have known at the time the document was acquired that it was made to evidence an obligation for home improvements, or who knew or should have known that the payee or transferor was engaged in the home improvement business, takes subject to all claims and defenses of the maker or obligor.

(5) Claims and defenses of any buyer against an assignee or transferee under the contract shall be limited to the total amount for which the buyer was obligated at the time of entering into the contract.

Assessment Question

112. No seller shall enter into any home improvement contract wherein the buyer _____ to assert against the seller or any assignee any claim or defense the buyer may have against the seller under the contract.

(a) possesses the right

(b) waives the right

(c) hires an attorney

(d) none of the above

113. True or false? Every assignee of a home improvement contract takes subject to all claims and defenses of the buyer or successors in interest.

(a) True

(b) False

114. Claims and defenses of any buyer against an assignee or transferee under the contract shall be limited to _____ for which the buyer was obligated at the time of entering into the contract.

(a) the total amount

(b) half the total amount

(c) twice the total amount

(d) 80% of the total amount

ATCP 110.07 Contract cancellation; return of payments.

(1) CONDITIONS WARRANTING EXERCISE OF BUYER'S REMEDIES. If, under a home improvement contract, a buyer pays a seller for any home improvement materials or services before the seller provides those materials or services to the buyer, the buyer may proceed under sub. (2) if any of the following occurs:

(a) The seller fails to provide the materials or services by a deadline specified in the home improvement contract.

(b) The seller fails to give buyer notice of an impending delay as required under s. ATCP 110.02 (7) (c), or fails to obtain the buyer's agreement to a new performance deadline.

Note: ***Section ATCP 110.02 (7) (c) specified that it was a prohibited unfair trade practice for a seller to fail to give the buyer timely notice of any impending delay in contract performance, if performance will be delayed beyond the deadline specified in the contract. Effective May 1, 2014, s. ATCP 110.02 (7) (c) is repealed and s. ATCP 110.027 (1) is created. Section ATCP 110.027 (1) requires sellers to give buyers timely notice of any impending delay in the home improvement contract performance if performance will be delayed beyond a specified deadline.***

(c) The buyer believes that the seller has failed to provide the materials or services in a timely manner, and the home improvement contract specifies no deadline for the seller to provide the materials or services.

(2) BUYER'S REMEDIES. If the conditions under sub. (1) are met, the buyer may do all of the following:

(a) Cancel the contract.

(b) Demand return of all payments which the seller has not yet expended on the home improvement.

(c) If the seller has used any of the buyer's payments to purchase materials for the home improvement, demand delivery to the home improvement site of those materials which have not yet been used for the home improvement or delivered to the site.

(d) Demand a written accounting for all payments that the buyer made to the seller. The written accounting shall detail how all payments were used by the seller.

(3) BUYER'S EXERCISE OF REMEDIES; PROCEDURE. In order to exercise any remedy under sub. (2), the buyer shall deliver written notice to the seller, or to the seller's officer, director, or agent. Notice shall be delivered in person, by certified mail to the seller's last known address, or by regular mail with evidence of mailing to the seller's last known address. If notice is mailed to the seller, the date on which the post office receives the notice for delivery is considered the date of service for purposes of sub. (4). Compliance with this subsection is not a prerequisite to the buyer's exercise of other remedies other than those specified under sub. (2).

(4) COMPLIANCE BY SELLER.

(a) If the buyer demands the return of payments to which the buyer is entitled under sub. (2) (b), the seller shall return those payments to the buyer within 15 calendar days after the buyer's demand is served on the seller under sub. (3).

(b) If the buyer demands delivery of materials to which the buyer is entitled under sub. (2) (c), the seller shall deliver those materials to the home improvement site within 15 calendar days after the buyer's demand is served on the seller under sub. (3), or within 5 calendar days after the seller receives the materials from the seller's supplier, whichever occurs later.

(c) If the buyer demands an accounting to which the buyer is entitled under sub. (2) (d), the seller shall provide the buyer with the written accounting within 30 calendar days after the buyer's demand is served on the seller under sub. (3).

(5) REMEDIES NOT EXCLUSIVE. A buyer's remedies under this section are in addition to any other legal remedies available to the buyer. They are not a prerequisite to the exercise of any other remedies, nor do they limit any other remedies.

COMMENTARY ON THE CODE

If a buyer pays for, but does not receive materials, services, or completion of work, they may cancel a home improvement contract after three business days by:

- **Giving a written notice canceling the contract.**
- **Demanding return of all money the contractor has not yet spent on the project. (The contractor must return this amount within 15 days.)**
- **Demanding delivery of all materials which the contractor has purchased with the buyer's money. (The contractor must deliver the materials within 15 days or within 5 days after the contractor receives materials from the supplier, whichever is later.)**
- **Demanding a written accounting for all payments made to the contractor including specific details of how all payments were spent or used. (The contactor must give this accounting within 30 days.)**

Assessment Question

115. A buyer may cancel a contract if they have paid a seller for any home improvement materials or services and the seller fails to do which of the following?

(a) Provide the materials or services by a deadline specified in the home improvement contract.

(b) Give buyer notice of an impending delay.

(c) Obtain the buyer's agreement to a new performance deadline.

(d) All of the above

116. Yes or no? If a buyer has paid a seller for any home improvement materials or services, and the buyer believes that the seller has failed to provide the materials or services in a timely manner, but the contract specifies no deadline for the seller to provide the materials or services, can the buyer cancel the contract?

(a) Yes

(b) No

117. In order to demand return of all payments which the seller has not yet expended on the home improvement, the buyer shall deliver _____ notice to the seller, or to the seller's officer, director, or agent.

(a) verbal

(b) written

(c) electronic

(d) all of the above

118. If the buyer demands the return of payments to which the buyer is entitled, the seller shall return those payments to the buyer within _____ calendar days after the buyer's demand is served on the seller.

(a) 5

(b) 10

(c) 12

(d) 15

119. If the buyer demands delivery of materials to which the buyer is entitled, the seller shall deliver those materials to the home improvement site within 15 calendar days after the buyer's demand is served on the seller, or within _____ calendar days after the seller receives the materials from the seller's supplier, whichever occurs later.

(a) 3

(b) 4

(c) 5

(d) 15

120. If the buyer demands an accounting to which the buyer is entitled, the seller shall provide the buyer with the written accounting within _____ calendar days after the buyer's demand is served on the seller.

(a) 5

(b) 15

(c) 20

(d) 30

WCI Wisconsin Contractors Institute

Masonry Construction

Course Number 22606 – 3 C.E. Hours

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INTRODUCTION

This course explores masonry construction; included in the course is an overview of the history of masonry, a review of masonry terms, an introduction to the types of masonry materials, their manufacturing methods, and applications in residential as well as the several types of masonry construction. The course allows contractors to explore the most widely used masonry materials in today's residential construction, and it includes the methods of installation of those materials.

THE HISTORY OF MASONRY

What is Masonry?

This section starts with a brief overview of masonry history, starting with some of the earliest uses of masonry throughout the years. Then offers some of the earliest examples of masonry construction and gradually moves through the development of masonry materials, concluding with a look at how masonry materials are used in the modern world.

Masonry is the art and craft of building or fabricating with stone, clay, brick, or concrete block, is one of the oldest of the skilled trades. It dates back to the use of sunbaked clay brick more than 6,000 years ago. Masonry construction helped build some of the world's most notable structures, including the Egyptian Pyramids, the Roman Colosseum, the Taj Mahal, and the Great Wall of China.

Located just east of the Roman Forum, the massive stone amphitheater known as the Colosseum was commissioned around A.D. 70-72. The Coliseum was officially opened in 80 A.D. The Coliseum, which is an amphitheater, had proximally 100 days of games in the opening year, including gladiatorial combat and wild animal fights after four centuries of active use the arena felon to neglect and up until the 18th century when it fell into neglect up until the 18th century it was used as a source of building materials, and approximately two-thirds of the original Coliseum had been destroyed over time. Today the amphitheater remains a popular tourist destination as well as an iconic symbol of Rome and its long, tumultuous history. The Coliseum, which measures some 620 x 513', was the largest amphitheater in the Roman world. The Coliseum was a freestanding structure that was built of travertine limestone, volcanic rock, and brick-faced concrete. The exterior had three stories of arched entrances and a total of around 80 supported or semicircular columns.

The Great Wall of China is another example of early masonry construction. The Great Wall is a series of fortifications that were built across the historical northern borders of the ancient Chinese states and Imperial China as protection against various nomadic groups. Several walls were built from as early as the seventh century B.C., with other stretches being constructed as late as the Ming Dynasty, which ran between 1366 and 1644. Not only was the Great Wall built for the defense against nomadic troops, but it also provided border control which allowed for the imposition of duties on goods arriving at the area. The Great Wall was one of the first efforts to regulate trade and to control immigration and emigration. Before the use of bricks, the Great Wall was mainly built from rammed earth stones; however, during the Ming Dynasty, bricks were used as well as earth and stone. While portions of the wall toward the north of Beijing and near tourist centers have been preserved and extensively renovated, many other areas of the wall are in disrepair. The wall sometimes provided a source of stones to build houses and roads. Some sections of the wall were prone to graffiti and vandalism, and a number of the brick were pilfered and sold on the open market.

The Taj Mahal represents the finest and most sophisticated example of Indo Islamic architecture. The Taj Mahal was built as a memorial to one of the deceased wives of an Emperor. Today the Taj Mahal is one of the most famous and recognizable buildings in the world, and its domed marble mausoleum is the most familiar part of the Taj Mahal. The Taj Ma included tombs, a waterworks infrastructure and encompasses the small town of Taj Ganji to the south and a moonlight garden to the north. Construction of the Taj Mahal began in 1632 A. D. The building is constructed with walls of brick and rubble on the inner core and faced with either marble or sandstone locked together with iron dowels and clamps. Over 1000 elephants were used to transport the building materials during construction. The bricks were fired locally, and the sandstone was quarried 28 miles away. The white

marble was brought 250 miles from quarries in the region. There were also a number of minerals used in the construction, including turquoise, Jasper, and Sapphire. In all, 28 types of precious and semi-precious stones were inlaid into the white marble. It is reported that the scaffolding and the centering for the arches were constructed entirely of brick. Legend says that the emperor offered the scaffolding brick to anyone who would remove them, and at the end of construction, they were all removed within a week. Wikipedia reports that many scholars dispute this last fact and consider that a great deal of the scaffold was constructed using bamboo and timber ramps. The construction project employed some 20,000 artisans.

The Egyptian Pyramids are thought to have been constructed in approximately 400 B.C. The Pyramid of Khufu is the largest Egyptian pyramid. It is the only one of the Seven Wonders of the World still in existence. The Colossus of Rhodes, the Lighthouse of Alexandria, the Mausoleum at Halicarnassus, the Temple of Artemis, and the Statue of Zeus were all destroyed. The location and ultimate fate of the Hanging Gardens are unknown, and there is speculation that they may not have existed at all. The limestone was likely transported on canal boats on the Nile River and then transferred to sleds that were dragged across the sand, which was moistened in order to help reduce friction as the sleds were being moved.

The Early Days of Masonry Construction

Through civilization, architects and builders have chosen masonry for its beauty, versatility, and durability. Masonry is resistant to fire, earthquakes, and sound. Masonry is artistic and durable, and masonry structures can withstand the normal wear and tear of centuries.

The level of complexity involved in masonry work varies from laying a simple masonry wall to installing an ornate exterior or high-rise building. Whether contractors are working with brick, block, tile, terra-cotta, or stone, and regardless of the level of craftsmanship involved, the skill and precision of the mason can never be replaced by machines. This concept will be discussed later in the course.

The art of masonry began spontaneously in the creation of walls from stone or pieces of caked mud. The first mortar was just mud smeared in between pieces of stone to add stability. Over time, brick and later limestone were introduced in masonry construction.

The most frequently used products are clay brick and concrete blocks by masons. Brick is man's oldest manufactured product. Sun-baked clay bricks were used in the construction of buildings more than 6,000 years ago. In order to prevent distortion and cracking of the clay shapes, chopped straw and grass were added to the clay mixture. The next big step in enhancing brick production occurred about 4,000 B.C. At that time, manufacturers began producing brick in uniform shapes. Along with the shaping of brick, the move from sunbaking to firing was another important change. This improved the durability of the brick.

Through the centuries, the methods for producing brick have continued to evolve. Today, the United States standard brick size is 2½ x 3¾ x 8 inches. Brick is composed of shale and clay and is fired in kilns of approximately 2,000 degrees Fahrenheit. The firing process causes the clay particles to bond chemically.

As brick construction became more elaborate, the use of brick became more sophisticated. The evolution of brick construction design led, in part, to the development of the concrete block.

The first hollow concrete block was designed in 1890 by Harmon S. Palmer in the United States. After ten years of experimenting, Palmer patented the design in 1900. Palmer's blocks were 8 in (20.3 cm) by 10 in (25.4 cm) by 30 in (76.2 cm), and they were so heavy they had to be lifted into place with a small crane. By 1905, an estimated 1,500 companies were manufacturing concrete blocks in the United States.

These early blocks were usually cast by hand, and the average output was about ten blocks per person per hour. Today, concrete block manufacturing is a highly automated process that can produce up to 2,000 blocks per hour.

The manufacturing and uses of concrete block evolved over a long period of time. This evolution was prompted by the development of cavity walls. When originally developed, cavity walls consisted of two separate brick or stone walls with about a 2-inch air space between them.

Cavity walls were developed to reduce the problems associated with water penetration. Water that would seep inside the outer wall would then run down that wall, while the inside wall would remain dry. Cavity walls soon became recognized as the best way to build, not only because they helped reduce problems with water penetration but because they could support a heavy load such as a roof or floor. In 1850 a special block with air cells was developed. Over the years, modifications to this product were introduced until the industry arrived at the standardized product that is used today.

Below is an approximate timeline regarding the development of masonry materials and techniques.

10,000 – 6,000 BC	The first sun-dried clay bricks were made.
3500 BC	The first kiln fired clay brick units were made.
2500 BC	Masons began using mortar made with sand and gypsum.
500 BC	Some mortar was made with sand and lime.
50 A.D.	Concrete brick units were made by Romans.
1824	Portland cement is invented-used in concrete and later in mortar.
1830	Imitation stone is made using Portland cement-based materials.
1890	Harmon S. Palmer invents concrete block in the U.S.
1940	Paddlewheel type mortar mixer is invented.

After more than 6,000 years, masonry is still used today. Today when looking around at office buildings, schools, houses, patios, and fireplaces, it is possible to notice that there are many aspects of society where some form of masonry can be seen.

There has been some recent advancement with technology regarding the role of masons. In the past, there was little doubt that the role of masons would be in jeopardy. For example, there is a company called FBR (Fast Brick Robotics) from Western Australia, which has developed a machine called the Hadrian X, which is the world's first mobile robotic block laying machine and system in the world. This is touted as being able to build block structures from a 3D CAD model, which produces far less waste than traditional construction methods and dramatically improves site safety and efficiency. The manufacturer claims that their machine is capable of building the walls of the house in as little as a day. The company has also developed a machine known as the Hadrian 105, which is an automated bricklaying machine. Even with advances in technology, it is believed that the skill and precision of the mason can't be fully replaced with machines.

FINAL EXAM QUESTIONS:

1. **All of the following statements about the art of masonry are true, EXCEPT for:**
   a. Masonry is the art and craft of building or fabricating with stone, clay, brick or concrete block.
   b. Masonry has only been a craft that has been practiced since 18th century.
   c. The art of masonry is one of the oldest of the skilled trades dating back more than 6,000 years.
   d. Some of the world's most notable structures including the Roman Coliseum, Egyptian Pyramids, the Taj Mahal, and the Great Wall of China are early examples of masonry.

2. **Masonry was developed through the years because:**
   a. It is less expensive than other forms of construction.
   b. Easy to find materials.
   c. Was chosen for its beauty, versatility and durability; it is also resistant to fire earthquakes and sound.
   d. Artisans skilled in masonry work were plentiful and therefore easy to build.

3. **All of the following statements about masonry construction are true except for:**
   a. Sunbaked clay products were used in the construction of building more than 6,000 years ago.
   b. Brick is man's oldest manufactured product.
   c. The brick we use today is basically the same as the brick we used six thousand years ago.
   d. The most significant development in manufacturing brick was producing brick and uniform shapes and firing the brick in order to improve durability.

4. **The first hollow concrete block was designed in 1890 by Harmon S Palmer, the design was patented in 1900. Which of the following statement(s) about that invention are true.**
   a. The block was so heavy they had to be lifted in place by crane.
   b. The block that Harmon invented is virtually the same size and weight as the block we have today.
   c. Both a and b
   d. Neither a or b

5. **A major problem with masonry construction was:**
   a. The material eroded very easily.
   b. The walls would leak allowing water and moisture to seep into the interior of the building, thus cavity walls were developed.
   c. The material did not prove to be as fireproof as originally thought.
   d. Artisans skilled in masonry construction were plentiful and it was difficult to determine which craftsmen to use.

6. **A masonry unit is a generic default term to reference which of the following?**
   a. Brick
   b. Concrete block
   c. Stone
   d. All of the above

MASONRY TERMS AND MATERIALS

It is important for contractors to be familiar with masonry terms. This section will define key masonry terms.

One of the most important masonry terms is a **masonry unit**. A masonry unit is a generic default term to reference any individual piece of masonry, whether it be glass, brick, block, stone, or any other material used in masonry construction. Masonry units can vary in the type of material that makes up the unit, as well as the shape, size, and color of the unit.

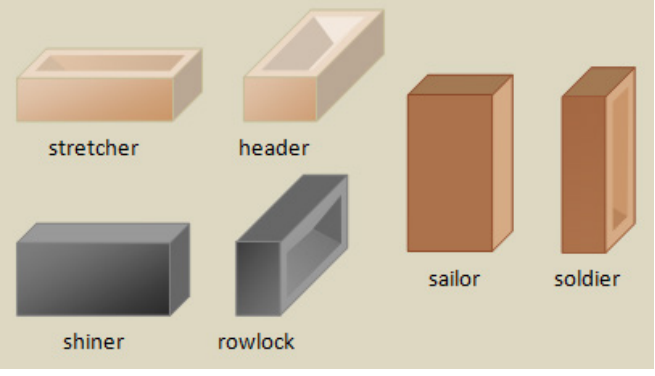
The most common types of masonry units include clay units, concrete units, and natural stone. Masonry units can be made up of both natural and manufactured materials. For example, natural stone is a masonry unit, although it is not a manufactured masonry unit.

Common Brick Terms

A brick is a cube with three dimensions. It has a length, a width, and a height. In the U.S. today, the standard brick size is 2½ x 3¾ x 8 inches. Bricks have six sides, with each side having a distinct name. The long side of the brick is called the **face**. The backside of the brick is called the **side**. The two edges are called the **cull** and the **end**. The top and bottom sides are called the **bed**.

It is often rather confusing to properly understand and to identify what brick may be called based on their orientation and installation. Below is a list of names that are often referred to in the masonry industry when referring to brick and their installation. The table contains the name and provides contractors with the exposed face of the brick, which is visible.

Brick Name	Exposed Faces of Brick
Stretcher	Length and Height
Header	Width and Height
Soldier	Height and Length
Sailor	Width and Length
Rowlock (Bull Header)	Height and Width
Rowlock Stretcher (Shiner)	Length and Width



This illustration gives some idea of how the brick is placed in reference to the preceding slide, and the terms are used. These names can often be referenced by remembering that a soldier stands at attention, a sailor more so at ease or at parade rest; a stretcher lying flat, a header and row lot showing just the end of the brick, and a row lock stretcher showing a face of the brick laid lengthwise.

The photo shows a representation of a row lock or what is sometimes called a bull header used beneath a window as an exterior windowsill. It also shows

a stretcher beneath the sill as the brick is laid in courses up the wall.

This photo shows a number of orientations of brick as they have been used in residential construction. At the sides of the windows and in the architectural detail at the second-floor level, the photo shows that headers have been used. Above the windows, the photo has a rowlock has been used as the brick have been installed in an arch above the fixed sash portion of the windows. In the architectural detail between floor levels, the photo shows brick standing on their ends with the vertical face exposed. This is a soldier. The courses of brick that make up the remainder of the wall are stretchers because the brick is laid lengthwise with one face visible.

Some additional brick terms to be familiar with include course, wythe, as well as terms that describe dimensions. A **course** of brick is a continuous horizontal bond. Courses are measured or counted vertically. **Wythe** is a term given to one thickness of masonry in a wall. A **specific dimension** is the anticipated dimension of the unit after manufacture. The **actual dimension** is the precise measurement after manufacture. The **nominal dimension** is the sum of the specified dimension plus the anticipated width of the mortar joint (usually 3/8"). In most instances, three courses of brick plus the mortar joints equals 8."

Here are some additional interesting facts about brick. The size of bricks has not changed significantly through the years. Brick is designed to fit comfortably in the hand of a mason and be laid in mortar. Brick has a dimensional relationship between length width and height for instance:

- Two brick plus one mortar joint equals one brick length.
- Three brick heights plus two mortar joints equal to brick length.
- The height of three courses of brick equals the height of one concrete block.

Another term important term to become familiar with is **concrete masonry unit** or what is often referred to as CMU's. A concrete masonry unit is any masonry unit that is made of concrete, that could be a standard concrete block, a split face concrete block, or cultured stone, which is also manufactured using concrete. Concrete masonry units will be covered in more detail later on in the course.

FINAL EXAM QUESTIONS:

7. A brick is a masonry unit which is composed of six sides; each side having a unique name depending on the face of the brick that is exposed. All of the following are common brick names with the exception of:

a. Sailor
b. Soldier
c. Trooper
d. Rowlock

8. When considering common brick terms, the word "course" means:

a. A continuous horizontal bond which is measured or counted vertically
b. The texture of the brick on the exposed face.
c. The size of the brick prior to firing.
d. The thickness of a masonry wall.

9. The specified dimension of a brick is:

a. The precise measurement after manufacture.

b. The sum of the specified dimension plus the anticipated width of the mortar joint which is usually three eights of an inch.

c. Not a significant number because all brick varies in size.

d. The anticipated dimension of the unit after manufacture.

10. The following statements about brick are all true except:

a. The height of three courses of brick equals the height of six one concrete block.

b. There is no relationship between the height of a concrete block and the number of courses of brick because all brick are different sizes.

c. Two brick plus one mortar joint equals one brick length.

d. Three brick Heights plus two mortar joints equals one brick length.

MANUFACTURING METHODS AND APPLICATIONS

This section dives a little deeper and discusses the manufacturing method for brick and other products as well as their application in the construction industry. The section also discusses the two most common brick products that are encountered as well as many others.

Clay Brick – Manufacturing and Applications

The fundamentals of brick manufacturing have not changed over time. However, technological advancements have made contemporary brick plants substantially more efficient and have improved the overall quality of the products. Complete knowledge of raw materials and their properties, better control of firing, improved kiln designs, and more advanced mechanization have all contributed to advancing the brick industry.

The most significant part of brick is the raw material that being clay. Clay is one of the most abundant materials on earth; however, Fort to be usable, it must possess plasticity strength both wet and dry in order to maintain its shape, and it must be able to fuse together when it is subject to the appropriate firing temperature. Clay can be found in nearly every state in the United States. For your interest, below is a list of the top 10 brick producers in the country. This list includes the name of the company, its location, the number of employees, and its gross revenues.

COMPANY	LOCATION	NUMBER OF EMPLOYEES	REVENUE
Acme Brick	Fort Worth, TX	2633	$750.8 M
General Shale, Inc.	Johnson City, TN	1500	$300 M
Brampton Brick, Inc.	Farmersburg, IN	319	$124.5 M
Glen-Gery Corp.	Wyomissing, PA	900	$124.3 M
Carolina Ceramics Brick Company	Columbia, SC	569	$113.8 M
Hebron Brick Supply Company	Fargo, ND	514	$102.8 M
Endicott Clay Products Co.	Fairbury, NE	447	$89.4 M
Triangle Brick Company	Durham, NC	388	$57.5 M

Morin Brick Company	Auburn, ME	300	$40 M
Palmetto Brick Co.	Wallace, SC	200	$33.2 M

Although the fact that the raw material used in manufacturing brick is clay, and it appears that there would not be multiple types of clay, there are, in fact, some different types that are used in manufacturing various types of brick. In manufacturing, common brick frequently surfaces clay and shale are used. Clay consists of upthrusts of older or recent sedimentary formations found near the surface of the earth. Shales are deeper and are clays that have been subject to extremely high pressure and have nearly hardened into slate. Fire clays our mind at the deepest levels, and they have refractory characteristics, which makes them very suitable for our typical firebrick that is used inside of masonry fireplaces.

