# UDC Appendix

# Table of Contents

| Wisconsin Division of Safety and Buildings<br>Wisconsin Stats. 101.63, 101.73 | **WISCONSIN UNIFORM BUILDING PERMIT APPLICATION**<br>**Instructions on back of yellow ply.** The information you provide may be used by other government agency programs (Privacy Law, s. 15.04 (1)(m) | Application No.<br>Parcel No. |
|---|---|---|

**PERMIT REQUESTED** ☐ Constr. ☐ HVAC ☐ Electric ☐ Plumbing ☐ Erosion Control Other:

| Owner's Name | Mailing Address | | Tel. |
|---|---|---|---|
| Contractor's Name: ☐Con ☐Elec ☐HVAC ☐Plbg | Lic/Cert# | Mailing Address | Tel.<br>FAX |
| Contractor's Name: ☐Con ☐Elec ☐HVAC ☐Plbg | Lic/Cert# | Mailing Address | Tel.<br>FAX |
| Contractor's Name: ☐Con ☐Elec ☐HVAC ☐Plbg | Lic/Cert# | Mailing Address | Tel.<br>FAX |
| Contractor's Name: ☐Con ☐Elec ☐HVAC ☐Plbg | Lic/Cert# | Mailing Address | Tel.<br>FAX |

**PROJECT LOCATION** Lot area Sq. ft. of Section , T N, R E (or) W

| Building Address | Subdivision Name | Lot No. | Block No. |
|---|---|---|---|

| Zoning District(s) | Zoning Permit No. | Setbacks: | Front ft. | Rear ft. | Left ft. | Right ft. |
|---|---|---|---|---|---|---|

**1. PROJECT**
☐ New ☐ Repair
☐ Alteration ☐ Raze
☐ Addition ☐ Move
☐ Other:

**2. AREA INVOLVED**
Unfin. Bsmt ____________Sq Ft
Living Area ____________Sq Ft
Garage ____________Sq Ft
Deck ____________Sq Ft.

**3. OCCUPANCY**
☐ Single Family
☐ Two Family
☐ Garage
☐ Other:

**4. CONST. TYPE**
☐ Site-Built
☐ Mfd: ☐ UDC ☐ HUD

**5. STORIES**
☐ 1-Story
☐ 2-Story
☐ Other:
☐ Plus Basement

**6. ELECTRICAL**
Entrance Panel Amps:
☐ Underground
☐ Overhead

**7. FOUNDATION**
☐ Concrete
☐ Masonry
☐ Treated Wood
☐ Other:

**8. USE**
☐ Seasonal
☐ Permanent
☐ Other:

**9. HVAC EQUIPMENT**
☐ Forced Air Furnace
☐ Radiant Basebd/ Panel
☐ Heat Pump
☐ Boiler
☐ Central Air Cond
☐ Other:

**10. SEWER**
☐ Municipal
☐ Septic Permit No.:

**11. WATER**
☐ Municipal Utility
☐ Private On-Site Well

**12. ENERGY SOURCE**

| Fuel | Nat Gas | LP | Oil | Elec | Solid | Solar |
|---|---|---|---|---|---|---|
| Space Htg | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Water Htg | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

☐ Dwelling unit has 3 kilowatt or more electric space heating equip. Infiltration control option is ☐ Sealing of all joints ☐ Blower door test. ☐ Exterior air infiltration barrier

**13. HEAT LOSS (Calculated)**
Envelope ____________________BTU/HR
Infiltration ____________________BTU/HR

**14. EST. BUILDING COST**
$

Sample

I agree to comply with all applicable codes, statutes and ordinances and with the conditions of this permit; understand that the issuance of the permit creates no legal liability, express or implied, on the state or municipality; and certify that all the above information is accurate. If I am an owner applying for an erosion control or construction permit, I have read the cautionary statement regarding contractor financial responsibility on the reverse side of the pink ply. I expressly grant the building inspector, or the inspector's authorized agent, permission to enter the premises for which this permit is sought at all reasonable hours and for any proper purpose to inspect the work which is being done.

**APPLICANT'S SIGNATURE** ______________________________ **DATE SIGNED** ______________

**APPROVAL CONDITIONS** This permit is issued pursuant to the following conditions. Failure to comply may result in suspension or revocation of this permit or other penalty.

**ISSUING JURISDICTION** ☐ Town ☐ Village ☐ City ☐ State of:
Municipality Number of Dwelling Location ___ ___ - ___ ___ ___

**FEES:**
Plan Review $__________
Inspection $__________
Wis. Permit Seal $__________
Other $__________
Total $__________

**PERMIT(S) ISSUED**
☐ Construction
☐ HVAC
☐ Electrical
☐ Plumbing
☐ Erosion

**WIS PERMIT SEAL #**

**PERMIT ISSUED BY:**
Name ______________________
Date ____________ Tel. ____________
Cert No. ______________________

SBD-5823(R.05/98) WHITE - Issuing Jurisdiction YELLOW - State w/in 30 days if new dwelling GREEN - Inspector PINK - Owner/Agent

## INSTRUCTIONS

The owner, builder or agents shall complete the application form down through the Signature of Applicant block and submit it and building plans and specifications to the enforcing municipality. Permit application data is used for statewide statistical gathering on new one– and two–family dwellings, as well as for local code administration.

PERMIT REQUESTED
- Check off type of Permit Requested, such as structural, HVAC, Electrical or Plumbing.
- Fill in owner's current Mailing Address and Telephone Number.

PROJECT LOCATION
- Fill in Building Address (number and street or sufficient information so that the building inspector can locate the construction site.
- Fill in Contractor Information. Note, per s. 101.63 (7) Wis. Stats., that the master plumber name and number must be entered before issuing a plumbing permit.
- Local zoning, land use and flood plain requirements must be satisfied before a building permit can be issued. County approval may be necessary.
- Fill in Zoning District, lot area and required building setbacks.

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PROJECT DATA – Fill in all numbered project data blocks (1–14) with the required information. All data blocks must be filled in, including the following:

2. Area (involved in project):
   Basements – include unfinished area only
   Living area – include any finished area including finished areas in basements
   Two–family dwellings – include total combined areas
3. Occupancy – Check only "Single–Family" or "Two–Family" if that is what is being worked on. In other words, do not check either of these two blocks if only a new detached garage is being built, even if it serves a one or two family dwelling. Instead, check "Garage" and number of stalls. If the project is a community based residential facility serving 3 to 8 residents, it is considered a single–family dwelling.
9. HVAC Equipment – Check only the major source of heat, plus central air conditioning if present. Only check "Radiant Baseboard or Panel" if there is no central source of heat.
10. Plumbing – A building permit cannot be issued until a county sanitary permit has been issued for any new of affected existing on–site sewage system.
14. Estimated Cost – Include the total cost of construction, including materials and market rate labor, but not the cost of land or landscaping.

SIGNATURE – Sign and date this application form.
CONDITIONS OF APPROVAL – The authority having jurisdiction uses this section to state any conditions that must be complied with pursuant to issuing the building permit.

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ISSUING JURISDICTION: This must be completed by the authority having jurisdiction.
- Check off Municipality Status, such as town, village or city.
- Fill in Municipality Name and Municipality Number of inspection authority.
- Fill in Municipality Number of Dwelling Location if different from municipality where inspection authority is located. (applies to county or state enforcement)
- Check off type of Permit Issued, such as construction, HVAC, electrical or plumbing.
- Fill in Wisconsin Uniform Permit Seal Number, if project is a new one– or two–family dwelling.
- Fill in Name and Inspector Certification Number of person reviewing building plans and date building permit issued.

**PLEASE RETURN YELLOW COPY WITHIN 30 DAYS AFTER ISSUANCE TO (You may fold along the dashed lines and insert this form into a window envelope.):**

**Safety & Buildings Division**
**P O Box 2509**
**Madison, WI 53701–2509**

## CAUTIONARY STATEMENT TO OWNERS OBTAINING BUILDING PERMITS

101.65 (1r) of the Wisconsin Statutes requires municipalities that enforce the Uniform Dwelling Code to provide an owner who applies for a building permit with a statement advising the owner that:

If the owner hires a contractor to perform work under the building permit and the contractor is not bonded or insured as required under s. 101.654 (2) (a), the following consequences might occur:

(a) The owner may be held liable for any bodily inquiry to or death of others or for any damage to the property of others that arises out of the work performed under the building permit or that is caused by any negligence of the contractor that occurs in connection with the work performed under the building permit.

(b) The owner may not be able to collect from the contractor damages for any loss sustained by the owner because of a violation by the contractor of the one– and 2– family dwelling code or an ordinance enacted under sub. (1) (a), because of any bodily injury to or death of others or damage to the property of others that arises out of the work performed under the building permit or because of any bodily injury to or death of others or damage to the property of others that is caused by any negligence by the contractor that occurs in connection with the work performed under the building permit.

SBD–5823 (R.05/98)

## SITE INFO

SUBDIVISION ______________________

LOT NO. ______________ BLOCK NO. ______________

ZONING DISTRICT ______________________

_____ 1/4, _____ 1/4, SEC _____, T _____, N, R _____ E or W

PARCEL NO. ______________________

SETBACKS:

FRONT ______________ ft REAR ______________ ft

LEFT ______________ ft RIGHT ______________ ft

## INSPECTIONS

| PHASE | ROUGH | FINAL | EROSION |
|---|---|---|---|
| FOOTING | | | |
| FOUNDATION | | | |
| BSMT DRAIN TILES | | | |
| CONSTRUCTION | | | |
| PLUMBING | | | |
| HEAT/VENT/AC | | | |
| ELECTRICAL | | | |
| INSULATION | | | |
| OCCUPANCY | | | |

## CONTRACTORS

______________________ # ______________
G.C.

______________________ # ______________
HVAC

______________________ # ______________
ELECT.

______________________ # ______________
PLBG.

______________________ # ______________

Work shall not proceed until the inspector has approved the various stages of construction or the 48 business hr. period since notification has elapsed. This permit will expire __24__ months after the date of issuance if the building's exterior has not been completed. **Keep this card posted until final inspection has been made.** (WI Stats. 101.63) ______________________

# WISCONSIN UNIFORM BUILDING PERMIT

affix uniform permit seal here (when applicable) Seal No ________

# ______________

☐ const ☐ hvac ☐ elec ☐ plumb ☐ erosion

**Project:**

| Issued to | |
|---|---|
| | OWNER (AGENT) |
| | BUILDING SITE ADDRESS |
| | CITY, VILLAGE, TOWN |

| Issued by | | |
|---|---|---|
| | PERSON ISSUING | CERT. NO. |
| | DATE ISSUED | TELEPHONE |

**Comments:** ______________________

______________________

**NOTICE OF NONCOMPLIANCE:** This issuing jurisdiction shall notify the applicant in writing of any violations to be corrected. All cited violations shall be corrected within 30 days of notification, unless extension time is granted.

SBD-5824 (R. 05/96)

Submit to non-enforcing municipalities for new 1- and 2- family dwellings

**WISCONSIN ADMINISTRATIVE BUILDING PERMIT APPLICATION**
(Wis. Stats. 101.63 (7) & 101.65 (3))
**EE INSTRUCTIONS ON BACK OF YELLOW COPY.**

State of Wisconsin
Safety and Buildings Division

Personal information you provide may be used for secondary purposes. [Privacy Law 15.04(1)(m)]

Sample

| | | | |
|---|---|---|---|
| **PERMIT APPLICANT** | | | |
| Last Name | First Name | Middle Initial | |
| Street Address | | | |
| City | State | Zip Code | Telephone No. (Include area code) |
| **PROJECT LOCATION** | | | |
| Building Address | Subdivision Name | Lot # | Block # |
| Legal Description ______ 1/4, ______ 1/4, Section ______ T ______ N, R ______ E or W | Parcel No. | | |

| | | | |
|---|---|---|---|
| **1. PROJECT TYPE** | **2. HVAC EQUIPMENT** | | |
| ☐ 1 Family | ☐ Forced Air Furnace | ☐ Radiant Baseboard or Panel | ☐ Heat Pump |
| ☐ 2 Family | ☐ Boiler | ☐ Central AC | ☐ Other: |

| **3. ENERGY SOURCE** | Nat. Gas | L.P. | Oil | Elect. | Solid | Solar |
|---|---|---|---|---|---|---|
| Space Heating | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Water Heating | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | |
|---|---|---|---|
| **4. CONSTRUCTION TYPE** | **5. FOUNDATION** | | |
| ☐ Site Constructed | ☐ Concrete | ☐ Masonry | ☐ Treated Wood |
| ☐ Manufactured | ☐ Other (specify): | | |
| **6. AREA** | **7. ESTIMATED BUILDING COST** | | |
| Living area = Square Feet | $ | | |

I vouch that all the above information is correct, and understand that the issuance of this permit is for administrative purposes only. I understand that onsite construction inspections will **not** be performed by the municipality, but that the Uniform Dwelling Code, Chapters Comm/ILHR 20-25, still applies to all new 1- and 2-family dwellings and must be complied with. I understand that the issuance of this permit does not relieve me of compliance with other applicable codes and ordinances.

Applicant's Signature ______________________ Date Signed ______________________

**MUST BE COMPLETED BY THE MUNICIPALITY BEFORE FORWARDING PINK PLY TO THE STATE DIVISION OF SAFETY AND BUILDINGS**

| | | | |
|---|---|---|---|
| **ISSUING JURISDICTION:** | ☐ Town ☐ Village ☐ City ☐ County of: | | |
| **MUNICIPALITY NUMBER:** of Dwelling Location | # ___ ___ - ___ ___ ___ | **FEES:** | |
| **PERMIT ISSUED BY:** | | **DATE ISSUED:** | |

SBD-8254 (R 01/98) **White - Issuing Jurisdiction** **Pink - State Within 30 Days** **Yellow - Applicant**

## INSTRUCTIONS

The owner, builder or agent shall complete and provide all required information on the application form down through the Signature of Applicant block. This data is used for statewide statistical gathering on new one– and two–family dwellings, as well as for local administration. When completed, submit to local municipality having jurisdiction. Plan review or building inspections will not be performed by the municipality.

### PERMIT REQUESTED:

- Fill in building address.
- Fill in legal description of lot, subdivision name, lot number and block number.

### PROJECT DATA:

- Fill in **all numbered** project data blocks (1–7) with the required information. All data blocks must be filled in, including the following:

1. **Type** – Check only "1–Family" or "2–Family" if that is what is being built. In other words, do NOT use this form if only a new detached garage is being built, even if it serves a one or two family dwelling.

2. **HVAC Equipment** – Check only the major source of heat, not any supplemental sources. Mark central air conditioning if present. Only check "Radiant Baseboard or Panel" if there is no central source of heat.

6. **Living Area** – Include any finished area including finished areas in basements. For two– family dwellings, include total combined areas.

7. **Estimated Cost** – Include the total cost of construction, but not cost of land or landscaping.

### SIGNATURE:

- Sign and date application form.

### ISSUING JURISDICTION – This must be completed by the AUTHORITY HAVING JURISDICTION.

Check off MUNICIPALITY STATUS of issuing jurisdiction, such as town, village, city or county.

Fill in MUNICIPALITY NUMBER OF DWELLING LOCATION. If issued by a county, indicate the specific municipality number where the dwelling will be built.

Fill in name of person issuing permit and date building permit issued.

**PLEASE RETURN PINK COPY WITHIN 30 DAYS AFTER ISSUANCE TO (You may fold along the dashed lines and insert this form into a window envelope.):**

**Safety & Buildings Division**
**P O Box 2509**
**Madison, WI 53701–2509**

## INSPECTION REPORT AND NOTICE OF NONCOMPLIANCE

| Report Date: | Inspection Date | Permit No.: | Parcel No: | |
|---|---|---|---|---|
| Project Address | | Subdivision | Lot No.: | Block No.: |

Inspection Type(s): ☐Footing ☐Heat/Vent/AC ☐Erosion Control ☐Plumbing ☐Foundation ☐Electrical ☐Bsmt Drain Tile ☐Insulation/Energy ☐Construction ☐Occupancy

| **Owner:** | **Contractor:** |
|---|---|
| | |
| | |
| | |
| | |

AN INSPECTION OF THE ABOVE PREMISES HAS DISCLOSED THE FOLLOWING NONCOMPLIANCES:

| ORDER NO. | CODE SECTION | FINDINGS AND REQUIREMENTS |
|---|---|---|
| | | |



**IMPORTANT:** Please report when violation are corrected. AVOID DELAY

**NOTICE OF NONCOMPLIANCE**

**All cited violations shall be corrected within __30__ days after written notification unless an extension of time is granted. Each day that the violatior continues after notice shall constitute a separate offense and is subject to remedies and penalties by the authority having jurisdiction.**

| Enforcement Jurisdiction: ☐Town ☐Village ☐County ☐State ☐City **OF** | | Authority By Municipal Ordinance Section:: |
|---|---|---|
| Inspector's Name: | Violations Explained To: | Compliance Date: |
| Inspector's Address: | Office Hours: | Telephone No: |

DO NOT REMOVE

# OFFICIAL MUNICIPAL NOTICE OF VIOLATION

**LOCATION:** ______________________________

☐ **LACKING** ____________ **PERMIT(S)** ☐ **NEED FOR** ________ **INSPECTION**
☐ **EXPIRED** ____________ **PERMIT** ☐ **PREMISES HOUSEKEEPING**
☐ **UNFIT FOR HUMAN OCCUPANCY**
☐ **EROSION CONTROL PERIMETER MEASURES** ☐ INSTALL ☐ MAINTAIN
☐ **ROCK DRIVEWAY** ☐ INSTALL ☐ MAINTAIN
☐ **SEDIMENT CLEANUP** ☐ STREET & SIDEWALKS ☐ ADJOINING PROPERTY
**OTHER:** ______________________________
______________________________

## ACTION:

☐ **CONTACT INSPECTOR** ☐ NOW ☐ AFTER CORRECTIONS
☐ **CORRECT** ☐ NOW ☐ BY END OF TODAY(TRACKING CLEANUP)
☐ BY END OF NEXT WORKDAY (SEDIMENT CLEANUP)
☐ IN 72 HRS (EROSION CONTROLS) ☐ BY ______________
☐ **STOP ALL WORK** ☐ EXCEPT CORRECTIONS



**FAILURE TO COMPLY SUBJECTS YOU TO APPLICABLE FINES & PENALTIES**

| ______________________ | ____________ | ________ |
|---|---|---|
| **MUNICIPAL INSPECTOR** | **PHONE NUMBER** | **DATE** |

SBD-10266 (N.10/95)

Safety and Buildings Division
201 W. Washington Avenue
P O Box 7162
Madison, WI 53707–7162
Telephone: (608) 266–3151

## PETITION FOR VARIANCE
## INFORMATION AND INSTRUCTIONS – ILHR 3

In instances where exact compliance with a particular code requirement cannot be met or alternative designs are desired, the Division has a petition for variance program where it reviews and considers acceptance of alternatives which are not in strict conformance with the letter of the code, but which meet the intent of the code. **A variance is not a waiver from a code requirement.** The petitioner must **provide an equivalency which meets the intent** of the code section petitioned to obtain a variance. Documentation of the rationale for the equivalency is requested below. Failure to provide adequate information may delay your petition. Pictures, sketches, and plans may be submitted to support equivalency. If the proposed equivalency does not adequately safeguard the health, safety, and welfare of building occupants, frequenters, firefighters, etc., the variance request will be denied. NOTE: A SEPARATE PETITION IS REQUIRED FOR EACH BUILDING AND EACH CODE ISSUE PETITIONED (i.e., 57.13 window issue cannot be processed on the same petition as 51.16 stair issue). It should be noted that **a petition for variance does not take the place of any required plan review submittal.**

The Division is unable to process petitions for variance that are not properly completed. Before submitting the application, the following items should be checked for completeness in order to avoid delays:

- Petitioner's name (typed or printed)
- Petitioner's signature
- The Petition For Variance Application must be signed by the owner of the building or project unless a Power of Attorney is submitted.
- Notary Public signature with affixed seal
- Analysis to establish equivalency, including any pictures, illustrations or sketches of the existing and proposed conditions to clearly convey your proposal to the reviewer.
- Proper fee
- Any required position statements by fire chief or municipal official

A position statement from the chief of the local fire department is required for fire safety issues. **No position statement is required for** non–fire safety topics such as sanitary and energy conservation. Position statements for both the fire department and municipality are required for ILHR 69 barrier–free petitions. For rules relating to one– and two–family dwellings, only a position statement from the local enforcing municipality is required. Position statements must be completed and signed by the appropriate fire chief or municipal enforcement official. See the back of SBD–9890, Petition For Variance Application form for these position statements forms. Signatures or seals on all documents must be originals. Photocopies are not acceptable.

SBD–9890 (R.01/98)

**Contact numbers and fees for the Division's review of the petition for variance are as follows:**

Chapters ILHR 20–25, Uniform Dwelling Code .......... (608) 267–5113 ...... $125.00
Chapters ILHR 67–68, Rental Unit Energy Efficiency Code (608) 266–1930 ..... $125.00
Chapters ILHR 50–64, Commercial Building Code ....... (608) 266–1835 ..... $490.00
Chapter ILHR 66, Uniform Multi–Family Dwellings ....... (608) 266–0669 ..... $490.00

- The cities of Milwaukee and Madison may process requests for variances from Chapters ILHR 50 through 64 requirements on projects in their jurisdiction.)

Chapter ILHR 66, Multifamily Dwelling ................. (608) 266–1930 ...... $490.00
Chapter ILHR 69, Barrier–Free Requirements ........... (414) 548–8609 ..... $200.00
Chapter ILHR 70, Historic Building Code ............... (715) 524–3626 ..... $300.00
All Other Chapters ................................................. $200.00
Boilers and Pressure Vessels ...................... (414) 548–8617
Electrical ........................................ (608) 266–7529
Elevators ......................................... (414) 521–5444
Flammable Liquids ................................ (608) 266–7529

**Priority Review:** Does not apply to Uniform Dwelling Code or Historic Building Code issues which already are treated as a priority ....... Double Above Amounts

Except for special cases, the Division will review and make a determination on a petition for variance within 30 business days of receipt of all calculations, documents, and fees required for the review. Uniform Dwelling Code petitions will be processed within 5 business days. Priority petitions will be processed within 10 business days.

**Petitions for variance should be submitted to:**

**Safety and Buildings Division**
**201 West Washington Avenue**
**P O Box 7162**
**Madison, Wisconsin 53707**
**(608) 266–3151**

**Elevator or barrier–free petitions may be submitted directly to the Waukesha office.**

**General Plumbing or Private Sewage petitions may be submitted to any of the six full–service offices.**

| GREEN BAY S&BD | HAYWARD S&BD | LACROSSE S&BD | MADISON S&BD | SHAWANO S&BD | WAUKESHA S&BD |
|---|---|---|---|---|---|
| 2331 San Luis Place | 15837 USH 63 | 2226 Rose Street | 201 W. Washington Ave. | 1340 Green Bay St | 401 Pilot Court |
| Green Bay, WI 54304 | Hayward, WI 54843 | La Crosse, WI 54603 | P.O. Box 7162 | Shawano, WI 54166 | Waukesha, WI 53188 |
| 920–492–5601 | 715–634–4870 | 608–785–9334 | Madison, WI 53707–7162 | 715–524–3626 | 414–548–8600 |
| FAX: 920–492–5604 | FAX: 715–634–5150 | FAX: 608–785–9330 | 608–261–8490 | FAX: 715–524–3633 | FAX: 414–548–8614 |
| | | | FAX: 608–267–9566 | | |

| Dept. Use Only |
|---|
| Plan No. |

## PETITION FOR VARIANCE APPLICATION

Safety and Buildings Division
201 W. Washington Ave.
P.O. Box 7162
Madison, WI 53707

Page 1 of ________

PLEASE TYPE OR PRINT CLEARLY - Personal information you provide may be used for secondary purposes [Privacy Law, s.15.04 (1)(m)].

| 1. Owner Information | | 2. Project Information | 3. Designer Information | |
|---|---|---|---|---|
| Name | | Building Occupancy Chapter(s) and Use | Designer | Registration No. |
| Company Name | | Tenant Name (if any) | Design Firm | |
| Number and Street | | Building Location (number and street) | Number and Street | |
| City, State, Zip Code | | ☐ City ☐ Village ☐ Township of | City, State, Zip Code | |
| Contact Person | | County of | Contact Person | |
| Telephone Number ( ) | FAX Number ( ) | Property ID # (tax parcel # - contact county) | Telephone Number ( ) | FAX Number ( ) |

**4. Plan Review Status**
Review by
☐State ☐Municipality

☐On hold
☐Preliminary design
☐Approved, requesting revision
☐Submitted with petition

☐Already built
☐Built according to older code but must be brought into compliance with current code
☐Plan will be submitted after petition determination
☐Other

Plan Number ____________________

5. State the code section being petitioned AND the specific condition or issue you are requesting be covered under this petition for variance.

6. Reason why compliance with the code cannot be attained without the variance.

7. State your proposed means and rationale of providing equivalent degree of health, safety, or welfare as addressed by the code section petitioned.

8. List attachments to be considered as part of the petitioner's statements (i.e., model code sections, test reports, research articles, expert opinion, previously approved variances, pictures, plans, sketches, etc.).

**VERIFICATION BY OWNER - PETITION IS VALID ONLY IF NOTARIZED WITH AFFIXED SEAL AND ACCOMPANIED BY REVIEW FEE** (See Section Comm 2.52 for complete fee information)

Note: Petitioner must be the owner of the building or project. Tenants, agents, designers, contractors, attorneys, etc., shall not sign petition unless Power of Attorney is submitted with the Petition for Variance Application.

____________________, being duly sworn, I state as petitioner that I have read the foregoing petition and I believe it is true and that I have significant ownership rights to the subject building or project.
Petitioner's Name (type or print)

| Petitioner's Signature | Subscribed and sworn to before me this date | Notary Public | My commission expires on |
|---|---|---|---|
| | | | |

**Complete other side for variance requests from ILHR 20-25 and ILHR 50-64.**

SBD-9890 (R.01/98)

| Owner's Name | Project Location | Plan Number |
| --- | --- | --- |
| | | |

Page 2 of ______

## Fire Department Position Statement

To be completed for variances requested from ILHR 50-64, ILHR 69, ILHR 10, and other fire related requirements.

**I have read the application for variance and recommend:** (check appropriate box)

Approval Conditional Approval Denial No Comment

Explanation for recommendation including any conflicts with local rules and regulations and suggested conditions:

______________________________

______________________________

______________________________

______________________________

______________________________

______________________________

| Fire Department Name and Address | |
| --- | --- |
| Name of Fire Chief or Designee (type or print) | Telephone Number |
| Signature of Fire Chief or Designee | Date Signed |

## MUNICIPAL BUILDING INSPECTION RECOMMENDATION

To be completed for variances requested from ILHR 20-23. Also to be used if ILHR 50-64 plan review is by municipality or orders are written on the building under construction; optional in other cases.

**I have read the application for variance and recommend:** (check appropriate box)

Approval Conditional Approval Denial No Comment

Explanation for recommendation including any conflicts with local rules and regulations and suggested conditions:

______________________________

______________________________

______________________________

______________________________

______________________________

| Municipality Exercising Jurisdiction | |
| --- | --- |
| Name and Address of Municipal Official (type or print) | Telephone Number of Enforcement Official |
| Signature of Municipal Enforcement Official | Date Signed |

SBD-9890 (R.01/98)

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 sill or girder, toe nail | 2–16d, 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 |
| Built–up girder and beams, top loaded | 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 | 16d at 16" o.c. |
| Top or sole plate to stud, end nail | 2–16d |
| Stud to sole plate, toe nail | 4–8d or 3–16d |
| Doubled studs, face nail | 16d at 24" o.c. |
| Doubled top plates, face nail | 16d at 16" o.c. |
| Top plates, laps and intersections, face nail | 2–16d |
| 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, 1 3/4" |
| Built–up corner studs | 16d at 30" o.c., 16d at 24" o.c. |
| **Roof/Ceiling Framing** | |
| Ceiling joists to plate, toe nail | 2–16d, 3–8d |
| Ceiling joist, laps over partitions, face nail | 3–16d |
| Ceiling joist to parallel rafters, face nail | 3–16d |
| Rafter to plate, toe nail (maximum 6' rafter span, engineered connector for longer) | 2–16d, 3–8d |
| 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, 1 3/4" |
| Wider than 1" x 6" subfloor toe to each joist, face nail | 3–8d or 4 staples 1 3/4" |
| 2" subfloor to joist or girder, blind and face nail | 2–16d |
| 1" x 6" roof sheathing to each bearing, face nail | 2–8d or 2 staples, 1 3/4" |
| 1" x 8" roof sheathing to each bearing, face nail | 2–8d or 3 staples, 1 3/4" |
| Wider than 1" x 8" roof sheathing to each bearing, face nail | 3–8d or 4 staples, 1 3/4" |
| 2–inch planks | 2–16d at each bearing |

**Panel Sheathing**

| Material | Fastener | Spacing of Fastener: Edges | Spacing of Fastener: Intermediate Supports |
|---|---|---|---|
| Engineered wood panel for subfloor and roof sheathing and wall corner wind bracing to framing | | | |
| 5/16–inch to 1/2–inch | 6d common or deformed nail or staple, 1 1/2" | 6" | 12" [4] |
| 5/8–inch to 3/4–inch | 8d smooth or common, 6d deformed nail, or staple, 14 ga. 1 ¾" | 6" | 12" [4] |
| 7/8–inch to 1–inch | 8d common or deformed nail | 6" | 12" |
| 1 1/8–inch to 1 1/4–inch | 10d smooth or common, or 8d deformed nail | 6" | 12" |
| Combination subfloor/ underlayment to framing | | | |
| 3/4–inch or less | 6d deformed or 8d smooth or common nail | 6" | 12" |
| 7/8–inch to 1–inch | 8d smooth, common or deformed nail | 6" | 12" |
| 1 1/8–inch to 1 1/4–inch | 10d smooth or common or 8d deformed nail | 6" | 12" |
| Wood panel siding to framing | | | |
| 1/2–inch or less | 6d corrosion–resistant siding and casing nails | 6" | 12" |
| 5/8–inch | 8d corrosion–resistant siding and casing nails | 6" | 12" |

[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–inch o.d. crown width.
[4]Staples shall be spaced at not more than 10 inches o.c. at intermediate supports for floors.

## UDC Floor & Ceiling Joist and Roof Rafter Span Tables And Design Value Tables

Use the following Span Tables to determine the maximum spans for floor and ceiling joists and roof rafters. These spans are based on:

- simple, single spans (although the tables may be safely used for continuous two–span floor joists)
- uniformly distributed loads
- fully supported members with one edge properly sheathed and nailed
- for floor joists and roof rafters, the top edge shall be properly sheathed and nailed

The criteria for each Span Table is given in the upper left hand corner and is also summarized in the table of Span Tables below. Choose the appropriate Span Table based on the member type and required loading. Select your desired member depth, member spacing and span to determine the minimum Fb value. Note that these tables include recommended deflection criteria. However, for strict code compliance, only the Fb strength requirements must be satisfied. The modulus of elasticity (E) values, would be met for serviceability purposes only.

Note that straight–line interpolation is permitted for intermediate spans and design values. Span is measured from face to face of supports. For sloping rafters, the span is measured along the horizontal projection.

Section Comm 21.27 allows reduction of the snow live load for roof slopes greater than 30 degrees (7/12 slope) based on the formula Cs = 1 – (a–30)/40, where "a" is the slope of the roof expressed in degrees. Following is a table of tabulated values for certain roof slopes.

| Slope | Angle in Degrees | Zone 1 Live Load (psf) | Zone 2 Live Load (psf) |
|---|---|---|---|
| 7/12 | 30 | 40 | 30 |
| 10/12 | 40 | 30 | 22.5 |
| 12/12 | 45 | 25 | 18.8 |
| 14/12 | 50 | 20 | 15 |

Use the Design Value tables following the Span Tables to determine the acceptable species and grades to satisfy minimum Fb values obtained from the Span Tables. The Design Value tables assume at least three members spaced no more than 24" on center. Use the Normal Duration column Fb values for joists and the Snow Loading column Fb values for rafters.

See the following examples for further guidance.

**Tables are reprinted courtesy of American Forest & Paper Association.**

| Table No. | Member Type | Live Load (psf) | Dead Load (psf) | Condition | (Deflection)* |
|---|---|---|---|---|---|
| F–2 | Floor Joists | 40 | 10 | – | L/360 |
| C–1 | Ceiling Joists | 10 | 5 | Drywall ceiling, no attic storage | L/240 |
| C–2 | Ceiling Joists | 20 | 10 | Attic storage | L/240 |
| R–2 | Roof Rafters | 30 (Zone 2) | 10 | Maximum 2 layers of asphalt shingles or wood shakes/shingles | L/240 |
| R–3 | Roof Rafters | 40 (Zone 1) | 10 | Maximum 2 layers of asphalt shingles or wood shakes/shingles | L/240 |
| R–10 | Roof Rafters | 30 (Zone 2) | 20 | Heavy roof covering (clay tile) | L/240 |
| R–11 | Roof Rafters | 40 (Zone 1) | 20 | Heavy roof covering (clay tile) | L/240 |
| R–14 | Roof Rafters | 30 (Zone 2) | 10 | Maximum 2 layers of asphalt shingles or wood shakes/shingles | L/180 |
| R–15 | Roof Rafters | 40 (Zone 1) | 10 | Maximum 2 layers of asphalt shingles or wood shakes/shingles | L/180 |
| R–22 | Roof Rafters | 30 (Zone 2) | 20 | Heavy roof covering (clay tile) | L/180 |
| R–23 | Roof Rafters | 40 (Zone 1) | 20 | Heavy roof covering (clay tile) | L/180 |

*Deflection criteria are optional. For roof rafters with drywall on the underside, use the stricter L/240 tables to limit deflection.

**Example 1. Floor Joists.** Assume a required single span of 12'–9", live load of 10 psf and joists spaced 16 inches on center. Table F–2 (see following highlighted tables) shows that one solution is a grade of 2x8 having an Fb value of 1255 would allow a span of 12'–10 which satisfies the condition. (Note that the recommended E value to limit deflection would be 1,600,000.) Going to the Design Value Tables, we find that as an example, 2x8 Hem Fir grade No.1 has an Fb value of 1310 for normal duration. (It also has an E value of 1,500,000 which satisfies the recommended deflection criteria.)

**Example 2. Rafters.** Assume a horizontal projected span of 13'–0", a live load of 40 psf, dead load of 10 psf, a roof slope of 4/12 and rafters spaced 16 inches on center. Since the slope is shallower than 7/12, there is no allowable reduction of the snow live load. Table R–3 shows that a 2x8 having an Fb value of 1300 would allow a span of 13'–1" which satisfies the condition. (Note that the recommended E value to limit deflection would be 1,120,000.) Going to the Design Value Tables, we find that as an example, 2x8 Douglas Fir–Larch grade No.2 has an Fb value of 1390 for snow loading. (It also has an E value of 1,600,000 which satisfies the recommended deflection criteria.)

# Example 1

## TABLE F- 2
## FLOOR JOISTS WITH L/360 DEFLECTION LIMITS

**DESIGN CRITERIA:**
Deflection - For 40 psf live load.
Limited to span in inches divided by 360.
Strength - Live load of 40 psf plus dead load
of 10 psf determines the required bending design value.

| Joist Size (in) | Spacing (in) | Modulus of Elasticity, E, in 1,000,000 psi | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 |
| | 12.0 | 8-6 | 8-10 | 9-2 | 9-6 | 9-9 | 10-0 | 10-3 | 10-6 | 10-9 | 10-11 | 11-2 | 11-4 | 11-7 | 11-9 | 11-11 | 12-1 | 12-3 |
| | 16.0 | 7-9 | 8-0 | 8-4 | 8-7 | 8-10 | 9-1 | 9-4 | 9-6 | 9-9 | 9-11 | 10-2 | 10-4 | 10-6 | 10-8 | 10-10 | 11-0 | 11-2 |
| 2x6 | 19.2 | 7-3 | 7-7 | 7-10 | 8-1 | 8-4 | 8-7 | 8-9 | 9-0 | 9-2 | 9-4 | 9-6 | 9-8 | 9-10 | 10-0 | 10-2 | 10-4 | 10-6 |
| | 24.0 | 6-9 | 7-0 | 7-3 | 7-6 | 7-9 | 7-11 | 8-2 | 8-4 | 8-6 | 8-8 | 8-10 | 9-0 | 9-2 | 9-4 | 9-6 | 9-7 | 9-9 |
| | 12.0 | 11-3 | 11-8 | 12-1 | 12-6 | 12-10 | 13-2 | 13-6 | 13-10 | 14-2 | 14-5 | 14-8 | 15-0 | 15-3 | 15-6 | 15-9 | 15-11 | 16-2 |
| | 16.0 | 10-2 | 10-7 | 11-0 | 11-4 | 11-8 | 12-0 | 12-3 | 12-7 | 12-10 | 13-1 | 13-4 | 13-7 | 13-10 | 14-1 | 14-3 | 14-6 | 14-8 |
| 2x8 | 19.2 | 9-7 | 10-0 | 10-4 | 10-8 | 11-0 | 11-3 | 11-7 | 11-10 | 12-1 | 12-4 | 12-7 | 12-10 | 13-0 | 13-3 | 13-5 | 13-8 | 13-10 |
| | 24.0 | 8-11 | 9-3 | 9-7 | 9-11 | 10-2 | 10-6 | 10-9 | 11-0 | 11-3 | 11-5 | 11-8 | 11-11 | 12-1 | 12-3 | 12-6 | 12-8 | 12-10 |
| | 12.0 | 14-4 | 14-11 | 15-5 | 15-11 | 16-5 | 16-10 | 17-3 | 17-8 | 18-0 | 18-5 | 18-9 | 19-1 | 19-5 | 19-9 | 20-1 | 20-4 | 20-8 |
| | 16.0 | 13-0 | 13-6 | 14-0 | 14-6 | 14-11 | 15-3 | 15-8 | 16-0 | 16-5 | 16-9 | 17-0 | 17-4 | 17-8 | 17-11 | 18-3 | 18-6 | 18-9 |
| 2x10 | 19.2 | 12-3 | 12-9 | 13-2 | 13-7 | 14-0 | 14-5 | 14-9 | 15-1 | 15-5 | 15-9 | 16-0 | 16-4 | 16-7 | 16-11 | 17-2 | 17-5 | 17-8 |
| | 24.0 | 11-4 | 11-10 | 12-3 | 12-8 | 13-0 | 13-4 | 13-8 | 14-0 | 14-4 | 14-7 | 14-11 | 15-2 | 15-5 | 15-8 | 15-11 | 16-2 | 16-5 |
| | 12.0 | 17-5 | 18-1 | 18-9 | 19-4 | 19-11 | 20-6 | 21-0 | 21-6 | 21-11 | 22-5 | 22-10 | 23-3 | 23-7 | 24-0 | 24-5 | 24-9 | 25-1 |
| | 16.0 | 15-10 | 16-5 | 17-0 | 17-7 | 18-1 | 18-7 | 19-1 | 19-6 | 19-11 | 20-4 | 20-9 | 21-1 | 21-6 | 21-10 | 22-2 | 22-6 | 22-10 |
| 2x12 | 19.2 | 14-11 | 15-6 | 16-0 | 16-7 | 17-0 | 17-6 | 17-11 | 18-4 | 18-9 | 19-2 | 19-6 | 19-10 | 20-2 | 20-6 | 20-10 | 21-2 | 21-6 |
| | 24.0 | 13-10 | 14-4 | 14-11 | 15-4 | 15-10 | 16-3 | 16-8 | 17-0 | 17-5 | 17-9 | 18-1 | 18-5 | 18-9 | 19-1 | 19-4 | 19-8 | 19-11 |
| $F_b$ | 12.0 | 718 | 777 | 833 | 888 | 941 | 993 | 1043 | 1092 | 1140 | 1187 | 1233 | 1278 | 1323 | 1367 | 1410 | 1452 | 1494 |
| $F_b$ | 16.0 | 790 | 855 | 917 | 977 | 1036 | 1093 | 1148 | 1202 | 1255 | 1306 | 1357 | 1407 | 1456 | 1504 | 1551 | 1598 | 1644 |
| $F_b$ | 19.2 | 840 | 909 | 975 | 1039 | 1101 | 1161 | 1220 | 1277 | 1333 | 1388 | 1442 | 1495 | 1547 | 1598 | 1649 | 1698 | 1747 |
| $F_b$ | 24.0 | 905 | 979 | 1050 | 1119 | 1186 | 1251 | 1314 | 1376 | 1436 | 1496 | 1554 | 1611 | 1667 | 1722 | 1776 | 1829 | 1882 |

Note: The required bending design value, $F_b$, in pounds per square inch is shown at the bottom of each table and is applicable to all lumber sizes shown. Spans are shown in feet-inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# Example 1

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Eastern White Pine** | | | | | |
| Select Structural | 2x4 | 2155 | 2480 | 1,200,000 | NELMA NSLB |
| No.1 | | 1335 | 1535 | 1,100,000 | |
| No.2 | | 990 | 1140 | 1,100,000 | |
| No.3 | | 605 | 695 | 900,000 | |
| Stud | | 570 | 655 | 900,000 | |
| Construction | | 775 | 895 | 1,000,000 | |
| Standard | | 430 | 495 | 900,000 | |
| Utility | | 200 | 230 | 800,000 | |
| Select Structural | 2x6 | 1870 | 2150 | 1,200,000 | |
| No.1 | | 1160 | 1330 | 1,100,000 | |
| No.2 | | 860 | 990 | 1,100,000 | |
| No.3 | | 525 | 600 | 900,000 | |
| Stud | | 520 | 595 | 900,000 | |
| Select Structural | 2x8 | 1725 | 1985 | 1,200,000 | |
| No.1 | | 1070 | 1230 | 1,100,000 | |
| No.2 | | 795 | 915 | 1,100,000 | |
| No.3 | | 485 | 555 | 900,000 | |
| Select Structural | 2x10 | 1580 | 1820 | 1,200,000 | |
| No.1 | | 980 | 1125 | 1,100,000 | |
| No.2 | | 725 | 835 | 1,100,000 | |
| No.3 | | 445 | 510 | 900,000 | |
| Select Structural | 2x12 | 1440 | 1655 | 1,200,000 | |
| No.1 | | 890 | 1025 | 1,100,000 | |
| No.2 | | 660 | 760 | 1,100,000 | |
| No.3 | | 405 | 465 | 900,000 | |
| **Hem Fir** | | | | | |
| Select Structural | 2x4 | 2415 | 2775 | 1,600,000 | WCLIB WWPA |
| No.1 & Btr | | 1810 | 2085 | 1,500,000 | |
| No.1 | | 1640 | 1885 | 1,500,000 | |
| No.2 | | 1465 | 1685 | 1,300,000 | |
| No.3 | | 865 | 990 | 1,200,000 | |
| Stud | | 855 | 980 | 1,200,000 | |
| Construction | | 1120 | 1290 | 1,300,000 | |
| Standard | | 635 | 725 | 1,200,000 | |
| Utility | | 290 | 330 | 1,100,000 | |
| Select Structural | 2x6 | 2095 | 2405 | 1,600,000 | |
| No.1 & Btr | | 1570 | 1805 | 1,500,000 | |
| No.1 | | 1420 | 1635 | 1,500,000 | |
| No.2 | | 1270 | 1460 | 1,300,000 | |
| No.3 | | 750 | 860 | 1,200,000 | |
| Stud | | 775 | 895 | 1,200,000 | |
| Select Structural | 2x8 | 1930 | 2220 | 1,600,000 | |
| No.1 & Btr | | 1450 | 1665 | 1,500,000 | |
| No.1 | | 1310 | 1510 | 1,500,000 | |
| No.2 | | 1175 | 1350 | 1,300,000 | |
| No.3 | | 690 | 795 | 1,200,000 | |
| Select Structural | 2x10 | 1770 | 2035 | 1,600,000 | |
| No.1 & Btr | | 1330 | 1525 | 1,500,000 | |
| No.1 | | 1200 | 1380 | 1,500,000 | |
| No.2 | | 1075 | 1235 | 1,300,000 | |
| No.3 | | 635 | 725 | 1,200,000 | |
| Select Structural | 2x12 | 1610 | 1850 | 1,600,000 | |
| No.1 & Btr | | 1210 | 1390 | 1,500,000 | |
| No.1 | | 1095 | 1255 | 1,500,000 | |
| No.2 | | 980 | 1125 | 1,300,000 | |
| No.3 | | 575 | 660 | 1,200,000 | |

# Example 2

## TABLE R-3
## RAFTERS WITH L/240 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength - Live Load of 40 psf plus
Dead Load of 10 psf determines the required bending design value.
Deflection - For 40 psf live load.
Limited to span in inches divided by 240.

**Rafter Bending Design Value, $F_b$, (psi)**

| Size (in) | Spacing (in) | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12.0 | 5-6 | 6-4 | 7-1 | 7-9 | 8-5 | 9-0 | 9-6 | 10-0 | 10-6 | 11-0 | 11-5 | 11-11 | 12-4 | 12-8 | 13-1 | 13-6 | 13-10 | 14-2 | | | | |
| | 16.0 | 4-9 | 5-6 | 6-2 | 6-9 | 7-3 | 7-9 | 8-3 | 8-8 | 9-1 | 9-6 | 9-11 | 10-3 | 10-8 | 11-0 | 11-4 | 11-8 | 12-0 | 12-4 | 12-7 | 12-11 | | |
| 2x 6 | 19.2 | 4-4 | 5-0 | 5-7 | 6-2 | 6-8 | 7-1 | 7-6 | 7-11 | 8-4 | 8-8 | 9-1 | 9-5 | 9-9 | 10-0 | 10-4 | 10-8 | 10-11 | 11-3 | 11-6 | 11-9 | 12-0 | 12-4 |
| | 24.0 | 3-11 | 4-6 | 5-0 | 5-6 | 5-11 | 6-4 | 6-9 | 7-1 | 7-5 | 7-9 | 8-1 | 8-5 | 8-8 | 9-0 | 9-3 | 9-6 | 9-9 | 10-0 | 10-3 | 10-6 | 10-9 | 11-0 |
| | 12.0 | 7-3 | 8-4 | 9-4 | 10-3 | 11-1 | 11-10 | 12-7 | 13-3 | 13-11 | 14-6 | 15-1 | 15-8 | 16-3 | 16-9 | 17-3 | 17-9 | 18-3 | 18-9 | | | | |
| | 16.0 | 6-3 | 7-3 | 8-1 | 8-11 | 9-7 | 10-3 | 10-10 | 11-6 | 12-0 | 12-7 | 13-1 | 13-7 | 14-0 | 14-6 | 14-11 | 15-5 | 15-10 | 16-3 | 16-7 | 17-0 | | |
| 2x 8 | 19.2 | 5-9 | 6-7 | 7-5 | 8-1 | 8-9 | 9-4 | 9-11 | 10-6 | 11-0 | 11-6 | 11-11 | 12-5 | 12-10 | 13-3 | 13-8 | 14-0 | 14-5 | 14-10 | 15-2 | 15-6 | 15-10 | 16-3 |
| | 24.0 | 5-2 | 5-11 | 6-7 | 7-3 | 7-10 | 8-4 | 8-11 | 9-4 | 9-10 | 10-3 | 10-8 | 11-1 | 11-6 | 11-10 | 12-2 | 12-7 | 12-11 | 13-3 | 13-7 | 13-11 | 14-2 | 14-6 |
| | 12.0 | 9-3 | 10-8 | 11-11 | 13-1 | 14-2 | 15-1 | 16-0 | 16-11 | 17-9 | 18-6 | 19-3 | 20-0 | 20-8 | 21-4 | 22-0 | 22-8 | 23-3 | 23-11 | | | | |
| | 16.0 | 8-0 | 9-3 | 10-4 | 11-4 | 12-3 | 13-1 | 13-10 | 14-8 | 15-4 | 16-0 | 16-8 | 17-4 | 17-11 | 18-6 | 19-1 | 19-7 | 20-2 | 20-8 | 21-2 | 21-8 | | |
| 2x10 | 19.2 | 7-4 | 8-5 | 9-5 | 10-4 | 11-2 | 11-11 | 12-8 | 13-4 | 14-0 | 14-8 | 15-3 | 15-10 | 16-4 | 16-11 | 17-5 | 17-11 | 18-5 | 18-11 | 19-4 | 19-10 | 20-3 | 20-8 |
| | 24.0 | 6-6 | 7-7 | 8-5 | 9-3 | 10-0 | 10-8 | 11-4 | 11-11 | 12-6 | 13-1 | 13-7 | 14-2 | 14-8 | 15-1 | 15-7 | 16-0 | 16-6 | 16-11 | 17-4 | 17-9 | 18-1 | 18-6 |
| | 12.0 | 11-3 | 13-0 | 14-6 | 15-11 | 17-2 | 18-4 | 19-6 | 20-6 | 21-7 | 22-6 | 23-5 | 24-4 | 25-2 | 26-0 | | | | | | | | |
| | 16.0 | 9-9 | 11-3 | 12-7 | 13-9 | 14-11 | 15-11 | 16-10 | 17-9 | 18-8 | 19-6 | 20-3 | 21-1 | 21-9 | 22-6 | 23-2 | 23-10 | 24-6 | 25-2 | 25-9 | | | |
| 2x12 | 19.2 | 8-11 | 10-3 | 11-6 | 12-7 | 13-7 | 14-6 | 15-5 | 16-3 | 17-0 | 17-9 | 18-6 | 19-3 | 19-11 | 20-6 | 21-2 | 21-9 | 22-5 | 23-0 | 23-6 | 24-1 | 24-8 | 25-2 |
| | 24.0 | 7-11 | 9-2 | 10-3 | 11-3 | 12-2 | 13-0 | 13-9 | 14-6 | 15-3 | 15-11 | 16-7 | 17-2 | 17-9 | 18-4 | 18-11 | 19-6 | 20-0 | 20-6 | 21-1 | 21-7 | 22-0 | 22-6 |
| E | 12.0 | 0.14 | 0.22 | 0.31 | 0.41 | 0.51 | 0.63 | 0.75 | 0.88 | 1.01 | 1.15 | 1.30 | 1.45 | 1.61 | 1.77 | 1.94 | 2.12 | 2.30 | 2.48 | | | | |
| E | 16.0 | 0.12 | 0.19 | 0.27 | 0.35 | 0.44 | 0.54 | 0.65 | 0.76 | 0.88 | 1.00 | 1.12 | 1.26 | 1.39 | 1.54 | 1.68 | 1.83 | 1.99 | 2.15 | 2.31 | 2.48 | | |
| E | 19.2 | 0.11 | 0.18 | 0.24 | 0.32 | 0.41 | 0.50 | 0.59 | 0.69 | 0.80 | 0.91 | 1.03 | 1.15 | 1.27 | 1.40 | 1.54 | 1.67 | 1.81 | 1.96 | 2.11 | 2.26 | 2.42 | 2.58 |
| E | 24.0 | 0.10 | 0.16 | 0.22 | 0.29 | 0.36 | 0.44 | 0.53 | 0.62 | 0.71 | 0.81 | 0.92 | 1.03 | 1.14 | 1.25 | 1.37 | 1.50 | 1.62 | 1.75 | 1.89 | 2.02 | 2.16 | 2.30 |

Note: The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet-inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# Example 2

| Species and Grade | Size | Design Value in Bending, "Fb" Normal Duration | Design Value in Bending, "Fb" Snow Loading | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| **Cottonwood** | | | | | |
| Select Structural | 2x4 | 1510 | 1735 | 1,200,000 | NSLB |
| No.1 | 2x4 | 1080 | 1240 | 1,200,000 | NSLB |
| No.2 | 2x4 | 1080 | 1240 | 1,100,000 | NSLB |
| No.3 | 2x4 | 605 | 695 | 1,000,000 | NSLB |
| Stud | 2x4 | 600 | 690 | 1,000,000 | NSLB |
| Construction | 2x4 | 805 | 925 | 1,000,000 | NSLB |
| Standard | 2x4 | 460 | 530 | 900,000 | NSLB |
| Utility | 2x4 | 200 | 230 | 900,000 | NSLB |
| Select Structural | 2x6 | 1310 | 1505 | 1,200,000 | NSLB |
| No.1 | 2x6 | 935 | 1075 | 1,200,000 | NSLB |
| No.2 | 2x6 | 935 | 1075 | 1,100,000 | NSLB |
| No.3 | 2x6 | 525 | 600 | 1,000,000 | NSLB |
| Stud | 2x6 | 545 | 630 | 1,000,000 | NSLB |
| Select Structural | 2x8 | 1210 | 1390 | 1,200,000 | NSLB |
| No.1 | 2x8 | 865 | 990 | 1,200,000 | NSLB |
| No.2 | 2x8 | 865 | 990 | 1,100,000 | NSLB |
| No.3 | 2x8 | 485 | 555 | 1,000,000 | NSLB |
| Select Structural | 2x10 | 1105 | 1275 | 1,200,000 | NSLB |
| No.1 | 2x10 | 790 | 910 | 1,200,000 | NSLB |
| No.2 | 2x10 | 790 | 910 | 1,100,000 | NSLB |
| No.3 | 2x10 | 445 | 510 | 1,000,000 | NSLB |
| Select Structural | 2x12 | 1005 | 1155 | 1,200,000 | NSLB |
| No.1 | 2x12 | 720 | 825 | 1,200,000 | NSLB |
| No.2 | 2x12 | 720 | 825 | 1,100,000 | NSLB |
| No.3 | 2x12 | 405 | 465 | 1,000,000 | NSLB |
| **Douglas Fir-Larch** | | | | | |
| Select Structural | 2x4 | 2500 | 2875 | 1,900,000 | WCLIB WWPA |
| No.1 & Btr | 2x4 | 1985 | 2280 | 1,800,000 | WCLIB WWPA |
| No.1 | 2x4 | 1725 | 1985 | 1,700,000 | WCLIB WWPA |
| No.2 | 2x4 | 1510 | 1735 | 1,600,000 | WCLIB WWPA |
| No.3 | 2x4 | 865 | 990 | 1,400,000 | WCLIB WWPA |
| Stud | 2x4 | 855 | 980 | 1,400,000 | WCLIB WWPA |
| Construction | 2x4 | 1150 | 1325 | 1,500,000 | WCLIB WWPA |
| Standard | 2x4 | 635 | 725 | 1,400,000 | WCLIB WWPA |
| Utility | 2x4 | 315 | 365 | 1,300,000 | WCLIB WWPA |
| Select Structural | 2x6 | 2170 | 2495 | 1,900,000 | WCLIB WWPA |
| No.1 & Btr | 2x6 | 1720 | 1975 | 1,800,000 | WCLIB WWPA |
| No.1 | 2x6 | 1495 | 1720 | 1,700,000 | WCLIB WWPA |
| No.2 | 2x6 | 1310 | 1505 | 1,600,000 | WCLIB WWPA |
| No.3 | 2x6 | 750 | 860 | 1,400,000 | WCLIB WWPA |
| Stud | 2x6 | 775 | 895 | 1,400,000 | WCLIB WWPA |
| Select Structural | 2x8 | 2000 | 2300 | 1,900,000 | WCLIB WWPA |
| No.1 & Str | 2x8 | 1585 | 1825 | 1,800,000 | WCLIB WWPA |
| No.1 | 2x8 | 1380 | 1585 | 1,700,000 | WCLIB WWPA |
| No.2 | 2x8 | 1210 | 1390 | 1,600,000 | WCLIB WWPA |
| No.3 | 2x8 | 690 | 795 | 1,400,000 | WCLIB WWPA |
| Select Structural | 2x10 | 1835 | 2110 | 1,900,000 | WCLIB WWPA |
| No.1 & Btr | 2x10 | 1455 | 1675 | 1,800,000 | WCLIB WWPA |
| No.1 | 2x10 | 1265 | 1455 | 1,700,000 | WCLIB WWPA |
| No.2 | 2x10 | 1105 | 1275 | 1,600,000 | WCLIB WWPA |
| No.3 | 2x10 | 635 | 725 | 1,400,000 | WCLIB WWPA |
| Select Structural | 2x12 | 1670 | 1920 | 1,900,000 | WCLIB WWPA |
| No.1 & Btr | 2x12 | 1325 | 1520 | 1,800,000 | WCLIB WWPA |
| No.1 | 2x12 | 1150 | 1325 | 1,700,000 | WCLIB WWPA |
| No.2 | 2x12 | 1005 | 1155 | 1,600,000 | WCLIB WWPA |
| No.3 | 2x12 | 575 | 660 | 1,400,000 | WCLIB WWPA |

## TABLE F– 2
## FLOOR JOISTS WITH L/360 DEFLECTION LIMITS

**DESIGN CRITERIA:**
Deflection – For 40 psf live load.
Limited to span in inches divided by 360.
Strength – Live load of 40 psf plus dead load
of 10 psf determines the required bending design value.

| Joist Size (in) | Spacing (in) | Modulus of Elasticity, E, in 1,000,000 psi | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 |
| 2x 6 | 12.0 | 8– 6 | 8–10 | 9– 2 | 9– 6 | 9– 9 | 10– 0 | 10– 3 | 10– 6 | 10– 9 | 10–11 | 11– 2 | 11– 4 | 11– 7 | 11– 9 | 11–11 | 12– 1 | 12– 3 |
| | 16.0 | 7– 9 | 8– 0 | 8– 4 | 8– 7 | 8–10 | 9– 1 | 9– 4 | 9– 6 | 9– 9 | 9–11 | 10– 2 | 10– 4 | 10– 6 | 10– 8 | 10–10 | 11– 0 | 11– 2 |
| | 19.2 | 7– 3 | 7– 7 | 7–10 | 8– 1 | 8– 4 | 8– 7 | 8– 9 | 9– 0 | 9– 2 | 9– 4 | 9– 6 | 9– 8 | 9–10 | 10– 0 | 10– 2 | 10– 4 | 10– 6 |
| | 24.0 | 6– 9 | 7– 0 | 7– 3 | 7– 6 | 7– 9 | 7–11 | 8– 2 | 8– 4 | 8– 6 | 8– 8 | 8–10 | 9– 0 | 9– 2 | 9– 4 | 9– 6 | 9– 7 | 9– 9 |
| 2x 8 | 12.0 | 11– 3 | 11– 8 | 12– 1 | 12– 6 | 12–10 | 13– 2 | 13– 6 | 13–10 | 14– 2 | 14– 5 | 14– 8 | 15– 0 | 15– 3 | 15– 6 | 15– 9 | 15–11 | 16– 2 |
| | 16.0 | 10– 2 | 10– 7 | 11– 0 | 11– 4 | 11– 8 | 12– 0 | 12– 3 | 12– 7 | 12–10 | 13– 1 | 13– 4 | 13– 7 | 13–10 | 14– 1 | 14– 3 | 14– 6 | 14– 8 |
| | 19.2 | 9– 7 | 10– 0 | 10– 4 | 10– 8 | 11– 0 | 11– 3 | 11– 7 | 11–10 | 12– 1 | 12– 4 | 12– 7 | 12–10 | 13– 0 | 13– 3 | 13– 5 | 13– 8 | 13–10 |
| | 24.0 | 8–11 | 9– 3 | 9– 7 | 9–11 | 10– 2 | 10– 6 | 10– 9 | 11– 0 | 11– 3 | 11– 5 | 11– 8 | 11–11 | 12– 1 | 12– 3 | 12– 6 | 12– 8 | 12–10 |
| 2x10 | 12.0 | 14– 4 | 14–11 | 15– 5 | 15–11 | 16– 5 | 16–10 | 17– 3 | 17– 8 | 18– 0 | 18– 5 | 18– 9 | 19– 1 | 19– 5 | 19– 9 | 20– 1 | 20– 4 | 20– 8 |
| | 16.0 | 13– 0 | 13– 6 | 14– 0 | 14– 6 | 14–11 | 15– 3 | 15– 8 | 16– 0 | 16– 5 | 16– 9 | 17– 0 | 17– 4 | 17– 8 | 17–11 | 18– 3 | 18– 6 | 18– 9 |
| | 19.2 | 12– 3 | 12– 9 | 13– 2 | 13– 7 | 14– 0 | 14– 5 | 14– 9 | 15– 1 | 15– 5 | 15– 9 | 16– 0 | 16– 4 | 16– 7 | 16–11 | 17– 2 | 17– 5 | 17– 8 |
| | 24.0 | 11– 4 | 11–10 | 12– 3 | 12– 8 | 13– 0 | 13– 4 | 13– 8 | 14– 0 | 14– 4 | 14– 7 | 14–11 | 15– 2 | 15– 5 | 15– 8 | 15–11 | 16– 2 | 16– 5 |
| 2x12 | 12.0 | 17– 5 | 18– 1 | 18– 9 | 19– 4 | 19–11 | 20– 6 | 21– 0 | 21– 6 | 21–11 | 22– 5 | 22–10 | 23– 3 | 23– 7 | 24– 0 | 24– 5 | 24– 9 | 25– 1 |
| | 16.0 | 15–10 | 16– 5 | 17– 0 | 17– 7 | 18– 1 | 18– 7 | 19– 1 | 19– 6 | 19–11 | 20– 4 | 20– 9 | 21– 1 | 21– 6 | 21–10 | 22– 2 | 22– 6 | 22–10 |
| | 19.2 | 14–11 | 15– 6 | 16– 0 | 16– 7 | 17– 0 | 17– 6 | 17–11 | 18– 4 | 18– 9 | 19– 2 | 19– 6 | 19–10 | 20– 2 | 20– 6 | 20–10 | 21– 2 | 21– 6 |
| | 24.0 | 13–10 | 14– 4 | 14–11 | 15– 4 | 15–10 | 16– 3 | 16– 8 | 17– 0 | 17– 5 | 17– 9 | 18– 1 | 18– 5 | 18– 9 | 19– 1 | 19– 4 | 19– 8 | 19–11 |
| $F_b$ | 12.0 | 718 | 777 | 833 | 888 | 941 | 993 | 1043 | 1092 | 1140 | 1187 | 1233 | 1278 | 1323 | 1367 | 1410 | 1452 | 1494 |
| $F_b$ | 16.0 | 790 | 855 | 917 | 977 | 1036 | 1093 | 1148 | 1202 | 1255 | 1306 | 1357 | 1407 | 1456 | 1504 | 1551 | 1598 | 1644 |
| $F_b$ | 19.2 | 840 | 909 | 975 | 1039 | 1101 | 1161 | 1220 | 1277 | 1333 | 1388 | 1442 | 1495 | 1547 | 1598 | 1649 | 1698 | 1747 |
| $F_b$ | 24.0 | 905 | 979 | 1050 | 1119 | 1186 | 1251 | 1314 | 1376 | 1436 | 1496 | 1554 | 1611 | 1667 | 1722 | 1776 | 1829 | 1882 |

Note: The required bending design value, $F_b$, in pounds per square inch is shown at the bottom of each table and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE C-1
# CEILING JOISTS WITH L/240 DEFLECTION LIMITS

**DESIGN CRITERIA:**
Deflection – For 10 psf live load.
Limited to span in inches divided by 240.
Strength – Live Load of 10 psf plus
dead load of 5 psf determines the required fiber stress value.

| Joist Size (in) | Spacing (in) | Modulus of Elasticity, E, in 1,000,000 psi | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 |
| | 12.0 | 9-10 | 10-3 | 10-7 | 10-11 | 11-3 | 11-7 | 11-10 | 12-2 | 12-5 | 12-8 | 12-11 | 13-2 | 13-4 | 13-7 | 13-9 | 14-0 | 14-2 |
| | 16.0 | 8-11 | 9-4 | 9-8 | 9-11 | 10-3 | 10-6 | 10-9 | 11-0 | 11-3 | 11-6 | 11-9 | 11-11 | 12-2 | 12-4 | 12-6 | 12-9 | 12-11 |
| 2x 4 | 19.2 | 8-5 | 8-9 | 9-1 | 9-4 | 9-8 | 9-11 | 10-2 | 10-4 | 10-7 | 10-10 | 11-0 | 11-3 | 11-5 | 11-7 | 11-9 | 12-0 | 12-2 |
| | 24.0 | 7-10 | 8-1 | 8-5 | 8-8 | 8-11 | 9-2 | 9-5 | 9-8 | 9-10 | 10-0 | 10-3 | 10-5 | 10-7 | 10-9 | 10-11 | 11-1 | 11-3 |
| | 12.0 | 15-6 | 16-1 | 16-8 | 17-2 | 17-8 | 18-2 | 18-8 | 19-1 | 19-6 | 19-11 | 20-3 | 20-8 | 21-0 | 21-4 | 21-8 | 22-0 | 22-4 |
| | 16.0 | 14-1 | 14-7 | 15-2 | 15-7 | 16-1 | 16-6 | 16-11 | 17-4 | 17-8 | 18-1 | 18-5 | 18-9 | 19-1 | 19-5 | 19-8 | 20-0 | 20-3 |
| 2x 6 | 19.2 | 13-3 | 13-9 | 14-3 | 14-8 | 15-2 | 15-7 | 15-11 | 16-4 | 16-8 | 17-0 | 17-4 | 17-8 | 17-11 | 18-3 | 18-6 | 18-10 | 19-1 |
| | 24.0 | 12-3 | 12-9 | 13-3 | 13-8 | 14-1 | 14-5 | 14-9 | 15-2 | 15-6 | 15-9 | 16-1 | 16-4 | 16-8 | 16-11 | 17-2 | 17-5 | 17-8 |
| | 12.0 | 20-5 | 21-2 | 21-11 | 22-8 | 23-4 | 24-0 | 24-7 | 25-2 | 25-8 | | | | | | | | |
| | 16.0 | 18-6 | 19-3 | 19-11 | 20-7 | 21-2 | 21-9 | 22-4 | 22-10 | 23-4 | 23-10 | 24-3 | 24-8 | 25-2 | 25-7 | 25-11 | | |
| 2x 8 | 19.2 | 17-5 | 18-1 | 18-9 | 19-5 | 19-11 | 20-6 | 21-0 | 21-6 | 21-11 | 22-5 | 22-10 | 23-3 | 23-8 | 24-0 | 24-5 | 24-9 | 25-2 |
| | 24.0 | 16-2 | 16-10 | 17-5 | 18-0 | 18-6 | 19-0 | 19-6 | 19-11 | 20-5 | 20-10 | 21-2 | 21-7 | 21-11 | 22-4 | 22-8 | 23-0 | 23-4 |
| | 12.0 | 26-0 | | | | | | | | | | | | | | | | |
| | 16.0 | 23-8 | 24-7 | 25-5 | | | | | | | | | | | | | | |
| 2x10 | 19.2 | 22-3 | 23-1 | 23-11 | 24-9 | 25-5 | | | | | | | | | | | | |
| | 24.0 | 20-8 | 21-6 | 22-3 | 22-11 | 23-8 | 24-3 | 24-10 | 25-5 | 26-0 | | | | | | | | |
| $F_b$ | 12.0 | 711 | 769 | 825 | 880 | 932 | 983 | 1033 | 1082 | 1129 | 1176 | 1221 | 1266 | 1310 | 1354 | 1396 | 1438 | 1480 |
| $F_b$ | 16.0 | 783 | 847 | 909 | 968 | 1026 | 1082 | 1137 | 1191 | 1243 | 1294 | 1344 | 1394 | 1442 | 1490 | 1537 | 1583 | 1629 |
| $F_b$ | 19.2 | 832 | 900 | 965 | 1029 | 1090 | 1150 | 1208 | 1265 | 1321 | 1375 | 1429 | 1481 | 1533 | 1583 | 1633 | 1682 | 1731 |
| $F_b$ | 24.0 | 896 | 969 | 1040 | 1108 | 1174 | 1239 | 1302 | 1363 | 1423 | 1481 | 1539 | 1595 | 1651 | 1706 | 1759 | 1812 | 1864 |

Note: The required bending design value, $F_b$, in pounds per square inch is shown at the bottom of each table and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE C–2
# CEILING JOISTS WITH L/240 DEFLECTION LIMITS

**DESIGN CRITERIA:**
Deflection – For 20 psf live load.
Limited to span in inches divided by 240.
Strength – Live Load of 20 psf plus
dead load of 10 psf determines the required bending design value.

**JoisModulus of Elasticity, E, in 1,000,000 psi**

| Size (in) | Spacing (in) | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2x 4 | 12.0 | 7–10 | 8– 1 | 8– 5 | 8– 8 | 8–11 | 9– 2 | 9– 5 | 9– 8 | 9–10 | 10– 0 | 10– 3 | 10– 5 | 10– 7 | 10– 9 | 10–11 | 11– 1 | 11– 3 |
| | 16.0 | 7– 1 | 7– 5 | 7– 8 | 7–11 | 8– 1 | 8– 4 | 8– 7 | 8– 9 | 8–11 | 9– 1 | 9– 4 | 9– 6 | 9– 8 | 9– 9 | 9–11 | 10– 1 | 10– 3 |
| | 19.2 | 6– 8 | 6–11 | 7– 2 | 7– 5 | 7– 8 | 7–10 | 8– 1 | 8– 3 | 8– 5 | 8– 7 | 8– 9 | 8–11 | 9– 1 | 9– 3 | 9– 4 | 9– 6 | 9– 8 |
| | 24.0 | 6– 2 | 6– 5 | 6– 8 | 6–11 | 7– 1 | 7– 3 | 7– 6 | 7– 8 | 7–10 | 8– 0 | 8– 1 | 8– 3 | 8– 5 | 8– 7 | 8– 8 | 8–10 | 8–11 |
| 2x 6 | 12.0 | 12– 3 | 12– 9 | 13– 3 | 13– 8 | 14– 1 | 14– 5 | 14– 9 | 15– 2 | 15– 6 | 15– 9 | 16– 1 | 16– 4 | 16– 8 | 16–11 | 17– 2 | 17– 5 | 17– 8 |
| | 16.0 | 11– 2 | 11– 7 | 12– 0 | 12– 5 | 12– 9 | 13– 1 | 13– 5 | 13– 9 | 14– 1 | 14– 4 | 14– 7 | 14–11 | 15– 2 | 15– 5 | 15– 7 | 15–10 | 16– 1 |
| | 19.2 | 10– 6 | 10–11 | 11– 4 | 11– 8 | 12– 0 | 12– 4 | 12– 8 | 12–11 | 13– 3 | 13– 6 | 13– 9 | 14– 0 | 14– 3 | 14– 6 | 14– 8 | 14–11 | 15– 2 |
| | 24.0 | 9– 9 | 10– 2 | 10– 6 | 10–10 | 11– 2 | 11– 5 | 11– 9 | 12– 0 | 12– 3 | 12– 6 | 12– 9 | 13– 0 | 13– 3 | 13– 5 | 13– 8 | 13–10 | 14– 1 |
| 2x 8 | 12.0 | 16– 2 | 16–10 | 17– 5 | 18– 0 | 18– 6 | 19– 0 | 19– 6 | 19–11 | 20– 5 | 20–10 | 21– 2 | 21– 7 | 21–11 | 22– 4 | 22– 8 | 23– 0 | 23– 4 |
| | 16.0 | 14– 8 | 15– 3 | 15–10 | 16– 4 | 16–10 | 17– 3 | 17– 9 | 18– 1 | 18– 6 | 18–11 | 19– 3 | 19– 7 | 19–11 | 20– 3 | 20– 7 | 20–11 | 21– 2 |
| | 19.2 | 13–10 | 14– 5 | 14–11 | 15– 5 | 15–10 | 16– 3 | 16– 8 | 17– 1 | 17– 5 | 17– 9 | 18– 1 | 18– 5 | 18– 9 | 19– 1 | 19– 5 | 19– 8 | 19–11 |
| | 24.0 | 12–10 | 13– 4 | 13–10 | 14– 3 | 14– 8 | 15– 1 | 15– 6 | 15–10 | 16– 2 | 16– 6 | 16–10 | 17– 2 | 17– 5 | 17– 9 | 18– 0 | 18– 3 | 18– 6 |
| 2x10 | 12.0 | 20– 8 | 21– 6 | 22– 3 | 22–11 | 23– 8 | 24– 3 | 24–10 | 25– 5 | 26– 0 | | | | | | | | |
| | 16.0 | 18– 9 | 19– 6 | 20– 2 | 20–10 | 21– 6 | 22– 1 | 22– 7 | 23– 1 | 23– 8 | 24– 1 | 24– 7 | 25– 0 | 25– 5 | 25–10 | | | |
| | 19.2 | 17– 8 | 18– 4 | 19– 0 | 19– 7 | 20– 2 | 20– 9 | 21– 3 | 21– 9 | 22– 3 | 22– 8 | 23– 1 | 23– 7 | 23–11 | 24– 4 | 24– 9 | 25– 1 | 25– 5 |
| | 24.0 | 16– 5 | 17– 0 | 17– 8 | 18– 3 | 18– 9 | 19– 3 | 19– 9 | 20– 2 | 20– 8 | 21– 1 | 21– 6 | 21–10 | 22– 3 | 22– 7 | 22–11 | 23– 4 | 23– 8 |
| $F_b$ | 12.0 | 896 | 969 | 1040 | 1108 | 1174 | 1239 | 1302 | 1363 | 1423 | 1481 | 1539 | 1595 | 1651 | 1706 | 1759 | 1812 | 1864 |
| $F_b$ | 16.0 | 986 | 1067 | 1145 | 1220 | 1293 | 1364 | 1433 | 1500 | 1566 | 1631 | 1694 | 1756 | 1817 | 1877 | 1936 | 1995 | 2052 |
| $F_b$ | 19.2 | 1048 | 1134 | 1216 | 1296 | 1374 | 1449 | 1522 | 1594 | 1664 | 1733 | 1800 | 1866 | 1931 | 1995 | 2058 | 2120 | 2181 |
| $F_b$ | 24.0 | 1129 | 1221 | 1310 | 1396 | 1480 | 1561 | 1640 | 1717 | 1793 | 1866 | 1939 | 2010 | 2080 | 2149 | 2217 | 2283 | 2349 |

Note: The required bending design value, $F_b$, in pounds per square inch is shown at the bottom of each table and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less.Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–2
# RAFTERS WITH L/240 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 30 psf plus
Dead Load of 10 psf determines the required bending design value.
Deflection – For 30 psf live load.
Limited to span in inches divided by 240.

**Bending Design Value, $F_b$, (psi)**

| Size (in) | Spacing (in) | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12.0 | 6–2 | 7–1 | 7–11 | 8–8 | 9–5 | 10–0 | 10–8 | 11–3 | 11–9 | 12–4 | 12–10 | 13–3 | 13–9 | 14–2 | 14–8 | 15–1 | 15–6 | 15–11 | | | | |
| | 16.0 | 5–4 | 6–2 | 6–10 | 7–6 | 8–2 | 8–8 | 9–3 | 9–9 | 10–2 | 10–8 | 11–1 | 11–6 | 11–11 | 12–4 | 12–8 | 13–1 | 13–5 | 13–9 | 14–1 | 14–5 | | |
| 2x 6 | 19.2 | 4–10 | 5–7 | 6–3 | 6–10 | 7–5 | 7–11 | 8–5 | 8–11 | 9–4 | 9–9 | 10–1 | 10–6 | 10–10 | 11–3 | 11–7 | 11–11 | 12–3 | 12–7 | 12–10 | 13–2 | 13–6 | |
| | 24.0 | 4–4 | 5–0 | 5–7 | 6–2 | 6–8 | 7–1 | 7–6 | 7–11 | 8–4 | 8–8 | 9–1 | 9–5 | 9–9 | 10–0 | 10–4 | 10–8 | 10–11 | 11–3 | 11–6 | 11–9 | 12–0 | 12–4 |
| | 12.0 | 8–1 | 9–4 | 10–6 | 11–6 | 12–5 | 13–3 | 14–0 | 14–10 | 15–6 | 16–3 | 16–10 | 17–6 | 18–1 | 18–9 | 19–4 | 19–10 | 20–5 | 20–11 | | | | |
| | 16.0 | 7–0 | 8–1 | 9–1 | 9–11 | 10–9 | 11–6 | 12–2 | 12–10 | 13–5 | 14–0 | 14–7 | 15–2 | 15–8 | 16–3 | 16–9 | 17–2 | 17–8 | 18–1 | 18–7 | 19–0 | | |
| 2x 8 | 19.2 | 6–5 | 7–5 | 8–3 | 9–1 | 9–9 | 10–6 | 11–1 | 11–8 | 12–3 | 12–10 | 13–4 | 13–10 | 14–4 | 14–10 | 15–3 | 15–8 | 16–2 | 16–7 | 16–11 | 17–4 | 17–9 | |
| | 24.0 | 5–9 | 6–7 | 7–5 | 8–1 | 8–9 | 9–4 | 9–11 | 10–6 | 11–0 | 11–6 | 11–11 | 12–5 | 12–10 | 13–3 | 13–8 | 14–0 | 14–5 | 14–10 | 15–2 | 15–6 | 15–10 | 16–3 |
| | 12.0 | 10–4 | 11–11 | 13–4 | 14–8 | 15–10 | 16–11 | 17–11 | 18–11 | 19–10 | 20–8 | 21–6 | 22–4 | 23–1 | 23–11 | 24–7 | 25–4 | 26–0 | | | | | |
| | 16.0 | 8–11 | 10–4 | 11–7 | 12–8 | 13–8 | 14–8 | 15–6 | 16–4 | 17–2 | 17–11 | 18–8 | 19–4 | 20–0 | 20–8 | 21–4 | 21–11 | 22–6 | 23–1 | 23–8 | 24–3 | | |
| 2x10 | 19.2 | 8–2 | 9–5 | 10–7 | 11–7 | 12–6 | 13–4 | 14–2 | 14–11 | 15–8 | 16–4 | 17–0 | 17–8 | 18–3 | 18–11 | 19–6 | 20–0 | 20–7 | 21–1 | 21–8 | 22–2 | 22–8 | |
| | 24.0 | 7–4 | 8–5 | 9–5 | 10–4 | 11–2 | 11–11 | 12–8 | 13–4 | 14–0 | 14–8 | 15–3 | 15–10 | 16–4 | 16–11 | 17–5 | 17–11 | 18–5 | 18–11 | 19–4 | 19–10 | 20–3 | 20–8 |
| | 12.0 | 12–7 | 14–6 | 16–3 | 17–9 | 19–3 | 20–6 | 21–9 | 23–0 | 24–1 | 25–2 | | | | | | | | | | | | |
| | 16.0 | 10–11 | 12–7 | 14–1 | 15–5 | 16–8 | 17–9 | 18–10 | 19–11 | 20–10 | 21–9 | 22–8 | 23–6 | 24–4 | 25–2 | 25–11 | | | | | | | |
| 2x12 | 19.2 | 9–11 | 11–6 | 12–10 | 14–1 | 15–2 | 16–3 | 17–3 | 18–2 | 19–0 | 19–11 | 20–8 | 21–6 | 22–3 | 23–0 | 23–8 | 24–4 | 25–0 | 25–8 | | | | |
| | 24.0 | 8–11 | 10–3 | 11–6 | 12–7 | 13–7 | 14–6 | 15–5 | 16–3 | 17–0 | 17–9 | 18–6 | 19–3 | 19–11 | 20–6 | 21–2 | 21–9 | 22–5 | 23–0 | 23–6 | 24–1 | 24–8 | 25–2 |
| E | 12.0 | 0.15 | 0.23 | 0.32 | 0.43 | 0.54 | 0.66 | 0.78 | 0.92 | 1.06 | 1.21 | 1.36 | 1.52 | 1.69 | 1.86 | 2.04 | 2.22 | 2.41 | 2.60 | | | | |
| E | 16.0 | 0.13 | 0.20 | 0.28 | 0.37 | 0.47 | 0.57 | 0.68 | 0.80 | 0.92 | 1.05 | 1.18 | 1.32 | 1.46 | 1.61 | 1.76 | 1.92 | 2.08 | 2.25 | 2.42 | 2.60 | | |
| E | 19.2 | 0.12 | 0.18 | 0.26 | 0.34 | 0.43 | 0.52 | 0.62 | 0.73 | 0.84 | 0.95 | 1.08 | 1.20 | 1.33 | 1.47 | 1.61 | 1.75 | 1.90 | 2.05 | 2.21 | 2.37 | 2.53 | |
| E | 24.0 | 0.11 | 0.16 | 0.23 | 0.30 | 0.38 | 0.46 | 0.55 | 0.65 | 0.75 | 0.85 | 0.96 | 1.08 | 1.19 | 1.31 | 1.44 | 1.57 | 1.70 | 1.84 | 1.98 | 2.12 | 2.27 | 2.41 |

Note: The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–3
## RAFTERS WITH L/240 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 40 psf plus
Dead Load of 10 psf determines the required bending design value.
Deflection – For 40 psf live load.
Limited to span in inches divided by 240.