There are several phases required in the process of manufacturing brick. They are listed below.

The phases of manufacturing brick include:

- Mining and storage of raw materials
- Preparing the raw materials
- Forming the brick
- Drying and hacking
- Firing and cooling
- De-hacking and storage

Mining and Storage

Surface clays, shales, and some fire clays are mined in open pits with power equipment. Then the clay or shale mixtures are transported to plant storage areas. Continuous brick production regardless of weather conditions is ensured by storing enough raw materials required for many days of plant operation. Normally, several storage areas (one for each source) are used to facilitate the blending of the clays. Blending produces more uniform raw materials, helps control color, and allows raw material control for manufacturing a certain brick.

Preparation

The first step in preparation is to break up clay lumps and stones. To do this, the materials are processed through size-reduction machines before mixing the raw material. Usually, the materials are processed through inclined vibrating screens to control particle size. During the process of preparing the raw materials often sand is added as well as additional water if it is needed to assist with the bonding of the clay particles.

Forming the Brick

Tempering, the first step in the forming process, produces a homogeneous, plastic clay mass. Usually, this is achieved by adding water to the clay in a pug mill, a mixing chamber with one or more revolving shafts with blade extensions. After pugging, the plastic clay mass is ready to form. There are three principal processes for forming brick: stiff-mud, soft-mud, and dry-press.

Stiff-Mud Process – In the stiff-mud or extrusion process, water in the range of 10 to 15 percent is mixed into the clay to produce plasticity. After pugging, the tempered clay goes through a deairing chamber that maintains a vacuum of 15 to 29 in. (375 to 725 mm) of mercury. De-airing removes air holes and bubbles, giving the clay increased workability and plasticity, resulting in greater strength. Next, the clay is extruded through a die to produce a column of clay. As the clay column leaves the die, textures or surface coatings may be applied (Textures, Coatings, and Glazes). An automatic cutter then slices through the clay column to create the individual brick. Cutter spacings and die sizes must be calculated to compensate for normal shrinkage that occurs during drying and firing. About 90 percent of bricks in the United States are produced by the extrusion process.

Soft-Mud Process – The soft-mud or molded process is particularly suitable for clays containing too much water to be extruded by the stiff-mud process. Clays are mixed to contain 20 to 30 percent water and then formed into a brick in molds. To prevent the clay from sticking, the molds are lubricated with either sand or water to produce "sand-struck" or "water-struck" brick. Brick may be produced in this manner by machine or by hand.

Dry-Press Process – This process is particularly

suited to clays of very low plasticity. Clay is mixed with a minimal amount of water (up to 10 percent), then pressed into steel molds under pressures from 500 to 1500 psi by hydraulic or compressed air rams.

Drying and Hacking

Wet brick from molding or cutting machines contains 7 to 30 percent moisture, depending upon the forming method. Before the firing process begins, most of this water is evaporated in dryer chambers at temperatures ranging from about 100 ºF to 400 ºF (38 ºC to 204 ºC). The extent of drying time, which varies with different clays, usually is between 24 to 48 hours. Although heat may be generated specifically for dryer chambers, it usually is supplied from the exhaust heat of kilns to maximize thermal efficiency. In all cases, heat and humidity must be carefully regulated to avoid cracking in the brick.

Hacking is the process of loading a kiln car or kiln with brick. The number of the brick on the kiln car is determined by kiln size. The bricks are typically placed by robots or mechanical means. The setting pattern has some influence on appearance. Bricks placed face-to-face will have a more uniform color than the brick that is cross-set or placed face-to-back.

Firing and Cooling

Bricks are fired between 10 and 40 hours, depending upon kiln type and other variables. There are several types of kilns used by manufacturers. The most common type is a tunnel kiln, followed by periodic kilns. Fuel may be natural gas, coal, sawdust, methane gas from landfills, or a combination of these fuels. In a tunnel kiln, bricks are loaded onto kiln cars, which pass through various temperature zones as they travel through the tunnel. The heat conditions in each zone are carefully controlled, and the kiln is continuously operated. A periodic kiln is one that is loaded, fired, allowed to cool, and unloaded, after which the same steps are repeated. Dried brick are set in periodic kilns according to a prescribed pattern that permits the circulation of hot kiln gases.

Firing may be divided into five general stages:

1. final drying (evaporating free water);
2. dehydration;
3. oxidation;
4. vitrification; and
5. flashing or reduction firing.

All except flashing are associated with rising temperatures in the kiln. Although the actual temperatures will differ with clay or shale, final drying takes place at temperatures up to about 400 ºF (204 ºC), dehydration from about 300 ºF to 1800 ºF (149 ºC to 982 ºC), oxidation from 1000 ºF to 1800 ºF (538 ºC to 982 ºC) and vitrification from 1600 ºF to 2400 ºF (871 ºC to 1316 ºC). Clay, unlike metal, softens slowly and melts or vitrifies gradually when subjected to rising temperatures. Vitrification allows the clay to become a hard, solid mass with relatively low absorption.

Melting takes place in three stages:

1. incipient fusion, when the clay particles become sufficiently soft to stick together in a mass when cooled;
2. vitrification, when extensive fluxing occurs and the mass becomes tight, solid, and nonabsorbent; and
3. viscous fusion, when the clay mass breaks down and becomes molten, leading to a deformed shape.

The key to the firing process is to control the temperature in the kiln so that incipient fusion and partial vitrification occur, but viscous fusion is avoided. The rate of temperature change must be carefully controlled and is dependent on the raw materials, as well as the size and coring of the brick being produced. Kilns are normally equipped with temperature sensors to control firing temperatures in the various stages. Near the end, the brick may be "flashed" to produce color variations

Cooling

After the temperature has peaked and is maintained for a prescribed time, the cooling process begins. Cooling time rarely exceeds 10 hours for tunnel kilns and from 5 to 24 hours in periodic kilns. Cooling is an important stage in brick manufacturing because the rate of cooling has a direct effect on color.

The next and final step in the manufacturing process is referred to as de-hacking.

De-hacking and Storage

De-hacking is the process of unloading a kiln or kiln car after the brick has cooled, a job often performed by robots. Brick are sorted, graded, and packaged. Then they are placed in a storage yard or loaded onto rail cars or trucks for delivery. Most of the brick today is packaged in self-contained, strapped cubes, which can be broken down into individual strapped packages for ease of handling on the job site. The packages and cubes are configured to provide openings for handling by forklifts.

Brick Applications

In residential and commercial construction, bricks are used primarily in:

- Foundations
- Veneers
- Structural Walls
- Fireplaces
- Architectural Design Enhancements

Below are some examples showing common uses of construction bricks.

Quoin Corners

The photo below illustrates brick being used as a veneer on a frame residential home. The brick, however, is laid at the corners in a manner that makes them stand out from the veneer itself. This type of architectural detail is referred to as a quoin corner. According to one 19th century encyclopedia, these imply strength, permanence, and expense, all reinforcing the onlooker's sense of a structure's presence.

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Herringbone Design

The following photo shows brick being used and laid in a herringbone design which creates additional architectural detail and variety to normal brick courses.

In some residential communities' brick veneer may only be used on the front exterior surface of the home, while other services will be covered in other less expensive materials. Contractors may also encounter homes that may be a combination of lap siding, brick veneer, and cultured stone. It is important to remember that when various materials are used on the exterior surfaces of the home, it is important to thoroughly evaluate the transition between materials because they require special attention in order to prevent water penetration which can cause damage to building components.

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FINAL EXAM QUESTIONS:

11. Clay which is the main ingredient in brick manufacturing is:

a. Difficult to find in the United States

b. A minor ingredient in the manufacturing of brick.

c. Is one of the most abundant minerals on earth.

d. Must not fuse together when exposed to appropriate temperatures.

12. **Which of the following is NOT a phase or step in brick manufacturing?**
    a. Mining and storage of raw materials
    b. Forming the brick.
    c. Firing and cooling
    d. Using the clay particles without controlling particle size.

13. **In the brick manufacturing process de-hacking refers to the process of:**
    a. Taking the brick out of the mold.
    b. Removing the straps around the brick at the job site.
    c. Unloading and unpacking the kiln after drying.
    d. Taking the brick out of the factory and placing them on the truck for delivery.

14. **In residential construction brick are:**
    a. Not used because they are expensive.
    b. Are not used because they lack durability.
    c. Are used primarily for foundations, veneers, structural walls, and fireplaces.
    d. Subject to damage and deterioration.

Concrete Block – Manufacturing and Applications

Definition

Concrete masonry units are an important concept, which was introduced in the definition section. Recall that concrete masonry units or (CMU) are any masonry unit that is made of concrete, that could be a standard concrete block, a split face concrete block, or cultured stone, which is also manufactured using concrete. This section focuses specifically on the concrete block. A concrete block is primarily used as a building material in the construction of walls. It is sometimes called a concrete masonry unit. A concrete block is one of several precast concrete products used in construction. The term precast refers to the fact that the blocks are formed and hardened before they are brought to the job site. Most concrete blocks have one or more hollow cavities, and their sides may be cast smooth or with a design. In use, concrete blocks are stacked one at a time and held together with fresh concrete mortar to form the desired length and height of the wall.

How Concrete Blocks Are Made

This section highlights the process for making concrete blocks. The concrete commonly used to make concrete blocks is a mixture of powdered Portland cement, water, sand, and gravel. This produces a light gray block with a fine surface texture and a high compressive strength. A typical concrete block weighs 38-43 lb. In general, the concrete mixture used for blocks has a higher percentage of sand and a lower percentage of gravel and water than the concrete mixtures used for general construction purposes. This produces a very dry, stiff mixture that holds its shape when it is removed from the block mold.

The production of concrete blocks consists of four basic processes: mixing, molding, curing and cubing. Some manufacturing plants produce only concrete blocks, while others may produce a wide variety of precast concrete products, including blocks, flat paver stones, and decorative landscaping pieces such as lawn edging. Some plants are capable of producing 2,000 or more blocks per hour.

Mixing

The sand and gravel are stored outside in piles and are transferred into storage bins in the plant by a conveyor belt as they are needed. The Portland cement is stored outside in large vertical silos to protect it from moisture. As a production run starts, the required amounts of sand, gravel, and cement are transferred by gravity or by mechanical means to a weigh batcher which measures the proper amounts of each material. The dry materials then flow into a stationary mixer, where they are blended together for several minutes.

There are two types of mixers commonly used. One type, called a planetary or pan mixer, resembles a shallow pan with a lid. Mixing blades are attached to a vertical rotating shaft inside the mixer. The

other type is called a horizontal drum mixer. After the dry materials are blended, a small amount of water is added to the mixer. If the plant is located in a climate subject to temperature extremes, the water may first pass through a heater or chiller to regulate its temperature. Admixture chemicals and coloring pigments may also be added at this time. The concrete is then mixed for six to eight minutes.

Molding

From the hopper, the concrete is conveyed to another hopper on top of the block machine at a measured flow rate. In the block machine, the concrete is forced downward into molds. The molds consist of an outer mold box containing several mold liners. The liners determine the outer shape of the block and the inner shape of the block cavities. As many as 15 blocks may be molded at one time. When the molds are full, the concrete is compacted by the weight of the upper mold head coming down on the mold cavities. This compaction may be supplemented by air or hydraulic pressure cylinders acting on the mold head. Most block machines also use a short burst of mechanical vibration to further aid compaction. The compacted blocks are pushed down and out of the molds onto a flat steel pallet. The pallet and blocks are pushed out of the machine and onto a chain conveyor. In some operations, the blocks then pass under a rotating brush which removes loose material from the top of the blocks.

Curing

The pallets of blocks are conveyed to an automated stacker or loader, which places them in a curing rack. Each rack holds several hundred blocks. When a rack is full, it is rolled onto a set of rails and moved into a curing kiln. The kiln is an enclosed room with the capacity to hold several racks of blocks at a time. There are two basic types of curing kilns. The most common type is a low-pressure steam kiln. In this type, the blocks are held in the kiln for one to three hours at room temperature to allow them to harden slightly. Steam is then gradually introduced to raise the temperature at a controlled rate of not more than 60°F per hour. Standard weight blocks are usually cured at a temperature of 150-165°F, while lightweight blocks are cured at 170-185°F. When the curing temperature has been reached, the steam is shut off, and the blocks are allowed to soak in the hot, moist air for 12-18 hours. After soaking, the blocks are dried by exhausting the moist air and further raising the temperature in the kiln. The whole curing cycle takes about 24 hours.

Another type of kiln is the high-pressure steam kiln, sometimes called an autoclave. In this type, the temperature is raised to 300-375°F, and the pressure is raised to 80-185 psi. The blocks are allowed to soak for five to 10 hours. The pressure is then rapidly vented, which causes the blocks to quickly release their trapped moisture. The autoclave curing process requires more energy and a more expensive kiln, but it can produce blocks in less time.

Cubing

The racks of cured blocks are rolled out of the kiln, and the pallets of blocks are unstacked and placed on a chain conveyor. The blocks are pushed off the steel pallets, and the empty pallets are fed back into the block machine to receive a new set of molded blocks. If the blocks are to be made into split-face blocks, they are first molded as two blocks joined together. Once these double blocks are cured, they pass through a splitter, which strikes them with a heavy blade along the section between the two halves. This causes the double block to fracture and form a rough, stone-like texture on one face of each piece. The blocks pass through a cuber which aligns each block and then stacks them into a cube three blocks across by six blocks deep by three or four blocks high. These cubes are carried outside with a forklift and placed in storage. Normally there is a 72–8” block on in a pallet or cube.

Lightweight Concrete vs. Cinder Block

Although contractors often refer to concrete block rather generically, it is important to differentiate between a standard concrete block, lightweight concrete block, and cinderblock.

Lightweight Concrete Block

Lightweight concrete blocks are made by replacing the sand and gravel with expanded clay, shale, or slate. Expanded clay, shale, and slate are produced by crushing the raw materials and heating them to about 2000°F (1093°C). At this temperature, the material bloats or puffs up because of the rapid generation of gases caused by the combustion of small quantities of organic material trapped inside. A typical lightweight block weighs 22-28 lb. and is used to build non-load-bearing walls and partitions. Expanded blast furnace slag, as well as natural

volcanic materials such as pumice and scoria, are also used to make lightweight blocks.

Cinder Block

If granulated coal or volcanic cinders are used instead of sand and gravel, the resulting block is commonly called a cinder block. This produces a dark gray block with a medium-to-coarse surface texture, good strength, good sound-deadening properties, and a higher thermal insulating value than a concrete block. A typical cinder block weighs 26-33 lb.

Applications

Some of the most common applications for the use of concrete block and the ones which contractors are most likely to encounter are where the concrete blocks are used for:

- Foundations with or without a brick
- Block Piers
- Dry stacked of modular or manufactured homes
- Load Bearing Walls
- Partition Walls
- Structural Walls reinforced with steel and concrete

When discussing concrete blocks, it is important to realize that blocks come in a number of shapes or designs, all of which have a different purpose in mind. It is important for contractors to highlight the stretcher unit, which is the common block that is used on the majority of a foundation wall; however single corner units are often used when making 90° turns so that the irregular end of the stretcher unit is not exposed. Another shape is double corner units that are often used for masonry piers. A third example of a different shape is Lintel units which are often filled with concrete and rebar, as well as bond beam units that are used when incorporating rebar into the wall, filling the voids with concrete in order to provide structural and loadbearing strength.

FINAL EXAM QUESTIONS:

15. Which statement about concrete block is most correct.

a. A concrete block is the only pre-cast product used in the construction industry.

b. The term pre-cast means that the block are always the same design and shape.

c. Concrete block is not considered a CMU.

d. The term pre-cast refers to the fact that the blocks are formed and hardened before they are brought to the job site.

16. Which of the following statements about kilns is NOT true?

a. There are two basic types of kilns

b. Kilns are used during the cubing process

c. The most common type of kiln is a low-pressure steam kiln

d. Kilns are used during the curing process

17. Concrete blocks are manufactured using what step(s)?

a. Firing in a kiln at the same temperatures as brick.

b. Mixing, molding, curing, and cubing.

c. Placing them in cubes containing exactly 100 block per cube.

d. Adding at least 50% water.

18. Which statement about concrete block is NOT true.

a. Concrete block and cinder block refer to the same product with the same ingredients.

b. Concrete block can be standard block weighing between 38-43 lbs. each, or lightweight block weighing between 22-28 lbs. each.

c. Concrete blocks are made from Portland cement, water, sand, and gravel.

d. Cinder block are made using coal or volcanic cinders instead of sand and gravel; they also have higher thermal insulating values than concrete block.

Concrete – Manufacturing and Applications

This section covers the manufacturing of concrete and the many applications that contractors will encounter in residential construction. Often times contractors will hear concrete known as ready-mix, wherein the concrete is manufactured in a batch plant and trucked to the job site for use. When ordering concrete, it is ordered in a set engineered mix design that is based on the strength of the concrete and its psi rating. Concrete is normally delivered in one of two ways it either arrives on site ready to use in a transit mixer, often referred to as a barrel truck, or in a volumetric concrete mixer. The major difference between the two is that the in-transit mixer comes stocked with a specified number of cubic yards of concrete, while the volumetric concrete mixer will mix the amount of concrete needed for the job while on site.

The major components of concrete simply put their water, sand, some sort of aggregate, and Portland cement. The exact proportion of these ingredients used will, in fact, determine the strength of the concrete mix.

This photo is of a barrel truck. With barrel trucks or in-transit mixers, there are several components involved in the successful operation and delivery of concrete on the job site. The barrel itself is driven by a hydraulic transmission system that constantly turns the barrel in order to successfully mix the concrete components while in transit and to prevent the mix from setting up in the barrel prematurely. There is a water supply located on each of the barrel trucks in order to keep the concrete moist and workable and also to clean the shoot or discharge system after the concrete is delivered. In most instances, the control of the discharge of the concrete is handled by a control system at the exterior of the truck or from inside the cab. Contractors may occasionally encounter a barrel truck where the discharge is actually located toward the front of the vehicle instead of at the rear. Functionally, however, the front and rear discharge types of in-transit mixers operate in the same fashion.

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This photo is of a volumetric concrete mixing truck. In volumetric concrete mixing trucks, there

are hoppers on the truck which hold the aggregate or rock, the sand, the cement, and water. They're also additional reservoirs for additives and bitumen emulsion. Bitumen emulsion, however, is primarily used for pavement preservation techniques. Once on-site, the ingredients are mixed in the proper proportions to provide the desired concrete strength, and they are delivered through the concrete mixing shoot and deposited where needed.

As mentioned previously, the strength of the **concrete** is inversely proportional to the water/**cement** ratio. In other words, the **more** water you use to mix the **concrete**, the weaker the **concrete** mix. The less water you use to mix the **concrete**, the **stronger** the **concrete** mix. To **make** the **concrete stronger**, **add more cement** or less sand.

Some customary concrete design requirements or required strength in psi are listed below:

- Minimum 2,500 – 3,000 psi
- Footings and Slabs 3,500 – 4,000 psi
- Suspended Slabs, Beams, and Girders 3,500 – 5,000 psi

Remember:

- Compressive strength is usually tested at 7 and 28 days.
- 28 Day psi test is the American Concrete Institute (ACI) standard.

Now to briefly address the tensile strength of concrete. It is important for contractors to realize the difference between compressive strength and tensile strength. Compressive strength is the amount of pressure per square inch which can be placed directly on the concrete without the concrete itself deteriorating. Tensile strength, however, is regarded as the ability of concrete to resist breaking or cracking under tension. Concrete has very low tensile strength. Cracks in concrete occur when the tensile force exceeds the tensile strength of the concrete. Concrete structures undergoing tensile stress must be reinforced with materials that have high tensile strength, such as steel. Concrete is often reinforced with 6-10 gauge wire mesh which comes in roles consisting of 6x6 inch squares. Often times concrete will be reinforced with rebar or reinforced steel bars which are connected together and placed in the concrete.

Later the course will discuss some of the inherent problems which can occur when steel or wire is introduced into concrete.

Applications

Some of the most common applications for the use of concrete:

- Footings
- Poured and Formed Concrete Foundations
- Slabs
- Driveways
- Walkways
- Patios
- Pools

When addressing footings and foundations, it is important to highlight how concrete is normally used in residential foundations. The most common uses today would be for a poured reinforced concrete basement foundation with a concrete basement floor, a slab on grade, or a raised foundation that simply has a home built over a crawlspace. It is important to note in all of these instances, and a poured concrete footing is normally required.

Masonry Mortar – Manufacturing and Applications

This section covers masonry mortar, how it is manufactured and how it is used in the construction industry. Mortar can be made in one of two ways.

The older method is to take Portland cement, add hydrated lime and mix with fine sand. Masonry cement is simply a material made by most cement companies where they inter-grind the Portland with lime or other ingredients designed to produce high air content in a kiln.

All traditional **mortars** are essentially a blend of sand, Portland cement, and hydrated lime. These three ingredients are mixed at different proportions depending on the intended use. The **four** main types

of mortar most commonly **used** are; Type N, M, S, and O. Now to take a look at each one of these types of mortar and what they are mainly used for.

Type N mortar is the most common type and is usually recommended on the exterior, above-grade walls. This general-purpose mortar has good bonding capabilities. And since the cement is not overburdened by Portland, it cures more slowly and allows for better workability. Type N mortar has a compressive strength of about 750 PSI, which is ideal for use with semi-soft stone or masonry applications. It is more elastic than a high-strength mortar, which helps to prevent cracking and spalling of adjacent masonry units. Although commonly used in setting bricks, Type N can also be used for repointing newer brickwork.

Type M mortar is the strongest of the four and has a compressive strength of 2500 PSI. Type M mortar should be used when the structure has to withstand high gravity and/or lateral loads. Type M mortar is also a good choice for hard stone projects where the compressive strength of the stone is greater than 2500 PSI. The characteristics of Type M mortar make it ideal for below-grade applications, such as at foundations and retaining walls.

Type S mortar is a medium-strength mortar achieving a compressive strength of approximately 1800 PSI. Type S mortar can be used on at/or below-grade exterior walls and hard coat traditional stucco systems. The strength and bonding properties of Type S mortar are greater than that of Type N, and the increased amount of lime in Type S allows the mortar to withstand excessive moisture and increases its bonding and elastic capabilities.

Type O mortar has the weakest compressive strength, approximately 350 PSI. Type O is easy to work with, and the consistency of the blend makes it a good choice for repointing performed at a structurally stable wall. Its low compressive strength makes it a good option for soft stone applications such as setting sandstone or brownstone. Type O mortar also allows for more flexing, which can help prevent cracks and spalls in masonry units.

The standard mortar mixing ratio normally includes one part mortar mix, whether it is premade or a combination of cement and lime, three to four parts sand, and water in an amount that makes the mortar workable.

It is often asked what the perfect consistency of mortar is. The answer is quite simple: "the perfect mortar is whatever the mason says it is!"

Applications

Common uses for masonry mortar include

- Brick Laying
- CMU – Block Laying
- Cultured Stone
- Real Stone
- Stucco

Cement – Manufacturing and Application

It is important to understand the difference between cement and concrete. Although the terms cement and concrete often are used interchangeably, cement is actually an ingredient of concrete. Concrete is a mixture of aggregates and paste. Cement comprises from 10 to 15 percent of the concrete mix by volume.

Cement is not stronger than concrete. On its own, in fact, cement is prone to cracking. When combined with aggregate materials and water and allowed to harden, however, cement—now concrete—is extraordinarily strong.

Cement is a product that should never be used alone. Occasionally contractors encounter it being used in an attempt to repair spalling concrete driveways are walks; however, in most cases, it quickly cracks and therefore is unacceptable as a standalone product. Concrete is, however, an important component in concrete, mortar, stucco, tile grout, and in many thin-set adhesives.

FINAL EXAM QUESTIONS:

19. Which statement about concrete is true?

a. Concrete is always delivered to the job site in the same type of truck.

b. Concrete can be delivered in an in-transit mixer (barrel truck) or in a volumetric concrete mixer.

c. Concrete is always mixed in the same way using the exact same proportion of ingredients.

d. Concrete has tremendous tensile strength.