**Bending Design Value, $F_b$, (psi)**

| Size (in) | Spacing (in) | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2x 6 | 12.0 | 5– 6 | 6– 4 | 7– 1 | 7– 9 | 8– 5 | 9– 0 | 9– 6 | 10– 0 | 10– 6 | 11– 0 | 11– 5 | 11–11 | 12– 4 | 12– 8 | 13– 1 | 13– 6 | 13–10 | 14– 2 | | | | |
| | 16.0 | 4– 9 | 5– 6 | 6– 2 | 6– 9 | 7– 3 | 7– 9 | 8– 3 | 8– 8 | 9– 1 | 9– 6 | 9–11 | 10– 3 | 10– 8 | 11– 0 | 11– 4 | 11– 8 | 12– 0 | 12– 4 | 12– 7 | 12–11 | | |
| | 19.2 | 4– 4 | 5– 0 | 5– 7 | 6– 2 | 6– 8 | 7– 1 | 7– 6 | 7–11 | 8– 4 | 8– 8 | 9– 1 | 9– 5 | 9– 9 | 10– 0 | 10– 4 | 10– 8 | 10–11 | 11– 3 | 11– 6 | 11– 9 | 12– 0 | 12– 4 |
| | 24.0 | 3–11 | 4– 6 | 5– 0 | 5– 6 | 5–11 | 6– 4 | 6– 9 | 7– 1 | 7– 5 | 7– 9 | 8– 1 | 8– 5 | 8– 8 | 9– 0 | 9– 3 | 9– 6 | 9– 9 | 10– 0 | 10– 3 | 10– 6 | 10– 9 | 11– 0 |
| 2x 8 | 12.0 | 7– 3 | 8– 4 | 9– 4 | 10– 3 | 11– 1 | 11–10 | 12– 7 | 13– 3 | 13–11 | 14– 6 | 15– 1 | 15– 8 | 16– 3 | 16– 9 | 17– 3 | 17– 9 | 18– 3 | 18– 9 | | | | |
| | 16.0 | 6– 3 | 7– 3 | 8– 1 | 8–11 | 9– 7 | 10– 3 | 10–10 | 11– 6 | 12– 0 | 12– 7 | 13– 1 | 13– 7 | 14– 0 | 14– 6 | 14–11 | 15– 5 | 15–10 | 16– 3 | 16– 7 | 17– 0 | | |
| | 19.2 | 5– 9 | 6– 7 | 7– 5 | 8– 1 | 8– 9 | 9– 4 | 9–11 | 10– 6 | 11– 0 | 11– 6 | 11–11 | 12– 5 | 12–10 | 13– 3 | 13– 8 | 14– 0 | 14– 5 | 14–10 | 15– 2 | 15– 6 | 15–10 | 16– 3 |
| | 24.0 | 5– 2 | 5–11 | 6– 7 | 7– 3 | 7–10 | 8– 4 | 8–11 | 9– 4 | 9–10 | 10– 3 | 10– 8 | 11– 1 | 11– 6 | 11–10 | 12– 2 | 12– 7 | 12–11 | 13– 3 | 13– 7 | 13–11 | 14– 2 | 14– 6 |
| 2x10 | 12.0 | 9– 3 | 10– 8 | 11–11 | 13– 1 | 14– 2 | 15– 1 | 16– 0 | 16–11 | 17– 9 | 18– 6 | 19– 3 | 20– 0 | 20– 8 | 21– 4 | 22– 0 | 22– 8 | 23– 3 | 23–11 | | | | |
| | 16.0 | 8– 0 | 9– 3 | 10– 4 | 11– 4 | 12– 3 | 13– 1 | 13–10 | 14– 8 | 15– 4 | 16– 0 | 16– 8 | 17– 4 | 17–11 | 18– 6 | 19– 1 | 19– 7 | 20– 2 | 20– 8 | 21– 2 | 21– 8 | | |
| | 19.2 | 7– 4 | 8– 5 | 9– 5 | 10– 4 | 11– 2 | 11–11 | 12– 8 | 13– 4 | 14– 0 | 14– 8 | 15– 3 | 15–10 | 16– 4 | 16–11 | 17– 5 | 17–11 | 18– 5 | 18–11 | 19– 4 | 19–10 | 20– 3 | 20– 8 |
| | 24.0 | 6– 6 | 7– 7 | 8– 5 | 9– 3 | 10– 0 | 10– 8 | 11– 4 | 11–11 | 12– 6 | 13– 1 | 13– 7 | 14– 2 | 14– 8 | 15– 1 | 15– 7 | 16– 0 | 16– 6 | 16–11 | 17– 4 | 17– 9 | 18– 1 | 18– 6 |
| 2x12 | 12.0 | 11– 3 | 13– 0 | 14– 6 | 15–11 | 17– 2 | 18– 4 | 19– 6 | 20– 6 | 21– 7 | 22– 6 | 23– 5 | 24– 4 | 25– 2 | 26– 0 | | | | | | | | |
| | 16.0 | 9– 9 | 11– 3 | 12– 7 | 13– 9 | 14–11 | 15–11 | 16–10 | 17– 9 | 18– 8 | 19– 6 | 20– 3 | 21– 1 | 21– 9 | 22– 6 | 23– 2 | 23–10 | 24– 6 | 25– 2 | 25– 9 | | | |
| | 19.2 | 8–11 | 10– 3 | 11– 6 | 12– 7 | 13– 7 | 14– 6 | 15– 5 | 16– 3 | 17– 0 | 17– 9 | 18– 6 | 19– 3 | 19–11 | 20– 6 | 21– 2 | 21– 9 | 22– 5 | 23– 0 | 23– 6 | 24– 1 | 24– 8 | 25– 2 |
| | 24.0 | 7–11 | 9– 2 | 10– 3 | 11– 3 | 12– 2 | 13– 0 | 13– 9 | 14– 6 | 15– 3 | 15–11 | 16– 7 | 17– 2 | 17– 9 | 18– 4 | 18–11 | 19– 6 | 20– 0 | 20– 6 | 21– 1 | 21– 7 | 22– 0 | 22– 6 |
| E | 12.0 | 0.14 | 0.22 | 0.31 | 0.41 | 0.51 | 0.63 | 0.75 | 0.88 | 1.01 | 1.15 | 1.30 | 1.45 | 1.61 | 1.77 | 1.94 | 2.12 | 2.30 | 2.48 | | | | |
| E | 16.0 | 0.12 | 0.19 | 0.27 | 0.35 | 0.44 | 0.54 | 0.65 | 0.76 | 0.88 | 1.00 | 1.12 | 1.26 | 1.39 | 1.54 | 1.68 | 1.83 | 1.99 | 2.15 | 2.31 | 2.48 | | |
| E | 19.2 | 0.11 | 0.18 | 0.24 | 0.32 | 0.41 | 0.50 | 0.59 | 0.69 | 0.80 | 0.91 | 1.03 | 1.15 | 1.27 | 1.40 | 1.54 | 1.67 | 1.81 | 1.96 | 2.11 | 2.26 | 2.42 | 2.58 |
| E | 24.0 | 0.10 | 0.16 | 0.22 | 0.29 | 0.36 | 0.44 | 0.53 | 0.62 | 0.71 | 0.81 | 0.92 | 1.03 | 1.14 | 1.25 | 1.37 | 1.50 | 1.62 | 1.75 | 1.89 | 2.02 | 2.16 | 2.30 |

Note: The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R-10
# RAFTERS WITH L/240 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 30 psf plus
Dead Load of 20 psf determines the required bending design value.
Deflection – For 30 psf live load.
Limited to span in inches divided by 240.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600 | 2700 |
| | 12.0 | 5-6 | 6-4 | 7-1 | 7-9 | 8-5 | 9-0 | 9-6 | 10-0 | 9-7 | 10-0 | 10-5 | 10-10 | 11-3 | 11-7 | 11-11 | 12-4 | 12-8 | 13-0 | 13-3 | 13-7 | 13-11 | 14-2 | | | |
| | 16.0 | 4-9 | 5-6 | 6-2 | 6-9 | 7-3 | 7-9 | 8-3 | 8-8 | 8-4 | 8-8 | 9-1 | 9-5 | 9-9 | 10-0 | 10-4 | 10-8 | 10-11 | 11-3 | 11-6 | 11-9 | 12-0 | 12-4 | 12-7 | 12-10 | 13-1 |
| 2x6 | 19.2 | 4-4 | 5-0 | 5-7 | 6-2 | 6-8 | 7-1 | 7-6 | 7-11 | 7-7 | 7-11 | 8-3 | 8-7 | 8-11 | 9-2 | 9-5 | 9-9 | 10-0 | 10-3 | 10-6 | 10-9 | 11-0 | 11-3 | 11-5 | 11-8 | 11-11 |
| | 24.0 | 3-11 | 4-6 | 5-0 | 5-6 | 5-11 | 6-4 | 6-9 | 7-1 | 6-10 | 7-1 | 7-5 | 7-8 | 7-11 | 8-2 | 8-5 | 8-8 | 8-11 | 9-2 | 9-5 | 9-7 | 9-10 | 10-0 | 10-3 | 10-5 | 10-8 |
| | 12.0 | 7-3 | 8-4 | 9-4 | 10-3 | 11-1 | 11-10 | 12-7 | 13-3 | 12-8 | 13-3 | 13-9 | 14-4 | 14-10 | 15-3 | 15-9 | 16-3 | 16-8 | 17-1 | 17-6 | 17-11 | 18-4 | 18-9 | | | |
| | 16.0 | 6-3 | 7-3 | 8-1 | 8-11 | 9-7 | 10-3 | 10-10 | 11-6 | 11-0 | 11-6 | 11-11 | 12-5 | 12-10 | 13-3 | 13-8 | 14-0 | 14-5 | 14-10 | 15-2 | 15-6 | 15-10 | 16-3 | 16-7 | 16-10 | 17-2 |
| 2x8 | 19.2 | 5-9 | 6-7 | 7-5 | 8-1 | 8-9 | 9-4 | 9-11 | 10-6 | 10-0 | 10-6 | 10-11 | 11-4 | 11-8 | 12-1 | 12-5 | 12-10 | 13-2 | 13-6 | 13-10 | 14-2 | 14-6 | 14-10 | 15-1 | 15-5 | 15-8 |
| | 24.0 | 5-2 | 5-11 | 6-7 | 7-3 | 7-10 | 8-4 | 8-11 | 9-4 | 9-0 | 9-4 | 9-9 | 10-1 | 10-6 | 10-10 | 11-2 | 11-6 | 11-9 | 12-1 | 12-5 | 12-8 | 12-11 | 13-3 | 13-6 | 13-9 | 14-0 |
| | 12.0 | 9-3 | 10-8 | 11-11 | 13-1 | 14-2 | 15-1 | 16-0 | 16-11 | 16-2 | 16-11 | 17-7 | 18-3 | 18-11 | 19-6 | 20-1 | 20-8 | 21-3 | 21-10 | 22-4 | 22-10 | 23-5 | 23-11 | | | |
| | 16.0 | 8-0 | 9-3 | 10-4 | 11-4 | 12-3 | 13-1 | 13-10 | 14-8 | 14-0 | 14-8 | 15-3 | 15-10 | 16-4 | 16-11 | 17-5 | 17-11 | 18-5 | 18-11 | 19-4 | 19-10 | 20-3 | 20-8 | 21-1 | 21-6 | 21-11 |
| 2x10 | 19.2 | 7-4 | 8-5 | 9-5 | 10-4 | 11-2 | 11-11 | 12-8 | 13-4 | 12-9 | 13-4 | 13-11 | 14-5 | 14-11 | 15-5 | 15-11 | 16-4 | 16-10 | 17-3 | 17-8 | 18-1 | 18-6 | 18-11 | 19-3 | 19-8 | 20-0 |
| | 24.0 | 6-6 | 7-7 | 8-5 | 9-3 | 10-0 | 10-8 | 11-4 | 11-11 | 11-5 | 11-11 | 12-5 | 12-11 | 13-4 | 13-9 | 14-3 | 14-8 | 15-0 | 15-5 | 15-10 | 16-2 | 16-6 | 16-1 | 17-3 | 17-7 | 17-11 |
| | 12.0 | 11-3 | 13-0 | 14-6 | 15-11 | 17-2 | 18-4 | 19-6 | 20-6 | 19-8 | 20-6 | 21-5 | 22-2 | 23-0 | 23-9 | 24-5 | 25-2 | 25-10 | | | | | | | | |
| | 16.0 | 9-9 | 11-3 | 12-7 | 13-9 | 14-11 | 15-11 | 16-10 | 17-9 | 17-0 | 17-9 | 18-6 | 19-3 | 19-11 | 20-6 | 21-2 | 21-9 | 22-5 | 23-0 | 23-6 | 24-1 | 24-8 | 25-2 | 25-8 | | |
| 2x12 | 19.2 | 8-11 | 10-3 | 11-6 | 12-7 | 13-7 | 14-6 | 15-5 | 16-3 | 15-7 | 16-3 | 16-11 | 17-6 | 18-2 | 18-9 | 19-4 | 19-11 | 20-5 | 21-0 | 21-6 | 22-0 | 22-6 | 23-0 | 23-5 | 23-11 | 24-4 |
| | 24.0 | 7-11 | 9-2 | 10-3 | 11-3 | 12-2 | 13-0 | 13-9 | 14-6 | 13-11 | 14-6 | 15-1 | 15-8 | 16-3 | 16-9 | 17-3 | 17-9 | 18-3 | 18-9 | 19-3 | 19-8 | 20-1 | 20-6 | 21-0 | 21-5 | 21-9 |
| E | 12.0 | 0.11 | 0.17 | 0.23 | 0.31 | 0.38 | 0.47 | 0.56 | 0.66 | 0.77 | 0.88 | 0.99 | 1.10 | 1.22 | 1.35 | 1.48 | 1.61 | 1.75 | 1.89 | 2.03 | 2.18 | 2.33 | 2.48 | | | |
| E | 16.0 | 0.09 | 0.14 | 0.20 | 0.26 | 0.33 | 0.41 | 0.49 | 0.57 | 0.67 | 0.76 | 0.86 | 0.96 | 1.06 | 1.17 | 1.28 | 1.39 | 1.51 | 1.63 | 1.76 | 1.88 | 2.01 | 2.15 | 2.28 | 2.42 | 2.56 |
| E | 19.2 | 0.09 | 0.13 | 0.18 | 0.24 | 0.30 | 0.37 | 0.44 | 0.52 | 0.61 | 0.69 | 0.78 | 0.87 | 0.97 | 1.07 | 1.17 | 1.27 | 1.38 | 1.49 | 1.60 | 1.72 | 1.84 | 1.96 | 2.08 | 2.21 | 2.34 |
| E | 24.0 | 0.08 | 0.12 | 0.16 | 0.22 | 0.27 | 0.33 | 0.40 | 0.46 | 0.54 | 0.62 | 0.70 | 0.78 | 0.87 | 0.95 | 1.04 | 1.14 | 1.23 | 1.33 | 1.43 | 1.54 | 1.64 | 1.75 | 1.86 | 1.98 | 2.09 |

**Note:** The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R-11
## RAFTERS WITH L/240 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 40 psf plus
Dead Load of 20 psf determines the required bending design value.
Deflection – For 40 psf live load.
Limited to span in inches divided by 240.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600 | 2700 |
| | 12.0 | 5-0 | 5-10 | 6-6 | 7-1 | 7-8 | 8-2 | 8-8 | 9-2 | 10-6 | 11-0 | 11-5 | 11-11 | 12-4 | 12-8 | 13-1 | 13-6 | 13-10 | 14-2 | 14-7 | 14-11 | 15-3 | 15-7 | 15-11 | | |
| | 16.0 | 4-4 | 5-0 | 5-7 | 6-2 | 6-8 | 7-1 | 7-6 | 7-11 | 9-1 | 9-6 | 9-11 | 10-3 | 10-8 | 11-0 | 11-4 | 11-8 | 12-0 | 12-4 | 12-7 | 12-11 | 13-2 | 13-6 | 13-9 | 14-0 | 14-3 |
| 2x6 | 19.2 | 4-0 | 4-7 | 5-1 | 5-7 | 6-1 | 6-6 | 6-10 | 7-3 | 8-4 | 8-8 | 9-1 | 9-5 | 9-9 | 10-0 | 10-4 | 10-8 | 10-11 | 11-3 | 11-6 | 11-9 | 12-0 | 12-4 | 12-7 | 12-10 | 13-1 |
| | 24.0 | 3-7 | 4-1 | 4-7 | 5-0 | 5-5 | 5-10 | 6-2 | 6-6 | 7-5 | 7-9 | 8-1 | 8-5 | 8-8 | 9-0 | 9-3 | 9-6 | 9-9 | 10-0 | 10-3 | 10-6 | 10-9 | 11-0 | 11-3 | 11-5 | 11-8 |
| | 12.0 | 6-7 | 7-8 | 8-7 | 9-4 | 10-1 | 10-10 | 11-6 | 12-1 | 13-11 | 14-6 | 15-1 | 15-8 | 16-3 | 16-9 | 17-3 | 17-9 | 18-3 | 18-9 | 19-2 | 19-8 | 20-1 | 20-6 | 20-11 | | |
| | 16.0 | 5-9 | 6-7 | 7-5 | 8-1 | 8-9 | 9-4 | 9-11 | 10-6 | 12-0 | 12-7 | 13-1 | 13-7 | 14-0 | 14-6 | 14-11 | 15-5 | 15-10 | 16-3 | 16-7 | 17-0 | 17-5 | 17-9 | 18-1 | 18-6 | 18-10 |
| 2x8 | 19.2 | 5-3 | 6-0 | 6-9 | 7-5 | 8-0 | 8-7 | 9-1 | 9-7 | 11-0 | 11-6 | 11-11 | 12-5 | 12-10 | 13-3 | 13-8 | 14-0 | 14-5 | 14-10 | 15-2 | 15-6 | 15-10 | 16-3 | 16-7 | 16-10 | 17-2 |
| | 24.0 | 4-8 | 5-5 | 6-0 | 6-7 | 7-2 | 7-9 | 8-1 | 8-7 | 9-10 | 10-3 | 10-8 | 11-1 | 11-6 | 11-10 | 12-2 | 12-7 | 12-11 | 13-3 | 13-7 | 13-11 | 14-2 | 14-6 | 14-10 | 15-1 | 15-5 |
| | 12.0 | 8-5 | 9-9 | 10-11 | 11-11 | 12-11 | 13-9 | 14-8 | 15-5 | 17-9 | 18-6 | 19-3 | 20-0 | 20-8 | 21-4 | 22-0 | 22-8 | 23-3 | 23-11 | 24-6 | 25-1 | 25-7 | | | | |
| | 16.0 | 7-4 | 8-5 | 9-5 | 10-4 | 11-2 | 11-11 | 12-8 | 13-4 | 15-4 | 16-0 | 16-8 | 17-4 | 17-11 | 18-6 | 19-1 | 19-7 | 20-2 | 20-8 | 21-2 | 21-8 | 22-2 | 22-8 | 23-1 | 23-7 | 24-0 |
| 2x10 | 19.2 | 6-8 | 7-8 | 8-7 | 9-5 | 10-2 | 10-11 | 11-7 | 12-2 | 14-0 | 14-8 | 15-3 | 15-10 | 16-4 | 16-11 | 17-5 | 17-11 | 18-5 | 18-11 | 19-4 | 19-10 | 20-3 | 20-8 | 21-1 | 21-6 | 21-11 |
| | 24.0 | 6-0 | 6-11 | 7-8 | 8-5 | 9-1 | 9-9 | 10-4 | 10-11 | 12-6 | 13-1 | 13-7 | 14-2 | 14-8 | 15-1 | 15-7 | 16-0 | 16-6 | 16-11 | 17-4 | 17-9 | 18-1 | 18-6 | 18-11 | 19-3 | 19-7 |
| | 12.0 | 10-3 | 11-10 | 13-3 | 14-6 | 15-8 | 16-9 | 17-9 | 18-9 | 21-7 | 22-6 | 23-5 | 24-4 | 25-2 | 26-0 | | | | | | | | | | | |
| | 16.0 | 8-11 | 10-3 | 11-6 | 12-7 | 13-7 | 14-6 | 15-5 | 16-3 | 18-8 | 19-6 | 20-3 | 21-1 | 21-9 | 22-6 | 23-2 | 23-10 | 24-6 | 25-2 | 25-9 | | | | | | |
| 2x12 | 19.2 | 8-1 | 9-4 | 10-6 | 11-6 | 12-5 | 13-3 | 14-1 | 14-10 | 17-0 | 17-9 | 18-6 | 19-3 | 19-11 | 20-6 | 21-2 | 21-9 | 22-5 | 23-0 | 23-6 | 24-1 | 25-2 | 25-8 | | | |
| | 24.0 | 7-3 | 8-5 | 9-4 | 10-3 | 11-1 | 11-10 | 12-7 | 13-3 | 15-3 | 15-11 | 16-7 | 17-2 | 17-9 | 18-4 | 18-11 | 19-6 | 20-0 | 20-6 | 21-1 | 21-7 | 22-0 | 22-6 | 23-0 | 23-5 | 23-10 |
| E | 12.0 | 0.11 | 0.17 | 0.24 | 0.31 | 0.39 | 0.48 | 0.57 | 0.67 | 0.76 | 0.86 | 0.97 | 1.09 | 1.21 | 1.33 | 1.46 | 1.59 | 1.72 | 1.86 | 2.00 | 2.14 | 2.29 | 2.44 | 2.60 | | |
| E | 16.0 | 0.09 | 0.15 | 0.20 | 0.27 | 0.34 | 0.41 | 0.49 | 0.58 | 0.66 | 0.75 | 0.84 | 0.94 | 1.05 | 1.15 | 1.26 | 1.37 | 1.49 | 1.61 | 1.73 | 1.86 | 1.99 | 2.12 | 2.25 | 2.39 | 2.53 |
| E | 19.2 | 0.09 | 0.13 | 0.19 | 0.24 | 0.31 | 0.38 | 0.45 | 0.53 | 0.60 | 0.68 | 0.77 | 0.86 | 0.95 | 1.05 | 1.15 | 1.25 | 1.36 | 1.47 | 1.58 | 1.70 | 1.81 | 1.93 | 2.05 | 2.18 | 2.31 |
| E | 24.0 | 0.08 | 0.12 | 0.17 | 0.22 | 0.28 | 0.34 | 0.40 | 0.47 | 0.54 | 0.61 | 0.69 | 0.77 | 0.85 | 0.94 | 2.03 | 1.12 | 1.22 | 1.31 | 1.41 | 1.52 | 1.62 | 1.73 | 1.84 | 1.95 | 2.06 |

**Note:** The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–14
## RAFTERS WITH L/180 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 30 psf plus
Dead Load of 10 psf determines the required bending design value.
Deflection – For 30 psf live load.
Limited to span in inches divided by 180.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600 | 2700 | 2800 | 2900 | 3000 |
| | 12.0 | 3-2 | 3-11 | 4-6 | 5-1 | 5-6 | 6-0 | 6-5 | 6-9 | 7-2 | 7-6 | 7-10 | 8-2 | 8-5 | 8-9 | 9-0 | 9-4 | 9-7 | 9-10 | 10-1 | 10-4 | 15-3 | 10-10 | 11-1 | | | | | | |
| | 16.0 | 2-9 | 3-5 | 3-11 | 4-4 | 4-10 | 5-2 | 5-6 | 5-10 | 6-2 | 6-6 | 6-9 | 7-1 | 7-4 | 7-7 | 7-10 | 8-1 | 8-40 | 8-6 | 8-9 | 9-0 | 13-2 | 9-5 | 9-7 | 9-9 | 10-0 | | | | |
| 2x4 | 19.2 | 2-6 | 3-1 | 3-7 | 4-0 | 4-4 | 4-9 | 5-1 | 5-4 | 5-8 | 5-11 | 6-2 | 6-5 | 6-8 | 6-11 | 7-2 | 7-4 | 7-7 | 7-9 | 8-0 | 8-2 | 12-0 | 8-7 | 8-9 | 8-11 | 9-1 | 9-3 | 9-5 | | |
| | 24.0 | 2-3 | 2-9 | 3-2 | 3-7 | 3-11 | 4-3 | 4-6 | 4-10 | 5-1 | 5-4 | 5-6 | 5-9 | 6-0 | 6-2 | 6-5 | 6-7 | 6-9 | 7-0 | 7-2 | 7-4 | 10-9 | 7-8 | 7-10 | 8-0 | 8-2 | 8-4 | 8-5 | 8-7 | 8-9 |
| | 12.0 | 5-0 | 6-2 | 7-1 | 7-11 | 8-8 | 9-5 | 10-0 | 10-8 | 11-3 | 11-9 | 12-4 | 12-10 | 13-3 | 13-9 | 14-2 | 14-8 | 15-1 | 15-6 | 15-11 | 16-3 | 15-3 | 17-0 | 17-5 | | | | | | |
| | 16.0 | 4-4 | 5-4 | 6-2 | 6-10 | 7-6 | 8-2 | 8-8 | 9-3 | 9-9 | 10-2 | 10-8 | 11-1 | 11-6 | 11-11 | 12-4 | 12-8 | 13-1 | 13-5 | 13-9 | 14-1 | 13-2 | 14-9 | 15-1 | 15-4 | 15-8 | | | | |
| 2x6 | 19.2 | 4-0 | 4-10 | 5-7 | 6-3 | 6-10 | 7-5 | 7-11 | 8-5 | 8-11 | 9-4 | 9-9 | 10-1 | 10-6 | 10-10 | 11-3 | 11-7 | 11-11 | 12-3 | 12-7 | 12-10 | 12-0 | 13-6 | 13-9 | 14-0 | 14-4 | 14-7 | 14-10 | | |
| | 24.0 | 3-7 | 4-4 | 5-0 | 5-7 | 6-2 | 6-8 | 7-1 | 7-6 | 7-11 | 8-4 | 8-8 | 9-1 | 9-5 | 9-9 | 10-0 | 10-4 | 10-8 | 10-11 | 11-3 | 11-6 | 10-9 | 12-0 | 12-4 | 12-7 | 12-10 | 13-1 | 13-3 | 13-6 | 13-9 |
| | 12.0 | 6-7 | 8-1 | 9-4 | 10-6 | 11-6 | 12-5 | 13-3 | 14-0 | 14-10 | 15-6 | 16-3 | 16-10 | 17-6 | 18-1 | 18-9 | 19-4 | 19-10 | 20-5 | 20-11 | 21-5 | 20-1 | 22-5 | 22-11 | | | | | | |
| | 16.0 | 5-9 | 7-0 | 8-1 | 9-1 | 9-11 | 10-9 | 11-6 | 12-2 | 12-10 | 13-5 | 14-0 | 14-7 | 15-2 | 15-8 | 16-3 | 16-9 | 17-2 | 17-8 | 18-1 | 18-7 | 17-5 | 19-5 | 19-10 | 20-3 | 20-8 | | | | |
| 2x8 | 19.2 | 5-3 | 6-5 | 7-5 | 8-3 | 9-1 | 9-9 | 10-6 | 11-1 | 11-8 | 12-3 | 12-10 | 13-4 | 13-10 | 14-4 | 14-10 | 15-3 | 15-8 | 16-2 | 16-7 | 11-11 | 15-10 | 17-9 | 18-1 | 18-6 | 18-10 | 19-3 | 19-7 | | |
| | 24.0 | 4-8 | 5-9 | 6-7 | 7-5 | 8-1 | 8-9 | 9-4 | 9-11 | 10-6 | 11-0 | 11-6 | 11-11 | 12-5 | 12-10 | 13-3 | 13-8 | 14-0 | 14-5 | 14-10 | 15-2 | 14-2 | 15-10 | 16-3 | 16-7 | 16-10 | 17-2 | 17-6 | 17-10 | 18-1 |
| | 12.0 | 8-5 | 10-4 | 11-11 | 13-4 | 14-8 | 15-10 | 16-11 | 17-11 | 18-11 | 19-10 | 20-8 | 21-6 | 22-4 | 23-1 | 23-11 | 24-7 | 25-4 | 26-0 | | | 25-7 | | | | | | | | |
| | 16.0 | 7-4 | 8-11 | 10-4 | 11-7 | 12-8 | 13-8 | 14-8 | 15-6 | 16-4 | 17-2 | 17-11 | 18-8 | 19-4 | 20-0 | 20-8 | 21-4 | 21-11 | 22-6 | 23-1 | 23-8 | 22-2 | 24-10 | 25-4 | 25-10 | | | | | |
| 2x10 | 19.2 | 6-8 | 8-2 | 9-5 | 10-7 | 11-7 | 12-6 | 13-4 | 14-2 | 14-11 | 15-8 | 16-4 | 17-0 | 17-8 | 18-3 | 18-11 | 19-6 | 20-0 | 20-7 | 21-1 | 21-8 | 20-3 | 22-8 | 23-1 | 23-7 | 24-1 | 24-6 | 25-0 | | |
| | 24.0 | 6-0 | 7-4 | 8-5 | 9-5 | 10-4 | 11-2 | 11-11 | 12-8 | 13-4 | 14-0 | 14-8 | 15-3 | 15-10 | 16-4 | 16-11 | 17-5 | 17-11 | 18-5 | 18-11 | 19-4 | 18-1 | 20-3 | 20-8 | 21-1 | 21-6 | 21-11 | 22-4 | 22-9 | 23-1 |
| E | 12.0 | 0.06 | 0.11 | 0.17 | 0.24 | 0.32 | 0.40 | 0.49 | 0.59 | 0.69 | 0.79 | 0.91 | 1.02 | 1.14 | 1.27 | 1.39 | 1.53 | 1.66 | 1.80 | 1.95 | 2.10 | 2.29 | 2.40 | 2.56 | | | | | | |
| E | 16.0 | 0.05 | 0.10 | 0.15 | 0.21 | 0.28 | 0.35 | 0.43 | 0.51 | 0.60 | 0.69 | 0.78 | 0.88 | 0.99 | 1.10 | 1.21 | 1.32 | 1.44 | 1.56 | 1.69 | 1.82 | 1.99 | 2.08 | 2.22 | 2.36 | 2.50 | | | | |
| E | 19.2 | 0.05 | 0.09 | 0.14 | 0.19 | 0.25 | 0.32 | 0.39 | 0.47 | 0.54 | 0.63 | 0.72 | 0.81 | 0.90 | 1.00 | 1.10 | 1.21 | 1.32 | 1.43 | 1.54 | 1.66 | 1.78 | 1.90 | 2.03 | 2.15 | 2.28 | 2.42 | 2.55 | | |
| E | 24.0 | 0.04 | 0.08 | 0.12 | 0.17 | 0.23 | 0.29 | 0.35 | 0.42 | 0.49 | 0.56 | 0.64 | 0.72 | 0.81 | 0.89 | 0.99 | 1.08 | 1.18 | 1.28 | 1.38 | 1.48 | 1.59 | 1.70 | 1.81 | 1.93 | 2.04 | 2.16 | 2.28 | 2.41 | 2.53 |

**Note:** The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–15
# RAFTERS WITH L/180 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 40 psf plus
Dead Load of 10 psf determines the required bending design value.
Deflection – For 40 psf live load.
Limited to span in inches divided by 180.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600 | 2700 | 2800 | 2900 | 3000 |
| | 12.0 | 2–10 | 3-6 | 4-0 | 4-6 | 4-11 | 5-4 | 5-9 | 6-1 | 6-5 | 6-8 | 7–0 | 7-3 | 7-7 | 7-10 | 8-1 | 8-4 | 8-7 | 8-10 | 9-1 | 9-3 | 9-6 | 9-8 | 9-11 | 10-1 | | | | | |
| | 16.0 | 2-6 | 3-0 | 3-6 | 3-11 | 4-3 | 4-8 | 4-11 | 5-3 | 5-6 | 5-10 | 6-1 | 6-4 | 6-7 | 6-9 | 7-0 | 7-3 | 7-5 | 7-8 | 7-10 | 8-0 | 8-2 | 8-5 | 8-7 | 8-9 | 8-11 | 9-1 | | | |
| 2x4 | 19.2 | 2-3 | 2-9 | 3-2 | 3-7 | 3-11 | 4-3 | 4-6 | 4-10 | 5-1 | 5-4 | 5-6 | 5-9 | 6-0 | 6-2 | 6-5 | 6-7 | 6-9 | 7-0 | 7-2 | 7-4 | 7-6 | 7-8 | 7-10 | 8-0 | 8-2 | 8-4 | 8-5 | 8-7 | |
| | 24.0 | 2-0 | 2-6 | 2-10 | 3-2 | 3-6 | 3-9 | 4-0 | 4-3 | 4-6 | 4-9 | 4-11 | 5-2 | 5-4 | 5-6 | 5-9 | 5-11 | 6-1 | 6-3 | 6-5 | 6-7 | 6-8 | 6-10 | 7-0 | 7-2 | 7-3 | 7-5 | 7-7 | 7-8 | 7-10 |
| | 12.0 | 4-6 | 5-6 | 6-4 | 7-1 | 7-9 | 8-5 | 9-0 | 9-6 | 10-0 | 10-6 | 11-0 | 11-5 | 11-11 | 12-4 | 12-8 | 13-1 | 13-6 | 13-10 | 14-2 | 14-7 | 14-11 | 15-3 | 15-7 | 15-11 | | | | | |
| | 16.0 | 3-11 | 4-9 | 5-6 | 6-2 | 6-9 | 7-3 | 7-9 | 8-3 | 8-8 | 9-1 | 9-6 | 9-11 | 10-3 | 10-8 | 11-0 | 11-4 | 11-8 | 12-0 | 12-4 | 12-7 | 12-11 | 13-2 | 13-6 | 13-9 | 14-0 | 14-3 | | | |
| 2x6 | 19.2 | 3-7 | 4-4 | 5-0 | 5-7 | 6-2 | 6-8 | 7-1 | 7-6 | 7-11 | 8-4 | 8-8 | 9-1 | 9-5 | 9-9 | 10-0 | 10-4 | 10-8 | 10-11 | 11-3 | 11-6 | 11-9 | 12-0 | 12-4 | 12-7 | 12-10 | 13-1 | 13-3 | 13-6 | |
| | 24.0 | 3-2 | 3-11 | 4-6 | 5-0 | 5-6 | 5-11 | 6-4 | 6-9 | 7-1 | 7-5 | 7-9 | 8-1 | 8-5 | 8-8 | 9-0 | 9-3 | 9-6 | 9-9 | 10-0 | 10-3 | 10-6 | 10-9 | 11-0 | 11-3 | 11-5 | 11-8 | 11-11 | 12-1 | 12-4 |
| | 12.0 | 5-11 | 7-3 | 8-4 | 9-4 | 10-3 | 11-1 | 11-10 | 12-7 | 13-3 | 13-11 | 14-6 | 15-1 | 15-8 | 16-3 | 16-9 | 17-3 | 17-9 | 18-3 | 18-9 | 19-2 | 19-8 | 20-1 | 20-6 | 20-11 | | | | | |
| | 16.0 | 5-2 | 6-3 | 7-3 | 8-1 | 8-11 | 9-7 | 10-3 | 10-10 | 11-6 | 12-0 | 12-7 | 13-1 | 13-7 | 14-0 | 14-6 | 14-11 | 15-5 | 15-10 | 16-3 | 16-7 | 17-0 | 17-5 | 17-9 | 18-1 | 18-6 | 18-10 | | | |
| 2x8 | 19.2 | 4-8 | 5-9 | 6-7 | 7-5 | 8-1 | 8-9 | 9-4 | 9-11 | 10-6 | 11-0 | 11-6 | 11-11 | 12-5 | 12-10 | 13-3 | 13-8 | 14-0 | 14-5 | 14-10 | 15-2 | 15-6 | 15-10 | 16-3 | 16-7 | 16-10 | 17-2 | 17-6 | 17-10 | |
| | 24.0 | 4-2 | 5-2 | 5-11 | 6-7 | 7-3 | 7-10 | 8-4 | 8-11 | 9-4 | 9-10 | 10-3 | 10-8 | 11-1 | 11-6 | 11-10 | 12-2 | 12-7 | 12-11 | 13-3 | 13-7 | 13-11 | 14-2 | 14-6 | 14-10 | 15-1 | 15-5 | 15-8 | 15-11 | 16-3 |
| | 12.0 | 7-7 | 9-3 | 10-8 | 11-11 | 13-1 | 14-2 | 15-1 | 16-0 | 16-11 | 17-9 | 18-6 | 19-3 | 20-0 | 20-8 | 21-4 | 22-0 | 22-8 | 23-3 | 23-11 | 24-6 | 25-1 | 25-7 | | | | | | | |
| | 16.0 | 6-6 | 8-0 | 9-3 | 10-4 | 11-4 | 12-3 | 13-1 | 13-10 | 14-8 | 15-4 | 16-0 | 16-8 | 17-4 | 17-11 | 18-6 | 19-1 | 19-7 | 20-2 | 20-8 | 21-2 | 21-8 | 22-2 | 22-8 | 23-1 | 23-7 | 24-0 | | | |
| 2x10 | 19.2 | 6-0 | 7-4 | 8-5 | 9-5 | 10-4 | 11-2 | 11-11 | 12-8 | 13-4 | 14-0 | 14-8 | 15-3 | 15-10 | 16-4 | 16-11 | 17-5 | 17-11 | 18-5 | 18-11 | 19-4 | 19-10 | 20-3 | 20-8 | 21-1 | 21-6 | 21-11 | 22-4 | 22-9 | |
| | 24.0 | 5-4 | 6-6 | 7-7 | 8-5 | 9-3 | 10-0 | 10-8 | 11-4 | 11-11 | 12-6 | 13-1 | 13-7 | 14-2 | 14-8 | 15-1 | 15-7 | 16-0 | 16-6 | 16-11 | 17-4 | 17-9 | 18-1 | 18-6 | 18-11 | 19-3 | 19-7 | 20-0 | 20-4 | 20-8 |
| E | 12.0 | 0.06 | 0.11 | 0.17 | 0.23 | 0.31 | 0.38 | 0.47 | 0.56 | 0.66 | 0.76 | 0.86 | 0.97 | 1.09 | 1.21 | 1.33 | 1.46 | 1.59 | 1.72 | 1.86 | 2.00 | 2.14 | 2.29 | 2.44 | 2.60 | | | | | |
| E | 16.0 | 0.05 | 0.09 | 0.14 | 0.20 | 0.26 | 0.33 | 0.41 | 0.49 | 0.57 | 0.66 | 0.75 | 0.84 | 0.94 | 1.05 | 1.15 | 1.26 | 1.37 | 1.49 | 1.61 | 1.73 | 1.86 | 1.99 | 2.12 | 2.25 | 2.39 | 2.53 | | | |
| E | 19.2 | 0.05 | 0.09 | 0.13 | 0.18 | 0.24 | 0.30 | 0.37 | 0.44 | 0.52 | 0.60 | 0.68 | 0.77 | 0.86 | 0.95 | 1.05 | 1.15 | 1.25 | 1.36 | 1.47 | 1.58 | 1.70 | 1.81 | 1.93 | 2.05 | 2.18 | 2.31 | 2.43 | 2.57 | |
| E | 24.0 | 0.04 | 0.08 | 0.12 | 0.16 | 0.22 | 0.27 | 0.33 | 0.40 | 0.46 | 0.54 | 0.61 | 0.69 | 0.77 | 0.85 | 0.94 | 1.03 | 1.12 | 1.22 | 1.31 | 1.41 | 1.52 | 1.62 | 1.73 | 1.84 | 1.95 | 2.06 | 2.18 | 2.30 | 2.41 |

**Note:** The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'

# TABLE R–22
# RAFTERS WITH L/180 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 30 psf plus
Dead Load of 20 psf determines the required bending design value.
Deflection – For 30 psf live load.
Limited to span in inches divided by 180.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600 | 2700 | 2800 | 2900 | 3000 |
| | 12.0 | 2–10 | 3-6 | 4-0 | 4-6 | 4-11 | 5-4 | 5-9 | 6-1 | 6-5 | 6-8 | 7-0 | 7-3 | 7-7 | 7-10 | 8-1 | 8-4 | 8-7 | 8-10 | 9-0 | 9-3 | 9-6 | 9-8 | 9-11 | 10-1 | 10-4 | 10-6 | 10-8 | 10-11 | 11-1 |
| | 16.0 | 2-6 | 3-0 | 3-6 | 3-11 | 4-3 | 4-8 | 4-11 | 5-3 | 5-6 | 5-10 | 6-1 | 6-4 | 6-7 | 6-9 | 7-0 | 7-3 | 7-5 | 7-8 | 7-10 | 8-0 | 8-2 | 8-5 | 8-7 | 8-9 | 8-11 | 9-1 | 9-3 | 9-5 | 9-7 |
| 2x4 | 19.2 | 2-3 | 2-9 | 3-2 | 3-7 | 3-11 | 4-3 | 4-6 | 4-10 | 5-1 | 5-4 | 5-6 | 5-9 | 6-0 | 6-2 | 6-5 | 6-7 | 6-9 | 7-0 | 7-2 | 7-4 | 7-6 | 7-8 | 7-10 | 8-0 | 8-2 | 8-4 | 8-5 | 8-7 | 8-9 |
| | 24.0 | 2-0 | 2-6 | 2-10 | 3-2 | 3-6 | 3-9 | 4-0 | 4-3 | 4-6 | 4-9 | 4-11 | 5-2 | 5-4 | 5-6 | 5-9 | 5-11 | 6-1 | 6-3 | 6-5 | 6-7 | 6-8 | 6-10 | 7-0 | 7-2 | 7-3 | 7-5 | 7-7 | 7-8 | 7-10 |
| | 12.0 | 4-6 | 5-6 | 6-4 | 7-1 | 7-9 | 8-5 | 9-0 | 9-6 | 10-0 | 10-6 | 11-0 | 11-5 | 11-11 | 12-4 | 12-8 | 13-1 | 13-6 | 13-10 | 14-2 | 14-7 | 14-11 | 15-3 | 15-7 | 15-11 | 16-2 | 16-6 | 16-10 | 17-1 | 17-5 |
| | 16.0 | 3-11 | 4-9 | 5-6 | 6-2 | 6-9 | 7-3 | 7-9 | 8-3 | 8-8 | 9-1 | 9-6 | 9-11 | 10-3 | 10-8 | 11-0 | 11-4 | 11-8 | 12-0 | 12-4 | 12-7 | 12-11 | 13-2 | 13-6 | 13-9 | 14-0 | 14-3 | 14-7 | 14-10 | 15-1 |
| 2x6 | 19.2 | 3-7 | 4-4 | 5-0 | 5-7 | 6-2 | 6-8 | 7-1 | 7-6 | 7-11 | 8-4 | 8-8 | 9-1 | 9-5 | 9-9 | 10-0 | 10-4 | 10-8 | 10-11 | 11-3 | 11-6 | 11-9 | 12-0 | 12-4 | 12-7 | 12-10 | 13-1 | 13-3 | 13-6 | 13-9 |
| | 24.0 | 3-2 | 3-11 | 4-6 | 5-0 | 5-6 | 5-11 | 6-4 | 6-9 | 7-1 | 7-5 | 7-9 | 8-1 | 8-5 | 8-8 | 9-0 | 9-3 | 9-6 | 9-9 | 10-0 | 10-3 | 10-6 | 10-9 | 11-0 | 11-3 | 11-5 | 11-8 | 11-11 | 12-1 | 12-4 |
| | 12.0 | 5-11 | 7-3 | 8-4 | 9-4 | 10-3 | 11-1 | 11-10 | 12-7 | 13-3 | 13-11 | 14-6 | 15-1 | 15-8 | 16-3 | 16-9 | 17-3 | 17-9 | 18-3 | 18-9 | 19-2 | 19-8 | 20-1 | 20-6 | 20-11 | 21-4 | 21-9 | 22-2 | 22-6 | 22-11 |
| | 16.0 | 5-2 | 6-3 | 7-3 | 8-1 | 8-11 | 9-7 | 10-3 | 10-10 | 11-6 | 12-0 | 12-7 | 13-1 | 13-7 | 14-0 | 14-6 | 14-11 | 15-5 | 15-10 | 16-3 | 16-7 | 17-0 | 17-5 | 17-9 | 18-1 | 18-6 | 18-10 | 19-2 | 19-6 | 19-10 |
| 2x8 | 19.2 | 4-8 | 5-9 | 6-7 | 7-5 | 8-1 | 8-9 | 9-4 | 9-11 | 10-6 | 11-0 | 11-6 | 11-11 | 12-5 | 12-10 | 13-3 | 13-8 | 14-0 | 14-5 | 14-10 | 15-2 | 15-6 | 15-10 | 16-3 | 16-7 | 16-10 | 17-2 | 17-6 | 17-10 | 18-1 |
| | 24.0 | 4-2 | 5-2 | 5-11 | 6-7 | 7-3 | 7-10 | 8-4 | 8-11 | 9-4 | 9-10 | 10-3 | 10-8 | 11-1 | 11-6 | 11-10 | 12-2 | 12-7 | 12-11 | 13-3 | 13-7 | 13-11 | 14-2 | 14-6 | 14-10 | 15-1 | 15-5 | 15-8 | 15-11 | 16-3 |
| | 12.0 | 7-7 | 9-3 | 10-8 | 11-11 | 13-1 | 14-2 | 15-1 | 16-0 | 16-11 | 17-9 | 18-6 | 19-3 | 20-0 | 20-8 | 21-4 | 22-0 | 22-8 | 23-3 | 23-11 | 24-6 | 25-1 | 25-7 | | | | | | | |
| | 16.0 | 6-6 | 8-0 | 9-3 | 10-4 | 11-4 | 12-3 | 13-1 | 13-10 | 14-8 | 15-4 | 16-0 | 16-8 | 17-4 | 17-11 | 18-6 | 19-1 | 19-7 | 20-2 | 20-8 | 21-2 | 21-8 | 22-2 | 22-8 | 23-1 | 23-7 | 24-0 | 24-6 | 24-11 | 25-4 |
| 2x10 | 19.2 | 6-0 | 7-4 | 8-5 | 9-5 | 10-4 | 11-2 | 11-11 | 12-8 | 13-4 | 14-0 | 14-8 | 15-3 | 15-10 | 16-4 | 16-11 | 17-5 | 17-11 | 18-5 | 18-11 | 19-4 | 19-10 | 20-3 | 20-8 | 21-1 | 21-6 | 21-11 | 22-4 | 22-9 | 23-1 |
| | 24.0 | 5-4 | 6-6 | 7-7 | 8-5 | 9-3 | 10-0 | 10-8 | 11-4 | 11-11 | 12-6 | 13-1 | 13-7 | 14-2 | 14-8 | 15-1 | 15-7 | 16-0 | 16-6 | 16-11 | 17-4 | 17-9 | 18-1 | 18-6 | 18-11 | 19-3 | 19-7 | 20-0 | 20-4 | 20-8 |
| E | 12.0 | 0.04 | 0.08 | 0.12 | 0.17 | 0.23 | 0.29 | 0.35 | 0.42 | 0.49 | 0.57 | 0.65 | 0.73 | 0.82 | 0.91 | 1.00 | 1.09 | 1.19 | 1.29 | 1.39 | 1.50 | 1.61 | 1.72 | 1.83 | 1.95 | 2.07 | 2.19 | 2.31 | 2.43 | 2.56 |
| E | 16.0 | 0.04 | 0.07 | 0.11 | 0.15 | 0.20 | 0.25 | 0.31 | 0.36 | 0.43 | 0.49 | 0.56 | 0.63 | 0.71 | 0.78 | 0.86 | 0.95 | 1.03 | 1.12 | 1.21 | 1.30 | 1.39 | 1.49 | 1.59 | 1.69 | 1.79 | 1.89 | 2.00 | 2.11 | 2.22 |
| E | 19.2 | 0.03 | 0.06 | 0.10 | 0.14 | 0.18 | 0.23 | 0.28 | 0.33 | 0.39 | 0.45 | 0.51 | 0.58 | 0.65 | 0.72 | 0.79 | 0.86 | 0.94 | 1.02 | 1.10 | 1.19 | 1.27 | 1.36 | 1.45 | 1.54 | 1.63 | 1.73 | 1.83 | 1.92 | 2.03 |
| E | 24.0 | 0.03 | 0.06 | 0.09 | 0.12 | 0.16 | 0.20 | 0.25 | 0.30 | 0.35 | 0.40 | 0.46 | 0.52 | 0.58 | 0.64 | 0.71 | 0.77 | 0.84 | 0.91 | 1.99 | 1.06 | 1.14 | 1.22 | 1.30 | 1.38 | 1.46 | 1.55 | 1.63 | 1.72 | 1.81 |

**Note:** The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–23
# RAFTERS WITH L/180 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 40 psf plus
Dead Load of 20 psf determines the required bending design value.
Deflection – For 40 psf live load.
Limited to span in inches divided by 180.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 |
| | 12.0 | 2–7 | 3–2 | 3–8 | 4–1 | 4–6 | 4–11 | 5–3 | 5–6 | 5–10 | 6–1 | 6–5 | 6–8 | 6–11 | 7–2 |
| | 16.0 | 2–3 | 2–9 | 3–2 | 3–7 | 3–11 | 4–3 | 4–6 | 4–10 | 5–1 | 5–4 | 5–6 | 5–9 | 6–0 | 6–2 |
| 2x4 | 19.2 | 2–1 | 2–6 | 2–11 | 3–3 | 3–7 | 3–10 | 4–1 | 4–4 | 4–7 | 4–10 | 5–1 | 5–3 | 5–5 | 5–8 |
| | 24.0 | 1–10 | 2–3 | 2–7 | 2–11 | 3–2 | 3–5 | 3–8 | 3–11 | 4–1 | 4–4 | 4–6 | 4–8 | 4–11 | 5–1 |
| | 12.0 | 4–1 | 5–0 | 5–10 | 6–6 | 7–1 | 7–8 | 8–2 | 8–8 | 9–2 | 9–7 | 10–0 | 10–5 | 10–10 | 11–3 |
| | 16.0 | 3–7 | 4–4 | 5–0 | 5–7 | 6–2 | 6–8 | 7–1 | 7–6 | 7–11 | 8–4 | 8–8 | 9–1 | 9–5 | 9–9 |
| 2x6 | 19.2 | 3–3 | 4–0 | 4–7 | 5–1 | 5–7 | 6–1 | 6–6 | 6–10 | 7–3 | 7–7 | 7–11 | 8–3 | 8–7 | 8–11 |
| | 24.0 | 2–11 | 3–7 | 4–1 | 4–7 | 5–0 | 5–5 | 5–10 | 6–2 | 6–6 | 6–10 | 7–1 | 7–5 | 7–8 | 7–11 |
| | 12.0 | 5–5 | 6–7 | 7–8 | 8–7 | 9–4 | 10–1 | 10–10 | 11–6 | 12–1 | 12–8 | 13–3 | 13–9 | 14–4 | 14–10 |
| | 16.0 | 4–8 | 5–9 | 6–7 | 7–5 | 8–1 | 8–9 | 9–4 | 9–11 | 10–6 | 11–0 | 11–6 | 11–11 | 12–5 | 12–10 |
| 2x8 | 19.2 | 4–3 | 5–3 | 6–0 | 6–9 | 7–5 | 8–0 | 8–7 | 9–1 | 9–7 | 10–0 | 10–6 | 10–11 | 11–4 | 11–8 |
| | 24.0 | 3–10 | 4–8 | 5–5 | 6–0 | 6–7 | 7–2 | 7–8 | 8–1 | 8–7 | 9–0 | 9–4 | 9–9 | 10–1 | 10–6 |
| | 12.0 | 6–11 | 8–5 | 9–9 | 10–11 | 11–11 | 12–11 | 13–9 | 14–8 | 15–5 | 16–2 | 16–11 | 17–7 | 18–3 | 18–11 |
| | 16.0 | 6–0 | 7–4 | 8–5 | 9–5 | 10–4 | 11–2 | 11–11 | 12–8 | 13–4 | 14–0 | 14–8 | 15–3 | 15–10 | 16–4 |
| 2x10 | 19.2 | 5–5 | 6–8 | 7–8 | 8–7 | 9–5 | 10–2 | 10–11 | 11–7 | 12–2 | 12–9 | 13–4 | 13–11 | 14–5 | 14–11 |
| | 24.0 | 4–11 | 6–0 | 6–11 | 7–8 | 8–5 | 9–1 | 9–9 | 10–4 | 10–11 | 11–5 | 11–11 | 12–5 | 12–11 | 13–4 |
| E | 12.0 | 0.04 | 0.08 | 0.13 | 0.18 | 0.23 | 0.29 | 0.36 | 0.43 | 0.50 | 0.58 | 0.66 | 0.74 | 0.83 | 0.92 |
| E | 16.0 | 0.04 | 0.07 | 0.11 | 0.15 | 0.20 | 0.25 | 0.31 | 0.37 | 0.43 | 0.50 | 0.57 | 0.64 | 0.72 | 0.80 |
| E | 19.2 | 0.04 | 0.06 | 0.10 | 0.14 | 0.18 | 0.23 | 0.28 | 0.34 | 0.40 | 0.46 | 0.52 | 0.59 | 0.65 | 0.73 |
| E | 24.0 | 0.03 | 0.06 | 0.09 | 0.13 | 0.16 | 0.21 | 0.25 | 0.30 | 0.35 | 0.41 | 0.46 | 0.52 | 0.59 | 0.65 |

| Size (in) | Spacing (in) | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600 | 2700 | 2800 | 2900 | 3000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12.0 | 7–5 | 7–7 | 7–10 | 8–0 | 8–3 | 8–5 | 8–8 | 8–10 | 9–0 | 9–3 | 9–5 | 9–7 | 9–9 | 9–11 | 10–1 |
| | 16.0 | 6–5 | 6–7 | 6–9 | 7–0 | 7–2 | 7–4 | 7–6 | 7–8 | 7–10 | 8–0 | 8–2 | 8–4 | 8–5 | 8–7 | 8–9 |
| 2x4 | 19.2 | 5–10 | 6–0 | 6–2 | 6–4 | 6–6 | 6–8 | 6–10 | 7–0 | 7–2 | 7–3 | 7–5 | 7–7 | 7–9 | 7–10 | 8–0 |
| | 24.0 | 5–3 | 5–5 | 5–6 | 5–8 | 5–10 | 6–0 | 6–1 | 6–3 | 6–5 | 6–6 | 6–8 | 6–9 | 6–11 | 7–0 | 7–2 |
| | 12.0 | 11–7 | 11–11 | 12–4 | 12–8 | 13–0 | 13–3 | 13–7 | 13–11 | 14–2 | 14–6 | 14–9 | 15–1 | 15–4 | 15–7 | 15–11 |
| | 16.0 | 10–0 | 10–4 | 10–8 | 10–11 | 11–3 | 11–6 | 11–9 | 12–0 | 12–4 | 12–7 | 12–10 | 13–1 | 13–3 | 13–6 | 13–9 |
| 2x6 | 19.2 | 9–2 | 9–5 | 9–9 | 10–0 | 10–3 | 10–6 | 10–9 | 11–0 | 11–3 | 11–5 | 11–8 | 11–11 | 12–2 | 12–4 | 12–7 |
| | 24.0 | 8–2 | 8–5 | 8–8 | 8–11 | 9–2 | 9–5 | 9–7 | 9–10 | 10–0 | 10–3 | 10–5 | 10–8 | 10–10 | 11–0 | 11–3 |
| | 12.0 | 15–3 | 15–9 | 16–3 | 16–8 | 17–1 | 17–6 | 17–11 | 18–4 | 18–9 | 19–1 | 19–6 | 19–10 | 20–3 | 20–7 | 20–11 |
| | 16.0 | 13–3 | 13–8 | 14–0 | 14–5 | 14–10 | 15–2 | 15–6 | 15–10 | 16–3 | 16–7 | 16–10 | 17–2 | 17–6 | 17–10 | 18–1 |
| 2x8 | 19.2 | 12–1 | 12–5 | 12–10 | 13–2 | 13–6 | 13–10 | 14–2 | 14–6 | 14–10 | 15–1 | 15–5 | 15–8 | 16–0 | 16–3 | 16–7 |
| | 24.0 | 10–10 | 11–2 | 11–6 | 11–9 | 12–1 | 12–5 | 12–8 | 12–11 | 13–3 | 13–6 | 13–9 | 14–0 | 14–4 | 14–7 | 14–10 |
| | 12.0 | 19–6 | 20–1 | 20–8 | 21–3 | 21–10 | 22–4 | 22–10 | 23–5 | 23–11 | 24–5 | 24–10 | 25–4 | 25–10 | | |
| | 16.0 | 16–11 | 17–5 | 17–11 | 18–5 | 18–11 | 19–4 | 19–10 | 20–3 | 20–8 | 21–1 | 21–6 | 21–11 | 22–4 | 22–9 | 23–1 |
| 2x10 | 19.2 | 15–5 | 15–11 | 16–4 | 16–10 | 17–3 | 17–8 | 18–1 | 18–6 | 18–11 | 19–3 | 19–8 | 20–0 | 20–5 | 20–9 | 21–1 |
| | 24.0 | 13–9 | 14–3 | 14–8 | 15–0 | 15–5 | 15–10 | 16–2 | 16–6 | 16–11 | 17–3 | 17–7 | 17–11 | 18–3 | 18–7 | 18–11 |
| E | 12.0 | 1.01 | 1.11 | 1.21 | 1.31 | 1.41 | 1.52 | 1.63 | 1.74 | 1.86 | 1.98 | 2.10 | 2.22 | 2.34 | 2.47 | 2.60 |
| E | 16.0 | 0.88 | 0.96 | 1.05 | 1.13 | 1.22 | 1.32 | 1.41 | 1.51 | 1.61 | 1.71 | 1.82 | 1.92 | 2.03 | 2.14 | 2.25 |
| E | 19.2 | 0.80 | 0.88 | 0.95 | 1.04 | 1.12 | 1.20 | 1.29 | 1.38 | 1.47 | 1.56 | 1.66 | 1.75 | 1.85 | 1.95 | 2.05 |
| E | 24.0 | 0.72 | 0.78 | 0.85 | 0.93 | 1.00 | 1.08 | 1.15 | 1.23 | 1.31 | 1.40 | 1.48 | 1.57 | 1.66 | 1.75 | 1.84 |

**Note:** The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

**Design Values for Joists and Rafters**

These "Fb" values are for use where repetitive members are spaced not more than 24 inches. Values for surfaced dry or surfaced green lumber apply at 19% maximum moisture content in use.

| Species and Grade | Size | Design Value in Bending, "Fb" Normal Duration | Design Value in Bending, "Fb" Snow Loading | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| **Cottonwood** | | | | | |
| Select Structural | 2x4 | 1510 | 1735 | 1,200,000 | NSLB |
| No.1 | 2x4 | 1080 | 1240 | 1,200,000 | |
| No.2 | 2x4 | 1080 | 1240 | 1,100,000 | |
| No.3 | 2x4 | 605 | 695 | 1,000,000 | |
| Stud | 2x4 | 600 | 690 | 1,000,000 | |
| Construction | 2x4 | 805 | 925 | 1,000,000 | |
| Standard | 2x4 | 460 | 530 | 900,000 | |
| Utility | 2x4 | 200 | 230 | 900,000 | |
| Select Structural | 2x6 | 1310 | 1505 | 1,200,000 | |
| No.1 | 2x6 | 935 | 1075 | 1,200,000 | |
| No.2 | 2x6 | 935 | 1075 | 1,100,000 | |
| No.3 | 2x6 | 525 | 600 | 1,000,000 | |
| Stud | 2x6 | 545 | 630 | 1,000,000 | |
| Select Structural | 2x8 | 1210 | 1390 | 1,200,000 | |
| No.1 | 2x8 | 865 | 990 | 1,200,000 | |
| No.2 | 2x8 | 865 | 990 | 1,100,000 | |
| No.3 | 2x8 | 485 | 555 | 1,000,000 | |
| Select Structural | 2x10 | 1105 | 1275 | 1,200,000 | |
| No.1 | 2x10 | 790 | 910 | 1,200,000 | |
| No.2 | 2x10 | 790 | 910 | 1,100,000 | |
| No.3 | 2x10 | 445 | 510 | 1,000,000 | |
| Select Structural | 2x12 | 1005 | 1155 | 1,200,000 | |
| No.1 | 2x12 | 720 | 825 | 1,200,000 | |
| No.2 | 2x12 | 720 | 825 | 1,100,000 | |
| No.3 | 2x12 | 405 | 465 | 1,000,000 | |
| **Douglas Fir–Larch** | | | | | WCLIB WWPA |
| Select Structural | 2x4 | 2500 | 2875 | 1,900,000 | |
| No.1 & Btr | 2x4 | 1985 | 2280 | 1,800,000 | |
| No.1 | 2x4 | 1725 | 1985 | 1,700,000 | |
| No.2 | 2x4 | 1510 | 1735 | 1,600,000 | |
| No.3 | 2x4 | 865 | 990 | 1,400,000 | |
| Stud | 2x4 | 855 | 980 | 1,400,000 | |
| Construction | 2x4 | 1150 | 1325 | 1,500,000 | |
| Standard | 2x4 | 635 | 725 | 1,400,000 | |
| Utility | 2x4 | 315 | 365 | 1,300,000 | |
| Select Structural | 2x6 | 2170 | 2495 | 1,900,000 | |
| No.1 & Btr | 2x6 | 1720 | 1975 | 1,800,000 | |
| No.1 | 2x6 | 1495 | 1720 | 1,700,000 | |
| No.2 | 2x6 | 1310 | 1505 | 1,600,000 | |
| No.3 | 2x6 | 750 | 860 | 1,400,000 | |
| Stud | 2x6 | 775 | 895 | 1,400,000 | |
| Select Structural | 2x8 | 2000 | 2300 | 1,900,000 | |
| No.1 & Str | 2x8 | 1585 | 1825 | 1,800,000 | |
| No.1 | 2x8 | 1380 | 1585 | 1,700,000 | |
| No.2 | 2x8 | 1210 | 1390 | 1,600,000 | |
| No.3 | 2x8 | 690 | 795 | 1,400,000 | |
| Select Structural | 2x10 | 1835 | 2110 | 1,900,000 | |
| No.1 & Btr | 2x10 | 1455 | 1675 | 1,800,000 | |
| No.1 | 2x10 | 1265 | 1455 | 1,700,000 | |
| No.2 | 2x10 | 1105 | 1275 | 1,600,000 | |
| No.3 | 2x10 | 635 | 725 | 1,400,000 | |
| Select Structural | 2x12 | 1670 | 1920 | 1,900,000 | |
| No.1 & Btr | 2x12 | 1325 | 1520 | 1,800,000 | |
| No.1 | 2x12 | 1150 | 1325 | 1,700,000 | |
| No.2 | 2x12 | 1005 | 1155 | 1,600,000 | |
| No.3 | 2x12 | 575 | 660 | 1,400,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rule Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Douglas Fir–Larch (North)** | | | | | |
| Select Structural | 2x4 | 2245 | 2580 | 1,900,000 | NLGA |
| No.1 /No.2 | | 1425 | 1635 | 1,600,000 | |
| No.3 | | 820 | 940 | 1,400,000 | |
| Stud | | 820 | 945 | 1,400,000 | |
| Construction | | 1095 | 1255 | 1,500,000 | |
| Standard | | 605 | 695 | 1,400,000 | |
| Utility | | 290 | 330 | 1,300,000 | |
| Select Structural | 2x6 | 1945 | 2235 | 1,900,000 | |
| No.1 /No.2 | | 1235 | 1420 | 1,600,000 | |
| No.3 | | 710 | 815 | 1,400,000 | |
| Stud | | 750 | 860 | 1,400,000 | |
| Select Structural | 2x8 | 1795 | 2065 | 1,900,000 | |
| No.1 /No.2 | | 1140 | 1310 | 1,600,000 | |
| No.3 | | 655 | 755 | 1,400,000 | |
| Select Structural | 2x10 | 1645 | 1890 | 1,900,000 | |
| No.1 /No–2 | | 1045 | 1200 | 1,600,000 | |
| No.3 | | 600 | 690 | 1,400,000 | |
| Select Structural | 2x12 | 1495 | 1720 | 1,900,000 | |
| No.1 /No.2 | | 950 | 1090 | 1,600,000 | |
| No.3 | | 545 | 630 | 1,400,000 | |
| **Douglas Fir–South** | | | | | |
| Select Structural | 2x4 | 2245 | 2580 | 1,400,000 | WWPA |
| No.1 | | 1555 | 1785 | 1,300,000 | |
| No.2 | | 1425 | 1635 | 1,200,000 | |
| No.3 | | 820 | 940 | 1,100,000 | |
| Stud | | 820 | 945 | 1,100,000 | |
| Construction | | 1065 | 1225 | 1,200,000 | |
| Standard | | 605 | 695 | 1,100,000 | |
| Utility | | 290 | 330 | 1,000,000 | |
| Select Structural | 2x6 | 1945 | 2235 | 1,400,000 | |
| No.1 | | 1345 | 1545 | 1,300,000 | |
| No.2 | | 1235 | 1420 | 1,200,000 | |
| No.3 | | 710 | 815 | 1,100,000 | |
| Stud | | 750 | 860 | 1,100,000 | |
| Select Structural | 2x8 | 1795 | 2065 | 1,400,000 | |
| No.1 | | 1240 | 1430 | 1,300,000 | |
| No.2 | | 1140 | 1310 | 1,200,000 | |
| No.3 | | 655 | 755 | 1,100,000 | |
| Select Structural | 2x10 | 1645 | 1890 | 1,400,000 | |
| No.1 | | 1140 | 1310 | 1,300,000 | |
| No.2 | | 1045 | 1200 | 1,200,000 | |
| No.3 | | 600 | 690 | 1,100,000 | |
| Select Structural | 2x12 | 1495 | 1720 | 1,400,000 | |
| No.1 | | 1035 | 1190 | 1,300,000 | |
| No.2 | | 950 | 1090 | 1,200,000 | |
| No.3 | | 545 | 630 | 1,100,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" Normal Duration | Snow Loading | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| **Eastern Hemlock–Tamarack** | | | | | |
| Select Structural | 2x4 | 2155 | 2480 | 1,200,000 | NELMA NSLB |
| No.1 | | 1335 | 1535 | 1,100,000 | |
| No.2 | | 990 | 1140 | 1,100,000 | |
| No.3 | | 605 | 695 | 900,000 | |
| Stud | | 570 | 655 | 900,000 | |
| Construction | | 775 | 895 | 1,000,000 | |
| Standard | | 430 | 495 | 900,000 | |
| Utility | | 200 | 230 | 800,000 | |
| Select Structural | 2x6 | 1870 | 2150 | 1,200,000 | |
| No.1 | | 1160 | 1330 | 1,100,000 | |
| No 2 | | 860 | 990 | 1,100,000 | |
| No.3 | | 525 | 600 | 900,000 | |
| Stud | | 520 | 595 | 900,000 | |
| Select Structural | 2x8 | 1725 | 1985 | 1,200,000 | |
| No.1 | | 1070 | 1230 | 1,100,000 | |
| No.2 | | 795 | 915 | 1,100,000 | |
| No.3 | | 485 | 555 | 900,000 | |
| Select Structural | 2xl0 | 1580 | 1820 | 1,200,000 | |
| No.1 | | 980 | 1125 | 1,100,000 | |
| No.2 | | 725 | 835 | 1,100,000 | |
| No.3 | | 445 | 510 | 900,000 | |
| Select Structural | 2xl2 | 1440 | 1655 | 1,200,000 | |
| No.1 | | 890 | 1025 | 1,100,000 | |
| No.2 | | 660 | 760 | 1,100,000 | |
| No.3 | | 405 | 465 | 900,000 | |
| **Eastern Softwoods** | | | | | |
| Select Structural | 2x4 | 2155 | 2480 | 1,200,000 | NELMA NSLB |
| No.1 | | 1335 | 1535 | 1,100,000 | |
| No.2 | | 990 | 1140 | 1,100,000 | |
| No.3 | | 605 | 695 | 900,000 | |
| Stud | | 570 | 655 | 900,000 | |
| Construction | | 775 | 895 | 1,000,000 | |
| Standard | | 430 | 495 | 900,000 | |
| Utility | | 200 | 230 | 800,000 | |
| Select Structural | 2x6 | 1870 | 2150 | 1,200,000 | |
| No.1 | | 1160 | 1330 | 1,100,000 | |
| No.2 | | 860 | 990 | 1,100,000 | |
| No.3 | | 525 | 600 | 900,000 | |
| Stud | | 520 | 595 | 900,000 | |
| Select Structural | 2x8 | 1725 | 1985 | 1,200,000 | |
| No.1 | | 1070 | 1230 | 1,100,000 | |
| No.2 | | 795 | 915 | 1,100,000 | |
| No.3 | | 485 | 555 | 900,000 | |
| Select Structural | 2xl0 | 1580 | 1820 | 1,200,000 | |
| No.1 | | 980 | 1125 | 1,100,000 | |
| No.2 | | 725 | 835 | 1,100,000 | |
| No.3 | | 445 | 510 | 900,000 | |
| Select Structural | 2xl2 | 1440 | 1655 | 1,200,000 | |
| No.1 | | 890 | 1025 | 1,100,000 | |
| No.2 | | 660 | 760 | 1,100,000 | |
| No.3 | | 405 | 465 | 900,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" Normal Duration | Snow Loading | Modulus of Elasticity "E" | Grading Rule Agency |
|---|---|---|---|---|---|
| **Eastern White Pine** | | | | | |
| Select Structural | 2x4 | 2155 | 2480 | 1,200,000 | NELMA NSLB |
| No.1 | | 1335 | 1535 | 1,100,000 | |
| No.2 | | 990 | 1140 | 1,100,000 | |
| No.3 | | 605 | 695 | 900,000 | |
| Stud | | 570 | 655 | 900,000 | |
| Construction | | 775 | 895 | 1,000,000 | |
| Standard | | 430 | 495 | 900,000 | |
| Utility | | 200 | 230 | 800,000 | |
| Select Structural | 2x6 | 1870 | 2150 | 1,200,000 | |
| No.1 | | 1160 | 1330 | 1,100,000 | |
| No.2 | | 860 | 990 | 1,100,000 | |
| No.3 | | 525 | 600 | 900,000 | |
| Stud | | 520 | 595 | 900,000 | |
| Select Structural | 2x8 | 1725 | 1985 | 1,200,000 | |
| No.1 | | 1070 | 1230 | 1,100,000 | |
| No.2 | | 795 | 915 | 1,100,000 | |
| No.3 | | 485 | 555 | 900,000 | |
| Select Structural | 2x10 | 1580 | 1820 | 1,200,000 | |
| No.1 | | 980 | 1125 | 1,100,000 | |
| No.2 | | 725 | 835 | 1,100,000 | |
| No.3 | | 445 | 510 | 900,000 | |
| Select Structural | 2x12 | 1440 | 1655 | 1,200,000 | |
| No.1 | | 890 | 1025 | 1,100,000 | |
| No.2 | | 660 | 760 | 1,100,000 | |
| No.3 | | 405 | 465 | 900,000 | |
| **Hem Fir** | | | | | |
| Select Structural | 2x4 | 2415 | 2775 | 1,600,000 | WCLIB WWPA |
| No.1 & Btr | | 1810 | 2085 | 1,500,000 | |
| No.1 | | 1640 | 1885 | 1,500,000 | |
| No.2 | | 1465 | 1685 | 1,300,000 | |
| No.3 | | 865 | 990 | 1,200,000 | |
| Stud | | 855 | 980 | 1,200,000 | |
| Construction | | 1120 | 1290 | 1,300,000 | |
| Standard | | 635 | 725 | 1,200,000 | |
| Utility | | 290 | 330 | 1,100,000 | |
| Select Structural | 2x6 | 2095 | 2405 | 1,600,000 | |
| No.1 & Btr | | 1570 | 1805 | 1,500,000 | |
| No.1 | | 1420 | 1635 | 1,500,000 | |
| No.2 | | 1270 | 1460 | 1,300,000 | |
| No.3 | | 750 | 860 | 1,200,000 | |
| Stud | | 775 | 895 | 1,200,000 | |
| Select Structural | 2x8 | 1930 | 2220 | 1,600,000 | |
| No.1 & Btr | | 1450 | 1665 | 1,500,000 | |
| No.1 | | 1310 | 1510 | 1,500,000 | |
| No.2 | | 1175 | 1350 | 1,300,000 | |
| No.3 | | 690 | 795 | 1,200,000 | |
| Select Structural | 2x10 | 1770 | 2035 | 1,600,000 | |
| No.1 & Btr | | 1330 | 1525 | 1,500,000 | |
| No.1 | | 1200 | 1380 | 1,500,000 | |
| No.2 | | 1075 | 1235 | 1,300,000 | |
| No.3 | | 635 | 725 | 1,200,000 | |
| Select Structural | 2x12 | 1610 | 1850 | 1,600,000 | |
| No.1 & Btr | | 1210 | 1390 | 1,500,000 | |
| No.1 | | 1095 | 1255 | 1,500,000 | |
| No.2 | | 980 | 1125 | 1,300,000 | |
| No.3 | | 575 | 660 | 1,200,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" Normal Duration | Snow Loading | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| **Hem–Fir (North)** | | | | | |
| Select Structural | | 2245 | 2580 | 1,700,000 | |
| No.1 /No.2 | | 1725 | 1985 | 1,600,000 | |
| No.3 | | 990 | 1140 | 1,400,000 | |
| Stud | 2x4 | 980 | 1125 | 1,400,000 | |
| Construction | | 1325 | 1520 | 1,500,000 | |
| Standard | | 720 | 825 | 1,400,000 | |
| Utility | | 345 | 395 | 1,300,000 | |
| Select Structural | | 1945 | 2235 | 1,700,000 | |
| No.1 /No.2 | 2x6 | 1495 | 1720 | 1,600,000 | |
| No.3 | | 860 | 990 | 1,400,000 | |
| Stud | | 890 | 1025 | 1,400,000 | NLGA |
| Select Structural | | 1795 | 2065 | 1,700,000 | |
| No.1 /No.2 | 2x8 | 1380 | 1585 | 1,600,000 | |
| No.3 | | 795 | 915 | 1,400,000 | |
| Select Structural | | 1645 | 1890 | 1,700,000 | |
| No.1 /No.2 | 2xl0 | 1265 | 1455 | 1,600,000 | |
| No.3 | | 725 | 835 | 1,400,000 | |
| Select Structural | | 1495 | 1720 | 1,700,000 | |
| No.1 /No.2 | 2xl2 | 1150 | 1325 | 1,600,000 | |
| No.3 | | 660 | 760 | 1,400,000 | |
| **Mixed Maple** | | | | | |
| Select Structural | | 1725 | 1985 | 1,300,000 | |
| No.1 | | 1250 | 1440 | 1,200,000 | |
| No.2 | | 1210 | 1390 | 1,100,000 | |
| No.3 | 2x4 | 690 | 795 | 1,000.000 | |
| Stud | | 695 | Boo | 1,000,000 | |
| Construction | | 920 | 1060 | 1,100,000 | |
| Standard | | 520 | 595 | 1,000,000 | |
| Utility | | 260 | 300 | 900,000 | |
| Select Structural | | 1495 | 1720 | 1,300,000 | |
| No.1 | | 1085 | 1245 | 1,200,000 | |
| No.2 | 2x6 | 1045 | 1205 | 1,100,000 | |
| No.3 | | 600 | 690 | 1,000,000 | |
| Stud | | 635 | 725 | 1,000,000 | NELMA |
| Select Structural | | 1380 | 1585 | 1,300,000 | |
| No.1 | 2x8 | 1000 | 1150 | 1,200,000 | |
| No.2 | | 965 | 1110 | 1,100,000 | |
| No.3 | | 550 | 635 | 1,000,000 | |
| Select Structural | | 1265 | 1455 | 1,300,000 | |
| No.1 | 2xl0 | 915 | 1055 | 1,200,000 | |
| No.2 | | 885 | 1020 | 1,100,000 | |
| No.3 | | 505 | 580 | 1,000,000 | |
| Select Structural | | 1150 | 1325 | 1,300,000 | |
| No.1 | 2xl2 | 835 | 960 | 1,200,000 | |
| No.2 | | 805 | 925 | 1,100,000 | |
| No.3 | | 460 | 530 | 1,000,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" Normal Duration | Snow Loading | Modulus of Elasticity "E" | Grading Rule Agency |
|---|---|---|---|---|---|
| **Mixed Oak** | | | | | |
| Select Structural | 2x4 | 1985 | 2280 | 1,100,000 | NELMA |
| No.1 | 2x4 | 1425 | 1635 | 1,000,000 | NELMA |
| No.2 | 2x4 | 1380 | 1585 | 900,000 | NELMA |
| No.3 | 2x4 | 820 | 940 | 800,000 | NELMA |
| Stud | 2x4 | 790 | 910 | 800,000 | NELMA |
| Construction | 2x4 | 1065 | 1225 | 900,000 | NELMA |
| Standard | 2x4 | 605 | 695 | 800,000 | NELMA |
| Utility | 2x4 | 290 | 330 | 800,000 | NELMA |
| Select Structural | 2x6 | 1720 | 1975 | 1,100,000 | NELMA |
| No.1 | 2x6 | 1235 | 1420 | 1,000,000 | NELMA |
| No.2 | 2x6 | 1195 | 1375 | 900,000 | NELMA |
| No.3 | 2x6 | 710 | 815 | 800,000 | NELMA |
| Stud | 2x6 | 720 | 825 | 800,000 | NELMA |
| Select Structural | 2x8 | 1585 | 1825 | 1,100,000 | NELMA |
| No.1 | 2x8 | 1140 | 1310 | 1,000,000 | NELMA |
| No.2 | 2x8 | 1105 | 1270 | 900,000 | NELMA |
| No.3 | 2x8 | 655 | 755 | 800,000 | NELMA |
| Select Structural | 2x10 | 1455 | 1675 | 1,100,000 | NELMA |
| No.1 | 2x10 | 1045 | 1200 | 1,000,000 | NELMA |
| No.2 | 2x10 | 1010 | 1165 | 900,000 | NELMA |
| No.3 | 2x10 | 600 | 690 | 800,000 | NELMA |
| Select Structural | 2x12 | 1325 | 1520 | 1,100,000 | NELMA |
| No.1 | 2x12 | 950 | 1090 | 1,000,000 | NELMA |
| No.2 | 2x12 | 920 | 1060 | 900,000 | NELMA |
| No.3 | 2x12 | 545 | 630 | 800,000 | NELMA |
| **Mixed Southern Pine** | | | | | |
| Select Structural | 2x4 | 2360 | 2710 | 1,600,000 | SPIB |
| No.1 | 2x4 | 1670 | 1920 | 1,500,000 | SPIB |
| No.2 | 2x4 | 1500 | 1720 | 1,400,000 | SPIB |
| No.3 | 2x4 | 865 | 990 | 1,200,000 | SPIB |
| Stud | 2x4 | 890 | 1020 | 1,200,000 | SPIB |
| Construction | 2x4 | 1150 | 1320 | 1,300,000 | SPIB |
| Standard | 2x4 | 635 | 725 | 1,200,000 | SPIB |
| Utility | 2x4 | 315 | 365 | 1,100,000 | SPIB |
| Select Structural | 2x6 | 2130 | 2450 | 1,600,000 | SPIB |
| No.1 | 2x6 | 1490 | 1720 | 1,500,000 | SPIB |
| No.2 | 2x6 | 1320 | 1520 | 1,400,000 | SPIB |
| No.3 | 2x6 | 775 | 895 | 1,200,000 | SPIB |
| Stud | 2x6 | 775 | 895 | 1,200,000 | SPIB |
| Select Structural | 2x8 | 2010 | 2310 | 1,600,000 | SPIB |
| No.1 | 2x8 | 1380 | 1590 | 1,500,000 | SPIB |
| No.2 | 2x8 | 1210 | 1390 | 1,400,000 | SPIB |
| No.3 | 2x8 | 720 | 825 | 1,200,000 | SPIB |
| Select Structural | 2x10 | 1730 | 1980 | 1,600,000 | SPIB |
| No.1 | 2x10 | 1210 | 1390 | 1,500,000 | SPIB |
| No.2 | 2x10 | 1060 | 1220 | 1,400,000 | SPIB |
| No.3 | 2x10 | 605 | 695 | 1,200,000 | SPIB |
| Select Structural | 2x12 | 1610 | 1850 | 1,600,000 | SPIB |
| No.1 | 2x12 | 1120 | 1290 | 1,500,000 | SPIB |
| No.2 | 2x12 | 1010 | 1160 | 1,400,000 | SPIB |
| No.3 | 2x12 | 575 | 660 | 1,200,000 | SPIB |