20. The ingredients of concrete are:

a. Water, sand, aggregate, and cement.

b. Clay, sand, water, and gravel.

c. Always cement, aggregate, fiber, and acrylic additives.

d. None of the above

21. Which statement is NOT correct:

a. Concrete is measured in compressive strength based on psi.

b. Concrete achieves its full compressive strength in 28 days.

c. Concrete and cement are correctly used as interchangeable words for the same product.

d. Reinforcement is often added to concrete to compensate for its lack of tensile strength.

22. Mortar can be mixed using:

a. Portland cement, lime, sand, and water.

b. Only pre-made mortar mix.

c. Using mortar mix, sand and lime.

d. Using the mix, but omitting the sand.

Gabion – Manufacturing and Applications

https://alleideen.com/garten-und-landschaftsbau/02/diepersonalisierte- gartengestaltung-gabione.html by Unknown Author is licensed under CC BY-ND

A gabion (from Italian gabbione meaning "big cage"; from Italian gabbia and Latin cavea meaning "cage") is a cage, cylinder, or box filled with rocks, concrete, or sometimes sand and soil for use in civil engineering, road building, military applications, and landscaping. "GAY bion"

You may see gabion used for flood control, the containment of rock slides, in the building of retaining walls, and used as architectural and landscaping accents.

Granite – Manufacturing and Applications

Granite is the most widespread of igneous rocks, underlying much of the continental crust. Granite is intrusive igneous rock. Intrusive rocks form from molten material (magma) that flows and solidifies underground, where magma cools slowly. Eventually, the overlying rocks are removed, exposing the granite. Granites usually have a coarse texture (individual minerals are visible without magnification) because the magma cools slowly underground, allowing larger crystal growth.

Granites are most easily characterized as light-colored and coarse-grained as a result of cooling slowly below the surface. Color variation is a response to the percent of each mineral found in the

sample. The crystals in granite provide a variety of mixed colors — feldspar (pink or red), mica (dark brown or black), quartz (clear pink, white, or black), and amphibole (black).

Granite is high in quartz (about 25%), feldspar, and mica. It is widely used for architectural facades, construction materials, ornamental stone, and monuments. Over 40% of the dimension stone quarried is granite. Crushed granite is used as a durable construction material in asphalt and concrete used in highway and infrastructure projects.

Mount Airy granite is more widely recognized for its dimensional uses — including such high-profile projects as the World War II Memorial in Washington, D.C.; the Arlington Memorial Bridge; and, in North Carolina, the Wright Brothers Memorial — but it is also popular for curbing, especially in Northern states.

Some of the most common applications for granite in addition to buildings, bridges, paving, monuments, curbing, countertops, floors, and stair treads would include the use of crushed granite or stone used for drainage, as a substrate beneath driveways or roadways, and as the bed for laying railroad tracks. Now when considering granite in most instances, it is the aggregate that is used in most concrete mixes.

Adobe – Manufacturing and Applications

Adobe is Spanish for 'mudbrick,' but in some English-speaking regions of Spanish heritage, the term is used to refer to any kind of earthen construction. Most adobe buildings are similar in appearance to cob (made of subsoil, water, and straw), and sometimes lime) and rammed (compacts damp soil with clay, sand, and gravel) earth buildings. Adobe is among the earliest building materials and is used throughout the world. In many parts of the United States, you may be unlikely to encounter an Adobe structure unless, of course, you are in the south or southwest.

Adobe was one of the first materials ancient humans used to create buildings, dating as far back as the 8th century B.C. The word "**adobe**" is Spanish, but etymologists trace its **origins** to an old Arabic word, al-tob or al-tub, meaning "brick."

The **adobe**, or sun-dried brick, is one of the oldest and most common building **materials** known to man. Traditionally, **adobe** bricks were never kiln fired. Unbaked **adobe** bricks consisted of sand, sometimes gravel, clay, water, and often straw or grass mixed together by hand, formed in wooden molds, and dried by the sun.

Due to the fact that adobe is a product that is made from using dried mud, it makes sense that it is subject to erosion and surface deterioration because these surface coatings were almost always applied to the exterior of adobe structures.

Next, the course will take a look at some of the products that were used in order to preserve the adobe buildings.

Mud Plaster

Mud plaster has long been used as a surface coating. Like adobe, mud plaster is composed of clay, sand, water, straw, or grass and therefore exhibits sympathetic properties to those of the original adobe. The mud plaster bonds to the adobe because the two are made of the same materials. Although applying mud plaster requires little skill, it is a time-consuming and laborious process. Once in place, the mud plaster must be smoothed. This is done by hand; sometimes deerskins, sheepskins, and small, slightly rounded stones are used to smooth the plaster to create a "polished" surface. In some areas, pink or ochre pigments are mixed into the final layer and "polished."

Whitewash

Whitewash has been used on earthen buildings since before recorded history. Consisting of ground gypsum rock, water, and clay, whitewash acts as a sealer, which can be either brushed on the adobe wall or applied with large pieces of coarse fabric such as burlap.

Initially, whitewash was considered inexpensive and easy to apply. But its impermanence and the cost of annually renewing it has made it less popular as a surface coating in recent years.

Lime Plaster

Lime plaster, widely used in the 19th century as both an exterior and interior coating, is much

harder than mud plaster. It is, however, less flexible and cracks easily. It consists of lime, sand, and water and is applied in heavy coats with trowels or brushes. To make the lime plaster adhere to adobe, walls are often scored diagonally with hatchets, making grooves about 1½ inches deep. The grooves are filled with a mixture of lime mortar and small chips of stone or broken roof tiles. The wall is then covered heavily with lime plaster.

Cement Stucco

In the United States, cement stucco came into use as an adobe surface coating in the early 20th century for the revival styles of Southwest adobe architecture. Cement stucco consists of cement, sand, and water, and it is applied with a trowel in from 1 to 3 coats over a wire mesh nailed to the adobe surface. This material has been very popular because it requires little maintenance when applied over-fired or stabilized adobe brick and because it can be easily painted.

It should be noted, however, that the cement stucco does not create a bond with unfired or un-stabilized adobe; it relies on the wire mesh and nails to hold it in place. Since nails cannot bond with the adobe, a firm surface cannot be guaranteed. Even when very long nails are used, moisture within the adobe may cause the nails and the wire to rust, thus, losing contact with the adobe.

FINAL EXAM QUESTIONS:

23. All of the following are true about Gabion, EXCEPT:

a. It is a term derived from Italian meaning "big cage"

b. It is constructed by placing stone, rock, concrete etc., in a wire cage.

c. It is used primarily for erosion control, flood control, retaining walls, sea walls, or architectural and landscaping accents.

d. It is a very good and suitable product for constructing foundations.

24. Granite is:

a. Only used for countertops.

b. Never used for drainage, substrates, driveways, roadways, or railroads.

c. Is only used for carving monuments and for exterior of large office buildings.

d. Is the most widespread indigenous rock which underlies most of the continental crust in the US.

25. Adobe structures are often coated in all of the following EXCEPT:

a. Mud plaster

b. Whitewash

c. Bituminous Waterproofing

d. Stucco

Cast Stone, Natural Stone, and Cultured Stone

This section shifts to discuss stone that is used in masonry construction. In order to grasp a full understanding of this subject, it is important for contractors to delineate between the types of stone that contractors will encounter. These include natural stone, cast stone, and cultured stone.

Natural stone is millions of years old. It is quarried from the earth and has gone through many natural changes over time. Granite, marble, and limestone

Cast stone is a type of precast concrete designed to simulate diverse types of natural cut stone.

Cultured stone (faux Stone, manufactured stone, manufactured stone) is concrete poured into a mold then colored to look like real stone.

Among the types of natural stone, contractors frequently encounter marble. Marble is simply metamorphosed limestone. It is commonly known that limestone is used for exterior veneers, fireplaces, columns, stairs, countertops, and floors.

An example of natural stone includes the statue of Abraham Lincoln at the Lincoln Memorial in Washington DC, which was carved out of Georgia white marble in 1920

There are several benefits of using natural stone; natural stone is:

- A product of the earth – the original green building material
- Stone is extremely durable and ages gracefully over time
- Offers ease of care and maintenance
- Stone is recyclable, and therefore environmentally friendly
- Quarried and manufactured sustainably-minimizing waste and conserving other resources.

Cast stone is the reconstructed stone that is made to look natural through a highly refined process. Depending on what the project is, the budget, and the design style, the cast stone may be the perfect material to use. The most significant difference between architectural precast concrete and cast stone is that cast stone isn't permitted to contain bug holes or air voids and must have a fine-grained texture. The texture is normally achieved by acid etching.

Cast Stone Pros

In terms of cast stone, there are a few positives.

- Quite often, it is considerably lighter and can be easier and quicker to manufacture and install than its natural stone counterpart. In many cases, it is less expensive than natural stone, but by no means is that always the case.

- Cast stone is often made by mixing natural elements like quartz, granite, limestone, or marble. Cast stone mix is then pushed through molds to give it a look that resembles the density and texture of natural stone. Unlike natural stone, cast stone can be manipulated to be a certain size, shape, and color, so it can be designed to have all the pieces with a similar appearance.

Cast Stone Drawbacks

There are a few drawbacks when considering cast stone.

- For example, cast stone struggles to achieve the same level of detail as carved natural stone. There is only so much one can capture with the precast molds that produce the product, whereas the possibilities are endless when you have a sculptor carving natural stone.

- The hardness and density of the natural stone and the artistic expression of the artisan doing the work add immeasurable value that simply cannot be achieved with the cast stone counterpart. It can also be quite challenging for a cast stone producer to achieve a genuine visual interpretation of veining and overall stone "movement."

Cultured stone is a product that is also referred to as adhered concrete masonry veneer and the installation guide put forth by the Masonry Veneer Manufacturer's Association refers to it as such. But the material is relatively lightweight and is primarily an architectural or design element. The material has no loadbearing capability and should not be used as such.

The product itself is made of the cast, if you will, by blending Cementous material, aggregates, iron oxide, and pigments in a manner that simulates natural stone. In some applications, it is often difficult to differentiate between the two.

Because this is a widely used product in residential construction, today, contractors will spend a significant amount of time discussing the product and the appropriate installation and applications of the product.

Cultured Stone

Another quite common material that is used today in modern construction is a product known as a cultured stone. Cultured stone requires very precise installation procedures, and these procedures are recommended by an organization known as the Masonry Veneer Manufacturer's Association. It is recommended that contractors become familiar with the recommendations that the Masonry

Veneer Manufacturer's Association puts forth when working with cultured stone.

The following terms and definitions are important when working with cultured stone.

- **Adhered Concrete Masonry Veneer (ACMV)** — a lightweight, architectural, non-load-bearing product that is manufactured by wet cast blending cementitious material, aggregate, iron oxide pigments, and admixtures to simulate the appearance of natural stone.
    - Note: The MVMA recognizes there are many names used to describe Adhered Concrete Masonry Veneer products. Manufactured Stone Veneer is used commonly throughout the industry and by some manufacturers. In the International Building Code, Adhered Concrete Masonry Veneer products are referred to as Adhered Masonry Veneer. In the ICC-ES Acceptance Criteria, AC51, the product is called Pre-cast Stone Veneer. This guide will use ACMV (Adhered Concrete Masonry Veneer) when referencing the product.
- **Concrete masonry unit Fasteners** — Corrosion resistant hardware used to secure lath and flashing material to the wall system.
- **Flashing** — Material used to restrict the seepage of moisture around any intersection or projection of materials in an assembly.
- **Lath** — Corrosion-resistant mesh building material fastened to the substrate to function as a base for adhering plaster or mortar.
- **Mortar** — A workable paste mixture of cementitious material, water, and aggregate used to bond masonry construction materials together and filled spaces between.
- **Mortar Grout** — Mortar mixture used to fill joints and cavities in masonry construction.
- **Mortar Scratch Coat** — Base coat of mortar used in the installation. Cross raked to improve the bond of subsequent mortar layers.
- **Mortar Screen** — Sheet material designed to prevent the mortar scratch coat from filling the drainage space.
- **Mortar Setting Bed** — Mortar is used to adhere the ACMV to the substrate or scratch coat.
- **Sealer** — Liquid material used over ACMV to protect against staining and moisture penetration.
- **Wall System** — The constructed exterior or interior vertical framework and substrate of the building.
- **Water Resistive Barrier** — Material used to restrict the transmission of moisture to the surface behind.

In order to properly install cultured stone, there are certain structural requirements that should be adhered to in order to ensure a proper installation of the material.

The wall system itself should consist of wood or steel studs that are placed no more than 16 inches in the center.

The sheathing should be a semi-rigid to rigid sheathing consisting of gypsum wallboard, plywood, OSB, fiberboard, or non-rigid insulation that is a minimum of 1/2 inch thick. The failure to adhere to these requirements can result in the failure of the attachment of the cultured stone.

Over the structural components, the Masonry Veneer Manufacturer's Association also recommends that a water-resistant barrier be installed over the exterior sheathing. That barrier should be composed of:

- Minimum 2 Layers of #15 Felt
- 2 Layers of Grade D Paper
  (water permeable/weather resistant paper)
- 1 Layer of House Wrap

The Masonry Veneer Manufacturer's Association also requires that a minimum of 2.5-pound corrosion-resistant metal lath be applied to the exterior wall. This 2.5-pound 18-gauge woven wire must be installed using corrosion-resistant fasteners. If an installer uses a method other than this, it can only be done so by providing documentation

and a product evaluation report from the product manufacturer.

On top of the metal lath, a mortar scratch coat must be applied. This scratch coat should be a minimum of 1/2 inch thick and be comprised of type and or type as masonry mortar. Once the scratch coat is applied, it should be scratched using either a trial or a scratch tool on the surface once the surface material is thumbprint hard. In many instances, an insufficient scratch coat is applied, and metal lath can be seen between the cultured stone.

When flashings are required at or near the cultured stone, including at rooflines or above windows and doors, all flashing must be corrosion resistant and must be installed at all through the wall penetrations.

Most manufacturers of cultured stone and most local building codes require the installation of a drainage plane behind the stone to allow for the escape of incidental water, improve the drying time of any moisture that gets behind the cultured stone. And it creates a capillary break or airspace between the cladding and the primary water-resistant barrier.

Weep screed is placed at the bottom of a frame wall at the foundation level. Weep screeds must be of corrosion-resistant material, normally plastic. And they were there required to be a specific size. Plastic weep screeds must have a vertical flange for attachment and to ensure the secure installation of the weep screed.

Often times there is a need to install cultured stone over concrete or masonry foundation or basement walls. In order for this to be successfully accomplished, the masonry or concrete wall must be free of dirt, not have any waterproofing material installed, be free of paint or oil, and have a rough texture in order to achieve an adequate bond. In some instances, the installation of a metal lath and a scratch coat may be required in order to ensure proper adhesion.

Autoclaved Aerated Concrete – Manufacturing and Applications

Another masonry product that may be relatively unfamiliar to contractors is a product known as autoclaved aerated concrete. Although the product is not a new product, its use in the United States is relatively uncommon. Some experts have referred to autoclaved aerated concrete as a near-perfect building material. The product was originally patented by a Swedish architect in 1924, and its common ingredients were Portland cement, lime, very fine nagger it is such as silica, sand, or fly ash. Often times a small amount of aluminum powder is also added. The secret ingredient, however, is the expansion agent that makes the mixture rise like bread so that the material contains 80% air. The blocks, once cured or joined together with a thin bed of mortar or thin-set in the components of autoclaved aerated concrete, can be used for walls, floors, and roofs.

The lightweight material offers excellent sound and thermal insulation, and like all cement-based materials, is strong and fire-resistant. In order to be durable, autoclaved aerated concrete requires some type of applied finish, such as a polymer-modified stucco, natural or manufactured stone, or siding.

- Autoclaved aerated concrete combines insulation and structural capability in one material for walls, floors, and roofs. It is lightweight/cellular properties make it easy to cut, shave, and shape accepts nails and screws readily and allow it to be routed to create chases for electrical conduits and smaller-diameter plumbing runs. This gives it design and construction flexibility and the ability to make easy adjustments in the field.
- Durability and dimensional stability. A cement-based material, autoclaved aerated concrete resists water, rot, mold, mildew, and insects. Units are precisely shaped and conform to tight tolerances.
- Fire resistance is excellent, with eight-inch thick autoclaved aerated concrete achieving a four-hour rating (actual performance exceeds that and meets test requirements for up to eight hours). Because it is non-combustible, it will not burn or give off toxic fumes.
- The lightweight means that *R*-values for autoclaved aerated concrete are comparable to conventional frame walls, but they have higher thermal mass, provide airtightness, and, as just noted, are not combustible. That lightweight also gives a high sound reduction

for privacy, both from outside noises and from other rooms when used as interior partition walls.

But the material does have some limitations. It is not as widely available as most concrete products, though it can be shipped anywhere. If it has to be shipped, its lightweight is advantageous. Because it is of lower strength than most concrete products or systems, in load-bearing applications, it must typically be reinforced. It also requires a protective finish since the material is porous and would deteriorate if left exposed.

Both blocks and panels are available. Blocks are stacked similarly to conventional masonry but with a thin-bed mortar, and panels are stood vertically, spanning full-story heights. For structural needs, grouted, reinforced cells and beams are placed within the wall section. (Concave depressions along vertical edges can create a cylindrical core between 2 adjacent panels.) For usual applications, a vertical cell is placed at corners, on either side of openings, and at 6- to 8-foot spacings along a wall. Autoclaved aerated concrete averages about 37 pounds per cubic foot (pcf), so blocks can be placed by hand, but panels, because of their size, usually require a small crane or other pieces of equipment.

FINAL EXAM QUESTIONS:

26. The installation of cultured stone should be performed in accordance with standards put forth by.

a. Your local masonry contractor.

b. The general contractor.

c. The Masonry Veneer Manufacturer's Association

d. The American Society of Home Inspectors.

27. When installing cultured stone, the following statements apply EXCEPT for:

a. A water-resistant barrier must be installed behind the lath and scratch coat.

b. The cultured stone can be installed in direct contact with the ground and paved surfaces.

c. Visible lath between the stones should be identified as a deficiency.

d. Caulking should be applied between the stone and dissimilar materials.

28. Select the incorrect fact about autoclaved aerated concrete:

a. It is heavier than concrete and therefore not widely used.

b. It is a lightweight product that offers excellent sound and thermal qualities.

c. It is fire resistant.

d. It is easy to work with and very contractor friendly.

Stucco – Manufacturing and Applications

Stucco is a construction material that is made of aggregates, a binder, and water. It is applied to the surface wet and hardens to a very dense solid. Stucco can be used as a decorative coating for walls and ceilings, exterior walls, and as a sculptural or artistic material. It can be applied on metal, metal lath, concrete, concrete/cinder block, or clay brick and adobe. Stucco can be used as both an interior and exterior finish.

In English, "stucco" sometimes refers to the coating on the exterior of a building, where "plaster" is used when describing the coating of the interior. These materials are often different. Other languages don't have different words. For example, in French,

stucco means plaster and is used for both internal and external descriptions.

Modern stucco is made of Portland cement, sand, and water, whereas traditional stucco is made of lime, sand, and water. Lime can be added to modern stucco to increase the permeability and workability of the stucco. Acrylics and glass fibers are additives that can be added to improve the structural properties of stucco.

There are two different processes for applying stucco, a one-coat system, and a three-coat system.

In a one-coat stucco system, the **base coat** consists of Portland cement, chopped fiberglass, acrylic additives, sand, and water. The stucco is modified like this because it is much thinner, so the fiberglass particles and acrylic additives give it a little bit of strength and make it a little bit more water-resistant. The one coat method speeds up the three-coat stucco process by combining the scratch and brown coat into a single application that is 3/8″ to 1/2″ thick.

In a traditional three-coat stucco system, the scratch coat is the first layer of the system, which is installed on top of the metal lath and the water-resistant barrier. Originally the lath material was horizontal strips of wood installed on the wall. There were spaces between the horizontal strips that would support the wet plaster until it cured. When used on exterior walls the lath is installed over a weather-resistant asphalt-impregnated felt or paper sheet that protects the framing from the moisture that can pass through the porous stucco for exterior wall applications. The scratch coat is field mixed with Portland cement, sand, lime, and water, which is applied to the wall and then has a series of horizontal or vertical lines scratched into the surface. This scratch coat provides adhesion for the next layer in the stucco system, that next layer is the brown coat.

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This photo is of a house that was initially wrapped in “Tyvek” house wrap. “Barricade” plus drainage was added over that to ensure waterproofing and positive drainage. Metal lath was secured to the structure. Areas prone to movement and cracking have control joint material added.

In this photo, this contractor is beginning to apply the brown coat. This layer is applied with a Darby or a long trowel to make sure that the cement is applied evenly. On this particular home, two brown coats were applied in an effort to help increase the strength of the wall unit and to minimize the possibility of cracking and movement.

This photo shows the final application or finish coat which is put on with a hawk and a trowl and applied either smooth or in a variety of textures. These finish coats can also come in a range of colors so that no additional painting is needed.

It is important for contractors to differentiate between a traditional stucco installation and what is referred to as EIFS or an Exterior Insulation Finishing System (EIFS). An Exterior Insulation Finishing System (EIFS), also known as EWI (Exterior Wall Insulation Systems) or External Thermal Insulation Composite Systems (ETICS), is a type of cladding system that provides exterior walls with an insulated finished surface and waterproofing in an integrated composite material system.

What are the problems with EIFS? The problems with barrier EIFS cladding all stem from water intrusion. These problems include moisture accumulation in the wall cavity, subsequent wood damage, and, in more advanced cases, mold growth and the infestation of pests such as carpenter ants or termites.

Contrary to some reports, water intrusion problems with EIFS are not unique to any part of the country. While the problems with EIFS were first discovered in Wilmington, North Carolina, this in no way means that you could not have similar moisture intrusion problems in other locations. Field investigations of barrier EIFS in other areas of the country have identified excessive moisture accumulation problems in New Jersey, New York, and Pennsylvania. Simply put, the more it rains, the greater the likelihood of water intrusion problems.

There are many sources of water intrusion in barrier EIFS, including improper joints around penetrations, improper joints where EIFS meets dissimilar materials, and lack of proper flashings. Water can also enter the system through cracks in the face of the EIFS, regardless of how small the crack is. Essentially, any joint or penetration in the EIFS material may be suspect.

TYPES OF MASONRY CONSTRUCTION

It is important for contractors to understand the difference between **solid masonry** and **brick veneer**. Solid masonry is just that a wall made up of bricks. Solid masonry walls are load bearing and are used to form the exterior of the home. With solid masonry the wall is more than one brick thick. Because the walls are made up of multiple layers of bricks, often the bricks can be seen on the interior walls as well as the exterior. Solid masonry supports building components including foundations and piers. Today most walls are now constructed as cavity walls.

A brick veneer is a single layer of full-sized bricks that are attached adjacent to the home's exterior. The structural wall is what bears the weight of the structure, not the bricks. The brick veneer is attached to the structural wall's exterior in using a variety of attachment methods. The primary purpose of brick veneer is to improve aesthetic appeal of a wall. Though veneers also provide some resistance to the elements. Because brick veneer isn't load bearing and is added to the exterior of a structural wall; brick veneer can be added to a home at any time during the home's construction as well as added on during a home improvement project. This is not the case with solid masonry.

FINAL EXAM QUESTIONS:

29. Which statement about stucco is the most accurate?

a. Stucco systems always consist of 3 coats.

b. Stucco is applied to the exterior of a home after a waterproof barrier, drainage plane and wire lathe are installed.

c. Control/expansion joints are never installed to control cracking.

d. The scratch coat is the final/finish coat on an exterior stucco finish.

30. Which of the following are true statements about solid masonry and veneer?

a. Solid masonry can be structural as can veneer.

b. Veneer masonry can be structural but solid masonry is not.

c. Solid masonry can hold up the house; but the house holds up the veneer.

d. None of the above

SUMMARY

This course discussed the history of masonry as well as some of the earliest uses of masonry throughout the years. It offered early examples of masonry construction and moved through the development of masonry tools, including how they are used in modern construction. Then detailed the manufacturing process and application of clay brick, concrete block, concrete, masonry mortar, cement, gabion, granite, adobe, cast Stone, natural stone, cultured stone, autoclaved aerated concrete, and stucco. The course concluded by differentiating solid masonry from veneer applications of brick.