| Species and Grade | Size | Design Value in Bending, "Fb" Normal Duration | Snow Loading | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| **Northern Red Oak** | | | | | |
| Select Structural | 2x4 | 2415 | 2775 | 1,400,000 | NELMA |
| No.1 | 2x4 | 1725 | 1985 | 1,400,000 | NELMA |
| No.2 | 2x4 | 1680 | 1935 | 1,300,000 | NELMA |
| No.3 | 2x4 | 950 | 1090 | 1,200,000 | NELMA |
| Stud | 2x4 | 950 | 1090 | 1,200,000 | NELMA |
| Construction | 2x4 | 1265 | 1455 | 1,200,000 | NELMA |
| Standard | 2x4 | 720 | 825 | 1,100,000 | NELMA |
| Utility | 2x4 | 345 | 395 | 1,000,000 | NELMA |
| Select Structural | 2x6 | 2095 | 2405 | 1,400,000 | NELMA |
| No.1 | 2x6 | 1495 | 1720 | 1,400,000 | NELMA |
| No.2 | 2x6 | 1460 | 1675 | 1,300,000 | NELMA |
| No 3 | 2x6 | 820 | 945 | 1,200,000 | NELMA |
| Stud | 2x6 | 865 | 990 | 1,200,000 | NELMA |
| Select Structural | 2x8 | 1930 | 2220 | 1,400,000 | NELMA |
| No 1 | 2x8 | 1380 | 1585 | 1,400,000 | NELMA |
| No.2 | 2x8 | 1345 | 1545 | 1,300,000 | NELMA |
| No.3 | 2x8 | 760 | 875 | 1,200,000 | NELMA |
| Select Structural | 2xl0 | 1770 | 2035 | 1,400,000 | NELMA |
| No.1 | 2xl0 | 1265 | 1455 | 1,400,000 | NELMA |
| No.2 | 2xl0 | 1235 | 1420 | 1,300,000 | NELMA |
| No.3 | 2xl0 | 695 | 800 | 1,200,000 | NELMA |
| Select Structural | 2xl2 | 1610 | 1850 | 1,400,000 | NELMA |
| No.1 | 2xl2 | 1150 | 1325 | 1,400,000 | NELMA |
| No.2 | 2xl2 | 1120 | 1290 | 1,300,000 | NELMA |
| No.3 | 2xl2 | 635 | 725 | 1,200,000 | NELMA |
| **Northern Species** | | | | | |
| Select Structural | 2x4 | 1640 | 1885 | 1,100,000 | NLGA |
| No.1 /No.2 | 2x4 | 990 | 1140 | 1,100,000 | NLGA |
| No.3 | 2x4 | 605 | 695 | 1,000,000 | NLGA |
| Stud | 2x4 | 570 | 655 | 1,000,000 | NLGA |
| Construction | 2x4 | 775 | 895 | 1,000,000 | NLGA |
| Standard | 2x4 | 430 | 495 | 900,000 | NLGA |
| Utility | 2x4 | 200 | 230 | 900,000 | NLGA |
| Select Structural | 2x6 | 1420 | 1635 | 1,100,000 | NLGA |
| No. 1 / No.2 | 2x6 | 860 | 990 | 1,100,000 | NLGA |
| No.3 | 2x6 | 525 | 600 | 1,000,000 | NLGA |
| Stud | 2x6 | 520 | 595 | 1,000,000 | NLGA |
| Select Structural | 2x8 | 1310 | 1510 | 1,100,000 | NLGA |
| No.l/No.2 | 2x8 | 795 | 915 | 1,100,000 | NLGA |
| No.3 | 2x8 | 485 | 555 | 1,000,000 | NLGA |
| Select Structural | 2xl0 | 1200 | 1380 | 1,100,000 | NLGA |
| No.1 /No.2 | 2xl0 | 725 | 835 | 1,100,000 | NLGA |
| No.3 | 2xl0 | 445 | 510 | 1,000,000 | NLGA |
| Select Structural | 2xl2 | 1095 | 1255 | 1,100,000 | NLGA |
| No.1 /No.2 | 2xl2 | 660 | 760 | 1,100,000 | NLGA |
| No.3 | 2xl2 | 405 | 465 | 1,000,000 | NLGA |

| Species and Grade | Size | Design Value in Bending, "Fb" Normal Duration | Design Value in Bending, "Fb" Snow Loading | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| **Northern White Cedar** | | | | | |
| Select Structural | 2x4 | 1335 | 1535 | 800,000 | NELMA |
| No.1 | 2x4 | 990 | 1140 | 700,000 | NELMA |
| No.2 | 2x4 | 950 | 1090 | 700,000 | NELMA |
| No.3 | 2x4 | 560 | 645 | 600,000 | NELMA |
| Stud | 2x4 | 540 | 620 | 600,000 | NELMA |
| Construction | 2x4 | 720 | 825 | 700,000 | NELMA |
| Standard | 2x4 | 405 | 465 | 600,000 | NELMA |
| Utility | 2x4 | 200 | 230 | 600,000 | NELMA |
| Select Structural | 2x6 | 1160 | 1330 | 800,000 | NELMA |
| No.1 | 2x6 | 860 | 990 | 700,000 | NELMA |
| No.2 | 2x6 | 820 | 945 | 700,000 | NELMA |
| No.3 | 2x6 | 485 | 560 | 600,000 | NELMA |
| Stud | 2x6 | 490 | 560 | 600,000 | NELMA |
| Select Structural | 2x8 | 1070 | 1230 | 800,000 | NELMA |
| No.1 | 2x8 | 795 | 915 | 700,000 | NELMA |
| No.2 | 2x8 | 760 | 875 | 700,000 | NELMA |
| No.3 | 2x8 | 450 | 515 | 600,000 | NELMA |
| Select Structural | 2x10 | 980 | 1125 | 800,000 | NELMA |
| No.1 | 2x10 | 725 | 835 | 700,000 | NELMA |
| No.2 | 2x10 | 695 | 800 | 700,000 | NELMA |
| No.3 | 2x10 | 410 | 475 | 600,000 | NELMA |
| Select Structural | 2x12 | 890 | 1025 | 800,000 | NELMA |
| No.1 | 2x12 | 660 | 760 | 700,000 | NELMA |
| No.2 | 2x12 | 635 | 725 | 700,000 | NELMA |
| No.3 | 2x12 | 375 | 430 | 600,000 | NELMA |
| **Red Maple** | | | | | |
| Select Structural | 2x4 | 2245 | 2580 | 1,700,000 | NELMA |
| No.1 | 2x4 | 1595 | 1835 | 1,600,000 | NELMA |
| No.2 | 2x4 | 1555 | 1785 | 1,500,000 | NELMA |
| No.3 | 2x4 | 905 | 1040 | 1,300,000 | NELMA |
| Stud | 2x4 | 885 | 1020 | 1,300,000 | NELMA |
| Construction | 2x4 | 1210 | 1390 | 1,400,000 | NELMA |
| Standard | 2x4 | 660 | 760 | 1,300,000 | NELMA |
| Utility | 2x4 | 315 | 365 | 1,200,000 | NELMA |
| Select Structural | 2x6 | 1945 | 2235 | 1,700,000 | NELMA |
| No.1 | 2x6 | 1385 | 1590 | 1,600,000 | NELMA |
| No.2 | 2x6 | 1345 | 1545 | 1,500,000 | NELMA |
| No.3 | 2x6 | 785 | 905 | 1,300,000 | NELMA |
| Stud | 2x6 | 805 | 925 | 1,300,000 | NELMA |
| Select Structural | 2x8 | 1795 | 2065 | 1,700,000 | NELMA |
| No.1 | 2x8 | 1275 | 1470 | 1,600,000 | NELMA |
| No.2 | 2x8 | 1240 | 1430 | 1,500,000 | NELMA |
| No.3 | 2x8 | 725 | 835 | 1,300,000 | NELMA |
| Select Structural | 2x10 | 1645 | 1890 | 1,700,000 | NELMA |
| No.1 | 2x10 | 1170 | 1345 | 1,600,000 | NELMA |
| No.2 | 2x10 | 1140 | 1310 | 1,500,000 | NELMA |
| No.3 | 2x10 | 665 | 765 | 1,300,000 | NELMA |
| Select Structural | 2x12 | 1495 | 1720 | 1,700,000 | NELMA |
| No.1 | 2x12 | 1065 | 1225 | 1,600,000 | NELMA |
| No.2 | 2x12 | 1035 | 1190 | 1,500,000 | NELMA |
| No.3 | 2x12 | 605 | 695 | 1,300,000 | NELMA |

| Species and Grade | Size | Design Value in Bending, "Fb" Normal Duration | Snow Loading | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| **Red Oak** | | | | | |
| Select Structural | 2x4 | 1985 | 2280 | 1,400,000 | NELMA |
| No.1 | | 1425 | 1635 | 1,300,000 | |
| No.2 | | 1380 | 1585 | 1,200,000 | |
| No.3 | | 820 | 940 | 1,100,000 | |
| Stud | | 790 | 910 | 1,100,000 | |
| Construction | | 1065 | 1225 | 1,200,000 | |
| Standard | | 605 | 695 | 1,100,000 | |
| Utility | | 290 | 330 | 1,000,000 | |
| Select Structural | 2x6 | 1720 | 1975 | 1,400,000 | |
| No.1 | | 1235 | 1420 | 1,300,000 | |
| No.2 | | 1195 | 1375 | 1,200,000 | |
| No.3 | | 710 | 815 | 1,100,000 | |
| Stud | | 720 | 825 | 1,100,000 | |
| Select Structural | 2x8 | 1585 | 1825 | 1,400,000 | |
| No.1 | | 1140 | 1310 | 1,300,000 | |
| No.2 | | 1105 | 1270 | 1,200,000 | |
| No.3 | | 655 | 755 | 1,100,000 | |
| Select Structural | 2x10 | 1455 | 1675 | 1,400,000 | |
| No.1 | | 1045 | 1200 | 1,300,000 | |
| No.2 | | 1010 | 1165 | 1,200,000 | |
| No.3 | | 600 | 690 | 1,100,000 | |
| Select Structural | 2x12 | 1325 | 1520 | 1,400,000 | |
| No.1 | | 950 | 1090 | 1,300,000 | |
| No.2 | | 920 | 1060 | 1,200,000 | |
| No.3 | | 545 | 630 | 1,100,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Redwood** | | | | | |
| Clear Structural | 2x4 | 3020 | 3470 | 1,400,000 | RIS |
| Select Structural | 2x4 | 2330 | 2680 | 1,400,000 | RIS |
| Select Structural, open grain | 2x4 | 1900 | 2180 | 1,100,000 | RIS |
| No.1 | 2x4 | 1680 | 1935 | 1,300,000 | RIS |
| No.1, open grain | 2x4 | 1335 | 1535 | 1,100,000 | RIS |
| No.2 | 2x4 | 1595 | 1835 | 1,200,000 | RIS |
| No.2, open grain | 2x4 | 1250 | 1440 | 1,000,000 | RIS |
| No.3 | 2x4 | 905 | 1040 | 1,100,000 | RIS |
| No.3, open grain | 2x4 | 735 | 845 | 900,000 | RIS |
| Stud | 2x4 | 725 | 835 | 900,000 | RIS |
| Construction | 2x4 | 950 | 1090 | 900,000 | RIS |
| Standard | 2x4 | 520 | 595 | 900,000 | RIS |
| Utility | 2x4 | 260 | 300 | 800,000 | RIS |
| Clear Structural | 2x6 | 2615 | 3010 | 1,400,000 | RIS |
| Select Structural | 2x6 | 2020 | 2320 | 1,400,000 | RIS |
| Select Structural, open grain | 2x6 | 1645 | 1890 | 1,100,000 | RIS |
| No.1 | 2x6 | 1460 | 1675 | 1,300,000 | RIS |
| No.1, open grain | 2x6 | 1160 | 1330 | 1,100,000 | RIS |
| No.2 | 2x6 | 1385 | 1590 | 1,200,000 | RIS |
| No.2, open grain | 2x6 | 1085 | 1245 | 1,000,000 | RIS |
| No.3 | 2x6 | 785 | 905 | 1,100,000 | RIS |
| No.3, open grain | 2x6 | 635 | 730 | 900,000 | RIS |
| Stud | 2x6 | 660 | 760 | 900,000 | RIS |
| Clear Structural | 2x8 | 2415 | 2775 | 1,400,000 | RIS |
| Select Structural | 2x8 | 1865 | 2140 | 1,400,000 | RIS |
| Select Structural, open grain | 2x8 | 1520 | 1745 | 1,100,000 | RIS |
| No.1 | 2x8 | 1345 | 1545 | 1,300,000 | RIS |
| No.1, open grain | 2x8 | 1070 | 1230 | 1,100,000 | RIS |
| No.2 | 2x8 | 1275 | 1470 | 1,200,000 | RIS |
| No.2, open grain | 2x8 | 1000 | 1150 | 1,000,000 | RIS |
| No.3 | 2x8 | 725 | 835 | 1,100,000 | RIS |
| No.3, open grain | 2x8 | 585 | 675 | 900,000 | RIS |
| Clear Structural | 2x10 | 2215 | 2545 | 1,400,000 | RIS |
| Select Structural | 2x10 | 1710 | 1965 | 1,400,000 | RIS |
| Select Structural, open grain | 2x10 | 1390 | 1600 | 1,100,000 | RIS |
| No.1 | 2x10 | 1235 | 1420 | 1,300,000 | RIS |
| No.1, open grain | 2x10 | 980 | 1125 | 1,100,000 | RIS |
| No.2 | 2x10 | 1170 | 1345 | 1,200,000 | RIS |
| No.2, open grain | 2x10 | 915 | 1055 | 1,000,000 | RIS |
| No.3 | 2x10 | 665 | 765 | 1,100,000 | RIS |
| No.3, open grain | 2x10 | 540 | 620 | 900,000 | RIS |
| Clear Structural | 2x12 | 2015 | 2315 | 1,400,000 | RIS |
| Select Structural | 2x12 | 1555 | 1785 | 1,400,000 | RIS |
| Select Structural, open grain | 2x12 | 1265 | 1455 | 1,100,000 | RIS |
| No.1 | 2x12 | 1120 | 1290 | 1,300,000 | RIS |
| No.1, open grain | 2x12 | 890 | 1025 | 1,100,000 | RIS |
| No.2 | 2x12 | 1065 | 1225 | 1,200,000 | RIS |
| No.2, open grain | 2x12 | 835 | 960 | 1,000,000 | RIS |
| No.3 | 2x12 | 605 | 695 | 1,100,000 | RIS |
| No.3, open grain | 2x12 | 490 | 560 | 900,000 | RIS |

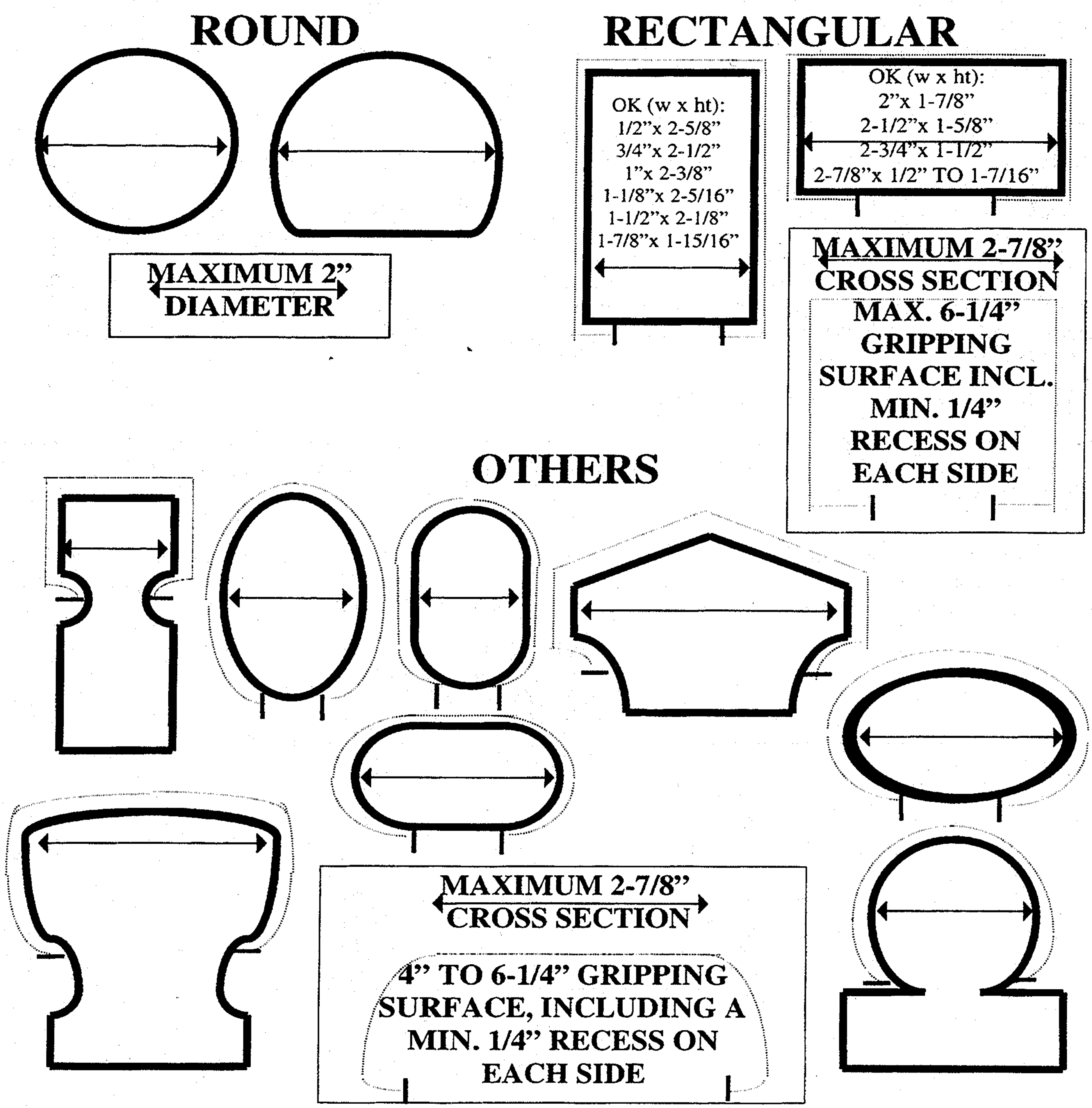
| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Southern Pine** | | | | | |
| Dense Select Structural | 2x4 | 3510 | 4030 | 1,900,000 | SPIB |
| Select Structural | | 3280 | 3770 | 1,800,000 | |
| Non–Dense Select Structural | | 3050 | 3500 | 1,700,000 | |
| No.1 Dense | | 2300 | 2650 | 1,800,000 | |
| No.1 | | 2130 | 2450 | 1,700,000 | |
| No.1 Non–Dense | | 1950 | 2250 | 1,600,000 | |
| No.2 Dense | | 1960 | 2250 | 1,700,000 | |
| No.2 | | 1720 | 1980 | 1,600,000 | |
| No.2 Non–Dense | | 1550 | 1790 | 1,400,000 | |
| No.3 | | 980 | 1120 | 1,400,000 | |
| Stud | | 1010 | 1160 | 1,400,000 | |
| Construction | | 1270 | 1450 | 1,500,000 | |
| Standard | | 720 | 825 | 1,300,000 | |
| Utility | | 345 | 395 | 1,300,000 | |
| Dense Select Structural | 2x6 | 3100 | 3570 | 1,900,000 | |
| Select Structural | | 2930 | 3370 | 1,800,000 | |
| Non–Dense Select Structural | | 2700 | 3110 | 1,700,000 | |
| No.1 Dense | | 2010 | 2310 | 1,800,000 | |
| No.1 | | 1900 | 2180 | 1,700,000 | |
| No.1 Non–Dense | | 1720 | 1980 | 1,600,000 | |
| No.2 Dense | | 1670 | 1920 | 1,700,000 | |
| No.2 | | 1440 | 1650 | 1,600,000 | |
| No.2 Non–Dense | | 1320 | T520 | 1,400,000 | |
| No.3 | | 865 | 990 | 1,400,000 | |
| Stud | | 890 | 1020 | 1,400,000 | |
| Dense Select Structural | 2x8 | 2820 | 3240 | 1,900,000 | |
| Select Structural | | 2650 | 3040 | 1,800,000 | |
| Non–Dense Select Structural | | 2420 | 2780 | 1,700,000 | |
| No.1 Dense | | 1900 | 2180 | 1,800,000 | |
| No.1 | | 1730 | 1980 | 1,700,000 | |
| No.1 Non–Dense | | 1550 | 1790 | 1,600,000 | |
| No 2 Dense | | 1610 | 1850 | 1,700,000 | |
| No.2 | | 1380 | 1590 | 1,600,000 | |
| No.2 Non–Dense | | 1260 | 1450 | 1,400,000 | |
| No 3 | | 805 | 925 | 1,400,000 | |
| Dense Select Structural | 2x10 | 2470 | 2840 | 1,900,000 | |
| Select Structural | | 2360 | 2710 | 1,800,000 | |
| Non–Dense Select Structural | | 2130 | 2450 | 1,700,000 | |
| No.1 Dense | | 1670 | 1920 | 1,800,000 | |
| No.1 | | 1500 | 1720 | 1,700,000 | |
| No.1 Non–Dense | | 1380 | 1590 | 1,600,000 | |
| No.2 Dense | | 1380 | 1590 | 1,700,000 | |
| No.2 | | 1210 | 1390 | 1,600,000 | |
| No.2 Non–Dense | | 1090 | 1260 | 1,400,000 | |
| No.3 | | 690 | 795 | 1,400,000 | |
| Dense Select Structural | 2x12 | 2360 | 2710 | 1,900,000 | |
| Select Structural | | 2190 | 2510 | 1,800,000 | |
| Non–Dense Select Structural | | 2010 | 2310 | 1,700,000 | |
| No.1 Dense | | 1550 | 1790 | 1,800,000 | |
| No.1 | | 1440 | 1650 | 1,700,000 | |
| No.1 Non–Dense | | 1320 | 1520 | 1,600,000 | |
| No.2 Dense | | 1320 | 1520 | 1,700,000 | |
| No 2 | | 1120 | 1290 | 1,600,000 | |
| No.2 Non–Dense | | 1040 | 1190 | 1,400,000 | |
| No.3 | | 660 | 760 | 1,400,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Spruce–Pine–Fir** | | | | | |
| Select Structural | 2x4 | 2155 | 2480 | 1,500,000 | NLGA |
| No.1 /No.2 | | 1510 | 1735 | 1,400,000 | |
| No.3 | | 865 | 990 | 1,200,000 | |
| Stud | | 855 | 980 | 1,200,000 | |
| Construction | | 1120 | 1290 | 1,300,000 | |
| Standard | | 635 | 725 | 1,200,000 | |
| Utility | | 290 | 330 | 1,100,000 | |
| Select Structural | 2x6 | 1870 | 2150 | 1,500,000 | |
| No.1 /No.2 | | 1310 | 1505 | 1,400,000 | |
| No.3 | | 750 | 860 | 1,200,000 | |
| Stud | | 775 | 895 | 1,200,000 | |
| Select Structural | 2x8 | 1725 | 1985 | 1,500,000 | |
| No. 1 / No.2 | | 1210 | 1390 | 1,400,000 | |
| No.3 | | 690 | 795 | 1,200,000 | |
| Select Structural | 2x10 | 1580 | 1820 | 1,500,000 | |
| No.1/No.2 | | 1105 | 1275 | 1,400,000 | |
| No.3 | | 635 | 725 | 1,200,000 | |
| Select Structural | 2x12 | 1440 | 1655 | 1,500,000 | |
| No.1 /No.2 | | 1005 | 1155 | 1,400,000 | |
| No.3 | | 575 | 660 | 1,200,000 | |
| **Spruce–Pine–Fir (South)** | | | | | |
| Select Structural | 2x4 | 2245 | 2580 | 1,300,000 | NELMA NSLB WCLIB WWPA |
| No.1 | | 1465 | 1685 | 1,200,000 | |
| No.2 | | 1295 | 1490 | 1,100,000 | |
| No.3 | | 735 | 845 | 1,000,000 | |
| Stud | | 725 | 835 | 1,000,000 | |
| Construction | | 980 | 1125 | 1,000,000 | |
| Standard | | 545 | 630 | 900,000 | |
| Utility | | 260 | 300 | 900,000 | |
| Select Structural | 2x6 | 1945 | 2235 | 1,300,000 | |
| No.1 | | 1270 | 1460 | 1,200,000 | |
| No.2 | | 1120 | 1290 | 1,100,000 | |
| No.3 | | 635 | 730 | 1000,000 | |
| Stud | | 660 | 760 | 1,000,000 | |
| Select Structural | 2x8 | 1795 | 2065 | 1,300,000 | |
| No.1 | | 1175 | 1350 | 1,200:000 | |
| No.2 | | 1035 | 1190 | 1,100,000 | |
| No.3 | | 585 | 675 | 1,000,000 | |
| Select Structural | 2x10 | 1645 | 1890 | 1,300,000 | |
| No.1 | | 1075 | 1235 | 1,200,000 | |
| No.2 | | 950 | 1090 | 1,100,000 | |
| No.3 | | 540 | 620 | 1,000,000 | |
| Select Structural | 2x12 | 1495 | 1720 | 1,300,000 | |
| No.1 | | 980 | 1125 | 1,200,000 | |
| No.2 | | 865 | 990 | 1,100,000 | |
| No.3 | | 490 | 560 | 1,000,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Western Cedars** | | | | | |
| Select Structural | 2x4 | 1725 | 1985 | 1,100,000 | WCLIB WWPA |
| No.1 | 2x4 | 1250 | 1440 | 1,000,000 | |
| No.2 | 2x4 | 1210 | 1390 | 1,000,000 | |
| No.3 | 2x4 | 690 | 795 | 900,000 | |
| Stud | 2x4 | 695 | 800 | 900,000 | |
| Construction | 2x4 | 920 | 1060 | 900,000 | |
| Standard | 2x4 | 520 | 595 | 800,000 | |
| Utility | 2x4 | 260 | 300 | 800,000 | |
| Select Structural | 2x6 | 1495 | 1720 | 1,100,000 | |
| No.1 | 2x6 | 1085 | 1245 | 1,000,000 | |
| No.2 | 2x6 | 1045 | 1205 | 1,000,000 | |
| No.3 | 2x6 | 600 | 690 | 900,000 | |
| Stud | 2x6 | 635 | 725 | 900,000 | |
| Select Structural | 2x8 | 1380 | 1585 | 1,100,000 | |
| No.1 | 2x8 | 1000 | 1150 | 1,000,000 | |
| No.2 | 2x8 | 965 | 1110 | 1,000,000 | |
| No.3 | 2x8 | 550 | 635 | 900,000 | |
| Select Structural | 2x10 | 1265 | 1455 | 1,100,000 | |
| No.1 | 2x10 | 915 | 1055 | 1,000,000 | |
| No.2 | 2x10 | 885 | 1020 | 1,000,000 | |
| No.3 | 2x10 | 505 | 580 | 900,000 | |
| Select Structural | 2x12 | 1150 | 1325 | 1,100,000 | |
| No.1 | 2x12 | 835 | 960 | 1,000,000 | |
| No.2 | 2x12 | 805 | 925 | 1,000,000 | |
| No.3 | 2x12 | 460 | 530 | 900,000 | |
| **Western Woods** | | | | | |
| Select Structural | 2x4 | 1510 | 1735 | 1,200,000 | WCLIB WWPA |
| No.1 | 2x4 | 1120 | 1290 | 1,100,000 | |
| No.2 | 2x4 | 1120 | 1290 | 1,000,000 | |
| No.3 | 2x4 | 645 | 745 | 900,000 | |
| Stud | 2x4 | 635 | 725 | 900,000 | |
| Construction | 2x4 | 835 | 960 | 1,000,000 | |
| Standard | 2x4 | 460 | 530 | 900,000 | |
| Utility | 2x4 | 230 | 265 | 800,000 | |
| Select Structural | 2x6 | 1310 | 1505 | 1,200,000 | |
| No.1 | 2x6 | 970 | 1120 | 1,100,000 | |
| No.2 | 2x6 | 970 | 1120 | 1,000,000 | |
| No.3 | 2x6 | 560 | 645 | 900,000 | |
| Stud | 2x6 | 575 | 660 | 900,000 | |
| Select Structural | 2x8 | 1210 | 1390 | 1,200,000 | |
| No.1 | 2x8 | 895 | 1030 | 1,100,000 | |
| No.2 | 2x8 | 895 | 1030 | 1,000,000 | |
| No.3 | 2x8 | 520 | 595 | 900,000 | |
| Select Structural | 2x10 | 110 | 1275 | 1,200,000 | |
| No.1 | 2x10 | 820 | 945 | 1,100,000 | |
| No.2 | 2x10 | 820 | 945 | 1,000,000 | |
| No.3 | 2x10 | 475 | 545 | 900,000 | |
| Select Structural | 2x12 | 1005 | 1155 | 1,200,000 | |
| No.1 | 2x12 | 750 | 860 | 1,100,000 | |
| No.2 | 2x12 | 750 | 860 | 1,000,000 | |
| No.3 | 2x12 | 430 | 495 | 900,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" Normal Duration | Snow Loading | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| **White Oak** | | | | | |
| Select Structural | 2x4 | 2070 | 2380 | 1,100,000 | NELMA |
| No.1 | | 1510 | 1735 | 1,000,000 | |
| No.2 | | 1465 | 1685 | 900,000 | |
| No.3 | | 820 | 940 | 800,000 | |
| Stud | | 820 | 945 | 800,000 | |
| Construction | | 1095 | 1255 | 900,000 | |
| Standard | | 605 | 695 | 800,000 | |
| Utility | | 290 | 330 | 800,000 | |
| Select Structural | 2x6 | 1795 | 2065 | 1,100,000 | |
| No.1 | | 1310 | 1505 | 1,000,000 | |
| No.2 | | 1270 | 1460 | 900,000 | |
| No.3 | | 710 | 815 | 800,000 | |
| Stud | | 750 | 860 | 800,000 | |
| Select Structural | 2x8 | 1655 | 1905 | 1,100,000 | |
| No.1 | | 1210 | 1390 | 1,000,000 | |
| No.2 | | 1175 | 1350 | 900,000 | |
| No.3 | | 655 | 755 | 800,000 | |
| Select Structural | 2x10 | 1520 | 1745 | 1,100,000 | |
| No.1 | | 1105 | 1275 | 1,000,000 | |
| No.2 | | 1075 | 1235 | 900,000 | |
| No.3 | | 600 | 690 | 800,000 | |
| Select Structural | 2x12 | 1380 | 1585 | 1,100,000 | |
| No.1 | | 1005 | 1155 | 1,000,000 | |
| No.2 | | 980 | 1125 | 900,000 | |
| No.3 | | 545 | 630 | 800,000 | |
| **Yellow Poplar** | | | | | |
| Select Structural | 2x4 | 1725 | 1985 | 1,500,000 | NSLB |
| No.1 | | 1250 | 1440 | 1,400,000 | |
| No.2 | | 1210 | 1390 | 1,300,000 | |
| No.3 | | 690 | 795 | 1,200,000 | |
| Stud | | 695 | 800 | 1,200,000 | |
| Construction | | 920 | 1060 | 1,300,000 | |
| Standard | | 520 | 595 | 1,100,000 | |
| Utility | | 230 | 265 | 1,100,000 | |
| Select Structural | 2x6 | 1495 | 1720 | 1,500,000 | |
| No.1 | | 1055 | 1245 | 1,400,000 | |
| No.2 | | 1045 | 1205 | 1,300,000 | |
| No.3 | | 600 | 690 | 1,200,000 | |
| Stud | | 635 | 725 | 1,200,000 | |
| Select Structural | 2x8 | 1380 | 1585 | 1,500,000 | |
| No.1 | | 1000 | 1150 | 1,400,000 | |
| No.2 | | 965 | 1110 | 1,300,000 | |
| No.3 | | 550 | 635 | 1,200,000 | |
| Select Structural | 2x10 | 1265 | 1455 | 1,500,000 | |
| No.1 | | 915 | 1055 | 1,400,000 | |
| No.2 | | 885 | 1020 | 1,300,000 | |
| No.3 | | 505 | 580 | 1,200,000 | |
| Select Structural | 2x12 | 1150 | 1325 | 1,500,000 | |
| No.1 | | 835 | 960 | 1,400,000 | |
| No.2 | | 805 | 925 | 1,300,000 | |
| No.3 | | 460 | 530 | 1,200,000 | |

# 21.04(2)(a)5.
# HANDRAIL SHAPES



# APPENDIX
# EROSION CONTROL PROCEDURES
# EXAMPLES, ILLUSTRATIONS AND GUIDELINES

The following examples and illustrations of some erosion control procedures are provided for your information. Many of these examples can be found in the "Wisconsin Construction Site Best Management Practices Handbook", developed by the Wisconsin department of natural resources. Note: The Handbook is available from Document sales, 202 South Thornton Avenue, P.O. Box 7840, Madison, WI 53707–8480; phone (608) 266–3358.

Figures E–1 to E–11, depict the materials and installation of some erosion control procedures.

Also included in the appendix are examples of plot plans depicting the best management practices that will help meet the requirements of the performance standards in this code.
Figure E – 12 is an example of a site with slopes of 12 % or less and also simple slopes, i.e. all slopes occurring in one general direction. Downslope measures are required, to reduce maintenance of these measures, the upslope diversion is recommended.
Figure E – 13 is an example of a site with complex slopes (slopes occurring in more than one direction). This site also has an area where slopes that are 12–20% are going to be disturbed. The location of the erosion control procedures are clearly indicated on the plot plan, including narratives that indicated methods of permanent stabilization.
Figure E – 14 is an example of a large lot, greater than 5 acres, with slopes greater than 12% and where the area of land disturbing activity is indicated. This plan indicates the use of vegetative barriers.

Figure E – 15 explains how to determine and calculate % slopes.

Guidelines for timing the implementation of the erosion control practices and procedures in order to stabilize areas disturbed during construction of one and 2–family dwellings are included in this appendix. Dormant seeding, the guidelines for the use of vegetative buffers and the recommended maintenance for erosion control practices are also included.

For sites using either straw bales or silt fences as a perimeter control, Table E–1 is included as a guide for determining the distance between parallel fences constructed on various slopes. Perimeter measures should be installed at right angles to the direction of flow. Drainage area is to be no more than 1/4 acres (approx. 10,000 square feet) per 100 feet of perimeter control.

**TABLE E–1**
**DISTANCE BETWEEN PARALLEL STRAW BALES OR SILT FENCES**

| Slope Percent | Slope Distance (feet) |
|---|---|
| < 2% | 100 feet |
| 2 to 5% | 75 feet |
| 5 to 10% | 50 feet |
| 10 to 20% | 25 feet |
| > 20% | 15 feet |

# VEGETATIVE BARRIERS

Vegetative barriers may be used as a perimeter measure if disturbed areas above consist of slopes no greater than 6% and barriers are on a grade no steeper than 5%. Vegetative barriers are to be a minimum of 10' wide for every 50 feet of open ground draining to them. These barriers must be maintained, i.e. not driven on or destroyed. If the barriers become covered with silt or otherwise destroyed, additional perimeter measures may be required.

# TEMPORARY STABILIZATION OR MULCH CROP

**It is much easier to control erosion than to control sediment.** Temporary stabilization helps to minimize erosion and therefore the need for long term maintenance of silt fences and straw bales. Annual rye grass may be planted as a temporary cover between April 1 and September 15. If seeding is done in the spring or late summer seeding dates and slopes are 6% or less, mulch may not be necessary.

Winter rye may be planted between July 15 and October 15. These seedings should be mulched.

# LATE SEASON CONSTRUCTION MULCHING/DORMANT SEEDING

If ground is broken after September 15, mulch should be applied as soon as a rough grade is established, unless final grade and landscaping is to be completed before the next growing season. Mulch will help to reduce the raindrop impact. Seeding should not be done between September 15 and November 1 as the weather is warm enough for the seed to germinate but it will not have an opportunity to establish a root system strong enough to survive the winter. A dormant seeding may be done OVER the mulch after November 1. These seedings are risky. A split application of seed may also be made, using half in November and balance early in spring.

# WINTER CONSTRUCTION

In areas with course soils, (sands) if excavation is possible most likely a trencher can be used to install the necessary silt fence. If at all possible leave the perimeter of the site undisturbed (this is assuming the site had vegetation present prior to frost); this may be the easiest erosion control for flat sites (6% or less).

In areas that have heavy soils, (clays) close attention should be paid to the try to get perimeter measures installed prior to frost penetrating greater than 6". If ground is solidly frozen, perimeter measures that need to be trenched may have to wait to be installed when the frost first starts to come out in the spring. This does not eliminate the need to keep sediment from leaving the site. Alternate methods for controlling erosion should be considered such as the use of soil stabilizers.

# MAINTENANCE OF THE MOST COMMONLY USED EROSION CONTROL PROCEDURES

**SILT FENCES**
Repair or replacement should be done within 24 hours if fencing is torn, sagging, overtopped, blown over (laying down), shows a lack of integrity, or in any way is not functioning as designed. Sediment deposits should be removed after each storm event. Sediment deposits shall be removed when deposits reach 0.5 the above ground height of the fence. Silt fence should be removed after upland areas have been stabilized. Any sediment deposits remaining in place after the silt fence is no longer required should be dressed to conform to the existing grade, prepared and stabilized.

**STRAWBALES**
Replacement of broken or torn bales should be done within 24 hours. Sediment deposits should be removed when deposits reach 0.5 the height of the bales. Strawbales should be removed after upland areas have been stabilized. Any sediment deposits remaining in place after the strawbale barrier is no longer required should be dressed to conform to the existing grade, prepared and stabilized.

**MULCHING**
Additional mulch or matting should be applied when rills develop (rill – small, eroded ditch measuring 1" or less width).

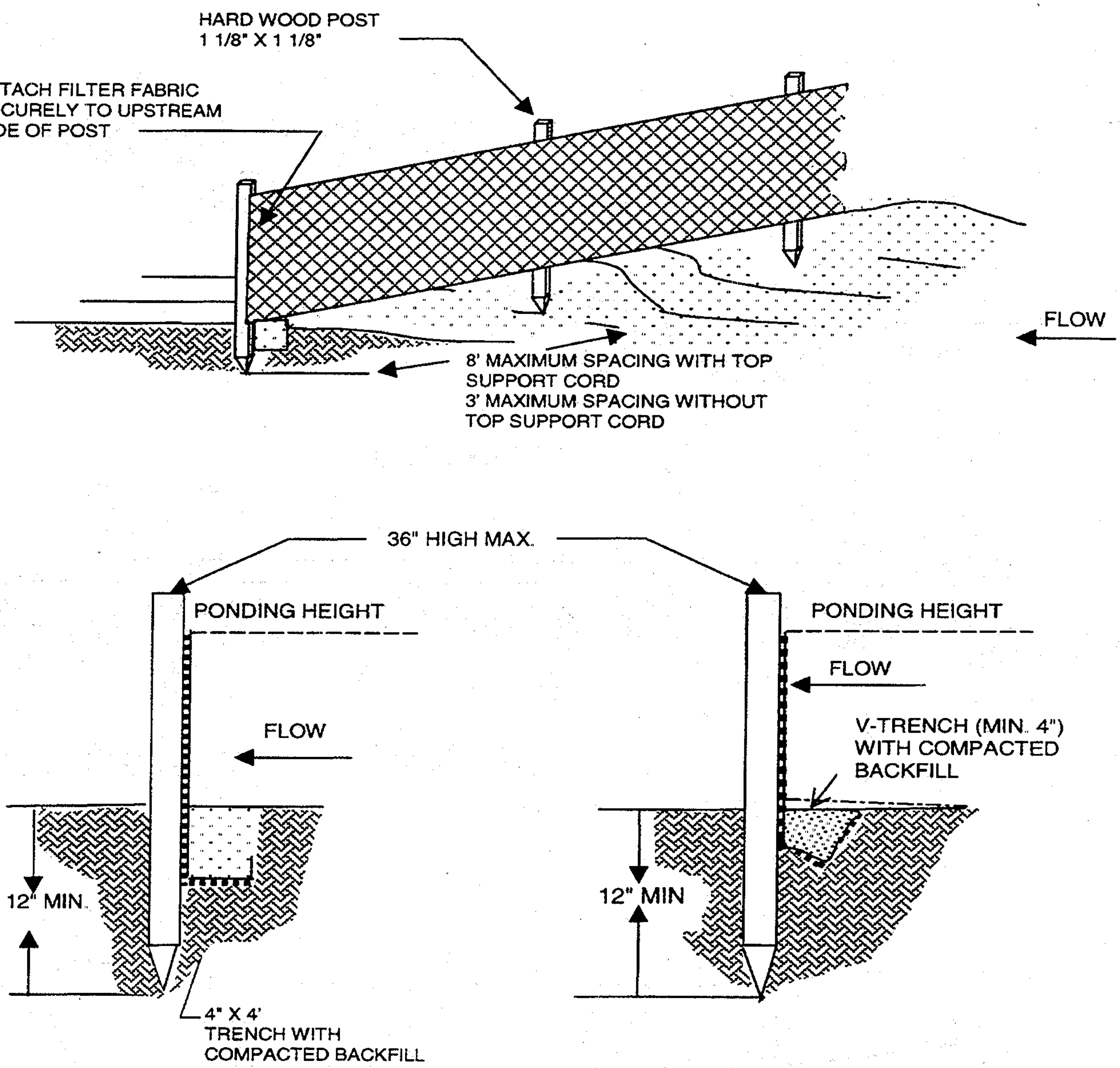
**TEMPORARY DIVERSION**
Any breaks or eroded areas of a diversion should be repaired within 24 hours.