Upon completion of this course, contractors should be able to summarize the history of masonry construction, be able to describe diverse types of masonry materials and the method of manufacture and recognize masonry materials and their use in residential construction.

Wisconsin Contractors Institute

From the Ground Up:
Current Construction Methods and Materials

Course Number 22608 – 3 C.E. Hours

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INTRODUCTION

There are more than 100 schools in the US that offer bachelor's degree programs in construction management. Master's degree programs are also available. However, regardless of formal education opportunities, most residential builders' knowledge of how to build comes from on-the-job experience in the industry and training from either family members or mentor/apprentice relationships, whether formal or informal. The result of this situation has been a form of traditionalism in methods and the selection of materials in the construction industry.

While *traditions* ensure the preservation and continuance of tried-and-true ways and means of building, *traditionalism* can result in a narrow conservatism that excludes new and improved methods and materials not known or available in the past.

The purpose of this course is to survey some of the methods and materials that have proven themselves over the history of building in the US, as well as to introduce to some recent advances in the building sciences.

FOUNDATIONS

Famous Foundation Failures

South Padre Island Ocean Tower

South Padre Island Ocean Tower is a 134-unit skyscraper close to the Mexican border, a 31-story condominium building with views over the ocean. It was marketed as the "highest structure in the Rio Grande Valley" with "Italian marble floors, granite counter tops, stainless steel appliances, custom cabinets, stainless steel fixtures, over-sized Jacuzzi tub and stand-up showers."

During construction, in May of 2008, however, cracks in the columns supporting the parking garage appeared. Structural analysis showed that the tower's core had sunk 14 to 16 inches. The attached parking lot had moved less than half that distance. Pier supports in the shifty clay more than 100 feet underground began buckling, stressing beams and columns, causing cracking, spalling, and breaking, eventually causing the building to lean towards the northwest corner.

By July, the developers were claiming that while Ocean Tower construction would be delayed, the skyscraper would reemerge "stronger and safer than ever". However, on November 4, 2008, a letter was delivered to investors:

We are deeply disappointed to report that the construction of Ocean Tower, which was suspended in May, has been terminated with no immediate prospects for completion.

Almost a year later, plans were announced for the tower's demolition. On December 13, 2009, the 376-foot unfinished skyscraper was destroyed with a controlled implosion. At 55,000 tons, it was the largest implosion of a reinforced concrete structure in the world.

Millennium Towers

The 645-foot Millennium Tower at 301 Mission Street in San Francisco was completed in 2008 and is the city's third-tallest skyscraper. It contains over 400 multimillion-dollar condo units. 100 million dollars' worth of units were sold in the first five weeks of sales. But seven years later in 2015, residents were shocked to learn that the building was sinking. By 2018, the building had sunk 17 inches and tilted 14 inches and has continued to sink at a rate of 2" per year.

The building rests on piles that are 60'-90' deep, but do not reach bedrock which is approximately 250' below the surface. A tentative settlement has been reached that will require Millennium Partners and Transbay Joint Powers Authority to pay for the $100m plan to fix the building which will involve installing 52 piles that would set on the bedrock 250' below the surface and be attached to the existing piles. Residents will also be compensated for their financial losses due to the building's notoriety.

The Leaning Tower of Pisa

Everybody is familiar with this example of a foundation failure. The tower began to lean during construction in the 12th century. This was due to soft soil on which it was built. The situation was worse by the time of completion in the 14th century. By 1990 the tilt had reached 5.5 degrees. To preserve

this world-famous tourist destination, work began in 1993 to stabilize the tower. The remediation efforts have successfully reduced the tilt to 3.97 degrees. In this case, a foundation failure has inadvertently become a phenomenal success!

Personal Failure

Here is an example from a new contractor who had just built their first basement. The house was rather large and not having laser levels available in those days, he discovered that the top of the foundation was 1½" out of level from one corner to the opposite diagonal corner. Being inexperienced, he thought we could correct the problem during the framing of the house. The framers were not happy with him to put it mildly. After much extra work, the framing was finally completed and was plumb. The next unhappy crew were the drywall hangers. The framing was plumb, but nothing was quite square. Thank heavens for drywall mud! But the nightmare wasn't over. The trim carpenters and the cabinet installers discovered that they didn't figure enough shims for the job. Oh well, the painters will fix it. You know… a little 3/8" caulk.

He shared this personal experience in hopes that this will not happen to others, and to stress the point that it's important to get the foundation right! But what does it mean to get the foundation right? Well, that's a matter of opinion.

Traditional Foundations

Often the stones that were gathered from the clearing of the land would serve as the stones for the foundation. The smaller stones were the base or the footing for the foundation. The larger stones were used for the vertical walls of the foundation. These types of foundations have been built for thousands of years. Even the great cathedrals of Europe were built in this way.

Concrete Block and Brick Foundations

More familiar to us today are poured concrete footings with masonry foundation walls, typically concrete block or brick. This type of foundation is an excellent choice where a crawlspace is desired. One of the greatest advantages of a crawl space is that it is a convenient space for plumbing, electrical, and mechanical systems. Since it is a free volume, very little extra planning is required for the plumbing piping, the ductwork for HVAC systems and the electrical wiring. Post installation servicing of MPE is also much easier. Another advantage to crawl spaces is that the floor system can be well insulated.

Conventional wisdom has been that crawlspaces needed to be ventilated. The purpose for ventilation was to keep air circulating to keep the air under the house dry. As it happens, in most cases, the foundation vents introduce moist air into the crawlspace. Warm moist air entering a cool crawl space will drop its moisture, which will condense on walls, pipes, ducts, and floor joists making conditions favorable for mold, corrosion, and rot.

Debates among code writers have continued for decades over whether to vent crawl spaces or not. The International Residential Code (IRC) requires:

Section R408.1, Ventilation

The under-floor space between the bottom of the floor joists and the earth under any building (except space occupied by a basement) shall have ventilation openings through foundation walls or exterior walls. The minimum net area of ventilation openings shall be not less than 1 square foot for each 150 square feet of under-floor space area unless the ground surface is covered by Class 1 vapor retarder material. Where a Class 1 vapor retarder material is used, the minimum net area of ventilation openings shall be not less than 1 square foot for each 1,500 square feet of under-floor space area. One such ventilating opening shall be within 3 feet of each corner of the building.

So, to be in compliance with code, you must include vents in the crawlspace foundation walls, even though it has been proven to be a bad idea.

One way to reduce moisture in a crawlspace is to employ dehumidification equipment.

Fortunately, the IRC also does allow for non-vented crawlspaces with certain specifications.

Section 308.3, Unventilated Crawlspaces

- Mechanically circulating air is established between the upper conditioned area of the home and crawlspace. The air-circulating

device must move at least 1 cubic foot of air per 50 square feet of crawlspace area.

- The crawlspace floor area must be completely sealed with a vapor-retarding material. This means lapping the edges of the vapor retarder up against the inner foundation walls, overlapping separate sheets by at least six inches, and sealing up those seams.
- All crawlspace walls must be insulated to appropriate R-values for the regional climate.

Another term for this type of crawl space is "encapsulated".

While foundations built with individual bricks or concrete masonry units (CMU) are prevalent, the conditions under which they are practical are limited. When foundation walls are to be backfilled, such as in the case of a fully excavated basement, alternative types of foundations must be utilized. Among the most common are poured cast-in-place reinforced concrete, ivany block, precast, and treated wood.

Reinforced Cast-in-Place Concrete Foundations

A reinforced concrete foundation wall is constructed by pouring concrete into forms wherein reinforcing steel has been placed. Concrete has superior strength under compression, but has little strength under tension, making it vulnerable to failure when exposed to the weight of soil pressure when backfilled or the hydrostatic pressures of ground waters. Steel, on the other hand, has superior tensile strength and makes for a beneficial marriage when paired with the compressive strength of concrete. Concrete and steel also possess similar coefficients of expansion making them compatible structural mates. That means that the steel reinforcing bars and concrete show similar elongation and shrinkage behaviors under thermal fluctuations. Wood and steel on the other hand do not share this compatibility, which is why when wood is bolted to steel such as in a flitch plate beam, the couple will "argue" with creaks and groans for the life of the structure.

Despite the complementary qualities of concrete and steel, there are also antagonisms. The most prevalent incompatibility is corrosion of the rebar within the concrete. Chloride ions are the primary cause of corrosion of steel reinforcement . Chlorides can permeate sound concrete through water migration or through cracks and fissures in the concrete by capillary action. Chloride-containing admixtures can also cause corrosion. Coating the rebar with corrosion resistant substances such as epoxies and zinc (galvanization) have been utilized with some success, but the abuse reinforcing steel suffers during the construction process makes it nearly impossible for the coatings to remain intact. Any breach in the coating can cause concentrated corrosion which can prove to be more damaging than the generalized corrosion of uncoated steel. Stainless steel is also an option albeit usually too expensive to be practical.

Another material often used for reinforcing concrete is fiber-reinforced polymer (FRP). FRP composite materials are made up of high strength fibers of glass, carbon, or steel, embedded in a polymer matrix.

Ivany Block Foundations

A hybrid of concrete masonry units and reinforced concrete is the Ivany block foundation. Ivany blocks are concrete blocks formed with notches to receive horizontal reinforcing bars and cells to receive vertical reinforcing bars and poured concrete. The resulting wall is similar in performance to a poured reinforced concrete wall but without the need for the placing and removal of forms.

FINAL EXAM QUESTIONS:

1. **Warm moist air entering a cool crawl space will drop its_____.**
   a. Moisture
   b. Temperature
   c. Density
   d. R-value

2. **One way to reduce moisture in a crawlspace is to employ _____.**
   a. Sump pumps
   b. Insulation
   c. Thermostats
   d. Dehumidification equipment

3. **Another term for an unventilated crawl space is "_____".**
   a. Innovative
   b. Encapsulated
   c. Closed cell
   d. Illegal

4. **When foundation walls are to be backfilled, such as in the case of a fully excavated basement, alternative types of foundations must be utilized. Among the most common are poured cast-in-place reinforced concrete, ivany block, precast, and _____.**
   a. Concrete Masonry Units
   b. Insulated Concrete Forms
   c. Treated Wood
   d. Monolithic

5. **_____blocks are concrete blocks formed with notches to receive horizontal reinforcing bars and cells to receive vertical reinforcing bars and poured concrete.**
   a. Lego
   b. Ivany
   c. Squash
   d. Mental

Non-Traditional Foundations

Precast Concrete Foundations

Precast foundation walls are made of high-strength concrete panels that are manufactured off site. In addition to the continuous vertical concrete component, each panel has regularly spaced solid concrete studs for load-bearing support and a built-in concrete footing. Because the footing is incorporated into the panel, there is no need for a traditional formed or excavated concrete footing. Panels often include rigid insulation where the basement will be used as heated space. The studs can also be wood or steel to receive finished wall materials such as drywall. These studs can also accommodate plumbing and wiring as in conventionally framed walls.

Although the constructing of a foundation using precast foundation walls is relatively simple in concept, the process requires meticulous preparation and skilled installation of the panels. Preparing the gravel base, which is usually 4 to 12 inches thick, should be done in coordination with a soils engineer. The gravel base or "subfooting" should be compacted and graded level. The panels are placed with a crane and are bolted together, and all joints are caulked with a urethane sealant. Some companies coat the exterior side of the panel eliminating the need for further waterproofing, although some state codes require additional waterproofing, nonetheless. The NC Building code does not require additional waterproofing.

After the panels are in place and secured, the basement slab is poured to anchor the bottom of the

panels. Back filling should not occur until the floor joists are installed above the foundation to brace the tops of the panels.

The advantages of precast foundation walls include more accurate and better-quality controlled manufacture of the foundation walls. Since the concrete is usually 5,000psi, the panels can be thinner and lighter than a poured concrete foundation. The walls are erected in a fraction of the time of block, Ivany, or cast-in-place concrete and can be erected even in inclement weather. The design of the panels accommodates the installation of piping and wiring, as is the installation of finished walls.

Insulated Concrete Forms (ICF)

Insulated concrete forms (ICFs) are similar in some respects to Ivany blocks in that they are individual units stacked in such a way to be filled with concrete resulting in a sort of cast-in-place concrete wall. The difference is that in ICF construction the blocks are not concrete, but polystyrene insulation material. Like cast-in-place concrete, the forms must be held in place by tensile connectors. In ICFs the connectors are usually plastic and can also serve as fastening points for drywall or other wall finishing materials. Unlike cast-in-place forms which are removed after the concrete has set, ICFs remain in place and serve as insulation for the wall, both on the exterior and the interior.

The use of ICFs dates back to the 1940s and 1950s in Switzerland where a similar system was used employing treated wood fibers rather than foam. In the 1960s, after chemical companies had developed plastic foams, Werner Gregori, a Canadian contractor and inventor, developed a foam block that resembles today's typical ICFs. In the 1980s and 1990s, American companies got involved in the technology, manufacturing blocks and panels or planks. In 1994, the Insulating Concrete Form Association (ICFA) was founded to do research and promotion of ICFs. Although no longer in operation, the organization was important to bring public awareness of the product and to obtain building code acceptance.

Owners choose ICF construction for several reasons such as the resulting strength of the walls, which is important for safety and resistance to storm and seismic events. ICF walls are resistant to moisture conditions such as mold and rot. They also afford minimal opportunity for insects and vermin infestation. Because of the foam, the thermal insulation results in better life cycle energy usage. The foam also adds the benefit of sound isolation.

Additionally, contractors appreciate the ease and speed of construction. The light weight and the ability to be cut with common carpentry tools allows erection by lower skilled workers.

Installation of insulated concrete form systems is similar to masonry construction or more like building with Legos. Construction usually starts at the corners and blocks are placed a layer at a time to build up the wall. Depending on the manufacturer, some units, must be glued together or taped at the joints. Most systems, however, are designed so as to eliminate the need for adhesives during stacking.

Once the forms are in place and the required reinforcement installed, it is extremely important that walls are plumb and adequately braced before concrete is pumped into the forms. Some contractors lean walls slightly in toward the bracing which allows for minor adjustments to ensure the walls are plumb. This is good practice since you can push the wall to plumb, but it is nearly impossible to pull it to plumb. Extreme care must be taken to fill the forms with concrete at the proper rate based on the formwork manufacturer specifications, otherwise misalignment and blowouts may occur. Openings for doors and windows require bucks to surround the opening and contain the fresh concrete during placement. The bucks also provide suitable material for fastening window or doorframes.

Forms can be delivered as preassembled blocks with connectors already installed or flat-packed panels that must be assembled with the connectors on site. Some preassembled blocks use hinged connectors to allow for more convenient packing and shipping. The foam most often used for ICFs is expanded polystyrene (EPS). The connectors that separate the two layers of forming material can be plastic or metal. The joints between individual forms can feature interlocking teeth or a tongue and groove configuration molded into the forming material, or simple butt jointed seams. Block sizes are usually 16 inches high by 48 inches long. The cavities are commonly six or eight inches wide but can be customized according to engineered requirements.

Autoclaved Aerated Concrete (AAC)

Autoclaved Aerated Concrete has been around for approximately 100 years and has been used extensively in Europe, Asia, and the Middle East, but has had limited use in the United States. First perfected by the Swedish architect and inventor Dr. Johan Axel Eriksson working with Professor Henrik Kreüger at the Royal Institute of Technology, their AAC materials were branded Ytong. Ytong autoclaved aerated concrete in Sweden was originally produced with alum shale. Unfortunately, the slate deposits used for Ytong contain a very low level of natural uranium, which makes the material give off radioactive radon gas in the building. By creating new formulations that did not contain alum shale, Ytong produced a new type of aerated concrete which solved the problem of radon emissions.

Unlike most other concrete materials, AAC is produced using no aggregate larger than sand. When AAC is mixed and cast in forms, several chemical reactions take place that gives AAC its light weight, since 80% of the volume of an AAC block is air. The finished product is solid but still soft. It is placed in an autoclave chamber which is a steam pressure hardening process. This gives AAC its high strength and other unique properties.

Some of the advantages of AAC are:

- They offer an improved thermal efficiency.
- They offer superior fire resistance.
- Their lighter weight saves cost and energy in transportation and labor expense.
- They are environmentally friendly. There is a decrease of 50% of greenhouse gas emissions.
- They are non-toxic. There are no toxic gases or other toxic substances in autoclaved aerated concrete.

The biggest disadvantage is that AAC is brittle in nature and needs to be handled more carefully than clay bricks to avoid breakage.

Treated Wood Foundations

Permanent Wood Foundations are built with pressure-treated 2X lumber and sheathed with pressure-treated plywood. The size of the studs as well as their spacing and thickness of the sheathing are dependent on the height of the wall, the vertical loads of the upper stories, and the horizontal pressure of the backfill. Wood foundations that sit on gravel or sand must have a footing plate that is wider than the wall stud/plate size and may be pre-attached to the framed wall or staked to the footing gravel or sand. When a poured concrete footing is employed, no footing plate is required. The bottom plate of the framed wall is bolted to the concrete footing. Plywood recommended for the PWF system is all-veneer APA-Rated plywood sheathing, Exposure 1 marked APA Series V-600 or Exterior marked APA Series V-611, and produced according to U.S. Product Standards PS1, PS2 or APA Standard PRP-108. All fasteners need to be hot dipped galvanized if above grade and stainless steel if below grade. The specifications must be determined by a qualified engineer. Permanent wood foundations may be built on site or built off site and transported to site for installation.

Like precast concrete foundation, before a wood foundation is backfilled, the top of the wall must be supported laterally by the floor system. The bottom of the wall must be supported by a cast in place concrete slab or by a pressure treated wood framed floor system. Wood foundations are generally placed on footings of crushed stone (1/2" maximum), gravel (3/4" maximum), coarse sand (1/16" minimum) or poured concrete. In crawl space construction, the interior base of the foundation wall should be backfilled before installing the floor system. Once the floor system is in place, the exterior side of the foundation may be backfilled.

Wiring and plumbing may be routed in the vertical spaces between the studs, but studs, plates and any required blocking may not be cut or drilled, however top plates may be drilled for electrical wiring. When installing insulation in below grade walls, a 2" space must be provided between the bottom end of the insulation and the bottom plate.

Permanent wood foundations can also be designed to support brick veneer exteriors.

FINAL EXAM QUESTIONS:

6. Back filling precast foundations should not occur until the _____ are installed above the foundation to brace the tops of the panels.

a. Straps
b. Purlins
c. Floor joists
d. Girts

7. Unlike cast-in-place forms which are removed after the concrete has set, Insulated Concrete Forms remain in place and serve as _____ for the wall, both on the exterior and the interior.

a. Waterproofing
b. Strengthening
c. Decoration
d. Insulation

8. When Autoclaved Aerated Concrete is mixed and cast in forms, several chemical reactions take place that gives AAC its light weight, since 80% of the volume of an AAC block is _____.

a. Air
b. Water
c. Portland cement
d. Carbon Dioxide

Monolithic Slab

Monolithic slabs are foundation systems poured as one unit and consists of a concrete slab (floor) with thickened portions of the slab around the perimeter and under interior load bearing walls which serve as footings. The footing sections are reinforced with reinforcing steel.

This type of foundation is popular in southern regions where the ground does not freeze. National builders often use this type of foundation/floor system because of its simplicity, cost savings, and reduced likelihood of call backs. Even if the natural terrain of a site does not easily accommodate a monolithic slab, extensive grading is often done to flatten the site.

Since much of the waste plumbing is under the slab, special care must be taken to ensure that stub ups are accurately placed. Sometimes HVAC ducting is also placed under the slab. HVAC air ducts located under concrete slab floors are especially problematic. Collapsed ductwork that can occur during construction can result in inadequate airflow. Even if the ductwork survives, many environmental problems can occur in under slab ducts such as condensation, flooding, odors, mold, insects, and radon emissions.

Open Foundations

All the foundations discussed so far have been closed foundations. However, some conditions require open foundations such as coastal regions and where the soil will not support the vertical force of the structure. Open foundations generally employ the use of pilings or piers and beams. Piers transfer loads by bearing only. Pilings transfer loads by bearing and friction (and suction). Pilings can be steel or wood and piers can be steel, wood, or concrete. In the case of pilings, the pilings are driven into unstable soil until they reach stable soil or rock. Piers are usually inserted or poured into drilled or bored holes. A foundation is considered to be ‹piled› when its depth is more than three times its breadth.

The most famous example of building on piles is the city of Venice, Italy. The city was built in a coastal lagoon by Romans who were trying to flee the Germanic and Hun invasions. They learned to build on the swamps by driving closely spaced alder wood piles into the unstable soils and capping them with limestone shelves.

Some houses are built on pilings not because of the soil quality, but because of inevitable flooding. While this type of construction protects the house from water, it makes it more vulnerable to fire. The

lower level is often screened with wood or lattice screening which is flammable. A better option would be a metal or a cementitious material. FEMA also recommends that the underside of the floor system be covered with fire rated gypsum board.

Pier and beam foundations are not always "houses on stilts". Where poor soil, not flooding, is the issue, houses can be built much closer to the grade.

FINAL EXAM QUESTIONS:

9. _____ slabs are foundation systems poured as one unit.

a. Precast
b. Cast-in-place
c. Post-tensioned
d. Monolithic

10. Open foundations generally employ the use of pilings or piers and _____.

a. Struts
b. Slabs
c. Beams
d. Girders

11. Piers transfer loads by bearing only. Pilings transfer loads by bearing and _____.

a. Rock
b. Friction
c. Trabeation
d. Shape shifting

Waterproofing

With the exception of slab on grade and pier and beam foundations, all other foundations are threatened by Public Enemy #1 – WATER!

Water, like all compounds, exists in three states, solid, liquid, and gas. In northern zones, water in its solid form, ice, is a critical issue, especially ice in the ground. Frozen soils swell and cause frost heaving. Frost heaving is the upwards swelling of soil during freezing conditions due to the presence of ice. Local codes where frost heaving is a problem require foundations to be built deep enough to bear on soils below the frost line.

Ice is also a threat to any material that has a crack or fissure. Ice wedging or frost wedging is a form of mechanical weathering in which cracks in rock or other surfaces fill with water, freeze, and expand, causing the cracks to enlarge and eventually break. Water penetrates the material, often through capillary action and freezes. This is especially destructive when the material is rigid such as stone or concrete.

Water in its gaseous state, vapor, is also destructive to foundations. As we have seen in ventilated crawlspaces, the foundation vents introduce moist air (vapor) into the crawlspace. Warm moist air entering a cool crawl space will drop its moisture, which will condense on walls, pipes, ducts, and floor joists making conditions favorable for mold, corrosion, and rot.

Vapor does not always originate in the air. Concrete emits vapor for the entire life of the curing process, which can last thousands of years. Even though concrete dries substantially in 24-48 hours, is 70% dry after 7 days, and is virtually fully cured after 28 days, it never fully dries. Also, due to its porosity, concrete can absorb water by direct contact with liquid water or water vapor.

Though ice and water vapor are seriously problematic, liquid water by far is the most serious threat to the integrity of foundations. There are two types of water that endanger foundations – surface water and ground water. The first line of defense is to prevent surface water from becoming ground water. Roof overhangs, gutters and sloping the grade (1/2"/ft for at least 6 ft) away from the foundation

are effective means to keeping the surface water away from the foundation. Once surface water penetrates the ground, it becomes ground water and must be managed to keep it from compromising the foundation.

The primary task in managing ground water is to keep the water away from the foundation, by allowing it to drain down without creating hydrostatic pressure against the foundation wall. Once hydrostatic pressure is allowed to develop, there will be a leak. Three things are required for a foundation leak – water, a hold or crack, and pressure. You can't not have water – it will always rain (and snow). You may try to have a foundation without holes, but you probably will not succeed, no matter how hard you try. The only thing left that can be controlled is the elimination of hydrostatic pressure. Traditionally, drainage materials such as gravel or sand have been used to enable the water to drain down and then collect the water into a perimeter drain that allows the water to flow out and way from the foundation. If you think hydrostatic pressure isn't that big of a deal, remember that 1" of water is equivalent to a 70 mile per hour wind, which means that hurricane forces can be attacking your foundation, while everything seems calm above ground.

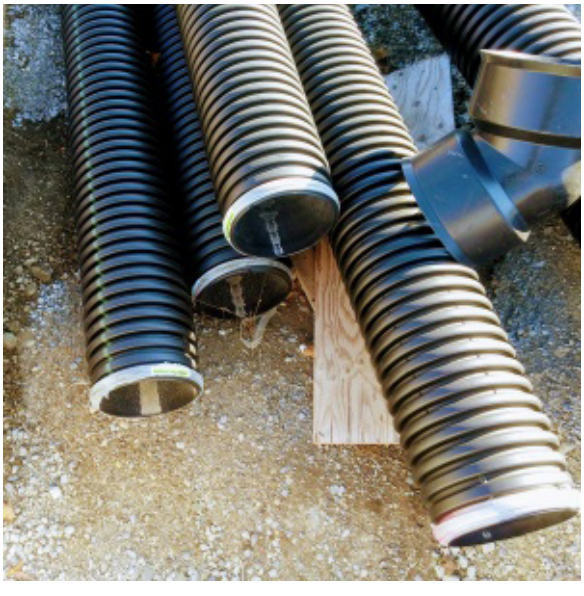
Three things are required to protect any foundation from the effects of hydrostatic pressure. A waterproof layer on the foundation, a capillary break, and a layer of free draining material, such as gravel, which allows the water to drain by gravity to a subsurface perimeter drain. With some systems using drainage board or dimple mats, the capillary break and the drainage field are incorporated.

Capillarity is of major concern in building since any material with pores will wick or suck water. Wood and concrete are common materials used in residential construction that contain pores and are therefore subject to capillarity. The smaller the pore, the greater the force of capillarity. This is what allows trees hundreds of feet tall to draw water up to the top branches. Concrete and brick are extremely porous, which makes it extremely important to prevent water from contacting the surface and being drawn into the foundation wall or floor slab by capillary action.

The waterproof barrier is usually attached to the exterior side of the foundation wall, usually a sheet membrane or a liquid membrane applied by spray, roller, or trowel. Sheet membranes are typically rubberized asphalt of at least 60 mil or bentonite. Bentonite is a type of clay that as it takes in water, swells to up to 15 times its original volume forcing itself into cracks and holes permanently sealing the foundation wall. Unfortunately, the seal doesn't form until the foundation is backfilled and water reaches the panel which leaves some doubt as to whether it was properly installed. On the plus side, it is a non-polluting material that is relatively easy to work with.

There is some confusion between the terms "waterproofing" and "dampproofing". The International Residential Code (IRC), in Section R406, specifies the conditions that require either dampproofing or waterproofing. Any concrete or masonry foundation walls "that retain earth and enclose interior spaces and floors below grade shall be dampproofed from the top of the footing to the finished grade." The IRC then provides a list of the permissible materials, which include bituminous coating and acrylic-modified cement. Waterproofing is only required by the IRC "in areas where a high-water table or other severe soil-water conditions are known to exist."

Perimeter Drains



https://wiki.sustainabletechnologies.ca/wiki/Underdrains by Unknown Author is licensed under CC BY

Perimeter drains, often referred to as French drains, named after Henry Flagg French, the man who invented it in 1859, have traditionally been round pipes that allow water to enter and then flow away from the structure. Years ago, the drains were made from terracotta pipes. However, there were problems of cracking and root intrusion.

Currently, perimeter drains are usually perforated corrugated plastic pipes, which are easy to install. It is important to cover any perforated pipe with a filter of some sort to prevent the drains from becoming clogged with silt. Many products come with filter fabric installed on the pipe.

Recently, rectangular strip drains are being used more and more. They come with incorporated filter fabric and in some cases an adhesive side which helps to place it against the foundation.

The placement of the drain is preferably next to the footing. Unfortunately, because of the way footings are excavated, this is rarely done. It usually finds itself sitting on top of the footing. The important thing to remember is that the top of the pipe must be below the top of any slab that may be inside the foundation.

Radon Abatement

Before we leave the subject of foundations and basements, a word needs to be said about harmful gas abatement, most often radon.

Radon is a naturally occurring radioactive gas that can cause lung cancer. It is inert, colorless, and odorless. Outdoors, radon is usually not an issue since it disperses rapidly due to natural air movement. Radon exposure is a problem when it occurs inside homes and other buildings. Breathing radon increases your risk of lung cancer. Radon is the second leading cause of lung cancer in the United States. Nationally, the EPA estimates that about 21,000 people die each year from radon-related lung cancer, second only to smoking, which means it is the leading cause of lung cancer in non-smokers.

Entry points of radon into buildings are typically cracks in foundations and walls, construction joints, under concrete slabs and around pipes, vents, and wires.

According to the EPA, the five basic features that builders should include to prevent radon from entering a home are:

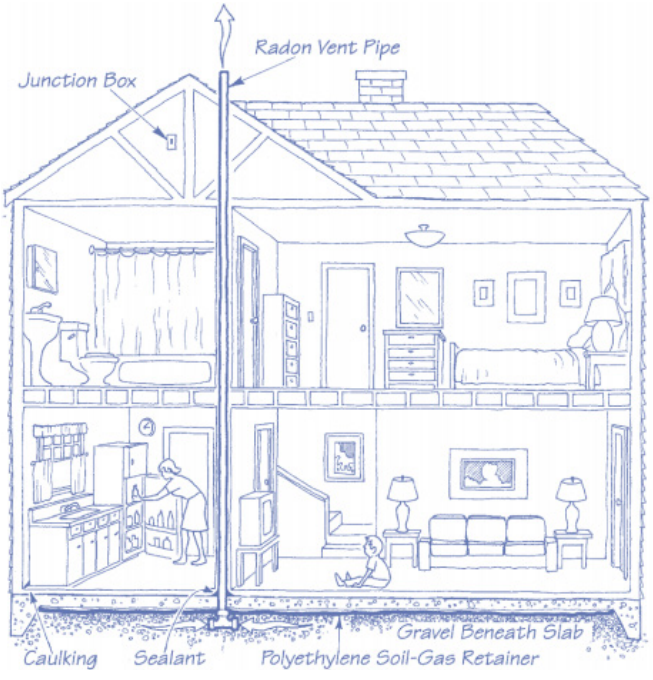
1. **Gravel:** Use a 4-inch layer of clean, coarse gravel below the "slab," also called the foundation. This layer of gravel allows the soil gases, which includes radon, that occur naturally in the soil to move freely underneath the house. Builders call this the "air flow layer" or "gas permeable layer" because the loose gravel allows the gases to circulate. **NOTE:** In some regions of the country, gravel may be too expensive or unnecessary. Alternatives are allowed, such as a perforated pipe or a collection mat.

2. **Plastic Sheeting or Vapor Retarder:** Place heavy duty plastic sheeting (6 mil. polyethylene) or a vapor retarder on top of the gravel to prevent the soil gases from entering the house. The sheeting also keeps the concrete from clogging the gravel layer when the slab is poured.

3. **A Vent Pipe:** Run a 3-inch or 4-inch solid PVC Schedule 40 pipe, like the ones commonly used for plumbing, vertically from the gravel layer (stubbed up when the slab is poured) through the house's conditioned space and roof to safely vent radon and other soil gases outside above the house. (Although serving a different purpose, this vent pipe is similar to the drain waste vent, DWV, installed by the plumber.) This pipe should be labeled "Radon System." Your plumber or a certified radon professional can do this.

4. **Sealing and Caulking:** Seal all openings, cracks, and crevices in the concrete foundation floor (including the slab perimeter crack) and walls with polyurethane caulk to prevent radon and other soil gases from entering the home.

5. **Junction Box:** Install an electrical junction box (outlet) in the attic for use with a vent fan, should, after testing for radon, a more robust system be needed.



https://www.epa.gov/sites/default/files/2014-08/documents/buildradonout.pdf from epa.gov

Though the considerations here are not exhaustive by any means, we will leave the subject of foundations and move "upward" and turn our attention to the subject of framing.

FINAL EXAM QUESTIONS:

12. Three things are required for a foundation leak – water, a hold or crack, and _____.

a. Clay
b. Silt
c. Bull Tallow
d. Pressure

13. The placement of a perimeter drain is preferably_____ the footing.

a. On top of
b. Under
c. On the side
d. Inside

FRAMING

Main Types of Wood Framing

Framing can be wood or steel, but since the preponderance of residential construction is wood framing, we will concentrate our considerations on wood framing.

The three main types of wood framing used for residential building are Western or platform framing, balloon framing, and braced framing.

Western or platform framing is a system of framing in which the floor system of one story sits on the wall assembly of the story beneath it.

Balloon framing, sometimes called Chicago framing, is a system of framing in which the vertical elements of the exterior walls, i.e. studs, extend the full height of the structure from the soleplate to the roof plate. Floor joists are fastened to the studs either by being nailed or screwed to the sides of the studs or by sitting on a ledger that has been let into the studs. The name comes from the French *maison en boulin*, *boulin* being a French term for a horizontal scaffolding support.

Braced framing, or post and beam framing, is a system of framing in which girts are mortised into solid corner posts which are full frame height. Intermediate studs are single story height and, once installed, are diagonally braced.

Braced framing is considered to be *heavy framing*, whereas balloon and platform framing are considered to be *light framing*, due to the use of smaller and more numerous components.

Braced framing was replaced by balloon framing, and balloon framing has been replaced by platform framing except in certain cases such as stairwells on exterior walls and multi-story height walls.

Advanced Framing

In the 1960s, a version of platform framing was proposed called Advance Framing or Optimum Value Engineering (OVE). Its intent was to reduce the amount of lumber used in framing. The purpose

was to reduce costs and also improve the energy efficiency of wall assemblies by reducing thermal bridges and allowing better insulation. Some of the methods of this technique were:

- Framing on wider centers such as 24". This saves studs and increases the amount of insulation in the wall.
- Inline framing where studs line up over joists and joists and rafters line up over studs. Where wall studs are 2X6 on 24" O.C. and in line with joists and rafters, this is sometimes referred to as *Arkansas framing*.
- The use of two stud corners which reduces the amount of studs and allows insulation to be installed in corners.
- Single stud jambs which prevent the bulking up of jack studs and cripple studs at window openings, which again reduces the number of studs and consequent thermal bridging.
- Right-sized insulated headers including no headers in non-bearing walls.
- Eliminating studs at intersections with interior partitions.

Although Advanced Framing has been around for over fifty years, it has not gained widespread acceptance. The International Residential Code recognizes some, but not all aspects of Advanced Framing, and areas with high wind loads or seismic zones will not allow some of the details. Even if you are building in an area amenable to using Advanced Framing, don't expect your local building inspector to sign off on the framing without an engineer's letter.

Mud Sill

Before the floor system can be installed, a sill plate, sometimes referred to as a mud sill, must be bolted to the top of the foundation. If it is in contact with concrete, it must be pressure treated lumber, and since it is pressure treated lumber the bolts, washers, and nuts must be hot dipped galvanized. It is also good practice to seal the space between the foundation and the sill plate. This is essential in the case of encapsulated crawlspaces and inhabitable basements. This can be accomplished with an appropriate caulk or with several types of foam gaskets that come in rolls. If foam rolls are used, butt joints of the treated sill plates should be caulked.

Floor Systems

Floor systems have traditionally been framed with 2X joists, typically made from Southern Yellow Pine (SYP), due to its abundance and inherent structural strength. Joists were usually lapped over a drop girder or flushed to the top of a flush girder using a ledger or joist hangers to attach the joists to the girder.

http://diy.stackexchange.com/que stions/20424/what-is-the-codeapproved-way-to-cut-and-patchfire-rated-drywall-hung-on-the-ce) by Unknown Author is licensed under CC BY-SA

I-joists

In 1969, an engineered wood joist, commonly known as an I-joist was invented. The I-joist differs from dimensional lumber in that the I-joist carries heavy loads with less lumber than a dimensional solid wood joist. The product was widely accepted and as of 2005, approximately half of all wood light framed floors are framed with I-joists. Unlike dimensional solid wood joists, I-joists are less likely to bow, crown, twist, cup, check or split. The greatest disadvantage is that the I-joist rapidly loses structural strength in the case of a fire.

Like a steel I-beam, an I-joist has two main parts, the web and flanges. The flanges can be constructed from laminated veneer lumber or finger-jointed solid

wood. The web is typically made from plywood, laminated veneer lumber, or oriented strand board. Sizes vary according to the I-joist's intended load and span. Depths can range from 9.25 to 24 inches and can reach up to 80 feet in length. The I-joist can be used for floor joists, ceiling joists, and roof rafters.

Due to the structural dynamics of I-joists, penetrations are possible that can greatly enhance the ability to install MPE systems. Often the allowed opening locations are marked on the web, and, in some cases, they perforated so they can be knocked out with a hammer.

FINAL EXAM QUESTIONS:

14. The three main types of wood framing used for residential building are Western or _____ framing, balloon framing, and braced framing.

a. Southern
b. Arkansas
c. Platform
d. Stud and Plate

15. A sill plate, sometimes referred to as a _____ sill, must be bolted to the top of the foundation.

a. Flat
b. Mud
c. Shoe
d. Top

16. The greatest disadvantage in using I-joists is that they rapidly lose structural strength in the case of a(n) _____.

a. Fire
b. Flood
c. Earthquake
d. Hurricane

17. Like a steel I-beam, an I-joist has two main parts, the web and the _____.

a. Chords
b. Flanges
c. Struts
d. Stations

Floor Trusses

Another alternative to dimensional lumber and I-joists are floor trusses. The technical definition of a truss is a structure that "consists of two-force members only, where the members are organized so that the assemblage as a whole behaves as a single object." *Truss* derives from the 13th century French word *trousse*, which means "collection of things bound together." A *planar* truss is a truss where all members and nodes lie within a *two*-dimensional plane. A *space* truss has members and nodes that extend into *three* dimensions. The top beams in a truss are called *top chords* and are typically in compression, the bottom beams are called *bottom chords*, and are typically in tension. The interior beams are called *webs*, and the areas inside the webs are called *panels.*

This Photo (http://diy.stackexchange.com/questions/107712/wiring-forrecessed-lighting-through-ceiling-with-floor-trusses) by Unknown Author is licensed under CC BY-SA

Trusses are usually a network of triangles since a triangle is the simplest geometric figure that will not change shape when the lengths of the sides are fixed. Therefore, before the common use of panels, such as plywood and OSB, let in bracing and 1X sheathing boards were installed on diagonals.

Floor trusses have the ability to span even greater distances than even I-Joists. The open web design also allows for great freedom in the installation of plumbing, electrical, and HVAC systems.

Not all wood trusses use wood for the webs; some use metal. In the early 1980s it was common to use floor tresses that were metal webbed trusses. The good thing about this type of truss is that they are easier to fabricate, lighter and easier to handle, however they "sang" when vibrated and the pressed-in cleat on the web ends were prone to fail.

Caveat on Trusses

Even though trusses are an assemblage that as a whole behaves as a single object, they are not truly static, and they do move. The top chord can change in length due to temperature and moisture fluctuations causing the other members to shift to accommodate the top chord dimensional change. This is referred to as "truss heave" or "truss uplift". In residential construction this is often observed in the tops of interior partitions that meet the bottom chord of the truss.

This condition can be dealt with by using a crown mold which is connected to the moving ceiling and not to the wall allowing the trim piece to travel with the truss as it moves up and down.

Subfloors

Until World War II subfloors were built with diagonal 1X solid boards, usually 1X6. During the building boom after the war, the introduction of plywood made it the standard for residential construction until the invention of oriented strand board in 1965. Since then, OSB accounts for 66% of all structural panels used in the United States.

Plywood was first used by the Egyptians and the Greeks over 5,000 years ago. In 1797 Samuel Bentham, a British naval engineer, applied for patents on machines to produce veneers that could be laminated into what would be later called plywood. His interest was in the use of plywood to construct boats. Plywood was introduced in the United States in 1865, the first year of the Civil War. The first 4X8 sheet of plywood was produced in 1928 and became an accepted general building material.

Oriented strand board is manufactured in wide mats from cross-oriented layers of thin, rectangular wooden strips compressed and bonded together with wax and synthetic resin adhesives. The mats are compressed under heat to form the sheets from which the finished panels are cut. Prior

to compression, a 1/2" (7/16" actual) nominal OSB panel is about 6" thick. OSB has structural properties similar to plywood and in some cases superior. It is available in thicknesses from 1/4" to 1-1/8". Standard panel size is 4'X8', but it is also available in 9' and 10" lengths. Longer lengths are useful for wall sheathing on walls that are greater than 8' tall. Health concerns have been raised over the years since some of the adhesives used in the production of OSB emit volatile organic compounds (VOCs) such as formaldehyde.

Subfloor panels can be nailed or screwed to the floor joists and should be glued. Typical adhesives come in cartridges dispensed through hand activated or pneumatic guns. DAP® has developed a dynamic polyurethane adhesive foaming gel that is faster and easier to use than traditional cartridge adhesives and bonds wet, frozen, and treated wood.

FINAL EXAM QUESTIONS:

18. The top beams in a truss are called top chords and are typically in compression, the bottom beams are called bottom chords, and are typically in _____.

a. Repose
b. Tension
c. Torsion
d. Crown

19. In 1797 Samuel Bentham, a British naval engineer, applied for patents on machines to produce veneers that could be laminated into what would be later called _____.

a. Parquetry
b. Polystyrene
c. Norwegion Wood
d. Plywood

20. _____has structural properties similar to plywood and in some cases superior.

a. Finger-joint
b. Oriented Strand Board
c. Parallam
d. Truss panel

Walls

"Something there is that doesn't love a wall." So wrote Robert Frost in his famous poem, *Mending Wall*. Of course, he was referring to the stone walls that separated neighbor from neighbor in his New England hometown. But when it comes to the walls in our residences, there is something to love. The wall serves as a vertical structure which supports the roof, which keeps the sun and rain off our heads. It serves as a barrier from the outside world, keeping us safe. It serves a planar structure to accommodate doors that allow us to come in and go out, and windows to admit light and let us view the outside. It is also one of the chief aesthetic components of our homes. It's the place where we attach our sidings or brick or stone. It's where we hang the shutters and the wreaths at

Christmas time. Yes, there is something that *does* love a wall. But when a wall is not built right, then we agree with Frost. There is something that doesn't love a wall.

As simple a thing as a wall has proven to be quite complex. Of all the advances in building science, knowledge of how a wall works has proven to be the most enigmatic. Astonishingly, it has taken literally thousands of years to understand and learn from the mistakes humans have made in the building of walls. Early walls were made by stacking stones on each other to some desired height, determined by what you wanted to keep out – a lion, or a bear, or an army. Where there were no available stones, humans (and some animals), made their own stones out of dried clay. Parts of tree trunks, branches, leaves, and grasses also proved to be convenient building materials. Each generation of builders

learned what previous builders had done before them and contributed his or her own ideas on how to improve on the methods and materials.

One of the most fundamental advances in wall building was the trabeated system or what is more commonly call post-and-lintel, *trabs* being the Latin term for beam.

- Stonehenge, UK
- Airavatesvara Temple, India
- Parthenon, Greece
- Dornstetten, Germany

As can be seen from these examples from various locations, the system was "discovered" by people from various lands and times, more than likely by observing naturally occurring instances. Modern day framing is only a variation of this type of construction. It is safe to say that the primary function of the post-and-lintel wall is to support the roof and to provide openings for windows and doors. As is also evident from these examples, the system evolved from a completely open system to a system of enclosure.

Functional Requirements

The functional requirements of walls as support components are strength and stability. A wall should be strong enough to support its own weight as well as any other loads that are placed upon it, such as floors and roofs and lateral pressure such as backfilled earth and wind loads. It should be stable enough to resist any overturning and buckling forces.

Enclosure

The functional requirements for walls as an enclosure component are weather resistance, fire resistance, heat insulation, acoustical insulation, privacy, and security. The need for strength and the need for insulation against the elements are often competing issues and a balanced compromise must be achieved.

Focusing on weather resistance and heat insulation, the wall must be designed and built to handle four major types of infiltration – water, air, vapor, and thermal.

In the typical wall section the exterior cladding served as the sole control layer. Also the roofing should felt over the sheathing and under the siding. Roofing felt (asphalt impregnated felt) has been used for centuries as a moisture barrier on walls, layers for mopped on built up roofs (BUR) and as an underlayment layer for cedar shakes and asphalt/fiberglass shingles. In some ways, it is adequate in its traditional applications, but it does have some downsides. Compositionally, it is primarily crude oil and therefore not a sustainable product. It is also combustible and therefore accelerates structure fires. Exposure to heat UV light greatly diminishes its integrity. Fumes from hot applications and in the manufacture of the product can cause skin irritations and respiratory problems. Asbestos was used in early versions of roofing felt and persons can be exposed to the asbestos in the demolition and remodeling of existing buildings.

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Alternative weather resistant barriers (WRB) to roofing felt have become popular since the introduction of Tyvek® in 1967. Tyvek is a nonwoven product consisting of spun bond olefin fiber. It resists liquid, but it allows the passage of water vapor. It is thin, but not easily ripped, making it useful for other applications such as mailing envelopes and personal protective equipment (PPE) suits. Similar housewraps are also available which are less expensive, but also less effective. Typar®, another leading housewrap, has lower vapor permeability than Tyvek®, but has better water holdout. It is also 5X more tear resistant. Typar's

superior water holdout makes it a better WRB when used in a rainscreen system.

Notice also that in the traditional wall section, a vapor barrier is indicated under the drywall or plaster layer. In the late 1970s codes required this vapor barrier. It could be achieved by facing the craft paper side of batt insulation toward the conditioned space or preferable (so was thought) by applying a continuous envelope of polyethylene plastic sheeting (visqueen) over the insulation, just under the drywall. This practice has continued for years if not decades. Sometime contractors may still see specifications for it from time to time. The original idea was that it would prevent water vapor created inside the house from bathing, cooking perspiring, etc. from entering the structure, i.e. the framing of the wall, after it had permeated the drywall, plaster, or wall paneling. The problem is, it doesn't. There are too many electrical receptacles, switches, lighting fixtures, mechanical penetrations that allow moisture into the wall structure. In fact, the interior vapor barrier prevents moisture that does get into the wall structure from being able to migrate into the house where it can be processed by the mechanical system. This became painfully evident in the mid 1990s, with the popular use of exterior insulating and finish system (EIFS). Any leaks of liquid water and/or vapor into the wall from the exterior or interior was trapped between the exterior insulation system and the interior vapor barrier causing the structure to mold and rot. The problem was so prevalent, a class action suit was opened against one of the leading EIFS companies in the US. Even though most of the problems were not the fault of the EIFS system, but due to improper installation by the subcontractors, a settlement was approved January 14, 2003. Attorneys still advertise for help with homeowners who have issues with their homes that have EIFS exteriors.

The 2018 International Building Code Section 1402.2 Weather protection requires that "Exterior walls shall provide the building with a weather-resistant exterior wall envelope….The exterior wall envelope shall be designed and constructed in such a manner as to prevent the accumulations of water within the wall assembly by providing a water-resistive barrier behind the exterior veneer, as described in Section 1403.2, and a means for draining water that enters the assembly to the exterior." Section 1403.2 reads, "Not fewer than one layer of No. 15 asphalt felt, complying with ASTM D226 for Type 1 felt or other approved materials, shall be attached to the studs or sheathing with flashings as described in Section 1404.4, in such a manner as to provide a continuous water-resistive barrier behind the exterior wall veneer." All that is to say, that some sort of approved housewrap is required. Also required is a means of draining any water that does enter the assembly. Water in the assembly may be present by water actively entering the assembly or by the condensation of water vapor that has entered the assembly. Water may exit the assembly by liquid drainage or by vapor evaporation.

Moisture Resistive Sheathing

Within the last ten years or so, a new approach has been developed using moisture resistive sheathing. The MRS becomes a combination of structural sheathing, air barrier, and water barrier and eliminates the need for a housewrap. The most well know is Zip System® by Huber Engineered Woods. The system includes structural OSB wall and roof panels with resin-impregnated overlays that are bonded to the outside face of the panel. The roofing panels have the added featured of a high friction, gritty texture to improve traction. Important to the success of the system are the tapes that are used to seal the seams between panels and window and door openings and any other penetrations. The tapes have a patented adhesive that when properly applied and rolled, form a molecular bond to the substratum surface. The resulting perm rating is that of an OSB panel covered with Typar® housewrap. Debate continues as to the cost effectiveness vis-à-vis conventional OSB and housewrap, but it is certainly gaining in popularity.