**SEDIMENT TRAP**
Any structural deficiencies should be repaired within 24 hours. Sediment should be removed when it reaches half of the outlet height of trap.

**SODDING**
Repair or replacement of sod that has been destroyed in an area of channelized flow should be done within 24 hours after the rain event.

**INLET PROTECTION BARRIERS**
Sediment deposits should be removed when deposits reach 0.5 the height of the fence. Repair or replacement should be made to damaged barriers within 24 hours.

**TEMPORARY GRAVEL CONSTRUCTION ENTRANCE**
Rock should be maintained to meet the design criteria of 2–3" aggregate stone; 12 feet wide and 50 feet long or the distance to the foundation, whichever is less; and maintained at a depth of 6". Filter fabric (geotextile) should be used as a separation barrier between the rock and soil if soils are mainly clay or silt.




**NOTES:**

1. SILT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.

2. THE ENDS OF THE FENCE SHALL BE TURNED UPSLOPE TO PREVENT WATER FROM RUNNING AROUND THE ENDS OF THE FENCE.

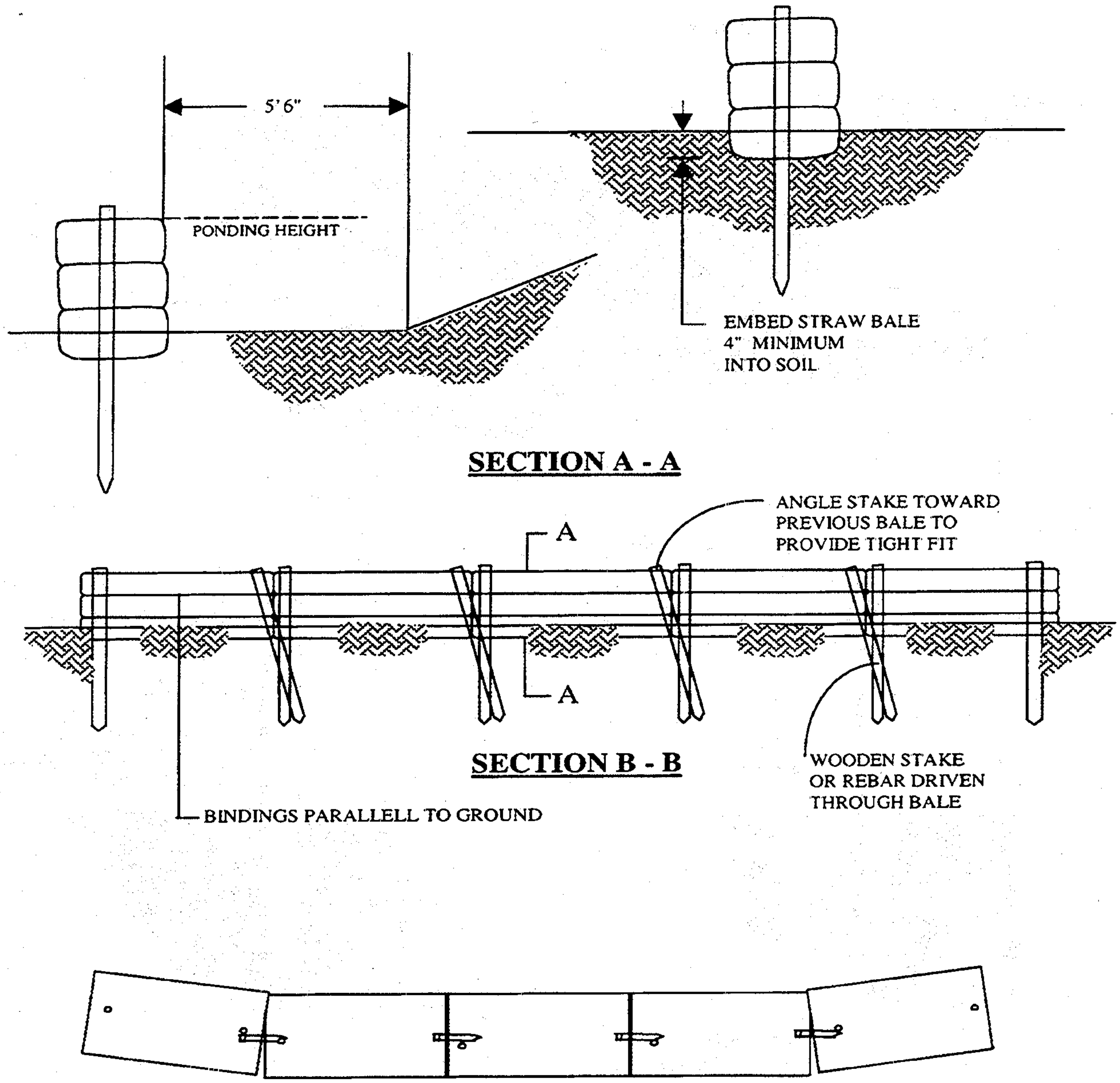
3. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY (9" MAXIMUM RECOMMENDED STORAGE HEIGHT)

4. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.

NOT TO SCALE

**FIG. E - 1**

SILT FENCE



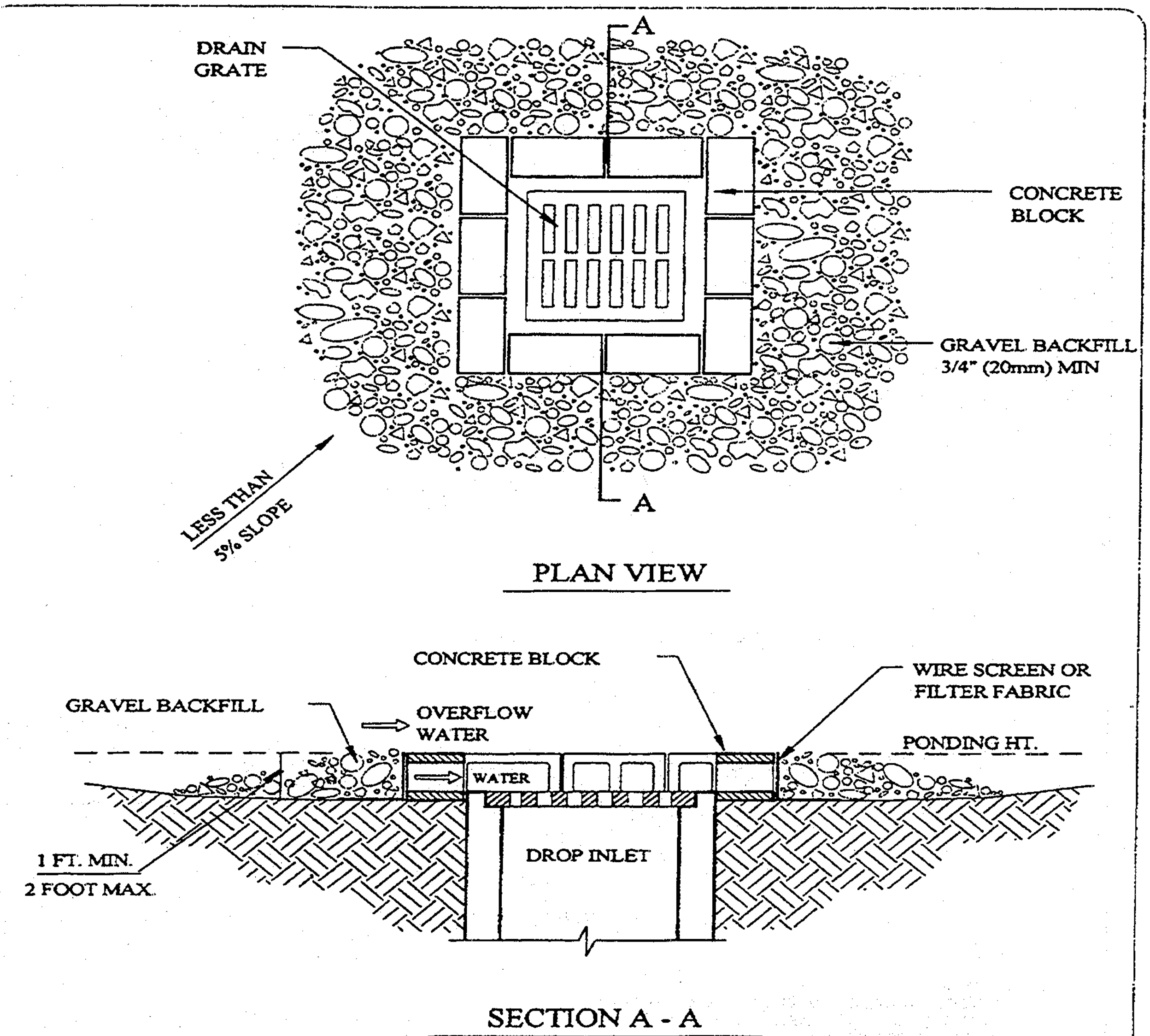

**PLAN**

**NOTES:**

1. THE STRAW BALES SHALL BE PLACED ON SLOPE CONTOUR WITH ENDS OF STRAW BALE FENCE TURNED UPSLOPE TO PREVENT FLANKING
2. BALES TO BE PLACED SO THAT BINDINGS ARE ORIENTED AROUND THE SIDES RATHER THAN ALONG THE TOPS AND BOTTOMS OF THE BALES.
3. BALES TO BE PLACED IN A ROW WITH THE ENDS TIGHTLY ABUTTING
4. KEY IN BALES 4" INTO SOIL TO PREVENT EROSION OR FLOW UNDER BALES

**FIG. E - 2**

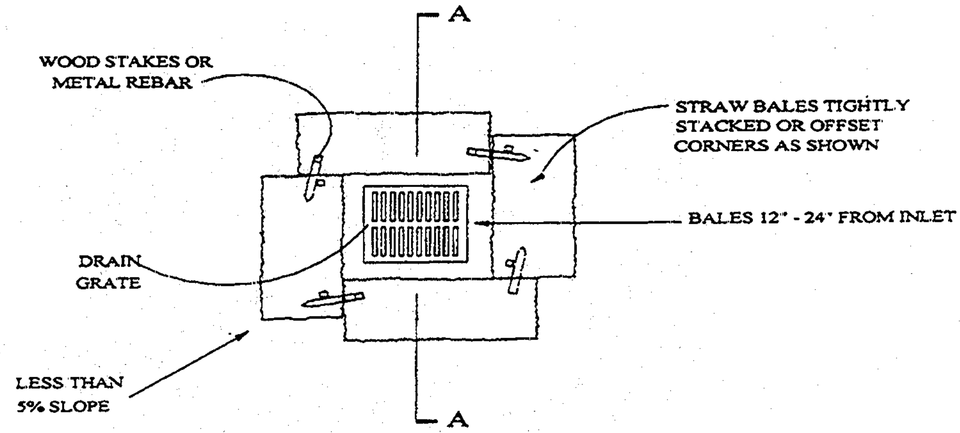
STRAW BALE FENCE



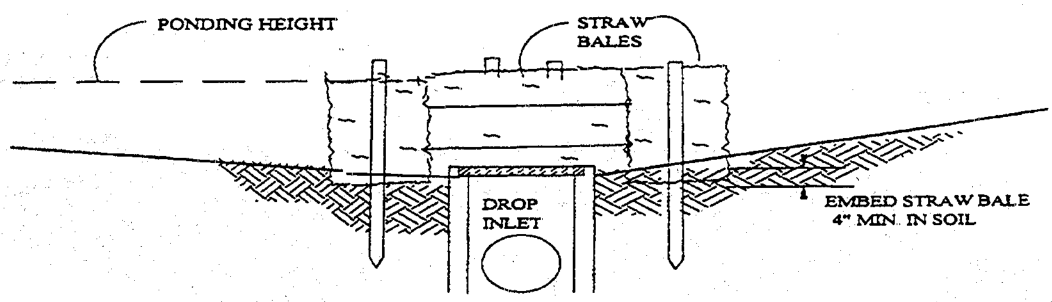

NOTES:

1. DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)
2. EXCAVATE A BASIN OF SUFFICIENT SIZE ADJACENT TO THE DROP INLET. .
3. THE TOP OF THE STRUCTURE (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BYPASSING THE INLET. A TEMPORARY DIKE MAY BE NECESSARY ON THE DOWNSLOPE SIDE OF THE STRUCTURE.

**FIG. E - 3**
**BLOCK AND GRAVEL DROP INLET SEDIMENT BARRIER**
(MAY BE USED ON PAVED SURFACES)




PLAN VIEW




SECTION A-A

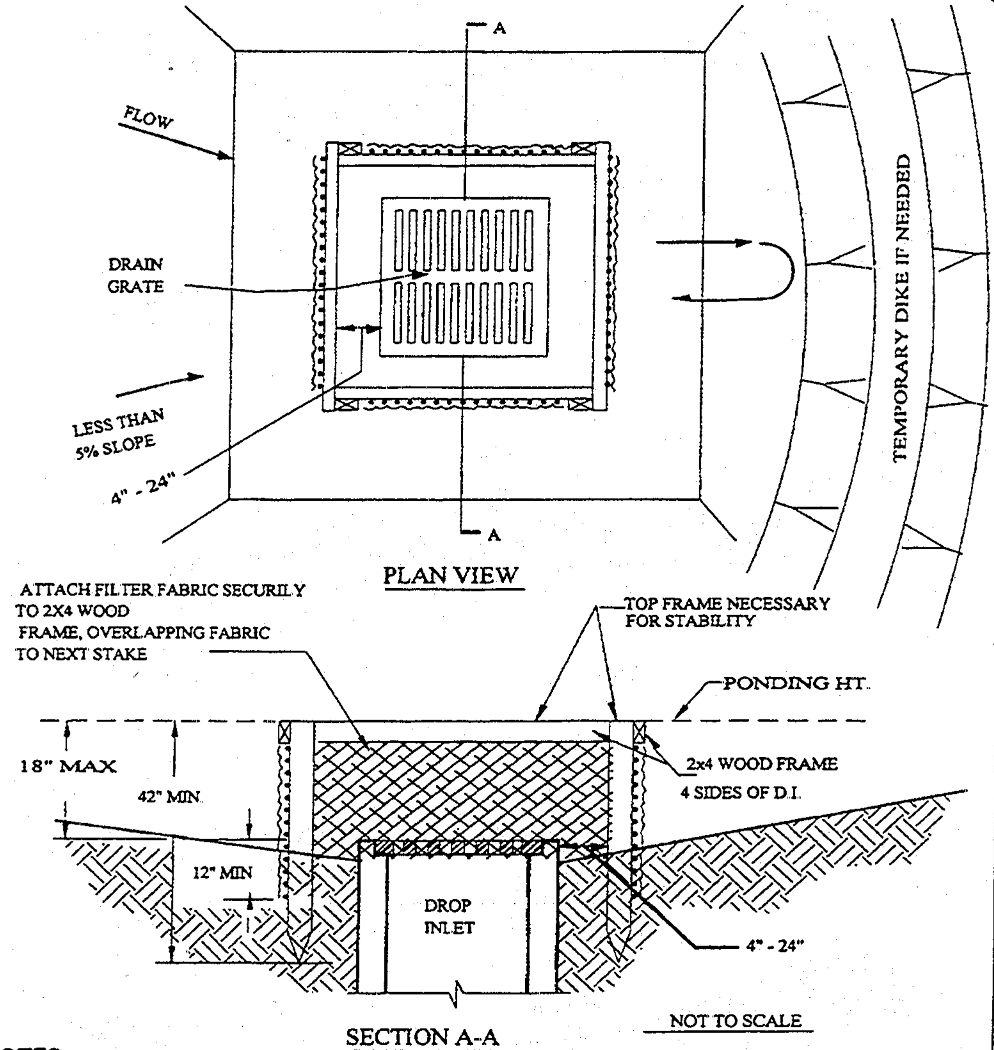
NOTES:

1. DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)

2. EMBED THE BALES 4" INTO THE SOIL AND OFFSET CORNERS OR PLACE BALES WITH ENDS TIGHTLY ABUTING.

3. THE TOP OF THE STRUCTURE (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BYPASSING THE INLET. EXCAVATION OF A BASIN ADJACENT TO THE DROP INLET OR A TEMPORARY DIKE ON THE DOWNSLOPE OF THE STRUCTURE MAY BE NECESSARY.

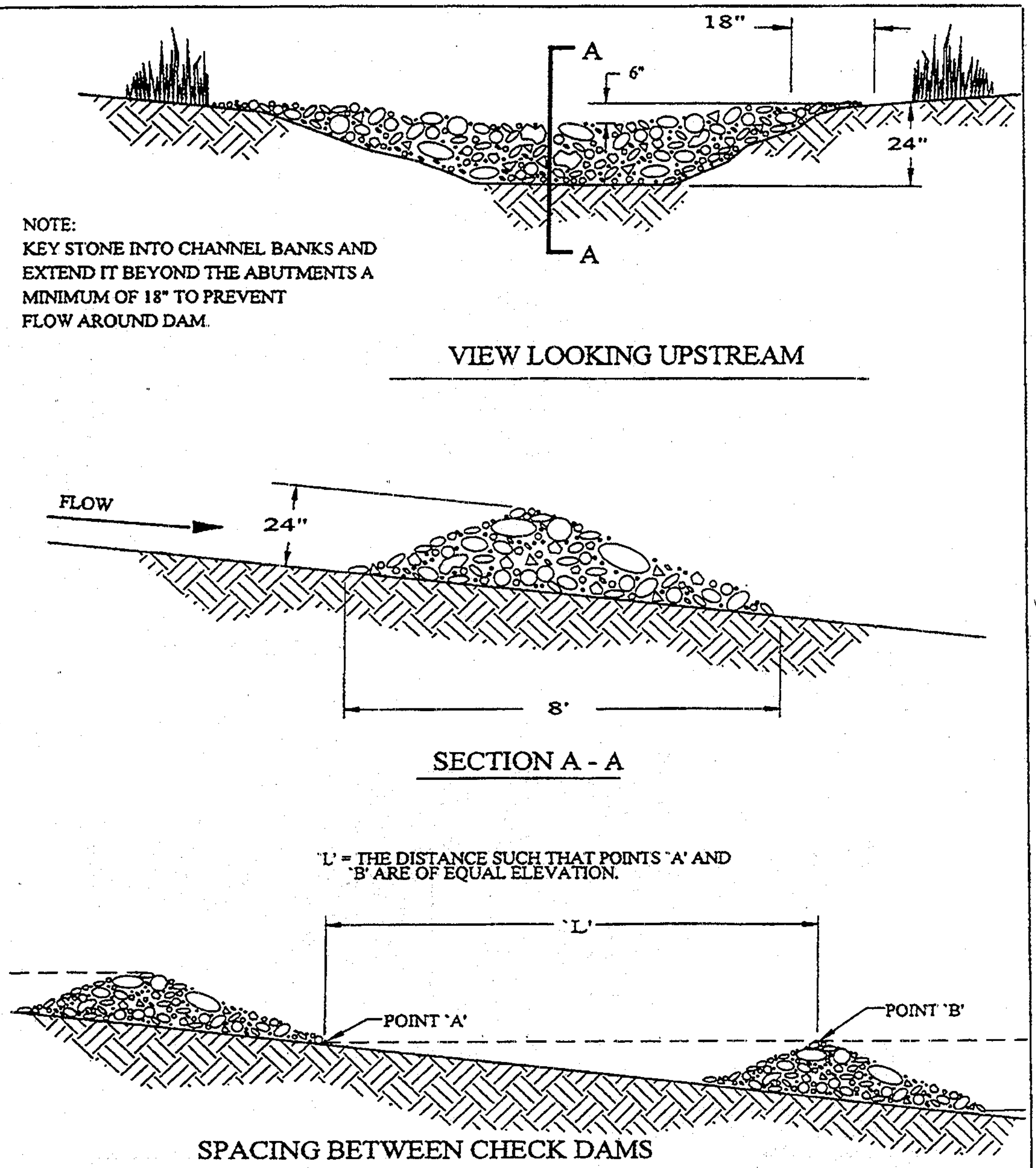
FIG. E - 4
STRAW BALE DROP INLET
SEDIMENT BARRIER
(FOR USE ON UNPAVED SURFACES)




NOTES:

1. DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)
2. USE 2"X4" WOOD OR EQUIVALENT METAL STAKES, 42" MINIMUM LENGTH.
3. INSTALL 2"X4" WOOD TOP FRAME TO INSURE STABILITY.
4. THE TOP OF THE FRAME (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BY-PASSING THE INLET. A TEMPORARY DIKE MAY BE NECESSARY ON THE DOWNSLOPE SIDE OF THE STRUCTURE.

**FIG. E - 5**
DROP INLET
SEDIMENT BARRIER
SILT FENCE
(FOR USE ON UNPAVED SURFACES)




NOT TO SCALE

**NOTES**

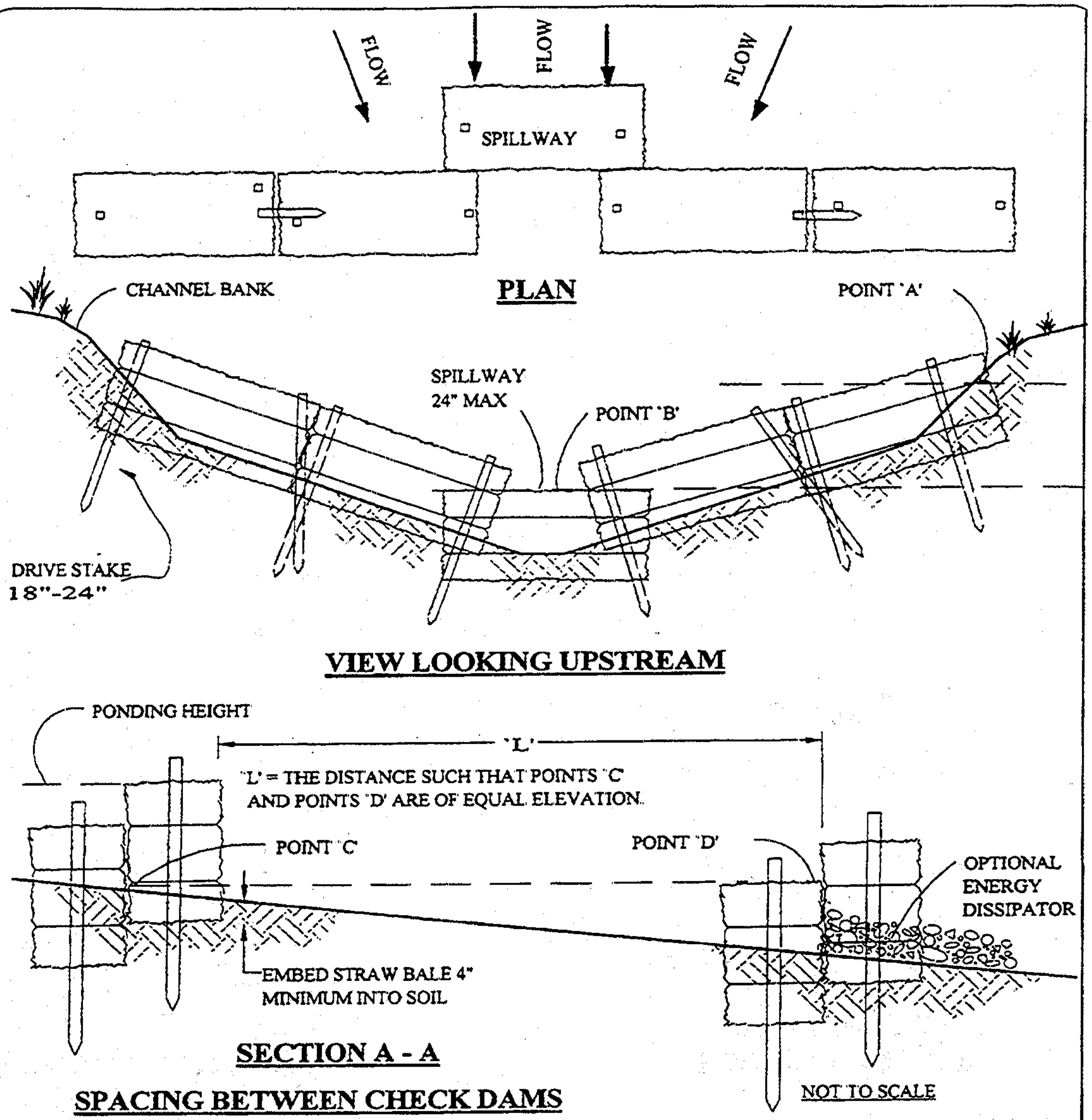
**CHECK DAMS ARE TO BE USED AS TEMPORARY GRADE STABILIZATION STURCTURES UNTIL THE DRAINGEWAY IS PERMANENTLY STABILIZED**

**CHECK DAMS MAY NOT BE USED IN A PERENNIAL STREAM**

1. DRAINAGE AREA ABOVE CHECK DAM SHALL BE LESS THAN 2 ACRES
2. THE MAXIMUM HEIGHT OF THE CHECK DAM CENTER SHALL BE 2 FT.
3. THE CENTER OF THE CHECK DAM SHALL BE 6 IN. LOWER THAN THE OUTER EDGES
4. ROCK DAMS SHALL BE CONSTRUCTED OF 2-15 IN. ROCK

'L' = THE DISTANCE SUCH THAT POINTS 'A' AND

**FIG. E - 6**
ROCK CHECK DAM




**NOTES:**

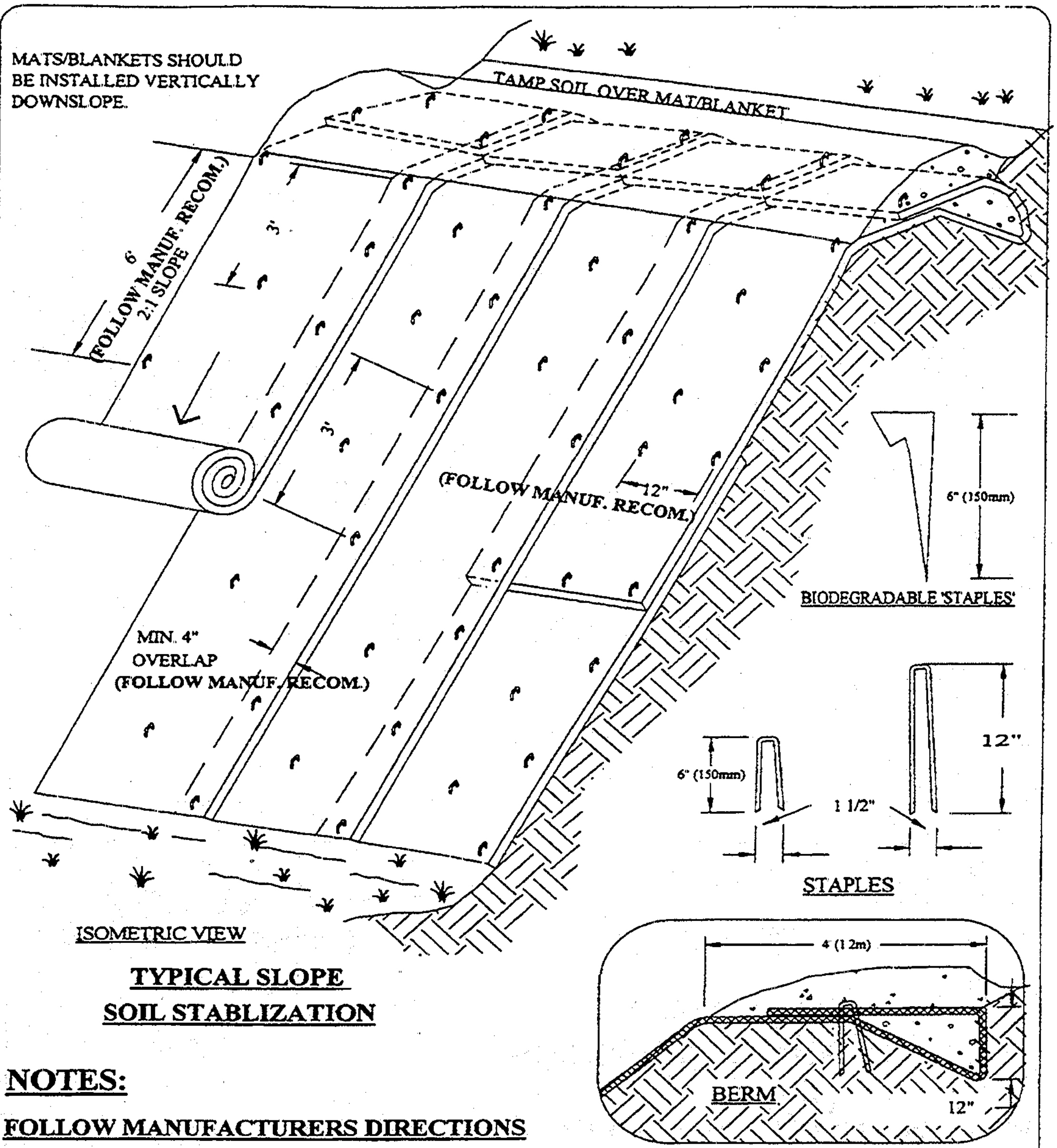
**CHECK DAMS ARE TO BE USED AS TEMPORARY GRADE STABILIZATION STRUCTURES UNTIL THE DRAINAGEWAY IS PERMANENTLY STABILIZED.**

**CHECK DAMS MAY NOT BE USED IN A PERENNIAL STREAM**

1. EMBED BALES 4" INTO THE SOIL AND 'KEY' BALES INTO THE CHANNEL BANKS
2. POINT 'A' MUST BE HIGHER THAN POINT 'B'. (SPILLWAY HEIGHT)
3. PLACE BALES PERPENDICULAR TO THE FLOW WITH ENDS TIGHTLY ABUTTING.
4. SPILLWAY HEIGHT SHALL NOT EXCEED 24".
5. INSPECT AFTER EACH SIGNIFICANT STORM, MAINTAIN AND REPAIR PROMPTLY.

**FIG. E - 7**

STRAW BALE CHECK DAM




**TYPICAL SLOPE SOIL STABLIZATION**

## NOTES:

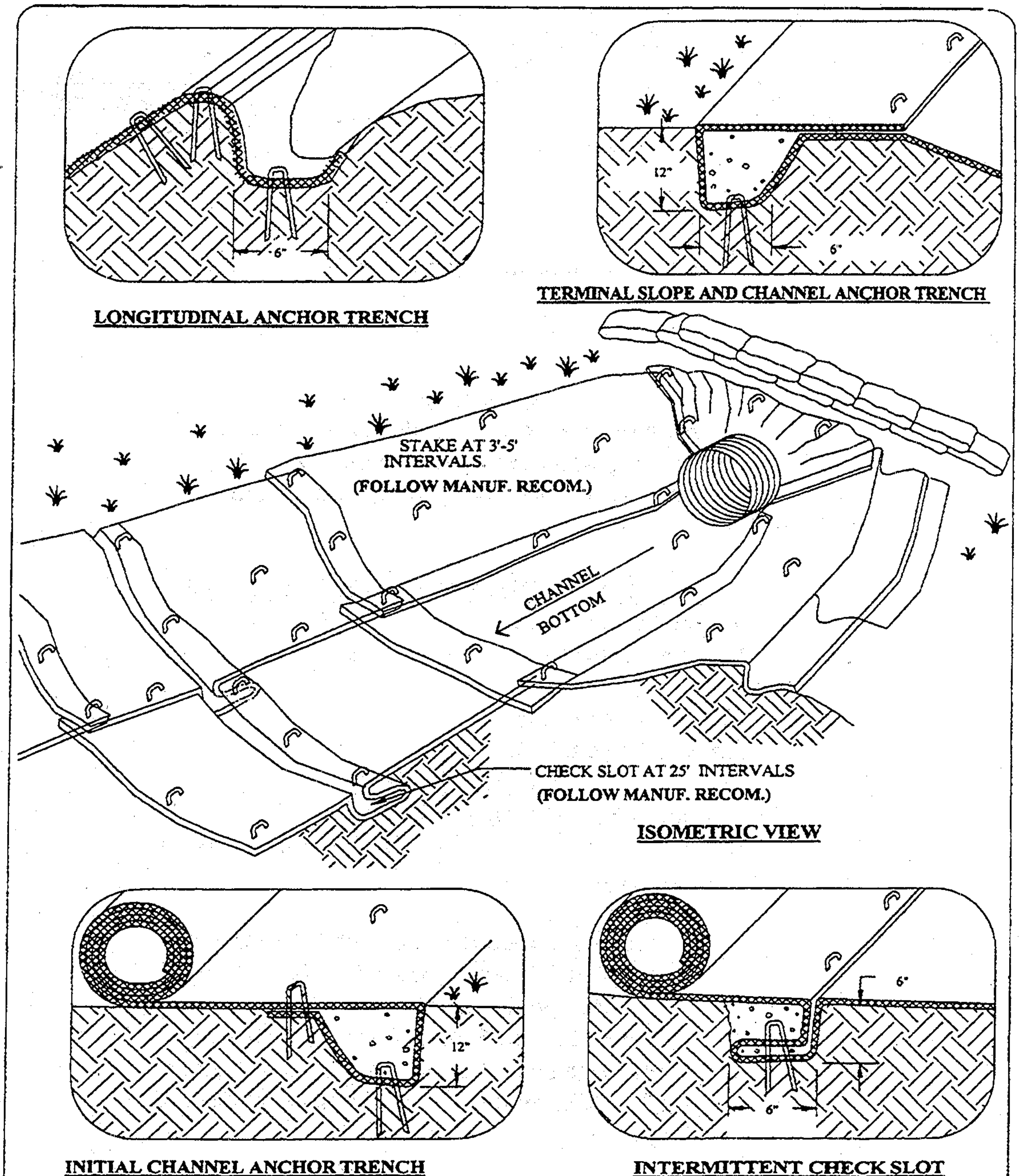
### FOLLOW MANUFACTURERS DIRECTIONS

1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/ BLANKETS SHALL HAVE GOOD SOIL CONTACT.
2. APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS.
3. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.

NOT TO SCALE

**FIG. E - 8**

**EROSION BLANKETS SLOPE INSTALLATION**



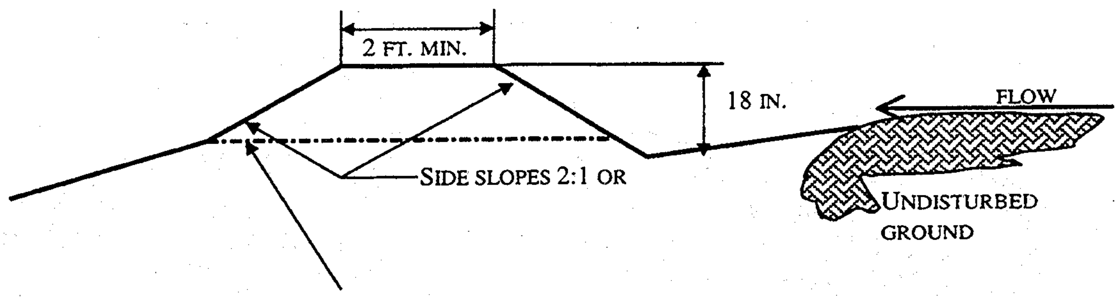

NOTES:

1. CHECK SLOTS TO BE CONSTRUCTED PER MANUFACTURERS SPECIFICATIONS.

2. STAKING OR STAPLING LAYOUT PER MANUFACTURERS SPECIFICATIONS.

**FIG. E - 9**

**EROSION BLANKETS CHANNEL INSTALLATION**




## PURPOSE

To divert runoff around disturbed areas to a location where the clean water can be discharged to existing vegetation in such a way as to prevent any negative offsite impacts.

## CONDITIONS WHERE PRACTICE APPLIES

1. Where drainage areas do not exceed 3 acres.
2. Upslope of disturbed areas where erosion is likely to occur.
3. Upslope of soil piles.
4. Above steep cut or fill slopes.

## STABILIZATION

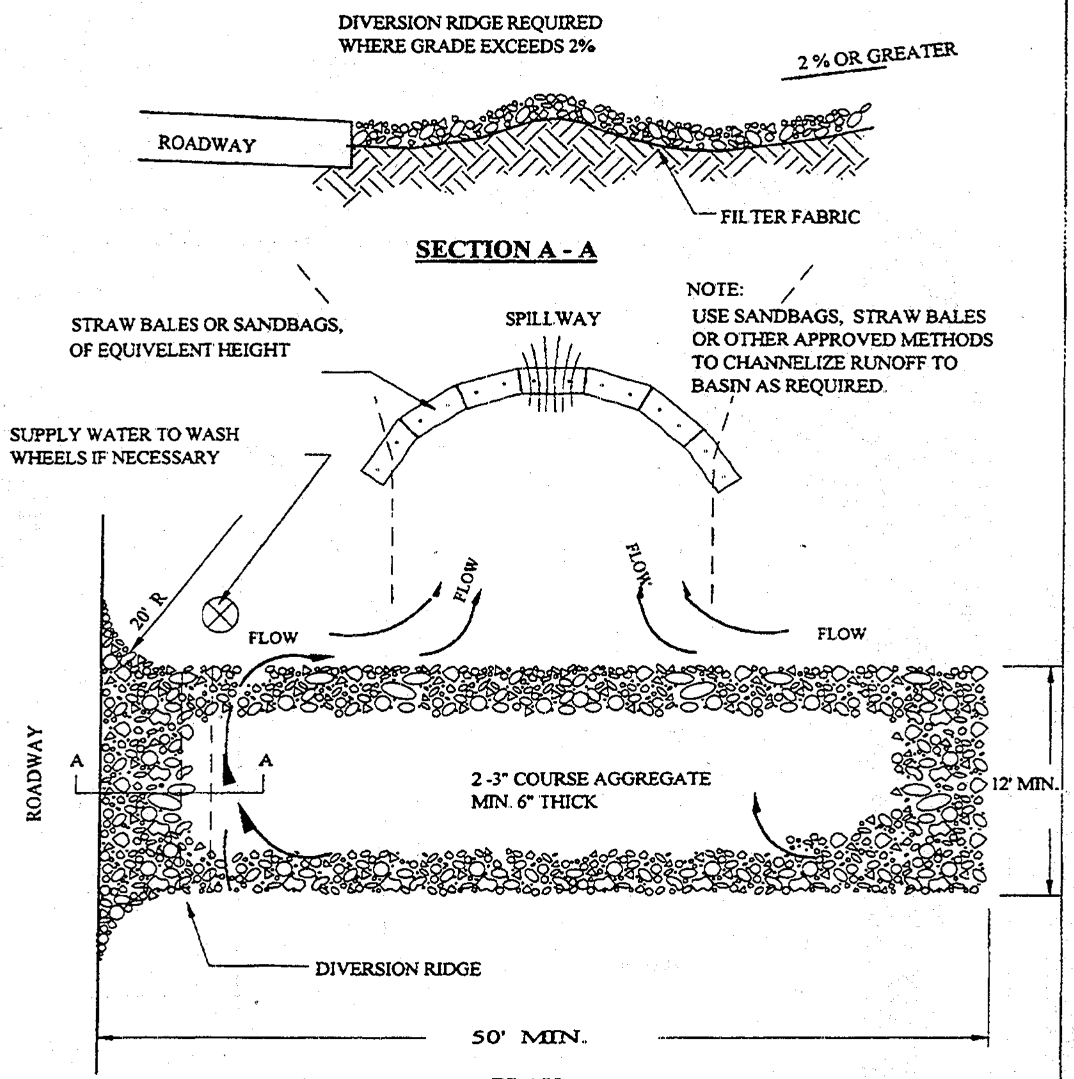
Diversions side slopes, ridge, downslope side of the berm and channel should be stabilized within 7 days of final grading by:

1. Sodding;
2. seeding and mulching in combination with filter fabric barriers or straw bale barriers;
3. covering with suitable geotextile;
4. covering with 6 mil polyethylene sheeting.

(vegetation should be used as the stabilization method if diversion is to be in place 30 days or longer)

**FIG. E – 10**

**TEMPORARY DIVERSION**




**PLAN**

**NOTES:**

IF SOILS ARE MAINLY COMPOSED OF CLAYS OR SILTS, USE OF A FILTER FABRIC AS A SEPARATION BARRIER BETWEEN THE ROCK AND SOIL IS RECOMMENDED.

1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT-OF-WAYS. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT.

2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT-OF-WAY.

3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABLIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.

**FIG. E - 11**
TEMPORARY
**GRAVEL CONSTRUCTION ENTRANCE/EXIT**

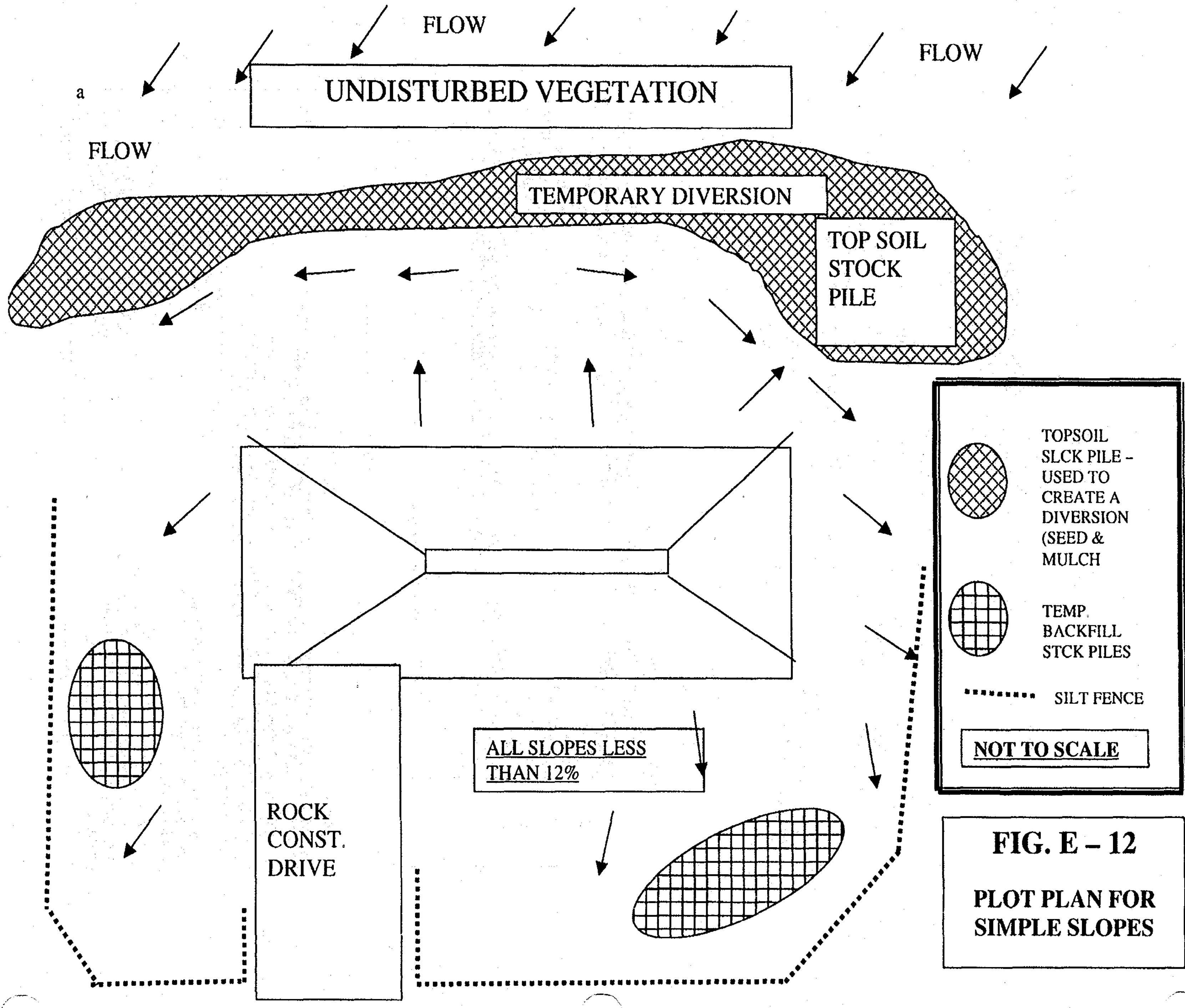



**FIG. E – 12**

**PLOT PLAN FOR SIMPLE SLOPES**

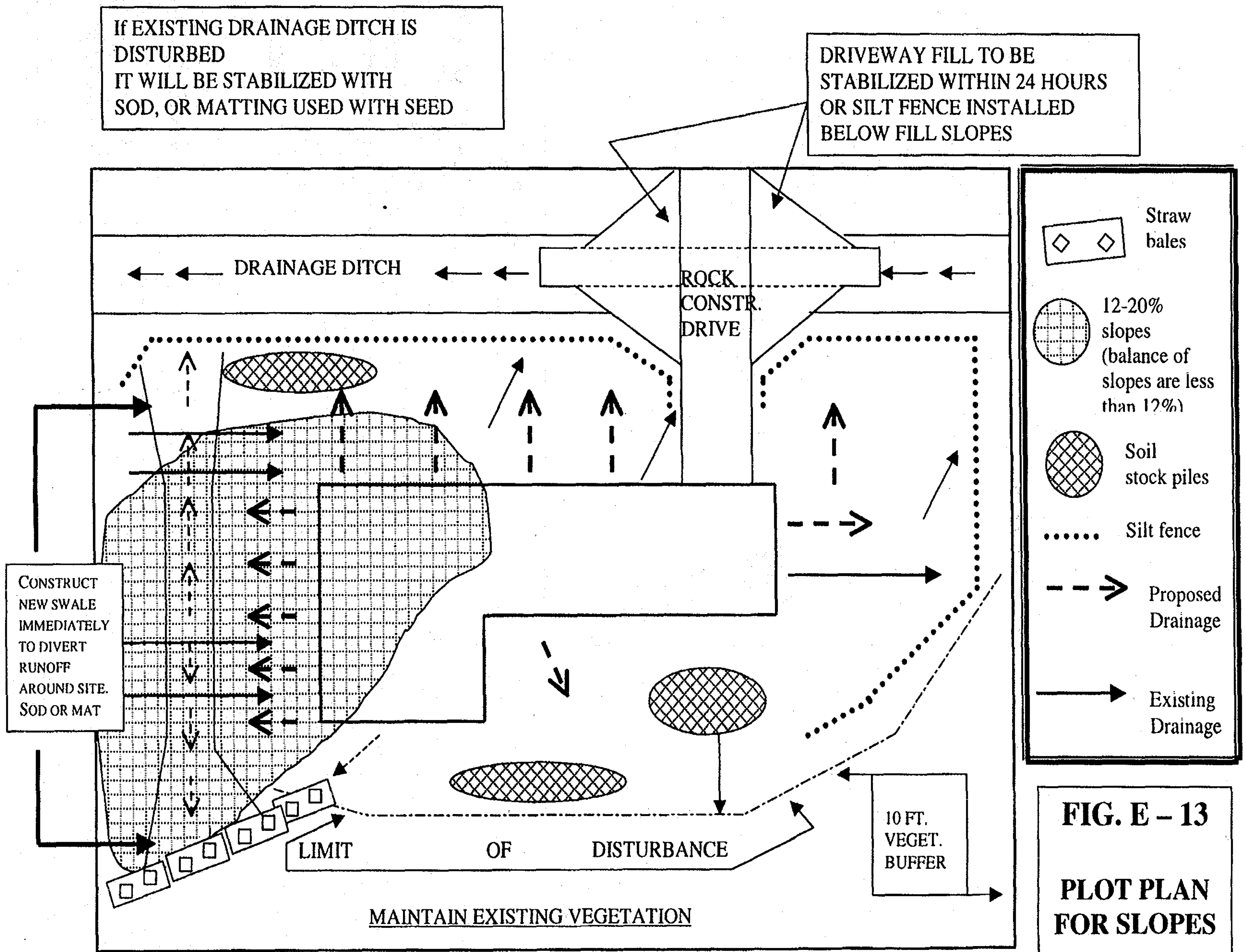
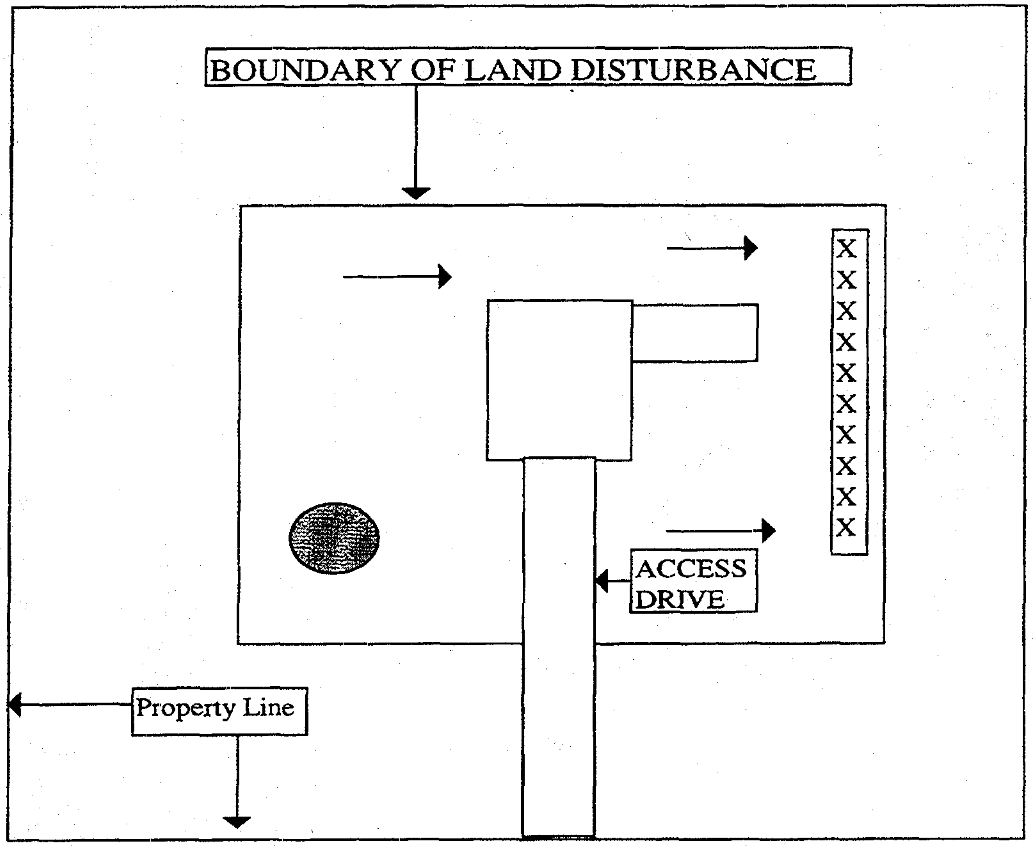
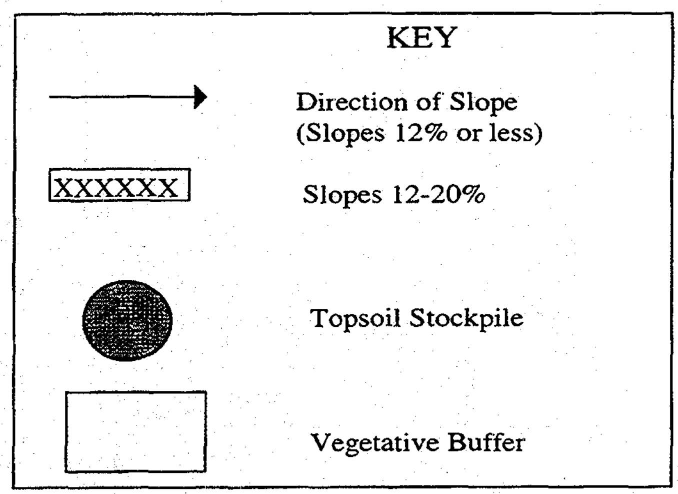



**FIG. E – 13**

**PLOT PLAN FOR SLOPES**



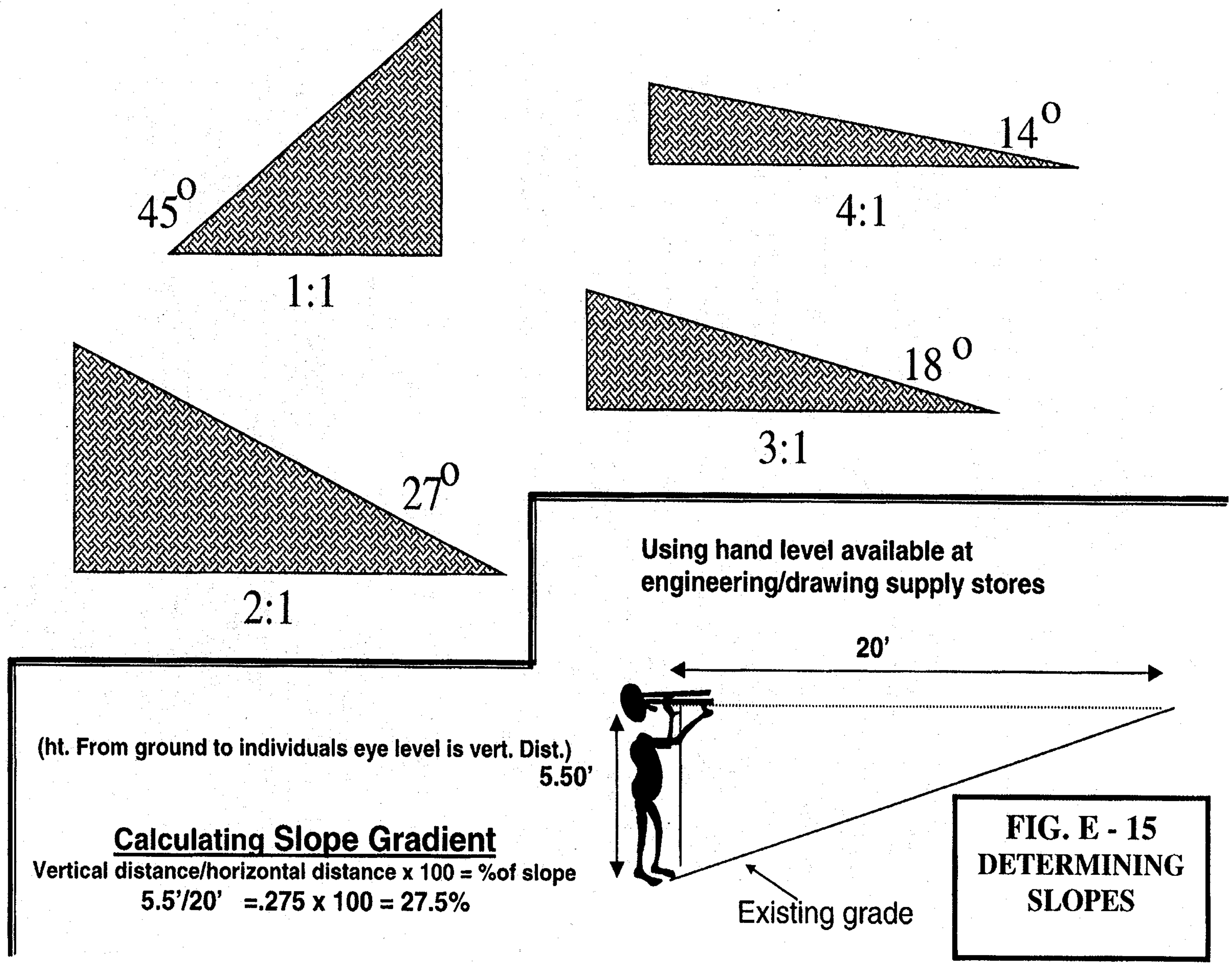




**NOTES:**

1. INDICATES BOUNDARY OF LAND DISTURBING ACTIVITY
2. INDICATE SLOPES IN DISTURBED AREAS BY RANGES:
   - 12% OR LESS
   - 12-20%
   - 20% OR STEEPER

**FIG. E – 14**

EROSION CONTROL PLAN FOR LARGE LOT




**Calculating Slope Gradient**

Vertical distance/horizontal distance x 100 = %of slope

5.5'/20' =.275 x 100 = 27.5%

**FIG. E - 15**
**DETERMINING SLOPES**

s. Comm 21.16

## Frost Protected Shallow Footings

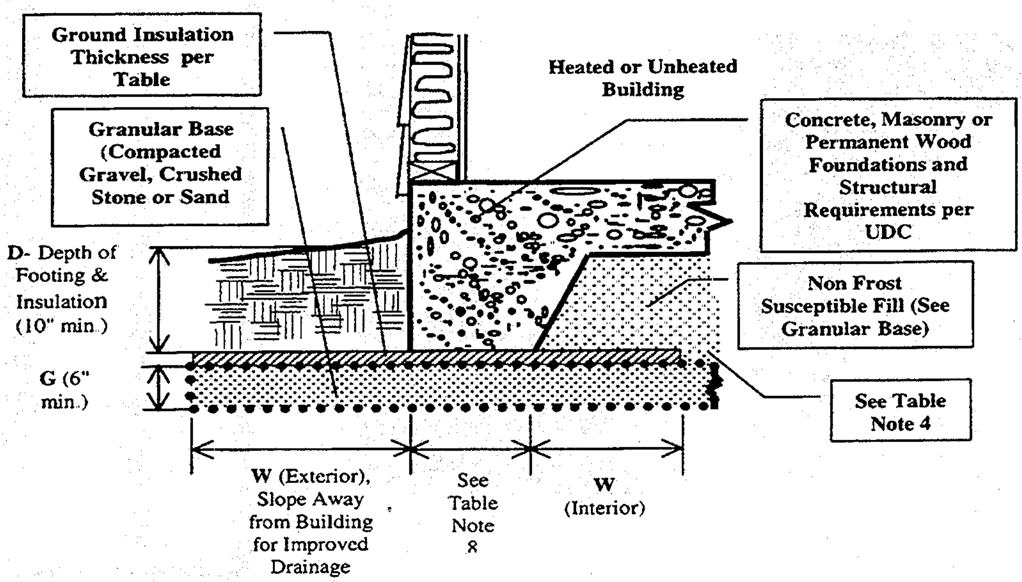
In lieu of frost walls, the following is an acceptable method.

### Minimum Ground Insulation Requirements (1)

| | | Mean Annual Temperature (2, 6) | | | Minimum Footing Depth (7, 8) | |
|---|---|---|---|---|---|---|
| Air Freezing Index (F-days) (3) | W-Insulation Width from Edge of Footing (4, 5) | 38 | 40 | ≥41 | D-Concrete Depth | G-Granular Base Thickness |
| 2250 or less | 63" | NA | NA | 2.5" | 10" | 6" |
| 2251 - 3000 | 79" | 4" | 3.5" | 3.5" | 10" | 6" |
| 3001 - 3750 | 91" | 5" | NA | NA | 10" | 6" |

Notes:

1. Recommendations are based on information found in "Design Guide for Frost-Protected shallow Foundations" prepared for the U. S. Department of Housing and Urban Development by NAHB Research Center (Instrument 3: DU100K000005987, dated June 1994
2. Units are degrees Fahrenheit. See estimate provided on Mean Annual Temperature Contour Map.
3. Air freezing index shall be based on maximum year expected for a 100 year return period. See estimate provided on AFI Contour Map.
4. Ground insulation to the building interior can be extended beneath the entire slab where it is desired to protect the entire slab from frost heave action.
5. Ground insulation to the building interior can be in one horizontal plane (as shown in the detail) and covered with non frost-susceptible fill or the insulation maybe placed directly beneath the slab.
6. Insulation thickness recommendations are for extruded polystyrene (XPS) insulation.
7. The minimum depth of concrete footing and horizontal insulation is 10". A 6" drainage layer is required under the insulation.
8. Insulation placed directly beneath the footing shall be Type IV or Type VI XPS in accordance with ASTM C578. Maximum deadload placed on the Type IV insulation shall be 1200 pounds/square foot. Maximum deadload placed on Type VI shall be 1900 psf.



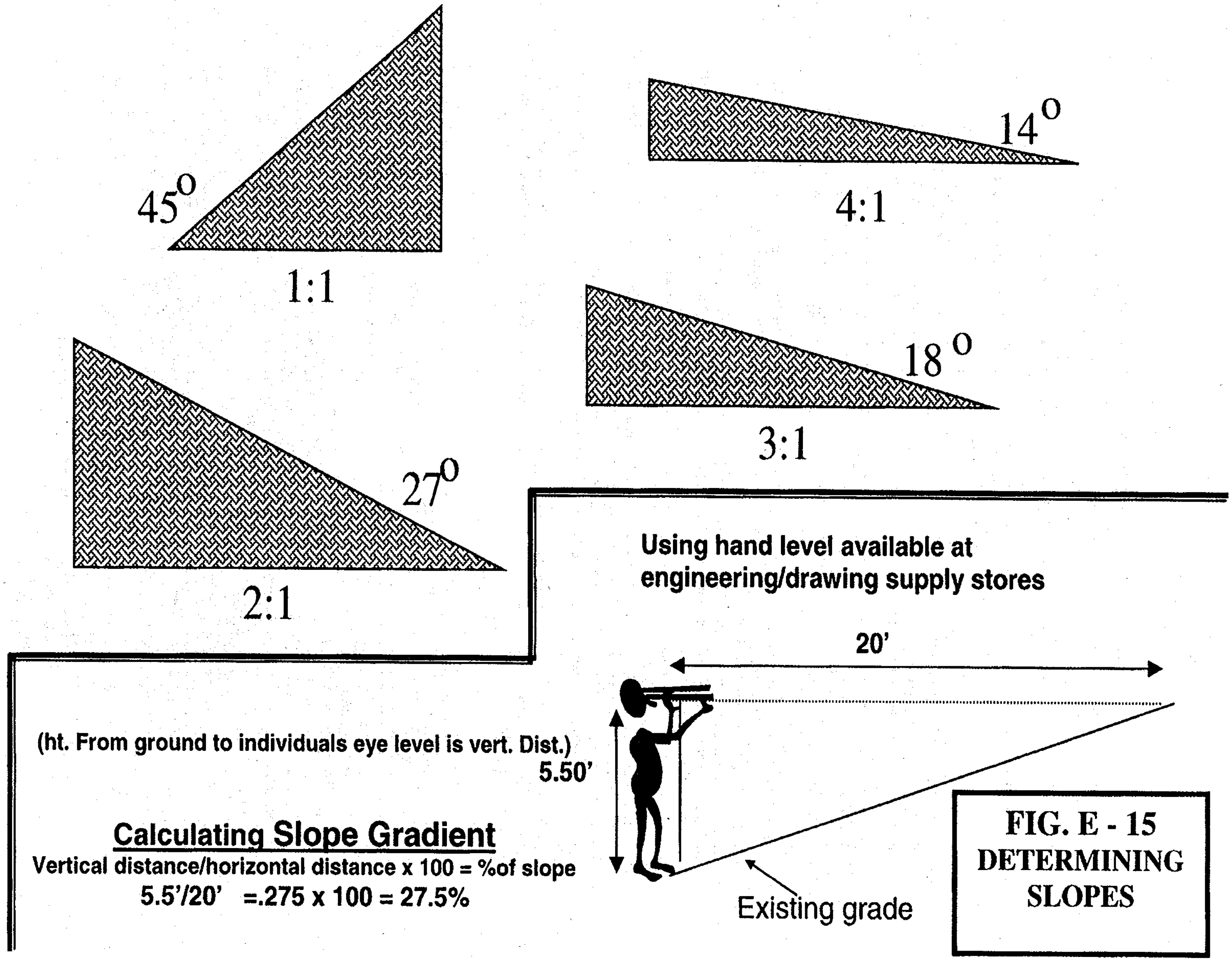



**FIG. E - 15**
**DETERMINING SLOPES**

s. Comm 21.16

## Frost Protected Shallow Footings

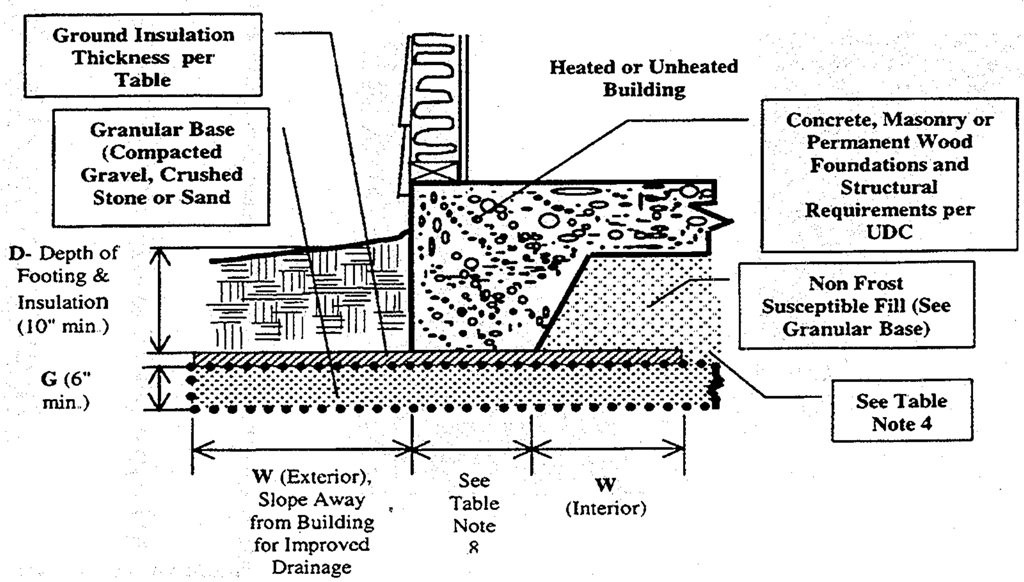
In lieu of frost walls, the following is an acceptable method.

### Minimum Ground Insulation Requirements (1)

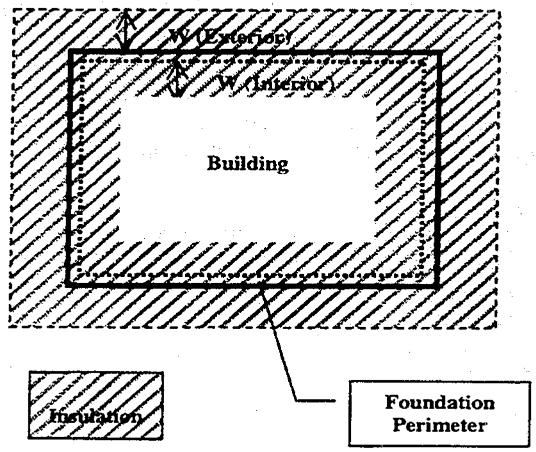
| | | Mean Annual Temperature (2, 6) | | | Minimum Footing Depth (7, 8) | |
|---|---|---|---|---|---|---|
| **Air Freezing Index (F-days) (3)** | **W-Insulation Width from Edge of Footing (4, 5)** | **38** | **40** | **≥41** | D-Concrete Depth | G-Granular Base Thickness |
| 2250 or less | 63" | NA | NA | 2.5" | 10" | 6" |
| 2251 - 3000 | 79" | 4" | 3.5" | 3.5" | 10" | 6" |
| 3001 - 3750 | 91" | 5" | NA | NA | 10" | 6" |

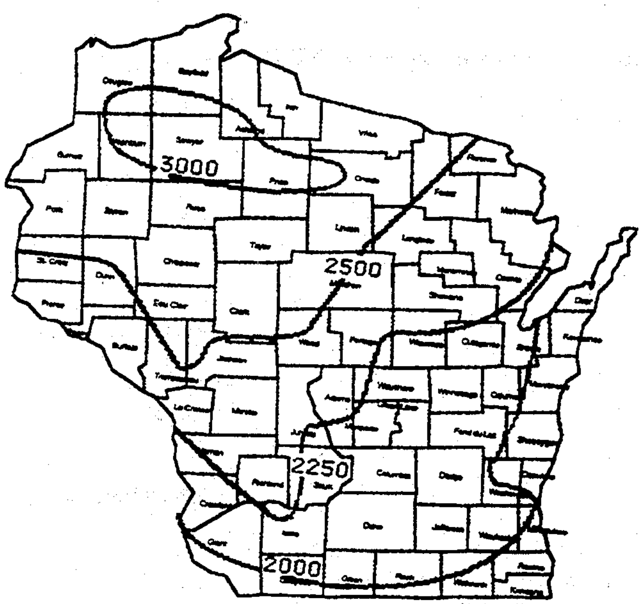
Notes:

1. Recommendations are based on information found in "Design Guide for Frost-Protected shallow Foundations" prepared for the U. S. Department of Housing and Urban Development by NAHB Research Center (Instrument 3: DU100K000005987, dated June 1994
2. Units are degrees Fahrenheit. See estimate provided on Mean Annual Temperature Contour Map.
3. Air freezing index shall be based on maximum year expected for a 100 year return period. See estimate provided on AFI Contour Map.
4. Ground insulation to the building interior can be extended beneath the entire slab where it is desired to protect the entire slab from frost heave action.
5. Ground insulation to the building interior can be in one horizontal plane (as shown in the detail) and covered with non frost-susceptible fill or the insulation maybe placed directly beneath the slab.
6. Insulation thickness recommendations are for extruded polystyrene (XPS) insulation.
7. The minimum depth of concrete footing and horizontal insulation is 10". A 6" drainage layer is required under the insulation.
8. Insulation placed directly beneath the footing shall be Type IV or Type VI XPS in accordance with ASTM C578. Maximum deadload placed on the Type IV insulation shall be 1200 pounds/square foot. Maximum deadload placed on Type VI shall be 1900 psf.

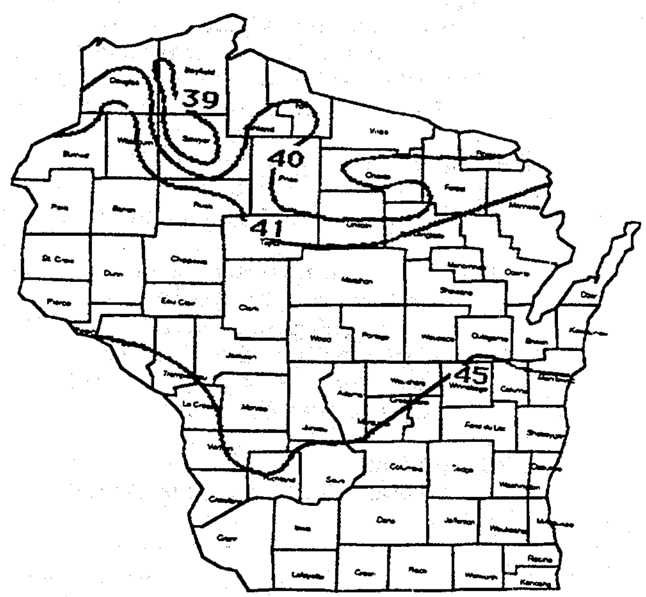


**Plan View**




**Air-Freeze Index Contour Map**



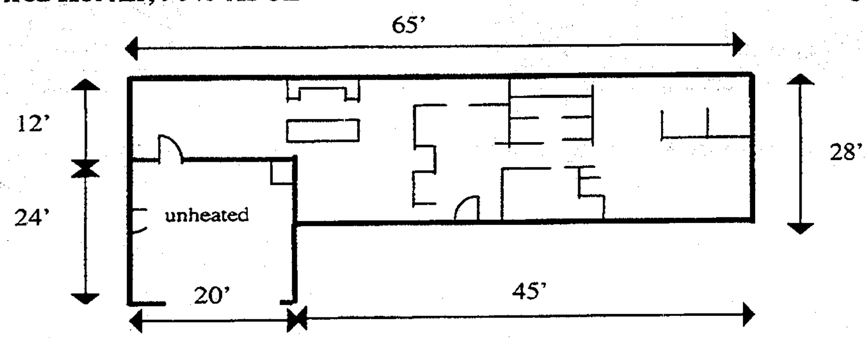

**Mean Annual Temperature Contour Map**

# UDC Energy Worksheet

The UDC Energy Worksheet is required to be submitted with building plans for plan review prior to issuance of a building permit. Following is a sample dwelling and completed Energy Worksheet and a blank worksheet after that. **The sample completed worksheet has been completed for both the Prescriptive Package and System Design Methods for demonstration purposes. Normally only one method is required to be completed for showing code compliance.**

**Sample dwelling**: Non-Electrically heated single-family dwelling located in Dane County (Zone 3). Has 1,500 square feet and 186 linear feet of perimeter building thermal envelope. Garage is not heated. Estimated infiltration rate is .3 air changes per hour. There will be 170 cfm of installed exhaust ventilation.

| | |
|---|---|
| **Gross Above-Foundation Walls:** | |
| Wall = 8.09' (97"-1/8") x 186 linear feet = 1,504 square feet | |
| Box sill = 0.81 feet (9-3/4 inches deep: sill, header, subfloor) x 186 linear feet = 151 square feet | |
| Wood 1 x 8-inch drop siding | R = 0.79 |
| **1-inch extruded polystyrene sheathing** | **R = 5** |
| **R13 batt insulation** | **R = 13** |
| 2 x 4 framing, 16 inches O.C. | R = 4.4 |
| 1/2-inch drywall finish | R = 0.56 |
| **Door area** = 38 sq ft | |
| **Insulated steel doors** | **U = 0.35** |
| **Windows:** | |
| Above-Foundation Windows - 150 sq ft | |
| **Wood, low-E, argon-filled, double-pane with 1/2" air space, rated by NFRC** | **U = 0.35** |
| Foundation wall window area = 20 square feet | |
| **Operable metal w/o thermal break, double pane** | **U = 0.87** |
| **Foundation** - 8 ft high, 1 ft exposed | |
| 8-inch poured concrete | R = 0.8 |
| **1-inch extruded polystyrene for full height** | **R = 5** |
| **Ceiling** - 1,500 square feet, standard roof trusses (no raised heel) | |
| 2 x 4 trusses, 24 inches O.C. | R = 4.4 |
| Blown fiberglass insulation | R/inch = 2.5 |
| **Insulation in cavity, 16 inches** | **R = 40** |
| Insulation over framing, 12.5 inches | R = 31.25 |
| 5/8-inch drywall finish | R = 0.56 |
| **Heating Plant** | |
| **Gas-Fired Hot Air, 90% AFUE** | **High Efficiency** |




tk\h:\udc\gentech

**Submit completed worksheet pages 3-6 with dwelling plans to local enforcing municipality.**

Project Address: ***Sample - Zone 3***

Builder: ______________________ Owner: ______________________

Worksheet Completed By: ______________________ Date: ______________________

Does dwelling unit have three kilowatts or more input capacity of permanently installed electrical space heating equipment?

☐ YES (see below) ☒ NO

You will need to apply the stricter standards shown for electrically-heated homes if you answered "YES" to the above question.

**A. Area Calculations**

Enter appropriate dimensions to obtain area values. Some calculations will not be necessary depending on home design or calculation method. These calculated areas are referenced elsewhere on this worksheet, for example, "(A.1.)".

| | |
|---|---|
| 1. Window, Skylight & Patio Door Area (overall unit area)<br>a. In Above- Foundation Walls: **150** sq. ft.<br>b. In Foundation Walls: **20** sq. ft.<br>c. Total (a. + b.) = **170** | 2. Opaque Door Area<br>a. In Above- Foundation Walls: **38** sq. ft.<br>b. In Foundation Walls: **0** sq. ft.<br>c. Total (a. + b.) = **38** |
| 3. Gross Exposed Basement Wall Area<br>***1' x 186'***<br>**186** sq. ft. | 4. Basement Wall Area Below Grade<br>***7' x 186'***<br>**1302** sq. ft. |
| 5. Opaque [1] Basement Wall Area (A.3. + A.4. - A.1.b.- A.2.b.)<br>***186 + 1302 - 20 - 0***<br>**1468** sq. ft.<br>If the exposed area of A.3. is greater than the below grade area of A.4., add A.5. to A.7 and cross out the number in this cell. | 6. Gross Heated Above-Foundation Wall Area, **including boxsill**<br>***1504 + 151***<br>**1655** sq. ft. |
| 7. Above Foundation Code Wall Area (A.6. + A1.b. + A.2.b.)<br>***1655 + 20 + 0***<br>**1675** sq. ft. | 8. Opaque [1] Above-Foundation Wall Area (A.6. - A1.a. - A.2.a.)<br>***1655 - 150 - 38***<br>**1467** sq. ft. |
| 9. Floor Area Over Interior Unconditioned Spaces Less Than 50°<br>**0** sq. ft. | 10. Insulated Roof Or Ceiling (less skylights)<br>***28 x 45 = 1260***<br>***12 x 20 = 240***<br>**1500** sq. ft. |
| 11. Exterior Floor Area (Overhangs)<br>**0** sq. ft. | 12. Crawl Space Wall Area<br>**0** sq. ft. |
| 13. Slab On Grade (above or less than 12 inches below grade)<br>**0** lineal feet of slab perimeter | 14. Total Heated Envelope Area (A.5 + A.7 + A.9 + A.10 +A.11 + A.12 +(A.13. X 2'))<br>***1468 + 1675 + 0 + 1500 + 0 + 0 + 0***<br>**4643** sq. ft. |
| 15. Percent Glazing (for Prescriptive Package Method, Section B, only) (A.1.c. ÷ A.7. X 100%)<br>***170 ÷ 1675 x 100%***<br>**10.2** % | 16. Windows Description - Above-Foundation Windows:<br>Frame type: ☒ Wood or Wood Clad ☐ Vinyl ☐ Metal<br>Glazing type: ☒ Dual ☐ Triple ☐ Dual w/storm panel<br>Dual-Glazing Air Space: ☐ 1/4' ☐ 3/8" ☒ 1/2" or more<br>Features: ☒ Low-E ☒ Argon-filled ☐ Suspended film<br>Foundation Windows: ☐ Vinyl ☒ Metal |

**B. Prescriptive Package Method (Skip this section if using the System Design Method of Sections C-F)**
The prescriptive package method is the simplest method for determining compliance with the UDC insulation and window requirements. To use the prescriptive package method, enter your actual design values in the "Actual " row below. **For a component, with two or more areas of different insulation levels, such as windows,** either use the least insulating value for both areas or use the Weighted Average tables below. Multiply your % glazing by the glazing U-value to obtain your "Glazing Factor". Find the Prescriptive Table that applies to your space heating fuel and sheathing type. Select a package from the table that most closely matches the construction indicated on your plans. **Do not exceed the package U-values or glazing factor or fall below the package R-values with your design.** Transfer the R-Values and U-values to the blank table below in the "Allowed" row. Then proceed to Section F. See page 2 for detailed instructions for this section.

| | Package # | % glazing | U glazing | Glazing Factor (% glazing × U glazing) | R wall | R ceiling | R Bsmt Crawl Space, Slab or Floor | U door | U overall | Equip. Eff. |
|---|---|---|---|---|---|---|---|---|---|---|
| Actual | ------ | *10.2* % (A.15) | *0.41* | *0.042* | *R13 + 5* | *R40* | *R5* | *0.35* | ---------- | *High* |
| Allowed | *45* | ---------------- | ------------ | *0.0504* Max | *R18, I* Min | *R40* Min | *R5* Min | *0.35* Max | *0.086* | *High* |

(Please go to Section F.)