In addition to resisting water and vapor from entering the wall assembly, means must be provided to process and eliminate water or vapor that does. Brick and stone veneers have for some time typically been installed so as to provide a 1" air space between the masonry and the WRB protected structure. More recently, weep holes have been required above the flashing at the foundation or over door and window openings. Unfortunately, the careless application of mortar often builds up in the air space and renders it useless for its intended purpose. Care must taken by masons to ensure that the air gap remains free for water to drain

downwards and vapor to evaporate upwards.

Returning to the subject of vapor barriers on the inside of the wall structure, there is a Swiss company, Siga, that has developed a uni-directional vapor barrier to be used on the conditioned side of the assembly. The barrier, a sheet product named Majrex (pronounced my-reks) comes in rolls and is attached to the studs by adhesive strips. It allows any moisture in the assembly to migrate across the barrier into the house, but blocks any vapor from the interior of the house from entering the wall assembly.

Insulation

Another important function of the wall is its service as a thermal barrier. In northern regions that means keeping the warm air in and in southern regions that means keeping the warm air out. (Air flows from warm to cold). The traditional way to insulate has been to fill the cavities between the studs in a wall with insulation. That insulation is typically fiberglass, cellulose, rockwool, or open or closed cell foam.

Fiberglass insulation works by limiting conductive heat transfer in the space that it occupies. Warmer air naturally moves towards a cooler space. The air trapped between the fibrous strands in fiberglass doesn't move and creates still air, effectively eliminating convection and conduction and insulating the space. Fiberglass is made from 50-80% recycled materials, is also a good acoustical insulator and has a life span of about 100 years.

Cellulose insulation is composed of recycled wood and paper, primarily used newspapers. (Remember what a newspaper is?) Like fiberglass, cellulose is an excellent thermal and acoustical insulator. Some tests have shown that cellulose is actually a better thermal insulator than fiberglass of the same R value. Cellulose is also less expensive than fiberglass. Unlike fiberglass, cellulose is always installed in loose form. The advantage of loose form insulation is that it can settle in nooks and crannies where fiberglass batts cannot. (To force fiberglass into tight spaces actually reduces its efficacy.) The disadvantage of loose form insulation is that it can settle over time, creating voids that are spaces that are no longer insulated. Cellulose is treated with boric acid to discourage pests and vermin and with fire retardants to reduce flammability. If cellulose is exposed to moisture, it is prone to absorb the moisture, and, while it may not encourage mold growth in itself, it can cause rot and mold on materials that it is in contact with. The life span of cellulose is 20-30 years.

Rockwool insulation is a rock-based mineral fiber insulation comprised of basalt, a volcanic rock, and recycled slag, a by-product of the steel and copper industries. The minerals are melted and spun into fibers. Prior to 1960, rockwool also often contained asbestos. Rockwool repels water, so R-value is not affected in the presence of moisture. In addition to being fire resistant, it is also completely resistant to rot, mildew, mold, and bacterial growth. There is some concern that the dust and loose fibers from rockwool can be irritants to eyes, skin, and respiratory systems. The life span of rockwool is equivalent to the materials it is comprised of – rocks!

Sprayed foam insulations are highly effective ways to insulate although they come with initially higher costs. Sprayed foam insulation is referred to open cell or closed cell. **Open cell foam** is full of cells that aren't completely enclosed. This makes the foam softer and more flexible. **Closed cell foam** is made up of cells that are completely closed. Closed cell foam is more rigid, stable, and resistance to air and moisture than open cell foam. Open cell foam has a density of about .5 pounds per cubic foot, while closed cell foam can have a density of 1.75 pounds per cubic foot or more. Open cell foams have an R-value of around 3.5 per inch. Closed cell foams have R values of almost twice that of open cell ranging from 5.0 to 7.0 per inch. Closed cell foam is designed to expand to about 1″ of thickness when sprayed. Open cell foam is designed to expand to 3″ of thickness. Open cell foam can expand into spaces that closed cell foam cannot. Closed cell is waterproof and can serve as a vapor barrier against moisture and active water. This feature can be useful in interior damp-proofing of existing basements.

If you'll notice that all of the aforementioned have one thing in common. They are all placed between the studs of the wall assembly, which means that the only part of the wall that is being insulated, is the spaces between the studs, but the studs are the primary thermal bridges in any wall. A thermal bridge, or thermal bypass, is an area or component

of an object which has higher thermal conductivity than the surrounding materials, creating a path of least resistance for heat transfer. So, the heat will avoid the insulated space between the studs and travel directly through the stud. In the case of wood framing the studs do have some U-value. In metal framing, the studs are extremely conductive. If the studs are cold, they will cause condensation of any moisture in the wall assembly and the results can be quite damaging. One of the arguments for Advanced, Inline, or Arkansas Framing was the reduction of the number of studs and therefore a reduction of thermal bridging.

With all of this consideration of misplaced vapor barriers and troublesome thermal bridges that have been an integral part of the way we have built walls for generations; it makes one wonder what in the world can be done about it?

FINAL EXAM QUESTIONS:

21. The functional requirements of walls as support components are strength and _____.

a. Uprightness
b. Thickness
c. Height
d. Stability

22. Some sort of approved housewrap is required. Also required is a means of _____any water that does enter the assembly.

a. Draining
b. Absorbing
c. Evaporating
d. Eviscerating

23. Fiberglass insulation works by limiting conductive heat transfer in the space that it occupies. Warmer air naturally moves towards a _____ space.

a. Larger
b. Closed
c. Cooler
d. Open

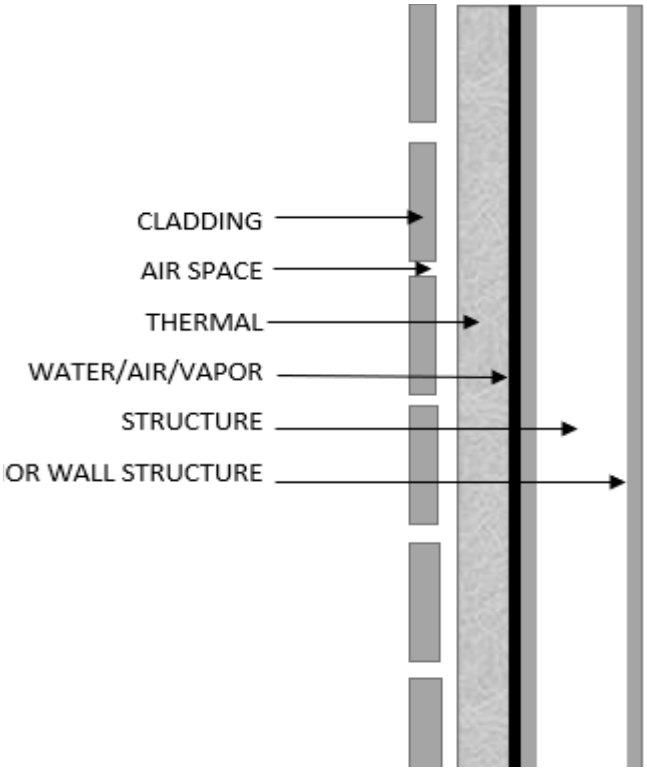
24. A thermal bridge, or thermal bypass, is an area or component of an object which has higher thermal _____than the surrounding materials, creating a path of least resistance for heat transfer.

a. Resistance
b. Mass
c. Conductivity
d. Uniformity

The "Perfect Wall"

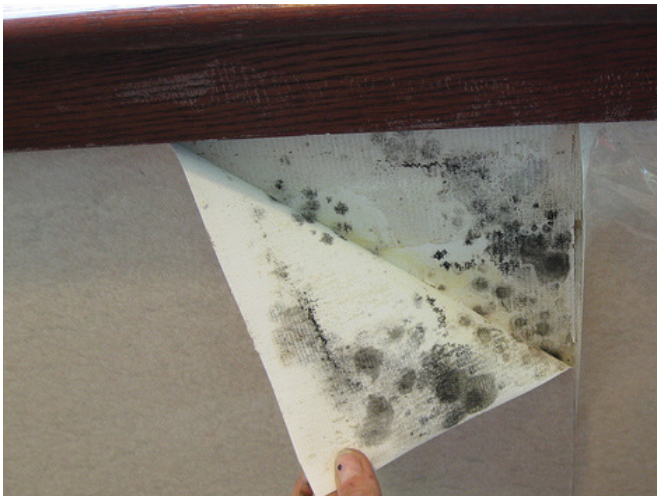
Rather than the traditional (and intuitive) way of building an effective wall consider the "perfect wall".

The Perfect Wall – Dr. Joseph Lstiburek



This is a wall section proposed by Dr. Joseph Lstiburek (the "L" is silent). Dr. Lstiburek is a Canadian of Czech descent and principal at Building Science Corporation. He noticed that many ancient buildings have endured for millennia while too many modern structures were rife with problems. His research led Dr. Lstiburek to identify four key control layers within the building envelope (rain, air, vapor, and thermal) critical to a building›s behavior, long-term performance, and viability. He noticed that in too many instances the designers and builders were ignoring the principals behind the control layers and where they were being placed.

An example that is familiar to almost everyone is the modern hotel room. Almost every hotel room in America is air conditioned, has vinyl wall coverings and has a bathroom that is exhausted from rooftop fans. This is a recipe for disaster. The exhaust creates a negative pressure in the room which draws the outside air through the wall and into the room. It is stopped at the vapor barrier which is the vinyl wallcovering. The wallcovering is also cool, due to the air conditioning, causing mold to grow on the backside of the vinyl. (Vinyl doesn't breathe). Does this look familiar?



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In 2007, at MIT's Stata Center, Lstiburek had observed problems during construction, noting that the building envelope's key control layers (rain, air, vapor and thermal) were in the wrong order, causing the building to soak in its own condensation causing erosion of building materials and mold, as well as causing the building to "smell like dirty socks." That same year, the architect, Frank Gehry, and the contractor, Skanska USA Building Inc., were sued by MIT reaching a settlement in 2010.

The most important principle in the Perfect Wall is that the best place for the control layers is on the outside of the structure to protect the structure. We generally think of the cladding, the outermost layer that we see, as a control layer, but it really isn't. The cladding has three functions. It serves as the aesthetic layer, and it protects the control layers from physical damage and UV exposure. If the cladding "leaks", that's a good thing. It's all the better as vapor and water release.

Behind the cladding, there needs to be an air space, sometimes referred to as the drainage plane. This needs to be at least 3/8" and free of debris to allow rapid dissipation of bulk water.

Behind the drainage plane are the control layers – water (rain), air, vapor, and thermal. These layers protect the structure. The layers can be separate but are often achieved with fewer than four components. For instance, a vapor barrier might also be a water barrier and even an air barrier. Certain foam insulations can serve as all four control layers. Whatever the combination might be, the outermost control layer should be the thermal control. This protects the other control layers from the expansions and contractions due to temperature fluctuations.

The follow details describe parts of what a section of wall based on what might occur in the real world. It contains a cladding that could be a brick veneer, stucco, stone, wood, cementitious sidings such as Hardie® or Nichiha, or metal, or vinyl. The rigid insulation can be extruded or expanded polystyrene, isocyanurate, rock wool or fiberglass. The drainage plane could be applied sheets or sprayed on. The exterior sheathing could be gypsum, plywood, or oriented strand board. Commonly inside a wall is gypsum board with some sort of semi-permeable wall finish such as latex paint. Vinyl wall coverings and oil or alkyd paints may produce a non-permeable barrier. Vapor needs to be able to travel in both directions from the air/vapor barrier. This must also be kept in mind when fixtures, such as cabinets and mirrors, are installed inside the residence. Wood may be safely attached directly to the wall, but any impermeable material such as a glass mirror or cabinets constructed with medium-density fibreboard or particle board will need to be installed in such a manner as to allow an air space between the fixture and the wall.

The principles of the Perfect Wall have been adopted in an exterior wall detail known as a “rainscreen”, a detail where the siding (wall cladding) stands off from the moisture-resistant surface of an air barrier applied to the sheathing to create a capillary break and to allow drainage and evaporation. The term rainscreen actually refers to the cladding itself, but it has come to describe the system as a whole.

Structural Insulated Panels (SIP)

A Structural Insulated Panel (SIP) is a sandwich structured composite building component, consisting of a core of rigid insulation sandwiched between two layers of structural board. The structural board is usually OSB, however, the board can be plywood, cement, sheet metal, or magnesia. The insulating core can be expanded or extruded polystyrene, polyisocyanurate, or polyurethane foam. In theory, SIPs share the same structural properties as an I-beam or I-column, with the structural board acting as the flanges and the rigid insulation core acting as a web. As a composite assembly, SIPs incorporate several standard components used in building such as studs, insulation, vapor barrier and air barrier. SIPs can be used as exterior walls, roofs, floors and foundations.

The advantages of building with SIPs are numerous. The whole-wall R values are much greater than a conventionally framed and insulated wall of the same R-value insulation, due to the reduction of thermal breaks. For instance, a 2x6 wall framed 24 inches on-center with plywood sheathing, drywall, and 5½-inch batts has a whole-wall R-value of 13.7. The same wall built with 6-inch OSB SIPs has a whole-wall R-value of 21.6, a 58% increase. The panels are built in environmentally controlled facilities which ensures superior quality control. Manufacturers of SIPs claim that field erection of SIP structures is simpler and requires less skilled labor, but that is a dubious claim, since manipulation and connection of large, thick panels presents a new set of challenges, and if panels are not properly connected, air infiltration problems can occur, resulting in future failures of the panels. Connection to foundations and to interior partitions can also be quite complicated. While drywall and carpentry trades enjoy the benefits SIPs provide for their trades, installation of the MEP trades present challenges that conventional construction does not.

FINAL EXAM QUESTIONS:

25. In the Perfect Wall, Dr. Lstiburek identified four key _____ layers within the building envelope (rain, air, vapor, and thermal) critical to a building's behavior, long-term performance, and viability.

a. Control
b. Insulating
c. Building
d. Outside

26. The most important principle in the Perfect Wall is that the best place for the control layers is on the outside of the structure in order to protect the _____.

a. Wiring
b. Insulation
c. Structure
d. Drywall

27. In theory, Structural Insulated Panels (SIPs) share the same structural properties as a(n) _____.

a. Wall
b. Roof
c. I-beam
d. TJI

Roofs and Attics

Roofs, in many ways, are just tilted walls. So, what we learned with the Perfect Wall can easily translate into the Perfect Roof.

Installing the insulation on the outside of the roof assembly, just as in the Perfect Wall, keeps the structure inside the insulated space. The problem is that except in the case of cathedral ceilings, most of us don't build roofs this way. And that's OK, because when we have ceilings above our rooms and roofs above our ceilings, we create a space called the attic.

Some attics are created using ceiling joists and rafters, but the same applies for attic created using trusses. It is a space that is not usually conditioned. Attics get cold in the winter, and hot in the summer – really hot. On a hot summer day, an attic can reach a temperature of 150 – 160° F. Don't store anything that is sensitive to heat in the attic!

Insulation is placed in the ceiling joists to insulate the living space below from the attic space above. In the summer the hot air will want to move down to the living space, because warm always moves to the cold to try to reach equilibrium. This is true for air, water, or any material. In the winter, the warmer air in the living space will move toward the colder attic space. So, we try to control this phenomenon with insulation.

Temperature control is not the only battle here. There is also the important issue of moisture. Just as moisture was extremely important in foundation and wall design, so it is in roof/attic design as well. Moisture enters roof assemblies and attics several ways. We're all familiar with roof leaks. It's the bane of any builder's existence. But moisture also enters the roof and attic as vapor from outside air and from moisture in the living space migrating through openings in the ceiling, especially in the winter when the warm air in the house is moving toward the colder attic space.

The very best way to solve the temperature as well as the moisture problems is by the use of ventilation.

An example regarding heat in the attic:

One hot summer afternoon the fire department received a call from an elderly woman who smelled smoke in her home. They surveyed her home and didn't find anything until they went into her attic. Her home had a hip roof with absolutely no ventilation whatsoever. Her rafters were not burning, but they were smoldering. If you heat wood continually, over a period of time it will become pyrolyzed and its flash point will be lowered. Pyrolyzed wood slowly dries out, breaks down chemically, and can combust at a minimum temperature of 200°F compared to regular wood that burns at around 400-570°F. The temperature of her attic, without ventilation, was in

excess of 200º. Our advice to her was to retrofit a ventilation system in her attic. That taught me an important lesson about the need for ventilation.

Most of us know that we should ventilate our attics, and as a matter of general practice we do. For decades, the standard way to do this was to install gable vents. In the 1980s, we were told that these didn't work and that what we really needed was a newfangled invention called the ridge vent. They looked awful and they leaked. But the idea seemed like a good idea. So, improvements were made.

They looked better and they leaked less. The idea was to install soffit vents that would allow the air to flow in from the outside and rise by convection to the highest and therefore the hottest part of the roof which was the ridge and flow out through the ridge vent providing continuous ventilation of the attic space. The added benefit to this ventilation system is that is also works for cathedral ceiling conditions as long as an adequate airspace (2") is provided above the insulation.

The use of some sort of roof vent with soffit vent is important, but a sufficient soffit vent is more important that the roof vent. If the roof vent is too robust, such as a roof vent with a powered fan, it will draw air (and moisture) from the living space into the attic. This would not happen if the ceiling of the living space was completely separated from the attic space by an air barrier, but this almost never happens because the ceiling is always full of holes caused by the penetrations of lighting fixture boxes and cans and HVAC vents.

Look at the following picture, can you identify what is wrong with it?

Answer:

The system is neatly installed, well organized, and very accessible. So, what's wrong? Answer: It's in the attic. I've done it, you've done it. It's being done each and every day. As counterintuitive as it may seem, it would be more efficient if all of this was outside. Remember how hot it gets in the attic? And that's in the summertime when we are running the air conditioning! Did you know that according to the EPA, residential HVAC ducts leak about 20-30%? This is one of those cases that the way we have been doing things for years is just plain wrong. This would all be better off in the crawl space, but even that is not ideal. The best place for all of this equipment and all of the ducts would be inside the space that it is heating and cooling. The system would not have to work nearly so hard and any leakage of the ducts would contribute to the conditioning of the living space rather than cooling or heating the attic.

FINAL EXAM QUESTIONS:

28. On a hot summer day, an attic can reach a temperature of _____° F.

a. 90-100
b. 110-130
c. 150-160
d. 175-200

29. The very best way to solve the temperature as well as the moisture problems in attics is by the use of _____.

a. Insulation
b. Ventilation
c. Foil sheeting
d. Drains

30. The use of some sort of roof vent with soffit vent is important, but a sufficient _____ vent is more important that the roof vent.

a. Radon
b. Power
c. Gable
d. Soffit

SUMMARY

The course started with a quick look at "famous foundation failures" to remind students of the importance of a solid foundation and the dire consequences of a poorly planned and executed foundation. Next, the course reviewed traditional foundations, including poured concrete footings, masonry foundation walls, reinforced cast-in-place concrete, ivany block, and non-traditional foundations. The section on foundations also discussed open foundations and concluded by reviewing radon abatement. The next section of the course focused on framing, offering an overview of the main types of framing, a discussion on I-joists and their importance, and information regarding floor tresses. After floor systems, the course covered information on walls, including challenges presented by wall, the essential purpose of wall, and the "Perfect Wall". The course concluded with a review of roofing and attic spaces, focusing on regulating temperature and ventilation.

This course started with foundations and ended with the roof ridge so it truly has covered homes from the ground up, we end with a reflection question:

"Is what I have been doing and the way I have been doing it the best way I should be doing it in the future?"

Wisconsin Contractors Institute

MODULAR CONSTRUCTION

2 Hours

Course Approval Number: 22959

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MODULAR CONSTRUCTION — TABLE OF CONTENTS

MODULAR CONSTRUCTION

Introduction

After completing this course, you will be able to:

- Describe what modular construction is
- Summarize the history and evolution of modular
- Differentiate between modular, panelized, and manufactured housing
- Compare the benefits of modular construction to other construction methods
- Provide clients with alternatives to residential and commercial modular construction

What is Modular Construction?

- Building is constructed off-site
- Built under controlled plant conditions
- Uses the same materials as conventionally built facilities
- Designed using the same codes and standards as conventionally built facilities
- Built in half the time

Let's define what modular construction is according to the Modular Building Institute (MBI):

"Modular construction is a process in which a building is constructed off-site, under controlled plant conditions, using the same materials and designing to the same codes and standards as conventionally built facilities – but in about half the time. Buildings are produced in "modules" that when put together on site, reflect the identical design intent and specifications of the most sophisticated site-built facility – without compromise."

Often there is some confusion between modular construction, panelized construction, tiny homes, and manufactured homes and building units. We're going to take some time differentiating and distinguishing between these various types of construction and defining each one before we move further in the course.

Differentiator: Panelized Construction

- Structural components constructed in a factory, delivered, then finished on site
  - Includes walls, floors and roof systems
- Often referred to as prefab, since prefabricated in a factory
- Offers some time savings, but shipping costs need to be considered as they increase the total cost of the materials

First, let's discuss panelized construction. Panelized construction is a building system wherein the structural components of the home (the walls, floors, and roof systems) are constructed in a factory and delivered to the jobsite where it is finished, just like a stick-built home. With panelized construction one must consider the cost of shipping the units to the jobsite which may increase the overall cost of materials, but there may still be some time and labor savings. Frequently you will hear panelized building units referred to as prefab, indicating that the building components were prefabricated in a factory environment.

Differentiator: Tiny Homes

- **A dwelling unit with 400 sq ft of floor area, excluding lofts.**
- **Seek to provide an eco-friendly solution**
- **Many of the units are self-contained living quarters that include all necessary amenities.**
- **They may be considered an accessory structure.**
- **Many tiny homes are considered a mobile modular unit.**

According to the 2018 International Residential Code, a tiny house is "a dwelling unit with a maximum of 400 sq ft of floor area, excluding lofts." Most tiny homes seek to provide an eco-friendly solution to the existing housing industry. Many of the units are self-contained living quarters with all the necessary amenities. However, if any of the amenities that are required for a dwelling unit are not present then a tiny home would be considered an accessory structure and must be placed on the same lot as a primary structure per the 2018 International Residential Code. Please note that many tiny homes are built on a wheeled chassis and therefore can be considered a mobile modular unit.

Tiny homes are built in different ways, and it is important to identify which types of tiny homes fall within the scope and application of building codes. Types of tiny homes include the following:

- Recreational vehicles
- Manufactured homes
- Modular dwellings
- Site-built dwellings

Regulations for each of these four types may vary from state to state and from jurisdiction to jurisdiction. Generally, building codes will apply only to tiny homes in the form of modular dwellings. They must also conform with the 2017 National Fire Protection Association standards for site-built dwellings. Those taking the form of recreational vehicles and manufactured homes are not regulated by building codes but are under the regulation of other codes and standards.

Tiny homes that can be set on a permanent trailer chassis with wheels are often referred to as tiny homes on wheels (THOW). Remaining in a mobile-ready state, they do not fall within the scope of building codes. They may fall within the scope of other laws or regulations, such as NFPA 1192, Standard on Recreational Vehicles, as well as rules established by the state Division of Motor Vehicles.

You may also hear a tiny home referred to as a "Park Model". A Park Model is a vehicular-type unit that has a floor area of 400 square feet or less and meets the American National Standards Institute (ANSI) recreational standard A119.5, Park Model Recreational Vehicle Standard. Park Models are primarily designed for permanent or semi-permanent installation and are used as residences. Some suggest that a park model may not be used for permanent occupancy and may be intended for recreational or seasonal use only, but you will discover that they are often used as both.

ASSESSMENT QUESTIONS

1. **All of the following statements regarding modular construction are accurate, except:**
   (a) Modular construction is a building or sections of a building built off-site
   (b) Modular construction is more expensive and takes longer than site-built construction
   (c) Modular construction uses the same building components as site-built construction
   (d) Modular construction and site work can take place simultaneously

2. **The most significant difference between modular construction and panelized construction is:**
   (a) Panelized construction and modular construction are the same
   (b) Panelized construction and modular both use standard building materials
   (c) Panelized construction usually involves the building of wall components, floor components and roof components to speed construction; but modular indicates nearly completed modules are used
   (d) Panelized construction is often referred to as prefab because components are prefabricated in a manufacturing facility

3. **"Tiny homes" is a phrase that describes all of the following, except:**
   (a) Any home that is less than 1000 square feet
   (b) A home that is 400 square feet or less
   (c) A home that is customarily constructed on wheels and is transportable
   (d) Are self-contained units that customarily include all of the necessary amenities

4. **Examples of types of tiny homes include all of the following, except:**
   (a) Manufactured homes
   (b) Site-built dwellings
   (c) Modular dwellings
   (d) Tree houses

5. **Panelized construction is often referred to as _____.**
   (a) stick-built
   (b) site-built
   (c) prefab
   (d) park model

6. **True or false? According to the 2018 International Residential Code, a tiny house is "a dwelling unit with a maximum of 400 sq ft of floor area, including lofts."**
   (a) True
   (b) False

The Difference Between Modular and Manufactured Homes

Now that we have a clear understanding of the difference between prefab, panelized, and tiny homes let's explore the difference between modular and manufactured homes. It can be confusing to tell the difference between a manufactured home, mobile home, and/or modular home. They can be very similar in appearance, and on top of that, many people use the terms interchangeably. So, let's try to clear it all up and get a better definition.

What are Modular Homes?

A modular home is any factory-built home that is constructed to a local (City or County), or state building code. In most cases, a state will have adopted one of the uniform construction codes (i.e. UBC, IRC, etc.). Modular homes will not have the red HUD Certification Label but will have a different label (often called a "UBC Label", or similar) attached to the home stating the code it complies with. Modular homes are, usually, only attached to private land, and not typically installed in manufactured (mobile) home parks.

What are Manufactured Building Units or Homes?

- **Buildings that are built on a permanent metal chassis or frame and pulled to the site with axles and wheels**
- **Manufactured homes are built to comply with the United States Housing and Urban Development Code**

What are Manufactured Homes?

Manufactured building units or homes are buildings that are built on a permanent metal chassis or frame and pulled to the site with axles and wheels. A manufactured home is any factory-built home in the United States that is built conforming to HUD Title 6 construction standards (commonly known as "the HUD-code"). The US Department of Housing and Urban Development establishes and enforces the national code for the construction, design, performance, and installation of manufactured homes in order to assure their quality, durability, affordability, and safety. The HUD-code was implemented and took effect starting June 15, 1976. A HUD-coded home will display documentation called the HUD Certification Label and the Data Plate. The red HUD Certification Label (sometimes called the "HUD Label") can be located on the tail end of each transportable section of the home (as shown here to the right). The Data Plate will be located inside of the home. A manufactured home is also built on a permanent chassis to ensure transportability. However, typically a manufactured home is not moved from its initial installed site. The home can then be placed on a HUD permanent foundation. HUD will require a foundation inspection and certification.

What are Mobile Homes?

A mobile home is similar to a manufactured home in that it is a factory-built home. However, it differs in that it is:

1) Built before June 15, 1976
2) Not built to any uniform construction code, including HUD, since the HUD code didn't come out until June 15, 1976

Every manufactured home has a chassis, or steel sub-floor frame. The beams and connecting "cross members", as well as outriggers, of the chassis are welded steel. The chassis also incorporates a removable hitch, axles, and wheels. The chassis is the rigid foundational frame for the home. However, the hitch, axles, and wheels are most often removed upon mobile home delivery and installation to make way for siding and skirting. If the home is to be moved, the axles and wheels are re-attached.

Modular vs Manufactured Homes

A dictionary definition of modular simply states that it is "a method of employing or involving a module or modules as the basis of design or construction, for instance modular housing units."

A modular home is a house that is built of prefabricated sections referred to as modules. They are constructed away from a building site, transported to the site, and fitted together.

They are built to the same code standards as any other site-built home, go through stringent quality control processes, and are becoming increasingly popular with new technologies. Ultimately it is a great construction method for your new home and a great solution to a housing market that is constantly in low supply.

MODULAR VS. MANUFACTURED *PART 1*	
Modular	**Manufactured**
• Key term is "module"	• Metal under-chassis and floor system; remains a part of the structure
• Built section by section	• Axles and wheels and tongue installed for towing
• Must comply with International Residential Code	• Floor System 2"x4" or 2"x6" 16" o.c. over steel chassis
• Permanent foundations	• Typical floor 40–76' in length
• Just like site-built	• Width ranges 14–18'
• Customizable	• Predetermined selection of styles

There is a clear delineation between modular construction and manufactured homes. In the Modular vs. Manufactured *Part 1* Table, the column on the left reiterates that when discussing modular construction, the key term is *module*. This means that the sections of the building are built in individual modules and then assembled at the jobsite. Modular building units must comply with the international building code, uniform building code, or the applicable code in your individual jurisdiction. Modular units are intended to be placed on permanent foundations and are built just like a site-built home. Modular units can be customized in the same manner that a site-built home can.

Manufactured homes on the other hand are built specifically on a metal chassis that has axles, wheels, and a tongue. Additionally, the floor system is usually some form of wood framing over a steel chassis. Manufactured homes typically come in a length of 40 to 76 feet and can range in width from 14 to 18 feet for single wide units. In most cases the manufactured unit comes with a predetermined selection of styles and materials.

MODULAR VS. MANUFACTURED *PART 2*	
Modular	**Manufactured**
• All wood/engineering wood products for structural framing	• Wall construction is 2"x4 studs
• 2"x10" floor joists	• Walls have 1"x4" top and bottom plate
• All wall studs 2"x4"	• Fire rated paneling or drywall
• Double top plate on walls	• Gusseted truss plate roof system
• 7/16" OSB wall sheathing	• No attic access
• Ceiling heights 8–9'	• Decorative ceiling board
• Same HVAC as site-built homes	• One-piece galvanized steel exterior roof (some have shingles)

To continue the comparison let's take a look at the Modular vs. Manufactured *Part 2* Table. This table illustrates some of the detailed building specifications in both modular and manufactured homes. Again, viewing the column on the left you will see that modular units have structural components that are all comprised of wood or engineered wood products. Some manufacturers are beginning to employ metal studs and structural framing members. However, in most cases wood is used, and as you can see in nearly every instance the floor system is constructed using 2 x 10 floor joists, the walls are constructed of 2 x 4 studs, the walls have double top plates, wall and roof sheathing is customarily 7/16 OSB, ceiling heights are a minimum of 8 feet (but can be higher), and the HVAC system is comparable to site-built homes with an equal conditioned air distribution.

Manufactured homes normally have 2 x 4 stud walls, although in some cases 2 x 3 framing members are used. The walls have a single one-

by-four top plate, and the interior is customarily a lighter weight paneling or a fire-rated drywall. The roof system is a rather shallow pitched cosseted trusts roof with no attic access. In order to achieve a lighter weight unit for transportation, a decorative ceiling board is frequently used instead of a drywall product. The exterior roof surface on the unit is frequently made of galvanized steel although in recent years more composite shingle roofing has been used.

MODULAR VS. MANUFACTURED *PART 3*	
Modular	**Manufactured**
• Considered the same as single family site-dwelling for loans and mortgages	• Windows and doors, meet fire and safety codes
• Not relocatable once placed on a permanent foundation	• Oftentimes windows are metal frames, new models have vinyl
• Building inspectors check all work	• Exterior siding normally prefinished aluminum, optional vinyl or composite
• Sometimes less expensive than site-built	• Home must be anchored to assure stability against movement
• Are normally allowed in all communities	• All foundation must be approved by an approved by an approved HUD inspector

A few other significant differentiators between modular and manufactured construction are listed in the Modular vs. Manufactured *Part 3* Table.

Modular building units are considered the same as single-family site-built dwellings when it comes to obtaining a residential loan or mortgage. Modular units are normally not relocatable once they are placed on a permanent foundation at the building site. Building inspectors who are employed by the jurisdiction having authority over the location inspect all assembly and completion of the modular building units. Sometimes modular units are actually less expensive than site-built homes. A huge difference between modular and manufactured homes is the fact that modular building units are normally allowed in all communities.

Some additional differences between modular and manufactured buildings are the fact that manufactured units have window and doors that meet fire and safety codes. However, most of the time those windows are metal frames or very inexpensive vinyl windows. The exterior siding on less expensive manufactured units is often prefinished aluminum panels or as another option vinyl or composite siding. Another important fact about manufactured homes is the home must be anchored with "tie-downs" to assure stability against movement caused by strong winds and storms. All foundations and the associated tiedowns must be approved by a HUD inspector.

ASSESSMENT QUESTIONS

7. **One of the most significant differences between modular homes and manufactured homes is that:**

   (a) There is no difference, modular and manufactured homes are the same, we simply use the terms interchangeably.

   (b) Modular homes depreciate while manufactured homes hold their value.

   (c) Modular and manufactured homes are constructed using the same codes and standards.

   (d) Manufactured homes are built on metal chassis, with a tongue and wheels installed, while modular homes are built with the same components as site-built homes.

8. **Building standards or "codes" used to construct <u>modular</u> homes are:**

   (a) Codes that are developed by the government agency know as HUD; an agency formally known as The Department of Housing and Urban Development.

   (b) Determined solely by the local authority having jurisdiction over the project.

   (c) By the same building codes that exist for site-built homes.

   (d) By specifications developed by the manufacturer.

9. As a contractor, if you were constructing a manufactured home then the foundation will likely need to be inspected by:

(a) No one, most manufactured homes don't have foundations

(b) By the local inspections department and (most likely) a HUD approved inspector

(c) Due to the fact that the foundation consists of dry stacked masonry block no inspection is needed

(d) By the supplier who set-up the unit

10. Which of the following statement(s) about modular construction is NOT true?

(a) Modular homes require anchors and ties downs which must be inspected after the unit(s) are set

(b) Modular is considered the same as site-built dwellings for loans and mortgages

(c) Modular homes or building are normally accepted in all communities

(d) Building Inspectors or certifying agencies inspect all modular work

11. The easiest way to identify a manufactured home is:

(a) There is no easy way, sometimes they can look identical to a modular home

(b) Look for the HUD label that is required to be placed on the tail end of every manufactured home

(c) Look at the roof, if it's a shingle roof it must be a modular home, not manufactured

(d) Ask the owner if it was built in a factory and delivered to the site

12. The HUD-code was implemented and took effect starting _____.

(a) January 1, 1976

(b) June 1, 1970

(c) June 15, 1976

(d) June 30, 1977

13. True or false? Manufactured homes must be built with access to the attic.

(a) True

(b) False

14. Another difference between modular and manufactured buildings is the fact that manufactured units have window and doors that meet which of the following codes?

(a) Building envelope codes

(b) Electrical codes

(c) Energy codes

(d) Fire and safety codes

15. Another important fact about manufactured homes is the home must be anchored with _____ to assure stability against movement caused by strong winds and storms.

(a) "Tie-downs"

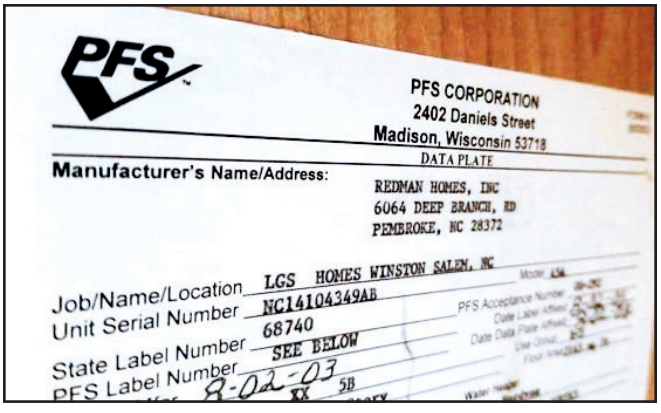
(b) Dry masonry block

(c) Installed skirting

(d) All of the above

Modular Home Compliance Certificate

Let's take a few minutes to look at some items that may give you a clear indicator as to which units would be considered modular units and which units might be considered manufactured homes. A very clear indicator is the type of labeling you may find on the interior of the building unit or on the exterior. The photo labeled *Modular Home Compliance Certificate* indicates a modular building unit because as you can see it list the manufacturer of the unit and shows the state in which the unit was constructed along with a stamp that is issued by the state showing that the unit conforms with the then current building code.



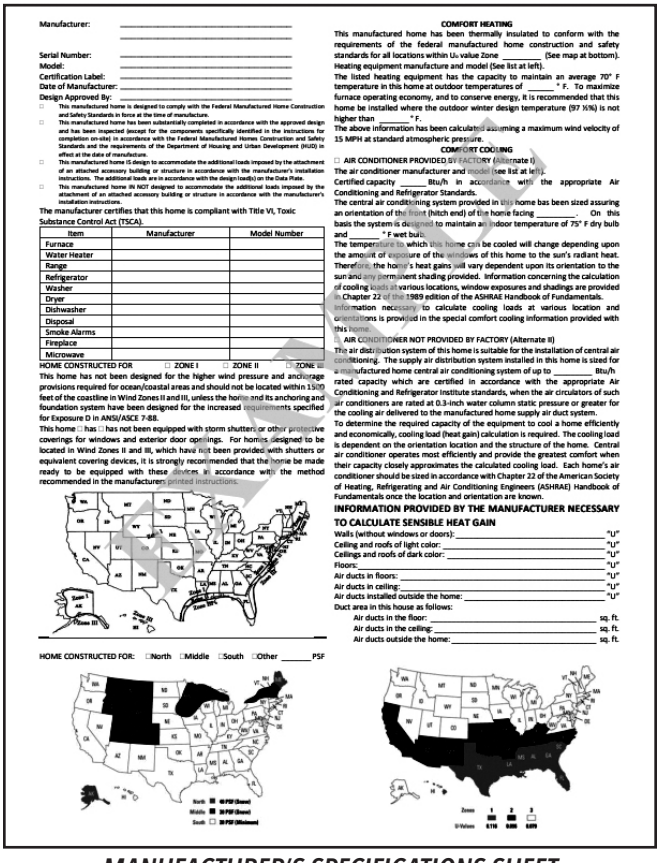
MODULAR HOME COMPLIANCE CERTIFICATE

Manufactured Homes Compliance Documentation

As mentioned previously, a manufactured home would have a HUD certification label affixed to the taillight end of each section of the manufactured home.

HUD CERTIFICATION LABEL

A manufactured home would also have a sheet mounted inside the unit which details the manufacturer of the unit and the building specifications that it was designed to. Anytime you see a unit placed on a foundation that has this red HUD label it clearly indicates that it is in fact a manufactured home and not a modular home.



MANUFACTURER'S SPECIFICATIONS SHEET

Modular Home Construction

On the other hand, a couple of visible indicators that a home is a modular home can be seen in the photos labeled *Modular 1* and *Modular 2* on the next page. A critical eye could easily identify what building units are modular and what might be manufactured. In the photos shown below you will see a typical modular roof system. You'll notice in the *Modular 1* photo that the roof system is hinged at the eve and overhang where the overhang can fall down, and the roof system can be lifted upward. The *Modular 2* photo shows a typical modular roof system and the home with an unfinished second level. You'll notice as the roof rafters rise upward toward the ridge that there is

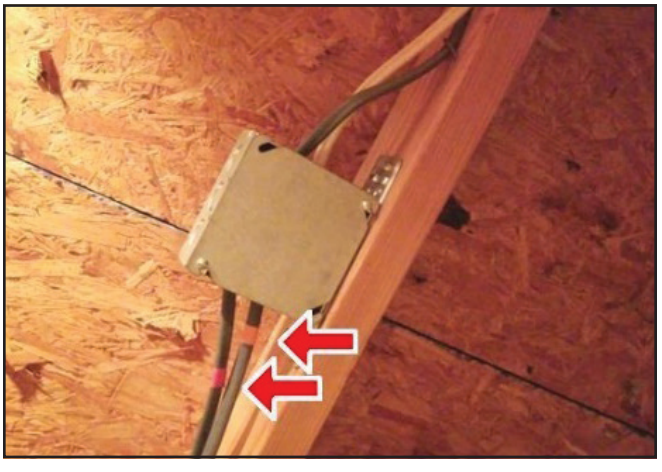
a break in the rafters, this is a location where the roof system was hinged in order to be successfully transported from the manufacturing facility to the jobsite.

MODULAR 1

MODULAR 2

Another indicator of a modular home is reflected in photos *Modular 3* and *Modular 4*. In the *Modular 3* photo you'll see where the two sections of a modular home were joined together. This mating/marriage wall is actually the roof system of two individual units that are pushed together prior to having the roof system and roof covering completed. The *Modular 4* photo shows an electrical junction box where branch circuit wiring was clearly marked or color-coded so that the electrician was easily able to identify the individual circuits and to properly join them together in an approved junction box with a cover installed. These on-site connections would later be inspected by a municipal building inspector.

MODULAR 3



MODULAR 4

The *Modular 5* and *Modular 6* photos on the next page show a modular home roof system in more detail.

The *Modular 5* photo shows hinged sections of the web or cripple wall which supports the roof rafters. These components fold into position to support the roof system once it has been lifted into position. The *Modular 6* photo shows the hinge points where the roof system can be moved from a down position to its finished upward position as the building is completed. We will look at these processes in more detail later in the course.

MODULAR 5

MODULAR 6

Manufactured Home Construction

Let's take a quick look at some of the things that can help us recognize a manufactured home and differentiate it from a modular home. In photo *Manufactured 1,* you can see a typical manufactured home park. Many individuals might refer to this as a mobile home park. But as you can see, these are actually manufactured units placed in a park-like residential setting with skirting around the bottom of each unit instead of permanent foundations placed around the base of the buildings. Installed skirting around the buildings is a clear indicator that it is a manufactured home.

If you look under a manufactured home, you will observe a metal chassis and be able to identify locations where the axle springs and wheels were removed from the unit. In photos *Manufactured 2 and Manufactured 3,* you can see how this unit demonstrates where the foundation consists of dry stacked masonry block with the manufactured unit being placed on top of the piers.

MANUFACTURED 1

Another item that is important to note is the fact that rust is beginning to develop on the metal frame. This rust and corrosion can lead to eventual structural deterioration of the manufactured unit. Due to this deterioration the unit will likely depreciate, unlike most modular buildings.

MANUFACTURED 2

MANUFACTURED 3

ASSESSMENT QUESTIONS

16. **A modular home compliance certificate indicates a modular building unit because it lists which of the following?**
    (a) The manufacturer of the unit
    (b) The state in which the unit was constructed
    (c) A stamp showing that the unit conforms with the then current building code
    (d) All of the above

17. **What color is the HUD certification label that must be affixed to the taillight end of each section of a manufactured home?**
    (a) Black
    (b) Red
    (c) Yellow
    (d) Green

18. **In the Modular 1 photo you can see that the roof system is hinged at which of the following places?**
    (a) The eve
    (b) The overhang
    (c) The rafters
    (d) Both a and b

19. **The Modular 5 photo shows hinged sections of the _____ wall which supports the roof rafters.**
    (a) web
    (b) cripple
    (c) Both a and b
    (d) None of the above

20. **True or false? Installed skirting around the buildings is a clear indicator that it is a manufactured home.**
    (a) True
    (b) False

21. **If you look under a manufactured home, you will observe which of the following?**
    (a) A metal chassis
    (b) Locations where the axle springs were removed from the unit
    (c) Locations where the wheels were removed from the unit
    (d) All of the above

22. **True or false? The rust and corrosion on the metal frame of a modular unit can lead to eventual structural deterioration of the unit.**
    (a) True
    (b) False

Benefits of Modular Construction

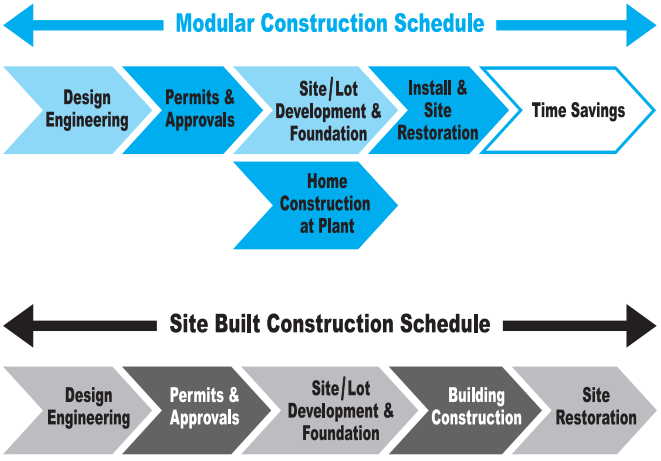
Let's shift gears and consider some of the benefits of modular construction over typical site-built construction. You'll note that in this course we use the terms "modular" and "site-built", and not the common term "stick-built". We do this because both modular units and site-built units are stick-built.

We'll begin by looking at many of the benefits that can be achieved by a contractor when they employ modular construction.

Time Savings

The greatest benefit for contractors is the benefit of time savings. As you can see in the *Modular Time Savings Graph,* when comparing site-built

construction to modular construction there is a significant time savings of approximately 30 to 50%. The greatest benefit is achieved when you consider that the home is being constructed in a manufacturing plant simultaneously with the site and lot being developed and the foundation being built.

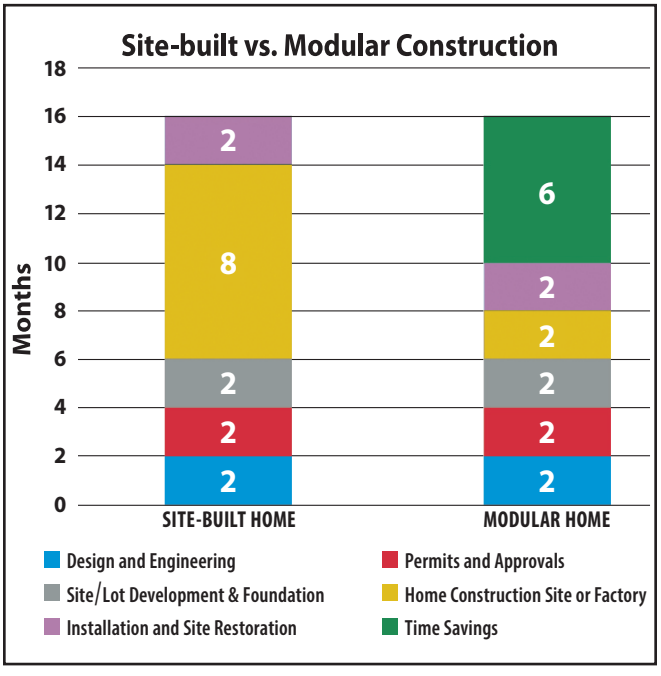


MODULAR TIME SAVINGS GRAPH

To further reinforce this point, let's look at the *Site-built vs Modular Construction Chart*. You have probably heard it said that "time is money", which is especially true if you are a contractor constructing a home using a construction loan and paying interest on that money from month-to-month. Even if you do not use lender financing you must consider the opportunity value of your money and the fact that it may be tied up longer when building a site-built home versus a modular home.

In viewing the *Site-built vs Modular Construction Chart* you'll see the time schedule for a typical home that takes 14 months to build. The column on the left of this chart is for a site- built home, and the column on the right is for a modular home. You'll notice that many of the stages will take approximately the same amount time whether it's the design and engineering phase, getting the permits and approvals for construction, or whether it is site clearing and development and construction of the foundation.

However, that is really where the similarities end. While a site-built home is being constructed on the jobsite, the modular home is being constructed in a climate-controlled factory in an assembly line fashion. The largest benefit is that while the site is being developed and the foundation is being constructed the modular home is being built concurrently. Once the modular building is delivered to the site the time to place the components and perform the necessary finishing and site restoration requires a minimal amount of time since 85% of the home is already complete. Therefore, the greatest benefit of using modular construction is the time savings which is represented in the green color at the top of the modular column. According to the Modular Builders Institute most projects that are built using modular construction units can be completed 30 to 50% sooner than traditional construction.



SITE-BUILT vs. MODULAR CONSTRUCTION CHART

Cost Benefits

Another major benefit for a contractor in choosing modular construction is the reduced overhead cost. Since most of the construction is done by the manufacturer in the factory, the builder can concentrate on sales and marketing. Manufacturers also offer a wide range of sales and marketing support to the builder. Additionally, because most of the structure was constructed by a modular home manufacturer many of the callbacks when problems come up are handled by the manufacturer and not necessarily by the contractor. Overhead

is further reduced simply because it takes less human capital to manage the business and the construction process.

Reduced Overhead Cost

- Most construction (60-90%) is done by the manufacturer in the factory
- Frees up time for the builder to focus on sales and marketing
- There is support from the supplier for sales and marketing as well as callbacks

There are several other benefits associated with improved cost control for the contractor. In today's construction environment finding available and skilled labor has become quite a challenge. With modular construction a majority of the module unit is constructed elsewhere, so the problem with finding skilled labor becomes the manufacturer's issue instead of an issue that must be handled by the contractor. When modular homes are constructed at a remote location then fewer subcontractors are needed for the contractor to finish the product. Another significant benefit is the fact that not having building materials left on a jobsite can reduce the risk of theft of building materials as well as reduce the risk of damage to those materials. Because modular units are manufactured in a controlled environment by experienced manufacturing staff the risk of material cost overruns is more manageable and largely handled by the manufacturer. Additionally, many of the unknown circumstances in site-built construction are eliminated due to the controlled construction environment, which creates more potential for profit for the contractor.

Improved Cost Control

- Eliminates problems caused by the shortage of skilled labor
- Fewer subcontractors are needed
- Reduces theft and material damage costs
- Reduces risk of material cost overruns
- Improves overall profit potential

Another significant benefit of modular construction is the sales and marketing support that the contractor will receive from the manufacturer of modular units. Keep in mind that the manufacturer doesn't sell units unless you sell units. Many modular companies have sales and advertising staff who will provide a great deal of sales collateral to you as a contractor, further reducing your costs. Furthermore, most manufacturers have skilled design staff who can work with your customers to design the home that they want and to ensure that your customer is satisfied with the final product. Once the home is complete you also have a partner in making sure that your customer is satisfied with the finished product.

Sales and Marketing Support

- Manufacturer doesn't sell units unless you sell units
- Manufacturers have skilled sales and design staff
- Manufacturer is your partner in assuring customer satisfaction

Improved Quality Control

Another benefit of modular construction is improved quality control. Remember that modular units are built to the same building codes as site-built homes or commercial properties. Because modular homes are built in factories, manufacturers can utilize tools unavailable to site builders such as custom manufactured jigs which ensure that all walls, floors, and ceilings are square and plumb. In addition, interior walls are lag-bolted to the exterior

walls and bracing and insulation are installed on all electrical outlet boxes. Finally, straps brace the wall to the floor. It's also important to note that because the modular units are built in a controlled environment that weather delays and material shortages typically do not occur. Requirements for modular manufacturers also ensure that stringent quality control measures are in place in the factory and are continuously reinforced.

As a contractor there is a tendency to get extremely busy and only have time to appear at a jobsite in a management capacity once or twice a day. However, in a factory environment management personnel are present around the clock and stringent quality control measures are employed. Additionally, most manufacturers also employ field service personnel that will be there to assist you not only during construction but after the building is complete.

Improved Quality Control

- **Modular units are built to the same building codes as site-built homes or commercial properties.**
- **Modular components are built in controlled environments. There are no weather delays or material shortages.**
- **Manufacturers employ stringent quality assurance and control measures in the factory setting.**

Many of us who are engaged in the construction industry are familiar with standards set forth by the Occupational Safety and Health Administration, or OSHA, which is a government agency that ensures workplace safety. Because most of a modular home or building is constructed in a factory environment then the adherence to safety protocols is the responsibility of the manufacturer. The risk of your building site being visited by an OSHA representative, and potentially finding something in noncompliance with OSHA standards, is dramatically reduced because most of the construction work is performed in the factory environment. The factory personnel are highly trained in safety protocols and understand that their strict compliance to those protocols is mandatory, and in many instances a condition of their continued employment.

Safer Construction

- **An indoor, dry, level work environment reduces accidents.**
- **Factory personnel are highly trained in safety protocols.**
- **Factories adhere to strict OSHA standards.**

ASSESSMENT QUESTIONS

23. Which of the following statement(s) about modular construction is NOT true?

(a) Modular homes require anchors and ties downs which must be inspected after the unit(s) are set

(b) Modular is considered the same as site-built dwellings for loans and mortgages

(c) Modular homes or building are normally accepted in all communities

(d) Building inspectors or certifying agencies inspect all modular work

24. Which of the following statements is NOT true when contemplating modular construction?

(a) Modular homes must comply with U.S Housing and Urban Development standards

(b) Modular homes are built in factory-controlled environments

(c) Modular homes are constructed according to International Residential Building Codes

(d) Modular homes are nearly indistinguishable from site-built homes once complete

25. **Modular homes are:**
    (a) Built with materials that are of lesser quality than those used with site-built homes
    (b) Are built with the same materials as site-built homes
    (c) Achieve efficiencies through better time management, and reduced material waste
    (d) Both b and c

26. **When comparing site-built construction to modular construction there is a significant time savings of approximately _____ to _____%.**
    (a) 10 to 20%
    (b) 30 to 50%
    (c) 5 to 10%
    (d) 75 to 80%

27. **According to the Site-built vs Modular Construction Chart, how many months does it take for home construction for a site-built home?**
    (a) 2 months
    (b) 4 months
    (c) 6 months
    (d) 8 months

28. **According to the Site-built vs Modular Construction Chart, how many months does it take for factory construction for a modular home?**
    (a) 2 months
    (b) 4 months
    (c) 6 months
    (d) 8 months

29. **According to the Site-built vs Modular Construction Chart, how many months of time savings are achieved for a modular home?**
    (a) 2 months
    (b) 4 months
    (c) 6 months
    (d) 8 months

30. **With modular homes, most of the construction (____ to ____%) is done by the manufacturer in the factory.**
    (a) 30 – 50%
    (b) 50 – 60%
    (c) 60 – 90%
    (d) 40 – 50%

Modular Home Manufacturing Facilities

Below you can see the picture *Manufacturing Facility 1* which depicts a modular home manufacturing facility. As you can see in this photo, these modular units are being built from the inside out. Once the frame walls are attached to the floor system the drywall is applied to the interior walls. This makes it very easy and efficient for the manufacturer to access the exterior for wiring runs, insulation, and exterior finish material.

MANUFACTURING FACILITY 1

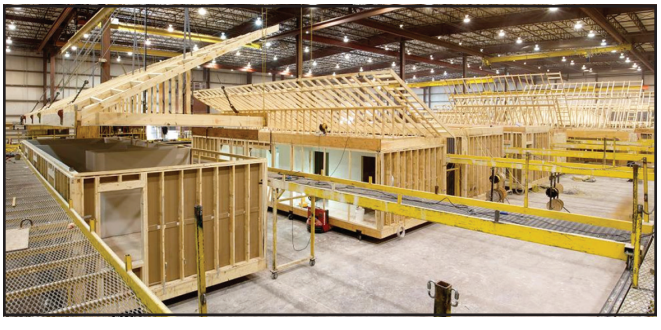
In the photos *Manufacturing Facility 2* and *Manufacturing Facility 3* below, you will see a manufacturing facility for a modular home that was being constructed in order to be placed on pilings at a beach in North Carolina. As you can see, the unit is nearly complete and ready for shipment to its final destination. Shown in the *Manufacturing Facility 3* picture is one of the excited homeowners doing a final review of their home just prior to shipment. The important thing to note is the assembly line fashion in which these units are constructed. Each individual station accomplishes a specific task in completing the home. This particular home traveled approximately 250 miles from the factory to its final destination.

MANUFACTURING FACILITY 2

MANUFACTURING FACILITY 3

In the photo *Manufacturing Facility 4* below, you can see a modular manufacturing plant that shows the individual modules on wheels being transported through the factory, and the efficiency in which the units are constructed. As you can see in *Manufacturing Facility 4* photo, scaffolding is located safely and conveniently next to each module, and overhead cranes and lifting capability is installed in order to facilitate the assembly of the pre-manufactured roof systems.

Another advantage of building in a modular factory is that electrical wire can be installed in the unit from the exterior which increases efficiency. Additionally, wall units are pre-manufactured and moved to the site of the unit construction for installation on the floor systems. Something to take note of is that most factories are now employing CAD design and CNC or Computerized Numerical Control automated construction techniques in order to improve efficiency and quality.



MANUFACTURING FACILITY 4

ASSESSMENT QUESTIONS

31. According to the photo Manufacturing Facility 1, modular homes built in a manufacturing facility are built from _____.

(a) the outside in
(b) the inside out
(c) front to back
(d) back to front

32. Constructing the home in a manufacturing facility allows the manufacturer to easily access the exterior to complete which of the following building aspects?

(a) wiring runs
(b) insulation
(c) finishing materials
(d) all of the above

33. Which of the following equipment are used in manufacturing facilities to facilitate the assembly of the pre-manufactured roof systems?

(a) Overhead cranes
(b) Lifting capability
(c) Hydraulic pulleys
(d) Both a and b

34. True or false? When constructing modular homes, the wall units are pre-manufactured and moved to the site of the unit construction for installation on the floor systems.

(a) True
(b) False

35. Manufacturing factories employ which of the following or Computerized Numerical Control automated construction techniques in order to improve efficiency and quality.

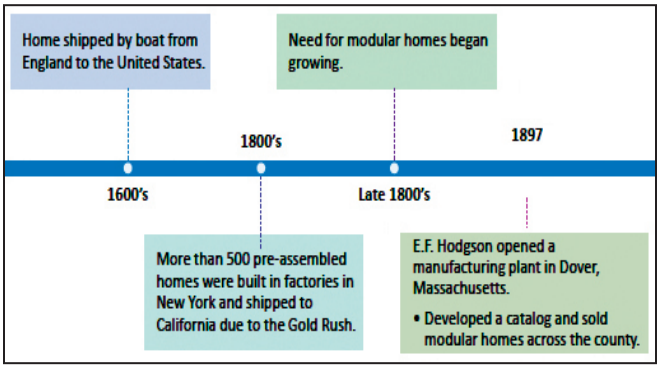
(a) CAD design
(b) CNC
(c) Both a and b
(d) None of the above

History of Modular Construction

Modular buildings date back to the 1600s. One of the first reported modular homes was brought to life by a colonial American fisherman who had recently moved from England and wanted a home built with trusted English construction methods. The solution to this was to have a disassembled home shipped by boat across the Atlantic Ocean.

In the 1800s, as the United States expanded westward, modular construction began to make a more prominent appearance. During the California Gold Rush, mining towns boomed, and as they flourished, a quick housing solution was needed. More than 500 preassembled homes were built in factories in New York and then shipped across the country to California.

But it wasn't until the end of the 19th century that the demand for modular homes started trending upwards. In 1897, E.F. Hodgson opened a manufacturing plant in Dover, Massachusetts which profited from the rapidly growing American population. The E.F Hodgson Company developed a catalog from which they sold modular homes across the country. Sears, Roebuck, and Montgomery Ward soon followed in their footsteps and sold hundreds of thousands of modular homes over the next few decades.



In the 20th-century, after the development of the assembly line, it became easier to manufacture modular homes at prices that were more affordable to consumers. After the Second World War, the United States faced a housing crisis and modular construction offered a quick and low-cost option in order to house a new generation of Americans.

The famed architect Frank Lloyd Wright also realized the benefit of factory construction. Between 1916 and 1917 he developed The System Built Homes, also known as the Ready-Cut System.

In later years the modular industry expanded from homes into commercial projects. The benefits of modular construction had become clear and modular construction was being used for housing, recreation, classrooms, offices, and even into the easily recognizable modular diner.

In the 21st century, consumers have begun to realize that modular construction can be friendly for both the environment and their budgets. Newer technology, such as better construction cranes, have allowed modular buildings to be built bigger, taller, and in many different designs. Units can be shipped across the country and can be put together on site in a matter of days. In 2003 a McDonald's fast-food restaurant was constructed in a record 13 hours. In the future we can expect more and more people and businesses to embrace modular building concepts.

ASSESSMENT QUESTIONS

36. How far back do modular buildings date?

(a) 1500s
(b) 1600s
(c) 1700s
(d) 1800s

37. During the California Gold Rush more than _____ preassembled homes were built in factories in New York and then shipped across the country to California.

(a) 50
(b) 200
(c) 500
(d) 1000

38. It was at the end of the _____ century that the demand for modular homes started trending upwards.

(a) 17th
(b) 18th
(c) 19th
(d) 20th

39. Between 1916 and 1917 Frank Lloyd Wright developed The System Built Homes, also known as the _____.

(a) Ready-Cut System
(b) Ready-Build System
(c) Pre-Cut System
(d) Pre-Built System

40. In 2003 a McDonald's fast-food restaurant was constructed in a record _____ hours.

(a) 5

(b) 8

(c) 12

(d) 13

Myths of Modular Construction

In order for us to clearly understand the benefits of modular construction there are several myths that we must dispel regarding what modular construction is and is not. Once these myths are dispelled, we can focus on facts regarding modular construction's use in our modern world. Let's take a look at, and dispel, seven different myths surrounding modular construction in order to enhance our understanding.

MYTH #1

All factory-built homes are trailers.

A common myth is that all factory-built homes are trailers. Let's take a look at the facts.

Manufactured homes are trailers, mobile homes, single-wide homes, and double-wide homes. Manufactured homes are built to different standards than modular homes or buildings. Manufactured homes must comply with standards put forth by the US Department of Housing and Urban Development.

Modular homes are similar to manufactured homes in that they are both built in a factory-controlled environment. Other than this similarity, manufactured and modular homes are entirely different.

Modular homes are constructed according to the International Residential Building Code. A completed modular home is basically indistinguishable from a traditionally site-built home of similar size and style.

MYTH #2

Modular homes are constructed using cheaper materials.

A second myth is that modular homes are constructed using cheaper or lesser quality materials.

Simply put, this myth is untrue. Modular homes are made with the same standard of building materials that site built homes are constructed with.

The reduced cost of building modular homes is a result of the time savings achieved when constructing them. Cost savings also occur due to the lesser amount of material wasted on the construction site. In most instances the building products, materials, finishes, and fixtures are the same that are used in site-built home, and in some cases the quality may even be better.

MYTH #3

Modular Homes aren't as safe as site-built homes.

Here's an interesting myth about modular construction that some people may believe: Modular homes aren't as safe as site-built homes. Once again, the facts dispel that myth.

The fact is modular homes meet the same construction standards as traditionally built homes. Modular homes must meet the same stringent building code requirements that are developed to protect the consumer. Modular homes and buildings can resist fires, earthquakes, hurricanes, and other disasters as well as a site-built home. As a matter of fact, modular homes have often been chosen by people who are rebuilding after a natural disaster. FEMA, the Federal Emergency Management Agency, has stated that modular homes may be safer than site-built homes.

Proponents of modular homes have maintained that the building system at manufacturing facilities can produce structures that are far stronger than site-built housing. For instance, the modular sections are built to withstand the stresses of highway

travel, containing up to 30% more building materials than a comparable site-built home. Drywall is often both glued and screwed to wall studs and triple-headers are used over window openings and around stairwells to withstand the stress of transportation and being lifted by a crane.

Recently, the Federal Emergency Management Agency (FEMA) confirmed that modular homes withstood Hurricane Andrew far better than site-built housing. In FEMA's report "Building Performance: Hurricane Andrew in Florida," the assessment teams from FEMA concluded that modular homes withstood the 131–155 mph winds of the Category 4 storm in August of 1992 far better than site-built housing. In their report FEMA stated: "Overall, relatively minimal structural damage was noted in modular housing developments. The module-to-module combination of units appears to have provided an inherently rigid system that performed much better than conventional residential framing. This was evident in both the transverse and longitudinal directions of the modular buildings". (FEMA publication number FIA-22, item 3-0180)

MYTH #4

The design of modular homes is simple and unattractive.

Another common myth is that the design of modular homes is simple and unattractive. However, you will see that the contrary is true.

As mentioned previously, modular buildings that are built today are virtually indistinguishable from traditionally built homes. Designs can vary to accommodate your taste and your budget. Sizes can vary from a smaller one-story starter home to a stately structure. If the truck transporting the modules can get to your site, any structure is possible!

ASSESSMENT QUESTIONS

41. Modular homes include which of the following?

(a) Trailers
(b) Single-wide homes
(c) Double-wide homes
(d) None of the above

42. True or false? Modular homes are made with the same standard of building materials that site built homes are constructed with.

(a) True
(b) False

43. Modular homes and buildings can resist which of the following disasters as well as site-built homes?

(a) fires
(b) earthquakes
(c) hurricanes
(d) all of the above

44. Modular sections are built to withstand the stresses of highway travel, containing up to _____% more building materials than a comparable site-built home.

(a) 10%
(b) 15%
(c) 30%
(d) 50%

45. **True or false? In FEMA's report "Building Performance: Hurricane Andrew in Florida," the assessment teams from FEMA concluded that modular homes withstood the 131–155 mph winds of the Category 4 storm in August of 1992 much worse than site-built housing.**

(a) True

(b) False

MYTH #5

As soon as the home is delivered to the property and placed on the foundation, the homeowners can move in!

Let's consider another common myth: Some individuals believe that as soon a modular home is delivered to the site and placed on the foundation that it is ready for occupancy. Well let's look at myth number five and discover what the real truth is.

When a modular structure arrives on site the modules themselves are virtually complete. However, there is still a significant amount of work to be performed. The sections must be joined together, plumbing connected, electrical joined together from section to section, utilities must be connected, and site work must be finished. On average it takes an additional 8–12 weeks to complete the project.

MYTH #6

You can't get a mortgage on a modular home.

Another myth about modular construction is that banks and mortgage companies will not lend money on a modular home. Let's take a look at this in a little more detail.

In many instances financial institutions must be educated about modular construction just as much as the general public. What we have discovered is that, as is the case with most construction projects, it may be necessary to obtain a construction loan in order to make progress payments on the construction of modular units.

The homeowner will also need financing in order to purchase the land and to perform all the necessary site work including the footings and foundation. Funds will also need to be acquired to perform the remaining work once the units are delivered. This construction loan can then be converted to a permanent mortgage and the home can be treated the same as a traditionally built structure.

According to one major bank, the process of securing financing for modular construction involves the following seven-step process.

1. The first step of modular home construction financing is to get preapproval for the loan. During the preapproval process it will be determined how much can be borrowed and which type of product best suits the borrower's needs.
2. Once the borrower is preapproved, and they have determined which modular company they want to do business with, they will complete the formal loan application and an appraisal will be ordered based on the home being completed. Many financial institutions have a list of preapproved modular suppliers which may in fact make the building experience easier.
3. The third step is to obtain mortgage approval after a complete review of the loan application. The lender will then issue a commitment letter which informs the borrower that the bank will underwrite the loan after all other requirements are met.
4. Once the mortgage has been approved, a disbursement or draw schedule is established which allows the homeowner or the contractor to obtain disbursements at predetermined milestones throughout the project.
5. Once agreement is reached between the builder, supplier, customer, and financial institution the next step is to close the construction loan.

6. Once the loan is closed then construction of the new modular home can begin.
7. The final step, after all construction is complete and a certificate of occupancy is granted, is to convert the construction loan into a permanent mortgage.

As you can see, this process is not much different from the process that is experienced with a conventional construction loan which is later converted to a permanent mortgage.

MYTH #7

Modular structures don't last as long and depreciate just like trailers do.

Another myth that we can dispel is the common belief that modular structures don't last as long as traditional site-built homes and that they depreciate just like manufactured homes or trailers and mobile homes do. However, as we will see, the facts will discredit this myth.

In an article from Forbes magazine from February 2021, the author questioned whether modular homes had comparable resale values, quality construction, and whether loans were available. What the writer discovered was that modular homes appreciate similar to stick-built homes and loans and mortgages were also treated similarly. The writer also stated that the same was not true for mobile homes that customarily aren't built on solid foundations.

ASSESSMENT QUESTIONS

46. Which of the following projects must be completed after a modular home is delivered to the site?

(a) The sections must be joined together
(b) The plumbing must be connected
(c) The utilities must be connected
(d) All of the above

47. On average it takes an additional _____ to _____ to complete a modular home after it has been delivered to the site.

(a) 4-5 weeks
(b) 4-5 months
(c) 8-12 weeks
(d) 8-12 months

48. True or false? A construction loan for a modular home can be converted to a permanent mortgage.

(a) True
(b) False

49. Which of the following is the <u>first</u> step to secure financing for modular home construction?

(a) Complete the formal loan application
(b) Get preapproval for the loan
(c) Obtain mortgage approval
(d) Establish a disbursement schedule

50. Which of the following is the <u>fourth</u> step to secure financing for modular home construction?

(a) Obtain mortgage approval
(b) Complete the formal loan application
(c) Establish a disbursement schedule
(d) Begin construction on the modular home

51. Which of the following is the <u>seventh</u> and final step to secure financing for modular home construction?

(a) Begin construction on the modular home

(b) Close the construction loan

(c) Issue a commitment letter

(d) Convert the construction loan into a permanent mortgage

52. True or false? The value of modular homes will depreciate, and the value of stick-built homes will appreciate.

(a) True

(b) False

Commercial Modular

Now let's take a quick look at commercial modular, and particularly at the two types of commercial modular that we may encounter as contractors: permanent and relocatable modular construction.

COMMERCIAL MODULAR	
Permanent	**Relocatable**
• Comparable to site-built construction	• Temporary modular
• Must meet IRC or IBC	• Meete temporary space needs
• Must meet local building codes	• Ofted leased under short-term agreements
• Accounts for over 50% of modular units shipped today, and 4% of all new commercial construction starts	• Examples of site trailers, classrooms, communication pods, etc.

The construction industry considers commercial modular construction to be either permanent modular construction or relocatable modular buildings. According to the Modular Building Institute:

Permanent Modular Construction (PMC) is an innovative, sustainable construction delivery method utilizing offsite, lean manufacturing techniques to prefabricate single or multi-story whole building solutions in deliverable module sections. PMC modules can be integrated into site-built projects or stand alone as a turn-key solution and can be delivered with mechanical, electrical and plumbing (MEP), fixtures and interior finishes in less time — with less waste, and higher quality control compared to projects utilizing only site-built construction. Recent research has come out supporting the fact that modular construction is an efficient construction process and poised to help the construction industry grow.

A Relocatable Building (RB) is a partially or completely assembled building that complies with applicable codes or state regulations and is constructed in a building manufacturing facility using a modular construction process. Relocatable buildings are designed to be reused or repurposed multiple times and transported to different building sites. They are utilized for schools, construction site offices, medical clinics, sales centers, and in any application where a relocatable building can meet a temporary space need. These buildings offer fast delivery, ease of relocation, low-cost reconfiguration, accelerated depreciation schedules and enormous flexibility. Relocatable buildings are not permanently affixed to real estate but are installed in accordance with manufacturer's installation guidelines and local code requirements. These buildings are essential in cases where speed, temporary space, and the ability to relocate are necessary.

Permanent modular construction would be comparable to site-built structures. Permanent module structures must meet either the International Residential Code or the International Building Code as well as any local codes that may exist regarding their construction. In today's market permanent modular construction accounts for over 50% of the total number of modular units that are shipped today and 4% of all new construction starts. The US is slightly behind the curve because other countries such as Sweden are manufacturing many more permanent modular structures. For example, in Sweden 70% of all new construction starts are permanent modular.

When considering relocatable modular we must understand that relocatable modular applies to modular structures that are temporary in nature and are designed to meet temporary space needs. In many instances these temporary modular structures are leased under short-term agreements to the end users for immediate and, in most instances, short-term needs. Some examples of short-term modular might be mobile classrooms, communication pods, and even military barracks in foreign destinations.

PERMANENT MODULAR

RELOCATABLE MODULAR

ASSESSMENT QUESTIONS

53. Permanent commercial modular accounts for over _____% of modular units shipped in the United States today.

(a) 15%
(b) 50%
(c) 70%
(d) 5%

54. Permanent commercial modular accounts for approximately _____% of all new construction starts in the United States today.

(a) 10%
(b) 50%
(c) 4%
(d) 70%

55. In Sweden, _____% of all new construction starts are permanent modular.

(a) 70%
(b) 50%
(c) 4%
(d) 100%

56. True or false? Permanent commercial modular constructions must meet either the International Residential Code or the International Building Code as well as any local codes that may exist regarding their construction.

(a) True
(b) False

57. Relocatable modular construction could be utilized for which of the following?

(a) Schools

(b) Construction site offices

(c) Medical clinics

(d) All of the above

58. Which of the following are benefits of relocatable modular construction?

(a) fast delivery

(b) ease of relocation

(c) low-cost reconfiguration

(d) All of the above

59. True or false? Relocatable modular constructions must meet the International Residential Code as well as any local codes that may exist regarding their construction.

(a) True

(b) False

60. True or false? Relocatable buildings are permanently affixed to real estate.

(a) True

(b) False

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