**Optional R-Value/U-Value Weighted Average Table** for Component: *Windows*

| Component Construction Description | R Value | U-Value (1÷R Value) | Area (sq ft) | U-Value × Area (UA) |
|---|---|---|---|---|
| *Basement windows* | | *0.87* | *20* | *17.4* |
| *Above-foundation windows* | | *0.35* | *150* | *52.5* |
| | | | | |
| | | | Total Area = *170* | Total UA = *69.9* |

*69.9* (Total UA) ÷ *170* (Total Area) = *0.41* (Weighted Average U-Value (for windows or doors))

____ (Total Area) ÷ ____ (Total UA) = ____ (Weighted Average R-Value (for all other components))

**Optional R-Value/U-Value Weighted Average Table** for Component:

| Component Construction Description | R Value | U-Value (1÷R Value) | Area (sq ft) | U-Value × Area (UA) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | Total Area = | Total UA = |

____ (Total UA) ÷ ____ (Total Area) = ____ (Weighted Average U-Value (for windows or doors))

____ (Total Area) ÷ ____ (Total UA) = ____ (Weighted Average R-Value (for all other components))

***Because the sample house fit a Package, you would normally skip ahead to Section F. For demonstration purposes here. the System Design Method is also completed.***

**C. Code-Allowed Heat Loss For System Design Method**
Enter area values from Section A as notated and temperature differences per footnote 2 into this table and then multiply across by the electric or non-electric code-required U-value. Total the right column to find the total allowed heat loss factor.

| Component | Area From Sect A. | × Required U-Value | | = Heat Loss UA |
|---|---|---|---|---|
| | | ☒ NON-ELEC | ☐ ELECTRIC | |
| 1. Opaque Basement Wall [2] | *1468* (A.5.) | 0.077 [3] | 0.077 [3] | *113* |
| 2. Above Foundation Code Wall | *1675* (A.7.) | 0.110 | 0.080 | *184* |
| 3. Floor Over Interior Unconditioned Space | (A.9.) | 0.050 | 0.050 | |
| 4. Roof or Ceiling | *1500* (A.10.) | 0.026 | 0.020 | *39* |
| 5. Floor Over Exterior | (A.11.) | 0.033 | 0.033 | |
| 6. Crawl Space Wall | (A.12.) | 0.060 | 0.060 | |
| 7. Slab On Grade ☐ Unheated<br>☐ Heated [3] | (A.13.) Lin. ft. | 0.72 'F'<br>0.70 'F' | 0.68 'F'<br>0.68' F' | |
| 8. Subtotal | | | | *336* |
| 9. Credit for High Efficiency Heating Plant: 1.18 for furnace or boiler >90% AFUE; 1.15 for heat pump> 7.8 HPSF, Otherwise use 1.0 | | | | × *1.18* |
| 10. | | **Total Code-Allowed Heat Loss Factor** | | *396.5* |

**D. System Design Method - Actual 'U' Values Of Your Home's Components**

**D.1. Above-Foundation Components** - If applicable, check the appropriate typical component constructions listed below, and use the pre-calculated U values. If your wall construction is not listed, you may obtain a pre-calculated U value from the default U-Value tables in the UDC Appendix. (Note that the default Table 2 Wood Frame U-values assume no insulating sheathing which penalizes you if your wall does have insulating sheathing, then you may need to use the Manual Calculation section below.) If you are using exterior metal framing, then you must use the Metal-Frame Wall U-Values of the UDC Appendix. If your component construction is not listed here or in the default tables, you need to use the Manual Calculation section below to manually enter R-values for the different layers of building materials from the Typical Thermal Properties of Building Materials Table of the UDC Appendix, ASHRAE Fundamentals Manual or manufacturer's specifications. Total them across and then obtain the U-value by taking the reciprocal (1/R) of the total R-value.

| | | |
|---|---|---|
| **Above-Foundation Walls** | ☐ 2X4, 16" O.C., R-13 batt, R-1 board: U - .079<br>☐ 2X6, 16" O.C., R-19 batt, R-1 board: U - .059 | ☐ 2X4, 16" O.C., R-13 batt, R-5 board: U - .061<br>☐ 2X6, 16" O.C., R-19 batt, R-5 board: U - .049 |
| ☐ Other - describe: | | U - from Default Table |
| **Roof or Ceiling** | ☐ 2X4 truss, 24" O.C., with R-38 insulation: U - .030<br>☐ 2X12 cathedral ceiling, 16" O.C., with R-38 insulation U - .027 | ☐ 2X4 truss, 24" O.C., with R-52 insulation: U - .025 |
| ☒ Other - describe: ***R40 with regular trusses*** | | U - ***0.029*** from Default Table ***1*** |
| **Floor Over Exterior or Unconditioned Space** | ☐ 2X10 joists, 16" O.C., R-19 batt: U - .047 | |
| ☐ Other - describe: | | U - from Default Table |

**Optional Manual U-Value Calculation (if assembly not listed above)**

| Component Name | Cavity Or Solid If Applicable | Ext. Air Film* | Ext. Finish | Insulation Over Framing | Shea-thing | Framing Or Solid | Insulation Within Cavity | Inter-ior Finish | Int. Air Film* | Total R-Value | U-Value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Above Foundation Wall*** | Cavity | *.17* | *0.79* | *5.0* | | ---------- | *13* | *0.56* | *.68* | *20.2* | *.050* |
| | Solid | *.17* | *0.79* | *5.0* | | *4.4* | ------------- | *0.56* | *.68* | *11.6* | *.086* |
| | Cavity | | | | | ---------- | | | | | |
| | Solid | | | | | | ------------- | | | | |

*** Air Film R-Values**

| Location | Heat Flow Direction | | |
|---|---|---|---|
| | Upwards | Horizontal | Downwards |
| **Exterior** | .17 | .17 | .17 |
| **Interior** | .61 | .68 | .92 |

**D.2. Foundation And Slab-On-Grade Components** - Check appropriate boxes for planned type of construction to determine pre-calculated overall 'U-value' including air films, wall, insulation, soil and cavity/solid differences. Slab on grade F-values are per lineal foot of slab perimeter.

| Component Type | U-Value | |
|---|---|---|
| **Foundation Wall** | **Basement** | **Crawl Space** |
| ☐ Masonry or concrete wall without insulation | 0.360 | 0.477 |
| ☒ Masonry or concrete wall with R-5 insulation board for full height | 0.115 | 0.136 |
| ☐ Masonry or concrete wall with R-10 insulation board or R-11 insulation batt and 2X4's for full height | 0.072 | 0.081 |
| ☐ Permanent wood foundation with R-19 batt for full height | 0.054 | 0.059 |
| ☐ Basement or crawl space floor without insulation | 0.025 | 0.025 |
| ☐ Basement floor with R-5 insulation | 0.022 | 0.022 |
| **Slab-On-Grade (or within 12" of grade)** | **F-Value** | |
| ☐ Slab-on-grade without insulation | 1.04 | |
| ☐ Slab-on-grade with R-5 insulation for 48" total horizontal and vertical application | 0.74 | |
| ☐ Slab-on-grade with R-10 insulation board for 48" total application | 0.68 | |

**D.3. Windows And Doors** - Use manufacturer's specifications for window and glazed door values, if they were determined per NFRC Std 100, to enter into Table E. Otherwise see default tables of UDC s. Comm 22.05 for U-values.

**E. System Design Method - Calculated Envelope Heat Loss Factor Of Your Home**

Enter values into table from elsewhere on this worksheet and multiply across to find the actual heat loss factor of each component. If using pre-calculated component U-values, **do not calculate separate cavity and solid figures or apply wood frame factors.** Total component heat loss factors in right column to find total envelope heat loss factors.

| Component | Cavity Or Solid If Applicable | Area From Sect. A | × Wood Frame Factor** | × Actual 'U' Value From Sect. D | = Heat Loss Factor (UA) |
|---|---|---|---|---|---|
| Above-Foundation Windows | --------- | 150 (A.1.a.) | --------- | 0.35 | 52.5 |
| Foundation Windows | --------- | 20 (A.1.b) | --------- | 0.87 | 17.4 |
| Doors | --------- | 38 (A.2.c) | --------- | 0.35 | 13.3 |
| Opaque Basement Wall | --------- | 1468 (A.5.) | --------- | 0.115 | 168.8 |
| Opaque Above-Foundation Wall | Cavity | | .75 | .050 | 55 |
| | Solid | 1467 (A.8.) | .25 | .086 | 31.5 |
| Floor Over Unconditioned Spaces | Cavity | | | | |
| | Solid | (A.9.) | | | |
| Roof or Ceiling | Cavity | | | | |
| | Solid | 1500 (A.10.) | | 0.029 | 43.5 |
| Floor Over Exterior | Cavity | | | | |
| | Solid | (A.11.) | | | |
| Crawl Space Wall | --------- | (A.12.) | --------- | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Slab On Grade | --------- | (A.13.)Lin. ft. | --------- | F-Value | |
| **Total Calculated Envelope Heat Loss Factor-** Not to exceed Total Code Allowed Heat Loss Factor of line 10 of Section C. (Enter here: 396.5 )by more than 1% | | | | | 382 |

** Adjustment Factors For Wood-Framed Components - Do not apply if your are using a pre-calculated or default U-Value.

| Spacing Of Framing Members | Stud Walls | | Joists/Rafters | |
|---|---|---|---|---|
| | Cavity | Solid | Cavity | Solid |
| 12" | .70 | .30 | .86 | .14 |
| 16" | .75 | .25 | .90 | .10 |
| 24" | .78 | .22 | .93 | .07 |

**F. Heat Loss Factor Due to Air Infiltration (for heating equipment sizing)**

Enter appropriate values. A maximum infiltration air change rate of 0.5 per hour is allowed in addition to ventilation losses.

| Floor Level | Area (sq ft) | × Height (ft) | Fan Capacity (cfm) | × Constant | × Air Changes Per Hour | = Heat Loss Factor(UA) |
|---|---|---|---|---|---|---|
| Basement | 1500 | 8 | --------- | .018 | 0.3 | 64.8 |
| Level 1 | 1500 | 8 | --------- | .018 | 0.3 | 64.8 |
| Level 2 | | | --------- | .018 | | |
| Level 3 | | | --------- | .018 | | |
| Ventilation | ------------- | ------------- | 170 | .432 | ------------- | 73.4 |
| **Total Infiltration & Ventilation Heat Loss Factor** | | | | | | 203 |

**G. Heating Equipment Sizing**

Enter appropriate value to determine the maximum and minimum allowable heating equipment capacity in BTUs/HR. A more detailed calculation may be submitted to the local code official. [4]

| | | |
|---|---|---|
| **Prescriptive Package Method:** 0.086 (**U overall** from selected Prescriptive Package of Section B) × 4643 (Total Envelope Area (A.14.)) = | | 399.3 |
| **OR System Design Method:** Calculated Heat Loss Factor from Sect. E. | | |
| Infiltration & Ventilation Heat Loss Factor (from Sect. F.) | + | 203 |
| Total Heat Loss Factor (UA) | = | 602.3 |
| Temperature Difference from Zone Table on page 1 | × | 85 |
| **Minimum Heating Equipment Output** | = | 51,196 |
| Allowable Heating Equipment Size Margin Multiplier | × | 1.15 |
| **Maximum Allowable Heating Equipment Output** [5] | = | 58,875 |
| Planned Furnace Output Or Boiler IBR Rating | | 60,000 |
| Make & Model if High Efficiency Credit has been taken: Acme XLH60K | | |

## Prescriptive Package Tables (Corrected)

(See notes on page 2 of Energy Worksheet; I = insulating sheathing, RT = raised heel roof truss)

**Table B-1 Prescriptive packages, Non-electric Heat, Structural Sheathing only**

| Package | Glazing Factor | R wall | R ceiling | R basement | U door | U overall | HVAC Equipment Efficiency |
|---|---|---|---|---|---|---|---|
| 1 | 0.0370 | R21 | R42 | R7 | 0.35 | 0.073 | Normal |
| 2 | 0.0264 | R21 | R51, RT | R5 | 0.35 | 0.073 | Normal |
| 3 | 0.0333 | R15 | R42 | R10 | 0.35 | 0.073 | Normal |
| 4 | 0.0440 | R19 | R33 | R10 | 0.35 | 0.073 | Normal |
| 5 | 0.0330 | R13 | R42 | R11 | 0.35 | 0.073 | Normal |
| 6 | 0.0480 | R19 | R33 | R11 | 0.35 | 0.073 | Normal |
| 7 | 0.0600 | R21 | R47 | R11 | 0.35 | 0.073 | Normal |
| 8 | 0.0407 | R13 | R44 | R13 | 0.35 | 0.073 | Normal |
| 9 | 0.0600 | R19 | R42 | R13 | 0.35 | 0.073 | Normal |
| 10 | 0.0680 | R21 | R38, RT | R13 | 0.35 | 0.073 | Normal |
| 11 | 0.0296 | R13 | R49 | R5 | 0.35 | 0.086 | High |
| 12 | 0.0440 | R19 | R30 | R5 | 0.35 | 0.086 | High |
| 13 | 0.0520 | R21 | R33 | R5 | 0.35 | 0.086 | High |
| 14 | 0.0720 | R13 | R47 | R10 | 0.35 | 0.086 | High |
| 15 | 0.0784 | R19 | R38 | R10 | 0.47 | 0.086 | High |
| 16 | 0.0640 | R13 | R33 | R11 | 0.47 | 0.086 | High |
| 17 | 0.0896 | R19 | R49 | R11 | 0.35 | 0.086 | High |
| 18 | 0.0896 | R21 | R34 | R11 | 0.35 | 0.086 | High |
| 19 | 0.0920 | R19 | R34 | R11 | 0.47 | 0.086 | High |
| 20 | 0.0840 | R13 | R49 | R13 | 0.35 | 0.086 | High |
| 21 | 0.0840 | R19 | R30 | R13 | 0.47 | 0.086 | High |
| 22 | 0.0896 | R21 | R31 | R13 | 0.47 | 0.086 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R crawl** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 23 | 0.0520 | R19 | R34 | R19 | 0.47 | 0.070 | Normal |
| 24 | 0.0672 | R13 | R36 | R19 | 0.47 | 0.083 | High |
| 25 | 0.0720 | R13 | R33 | R19 | 0.47 | 0.083 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 26 | 0.0560 | R21 | R36 | R5 | 0.47 | 0.103 | Normal |
| 27 | 0.0728 | R13 | R36 | R5 | 0.47 | 0.121 | High |
| 28 | 0.0760 | R13 | R34 | R5 | 0.47 | 0.121 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R heated-slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 29 | 0.0560 | R21 | R47 | R5 | 0.47 | 0.101 | Normal |
| 30 | 0.0728 | R13 | R42 | R5 | 0.47 | 0.120 | High |
| 31 | 0.0760 | R13 | R38 | R5 | 0.47 | 0.120 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R floor** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 32 | 0.0480 | R19 | R47 | R19 | 0.35 | 0.065 | Normal |
| 33 | 0.0728 | R19 | R36 | R19 | 0.47 | 0.077 | High |
| 34 | 0.0560 | R13 | R34 | R19 | 0.47 | 0.077 | High |

**Table B-2 Prescriptive packages, Non-electric Heat, Insulating Sheathing**

| Package | Glazing Factor | R wall | R ceiling | R basement | U door | U overall | HVAC Equipment Efficiency |
|---|---|---|---|---|---|---|---|
| 35 | 0.0370 | R20, I | R42 | R7 | 0.35 | 0.073 | Normal |
| 36 | 0.0363 | R28, I | R38, RT | R5 | 0.35 | 0.073 | Normal |
| 37 | 0.0552 | R18, I | R44 | R10 | 0.35 | 0.073 | Normal |
| 38 | 0.0560 | R20, I | R47 | R10 | 0.35 | 0.073 | Normal |
| 39 | 0.0560 | R23, I | R34 | R10 | 0.35 | 0.073 | Normal |
| 40 | 0.0560 | R18, I | R47 | R11 | 0.35 | 0.073 | Normal |
| 41 | 0.0616 | R23, I | R42 | R11 | 0.35 | 0.073 | Normal |
| 42 | 0.0546 | R18, I | R44 | R11 | 0.35 | 0.073 | Normal |
| 43 | 0.0672 | R23, I | R40 | R13 | 0.35 | 0.073 | Normal |
| 44 | 0.0720 | R25, I | R36 | R13 | 0.35 | 0.073 | Normal |
| 45 | 0.0504 | R18, I | R40 | R5 | 0.35 | 0.086 | High |
| 46 | 0.0560 | R19, I | R47 | R5 | 0.35 | 0.086 | High |
| 47 | 0.0560 | R23, I | R38 | R5 | 0.47 | 0.086 | High |
| 48 | 0.0600 | R25, I | R38 | R5 | 0.47 | 0.086 | High |
| 49 | 0.0680 | R26, I | R42 | R5 | 0.35 | 0.086 | High |
| 50 | 0.0680 | R28, I | R47 | R5 | 0.47 | 0.086 | High |
| 51 | 0.0672 | R26, I | R47 | R5 | 0.35 | 0.086 | High |
| 52 | 0.0672 | R28, I | R38 | R5 | 0.35 | 0.086 | High |
| 53 | 0.0720 | R20, I | R42 | R7 | 0.47 | 0.086 | High |
| 54 | 0.0855 | R18, I | R36 | R11 | 0.35 | 0.086 | High |

# Wisconsin Uniform Dwelling Code
# Energy Worksheet

**Instructions:** This worksheet is a Safety & Buildings Division (S&BD)-approved method of manually showing compliance with the energy conservation and heating equipment sizing requirements of the Uniform Dwelling Code (UDC), for new dwelling permits **submitted on or after February 1, 1999**. It may be necessary for the user to purchase a copy of the UDC from State Document Sales, (608)266-3358. Additional information is printed in the UDC Commentary, which is available for a fee, as are blank copies of this form, from S&BD at POB 2509, Madison, WI 53701, Tel. 608-267-4405. **Earlier editions of this worksheet may NOT be used**. Numbers in brackets, [1], refer to the footnotes printed on page 2.

You may also submit completed worksheets from the computer program WIS*check*, which is available for free download from http://www.energycodes.org/ on the Internet.

A required U-value is the **maximum** acceptable heat transmittance for an element. A required insulation R-value is the **minimum** acceptable level of resistance to heat transmittance. (U-values and R-values are reciprocals of each other.) If a component includes two or more areas of different insulation levels, either use the less insulating value for both areas, or use the Optional Weighted Average table in the **Prescriptive Package Method** section or enter separate areas and insulation values in the **System Design Method**. All "U" values must be carried to four places after the decimal point, rounded to three places. Other values may be rounded to the whole number.

**Window and door U-values** must be tested and documented by the manufacturer in accordance with the National Fenestration Rating Council (NFRC) test procedures or be taken from the glazing U-value table in s. Comm 22.05. Center-of-glass U-values cannot be used. If a door contains glass and an aggregate U-value rating for that door is not available, include the glass area of the door with your windows and use the opaque door U-value to determine compliance of the door.

The code gives credit for **high-efficiency heating equipment**. "High-Efficiency" means a furnace with an AFUE of 90% or more, or a heat pump with an HSPF of 7.8 or more without the use of electric resistance backup heat of greater than 3 kilowatts. If you plan to install more than one piece of heating equipment, the equipment with the lowest efficiency must exceed the efficiency required by the selected package.

**Choice of Method:** You have the choice of using the Prescriptive Package Method or the System Design Method to show code compliance. For the simpler **Prescriptive Package Method** , which is recommended for standard designs, complete Sections **A., B., F., and G.** Instructions are on page 2. You will be first calculating component areas, then comparing your planned insulation levels to the required insulation levels of the Prescriptive Packages. You will then calculate infiltration and ventilation heat losses to size your heating equipment. If you cannot comply with one of the prescriptive packages, you may be able to show compliance by the System Design Method.

For the **System Design Method**, which is recommended for alternative designs in which more insulation is installed in one component to offset less in another, complete **Sections A., C., D., E., F. and G.** You will be first calculating component areas, then a code-allowed heat loss factor, then component U- and R-values and then your calculated heat loss factor which you will compare to the code-allowed heat loss factor. You will then calculate infiltration and ventilation heat losses to size your heating equipment.

The **County Zone Table** below is use for determining the temperature difference for sizing your heating plant in Section G. You may submit to your local code official more exact calculations to size your heating equipment.

| Zone 1 - 95 degrees | Zone 2 - 90 degrees | Zone 3 - 85 degrees | Zone 4 - 80 degrees |
|---|---|---|---|
| Ashland, Barron, Bayfield, Burnett, Chippewa, Douglas, Dunn, Florence, Forest, Iron, Lincoln, Oneida, Pierce, Polk, Price, Rusk, Saint Croix, Sawyer, Taylor, Vilas, Washburn | Adams, Buffalo, Clark, Eau Claire, Jackson, Juneau, LaCrosse, Langlade, Marathon, Marinette, Menominee, Monroe, Portage, Shawano, Oconto, Pepin, Trempeleau, Vernon, Waupaca, Wood | Brown, Calumet, Columbia, Crawford, Dane, Dodge, Door, Fond du Lac, Grant, Green, Green Lake, Iowa, Kewaunee, LaFayette, Manitowoc, Marquette, Outagamie, Richland, Sauk, Sheboygan, Waushara, Winnebago | Jefferson, Kenosha, Milwaukee, Ozaukee, Racine, Rock, Walworth, Washington, Waukesha |

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# Detailed Instructions for Section B. Prescriptive Package Method:

**R-value requirements** are for insulation only and do not include structural components.

**For a component with two or more areas of different insulation levels**, either use the least insulating value for both areas or use the Weighted Average tables on page 4.

**Wall R-values** represent the sum of the wall cavity insulation plus insulating sheathing, if used. Do not include exterior siding, structural sheathing or interior drywall. For example, an R-20 requirement could be met *EITHER* by R-15 cavity insulation plus R-5 sheathing *OR* R-13 cavity insulation plus R-7 sheathing. Note that there are separate tables for walls with structural sheathing only and for walls with insulating sheathing. To use a table for insulating sheathing, the sheathing used must be at least R-4, except that at least R-2 insulation may be provided over corner bracing. Table wall R-Values apply to wood-frame or mass (concrete, masonry, log) wall assemblies, but not to metal-frame construction. If metal frame is planned, use the adjusted R-Values from the Metal-Frame Wall Tables of the UDC Appendix. Table wall values apply to boxsills.

**Ceiling R-values** represent the sum of the cavity insulation plus insulating sheathing, if used. For ventilated ceilings, any insulating sheathing must be placed between the conditioned space and the ventilated portion of the roof. Ceiling R-values with "**RT**" indicates that a raised-heel truss or oversized truss construction must be used so that the insulation achieves the full insulation thickness over the exterior walls.

**Floor requirements** apply to floors over unconditioned spaces (such as un-insulated crawlspaces, basements and garages). Floors over outside air shall have a Uoverall = 0.033 or R-30 added insulation.

**"Heated-Slab"** requirements apply to slabs that contain heat ducts or pipes. All slab insulation must extend at least 48 inches either 1) down from the top of the slab, or 2) down from the top of the slab to the bottom of the slab and then horizontally underneath the slab, or 3) down from the top of the slab to the bottom of the slab and then horizontally away from the slab, with pavement or at least 10 inches of soil covering the horizontal insulation.

**Walls of basements** below un-insulated floors must be insulated from the top of the basement wall to the level of the basement floor. Conditioned basement windows and glass doors must be included with the other glazing. Exterior basement doors must meet the door U-value requirements. If more than 50% of the basement is exposed, then all of the basement walls must instead meet the above-foundation wall requirements.

**Crawl space wall R-value requirements** are for walls of unventilated crawlspaces. The crawlspace wall insulation must extend from the top of the wall (including the sill plate) to at least 12 inches below the outside finished grade. If the distance from the outside finished grade to the top of the footing is less than 12 inches, the insulation must extend a total vertical plus horizontal distance of 24 inches from the outside finished grade.

---

**Footnotes for worksheet:**

[1] Opaque wall area is wall area minus opening areas of doors and windows.

[2] These below-grade U-values have the insulating value of the soil added to the code-required U-values which apply to the building materials only. See Sect. D.2. for typical insulated component U-values.

[3] These slab-on-grade F-values are derived from the code-required U-values and include the heat loss through the edge and body of the slab. See Sect. D.2. Temperature difference is the same as for above-grade spaces.

[4] For building additions, show that the existing heating equipment, if used to heat the addition, is large enough. To do so, you must calculate the heat loss of the whole building.

[5] If desired manufacturer does not have a furnace of this size, then a designer may select the manufacturer's next larger size.

**Submit completed worksheet pages 3-6 with dwelling plans to local enforcing municipality.**

Project Address: ____________________

Builder: ____________________ Owner: ____________________

Worksheet Completed By: ____________________ Date: ____________________

Does dwelling unit have three kilowatts or more input capacity of permanently installed electrical space heating equipment?

☐ YES (see below) ☐ NO

You will need to apply the stricter standards shown for electrically-heated homes if you answered "YES" to the above question.

**A. Area Calculations**

Enter appropriate dimensions to obtain area values. Some calculations will not be necessary depending on home design or calculation method. These calculated areas are referenced elsewhere on this worksheet, for example, "(A.1.)".

| | |
|---|---|
| 1. Window, Skylight & Patio Door Area (overall unit area)<br>a. In Above-Foundation Walls b. In Foundation Walls<br>_______ sq. ft. _______ sq. ft.<br>c. Total (a. + b.) = _______ | 2. Opaque Door Area<br>a. In Above- Foundation Walls b. In Foundation Walls<br>_______ sq. ft. _______ sq. ft.<br>c. Total (a. + b.) = _______ |
| 3. Gross Exposed Basement Wall Area<br>_______ sq. ft. | 4. Basement Wall Area Below Grade<br>_______ sq. ft. |
| 5. Opaque [1] Basement Wall Area (A.3. + A.4. - A.1.b.- A.2.b.)<br>_______ sq. ft.<br>If the exposed area of A.3.is greater than the below grade area of A.4., add A.5. to A.7 and cross out the number in this cell. | 6. Gross Heated Above-Foundation Wall Area, **including boxsill**<br>_______ sq. ft. |
| 7. Above Foundation Code Wall Area (A.6. + A1.b. + A.2.b.)<br>_______ sq. ft. | 8. Opaque [1] Above-Foundation Wall Area (A.6. - A1.a. - A.2.a.)<br>_______ sq. ft. |
| 9. Floor Area Over Interior Unconditioned Spaces Less Than 50°<br>_______ sq. ft. | 10. Insulated Roof Or Ceiling (less skylights)<br>_______ sq. ft. |
| 11. Exterior Floor Area (Overhangs)<br>_______ sq. ft. | 12. Crawl Space Wall Area<br>_______ sq. ft. |
| 13. Slab On Grade (above or less than 12 inches below grade)<br>_______ lineal feet of slab perimeter | 14. Total Heated Envelope Area (A.5 + A.7 + A.9 + A.10 +A.11 + A.12 +(A.13. × 2'))<br>_______ sq. ft. |
| 15. Percent Glazing (for Prescriptive Package Method, Section B, only) (A.1.c. ÷ A.7. × 100%)<br>_______ % | 16. Windows Description - Above-Foundation Windows:<br>Frame type: ☐ Wood or Wood Clad ☐ Vinyl ☐ Metal<br>Glazing type: ☐ Dual ☐ Triple ☐ Dual w/storm panel<br>Dual-Glazing Air Space: ☐ 1/4' ☐ 3/8" ☐ 1/2" or more<br>Features: ☐ Low-E ☐ Argon-filled ☐ Suspended film<br>Foundation Windows: ☐ Vinyl ☐ Metal |

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**B. Prescriptive Package Method (Skip this section if using the System Design Method of Sections C-F)**
The prescriptive package method is the simplest method for determining compliance with the UDC insulation and window requirements. To use the prescriptive package method, enter your actual design values in the "Actual " row below. **For a component, with two or more areas of different insulation levels, such as windows,** either use the least insulating value for both areas or use the Weighted Average tables below. Multiply your % glazing by the glazing U-value to obtain your "Glazing Factor". Find the Prescriptive Table that applies to your space heating fuel and sheathing type. Select a package from the table that most closely matches the construction indicated on your plans. **Do not exceed the package U-values or glazing factor or fall below the package R-values with your design.** Transfer the R-Values and U-values to the blank table below in the "Allowed" row. Then proceed to Section F. See page 2 for detailed instructions for this section.

| | Package # | % glazing | U glazing | Glazing Factor (% glazing × U glazing) | R wall | R ceiling | R Bsmt, Crawl Space, Slab or Floor | U door | U overall | Equip. Eff. |
|---|---|---|---|---|---|---|---|---|---|---|
| **Actual** | ------ | % (A.15) | | | | | | | ---------- | |
| **Allowed** | | ---------------- | ------------ | Max | Min | Min | Min | Max | | |

**(Please go to Section F.)**

**Optional R-Value/U-Value Weighted Average Table for Component:**

| Component Construction Description | R Value | U-Value (1÷R Value) | Area (sq ft) | U-Value × Area (UA) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | Total Area = | Total UA = |

______ ÷ ______ = ______
(Total UA) (Total Area) (Weighted Average U-Value (for windows or doors))

______ ÷ ______ = ______
(Total Area) (Total UA) (Weighted Average R-Value (for all other components))

**Optional R-Value/U-Value Weighted Average Table for Component:**

| Component Construction Description | R Value | U-Value (1÷R Value) | Area (sq ft) | U-Value × Area (UA) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | Total Area = | Total UA = |

______ ÷ ______ = ______
(Total UA) (Total Area) (Weighted Average U-Value (for windows or doors))

______ ÷ ______ = ______
(Total Area) (Total UA) (Weighted Average R-Value (for all other components))

**C. Code-Allowed Heat Loss For System Design Method**
Enter area values from Section A as notated and temperature differences per footnote 2 into this table and then multiply across by the electric or non-electric code-required U-value. Total the right column to find the total allowed heat loss factor.

| **Component** | **Area From Sect A.** | **× Required U-Value** | | **= Heat Loss UA** |
|---|---|---|---|---|
| | | ☐ NON-ELEC | ☐ ELECTRIC | |
| 1. Opaque Basement Wall [2] | (A.5.) | 0.077 [3] | 0.077 [3] | |
| 2. Above Foundation Code Wall | (A.7.) | 0.110 | 0.080 | |
| 3. Floor Over Interior Unconditioned Space | (A.9.) | 0.050 | 0.050 | |
| 4. Roof or Ceiling | (A.10.) | 0.026 | 0.020 | |
| 5. Floor Over Exterior | (A.11.) | 0.033 | 0.033 | |
| 6. Crawl Space Wall | (A.12.) | 0.060 | 0.060 | |
| 7. Slab On Grade ☐ Unheated<br>☐ Heated [3] | (A.13.) Lin. ft. | 0.72 'F'<br>0.70 'F' | 0.68 'F'<br>0.68' F' | |
| 8. Subtotal | | | | |
| 9. Credit for High Efficiency Heating Plant: 1.18 for furnace or boiler >90% AFUE; 1.15 for heat pump> 7.8 HPSF, Otherwise use 1.0 | | | | × |
| **10.** | | | **Total Code-Allowed Heat Loss Factor** | |

**D. System Design Method - Actual 'U' Values Of Your Home's Components**

**D.1. Above-Foundation Components** - If applicable, check the appropriate typical component constructions listed below, and use the pre-calculated U values. If your wall construction is not listed, you may obtain a pre-calculated U value from the default U-Value tables in the UDC Appendix. (Note that the default Table 2 Wood Frame U-values assume no insulating sheathing which penalizes you if your wall does have insulating sheathing, then you may need to use the Manual Calculation section below.) If you are using exterior metal framing, then you must use the Metal-Frame Wall U-Values of the UDC Appendix. If your component construction is not listed here or in the default tables, you need to use the Manual Calculation section below to manually enter R-values for the different layers of building materials from the Typical Thermal Properties of Building Materials Table of the UDC Appendix, ASHRAE Fundamentals Manual or manufacturer's specifications. Total them across and then obtain the U-value by taking the reciprocal (1/R) of the total R-value.

| | | |
|---|---|---|
| **Above-Foundation Walls** | ☐ 2X4, 16" O.C., R-13 batt, R-1 board: U - .079<br>☐ 2X6, 16" O.C., R-19 batt, R-1 board: U - .059 | ☐ 2X4, 16" O.C., R-13 batt, R-5 board: U - .061<br>☐ 2X6, 16" O.C., R-19 batt, R-5 board: U - .049 |
| ☐ Other - describe: | | U - from Default Table |
| **Roof or Ceiling** | ☐ 2X4 truss, 24" O.C., with R-38 insulation: U - .030<br>☐ 2X12 cathedral ceiling, 16" O.C., with R-38 insulation U - .027 | ☐ 2X4 truss, 24" O.C., with R-52 insulation: U - .025 |
| ☐ Other - describe: | | U - from Default Table |
| **Floor Over Exterior or Unconditioned Space** | ☐ 2X10 joists, 16" O.C., R-19 batt: U - .047 | |
| ☐ Other - describe: | | U - from Default Table |

**Manual U-Value Calculation (if assembly not listed above)**

| Component Name | Cavity Or Solid If Applicable | Ext. Air Film* | Ext. Finish | Insulation Over Framing | Sheathing | Framing Or Solid | Insulation Within Cavity | Interior Finish | Int. Air Film* | Total R-Value | U-Value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cavity | | | | | ---------- | | | | | |
| | Solid | | | | | | ------------ | | | | |
| | Cavity | | | | | ---------- | | | | | |
| | Solid | | | | | | ------------ | | | | |

*** Air Film R-Values**

| Location | Heat Flow Direction | | |
|---|---|---|---|
| | Upwards | Horizontal | Downwards |
| **Exterior** | .17 | .17 | .17 |
| **Interior** | .61 | .68 | .92 |

**D.2. Foundation And Slab-On-Grade Components** - Check appropriate boxes for planned type of construction to determine pre-calculated overall 'U-value' including air films, wall, insulation, soil and cavity/solid differences. Slab on grade F-values are per lineal foot of slab perimeter.

| Component Type | U-Value | |
|---|---|---|
| **Foundation Wall** | **Basement** | **Crawl Space** |
| ☐ Masonry or concrete wall without insulation | 0.360 | 0.477 |
| ☐ Masonry or concrete wall with R-5 insulation board for full height | 0.115 | 0.136 |
| ☐ Masonry or concrete wall with R-10 insulation board or R-11 insulation batt and 2X4's for full height | 0.072 | 0.081 |
| ☐ Permanent wood foundation with R-19 batt for full height | 0.054 | 0.059 |
| ☐ Basement or crawl space floor without insulation | 0.025 | 0.025 |
| ☐ Basement floor with R-5 insulation | 0.022 | 0.022 |
| **Slab-On-Grade (or within 12 " of grade)** | **F-Value** | |
| ☐ Slab-on-grade without insulation | 1.04 | |
| ☐ Slab-on-grade with R-5 insulation for 48" total horizontal and vertical application | 0.74 | |
| ☐ Slab-on-grade with R-10 insulation board for 48" total application | 0.68 | |

**D.3. Windows And Doors** - Use manufacturer's specifications for window and glazed door values, if they were determined per NFRC Std 100, to enter into Table E. Otherwise see default tables of UDC s. Comm 22.05 for U-values.

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**E. System Design Method - Calculated Envelope Heat Loss Factor Of Your Home**
Enter values into table from elsewhere on this worksheet and multiply across to find the actual heat loss factor of each component. If using pre-calculated component U-values, **do not calculate separate cavity and solid figures or apply wood frame factors.** Total component heat loss factors in right column to find total envelope heat loss factors.

| Component | Cavity Or Solid If Applicable | Area From Sect. A | × Wood Frame Factor** | × Actual 'U' Value From Sect. D | = Heat Loss Factor (UA) |
|---|---|---|---|---|---|
| Above-Foundation Windows | --------- | (A.1.a.) | --------- | | |
| Foundation Windows | --------- | (A.1.b) | --------- | | |
| Doors | --------- | (A.2.c) | --------- | | |
| Opaque Basement Wall | --------- | (A.5.) | --------- | | |
| Opaque Above-Foundation Wall | Cavity | | | | |
| | Solid | (A.8.) | | | |
| Floor Over Unconditioned Spaces | Cavity | | | | |
| | Solid | (A.9.) | | | |
| Roof or Ceiling | Cavity | | | | |
| | Solid | (A.10.) | | | |
| Floor Over Exterior | Cavity | | | | |
| | Solid | (A.11.) | | | |
| Crawl Space Wall | --------- | (A.12.) | --------- | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Slab On Grade | --------- | (A.13.)Lin. ft. | --------- | F-Value | |
| **Total Calculated Envelope Heat Loss Factor-** Not to exceed Total Code Allowed Heat Loss Factor of line 10 of Section C. (Enter here: )by more than 1% | | | | | |

** Adjustment Factors For Wood-Framed Components - Do not apply if your are using a pre-calculated or default U-Value.

| Spacing Of Framing Members | Stud Walls | | Joists/Rafters | |
|---|---|---|---|---|
| | Cavity | Solid | Cavity | Solid |
| 12" | .70 | .30 | .86 | .14 |
| 16" | .75 | .25 | .90 | .10 |
| 24" | .78 | .22 | .93 | .07 |

**F. Heat Loss Factor Due to Air Infiltration (for heating equipment sizing)**
Enter appropriate values. A maximum infiltration air change rate of 0.5 per hour is allowed in addition to ventilation losses.

| Floor Level | Area (sq ft) | × Height (ft) | Fan Capacity (cfm) | × Constant | × Air Changes Per Hour | = Heat Loss Factor(UA) |
|---|---|---|---|---|---|---|
| Basement | | | --------- | .018 | | |
| Level 1 | | | --------- | .018 | | |
| Level 2 | | | --------- | .018 | | |
| Level 3 | | | --------- | .018 | | |
| Ventilation | ------------- | -------------- | | .432 | -------------- | |
| **Total Infiltration & Ventilation Heat Loss Factor** | | | | | | |

**G. Heating Equipment Sizing**
Enter appropriate value to determine the maximum and minimum allowable heating equipment capacity in BTUs/HR. A more detailed calculation may be submitted to the local code official. [4]

| | |
|---|---|
| **Prescriptive Package Method:** ______ × ______ = <br> **U overall** from selected Prescriptive Package of Section B × Total Envelope Area (A.14.) | |
| **OR System Design Method:** Calculated Heat Loss Factor from Sect. E. | |
| Infiltration & Ventilation Heat Loss Factor (from Sect. F.) | + |
| Total Heat Loss Factor (UA) | = |
| Temperature Difference from **County Zone Table** on page 1 | × |
| **Minimum Heating Equipment Output** | = |
| Allowable Heating Equipment Size Margin Multiplier | × 1.15 |
| **Maximum Allowable Heating Equipment Output [5]** | = |
| Planned Furnace Output Or Boiler IBR Rating | |
| Make & Model if High Efficiency Credit has been taken: | |

## Prescriptive Package Tables (Corrected)

(See notes on page 2 of Energy Worksheet: I = insulating sheathing, RT = raised heel roof truss)

**Table B-1 Prescriptive packages, Non-electric Heat, Structural Sheathing only**

| Package | Glazing Factor | R wall | R ceiling | R basement | U door | U overall | HVAC Equipment Efficiency |
|---|---|---|---|---|---|---|---|
| 1 | 0.0370 | R21 | R42 | R7 | 0.35 | 0.073 | Normal |
| 2 | 0.0264 | R21 | R51, RT | R5 | 0.35 | 0.073 | Normal |
| 3 | 0.0333 | R15 | R42 | R10 | 0.35 | 0.073 | Normal |
| 4 | 0.0440 | R19 | R33 | R10 | 0.35 | 0.073 | Normal |
| 5 | 0.0330 | R13 | R42 | R11 | 0.35 | 0.073 | Normal |
| 6 | 0.0480 | R19 | R33 | R11 | 0.35 | 0.073 | Normal |
| 7 | 0.0600 | R21 | R47 | R11 | 0.35 | 0.073 | Normal |
| 8 | 0.0407 | R13 | R44 | R13 | 0.35 | 0.073 | Normal |
| 9 | 0.0600 | R19 | R42 | R13 | 0.35 | 0.073 | Normal |
| 10 | 0.0680 | R21 | R38, RT | R13 | 0.35 | 0.073 | Normal |
| 11 | 0.0296 | R13 | R49 | R5 | 0.35 | 0.086 | High |
| 12 | 0.0440 | R19 | R30 | R5 | 0.35 | 0.086 | High |
| 13 | 0.0520 | R21 | R33 | R5 | 0.35 | 0.086 | High |
| 14 | 0.0720 | R13 | R47 | R10 | 0.35 | 0.086 | High |
| 15 | 0.0784 | R19 | R38 | R10 | 0.47 | 0.086 | High |
| 16 | 0.0640 | R13 | R33 | R11 | 0.47 | 0.086 | High |
| 17 | 0.0896 | R19 | R49 | R11 | 0.35 | 0.086 | High |
| 18 | 0.0896 | R21 | R34 | R11 | 0.35 | 0.086 | High |
| 19 | 0.0920 | R19 | R34 | R11 | 0.47 | 0.086 | High |
| 20 | 0.0840 | R13 | R49 | R13 | 0.35 | 0.086 | High |
| 21 | 0.0840 | R19 | R30 | R13 | 0.47 | 0.086 | High |
| 22 | 0.0896 | R21 | R31 | R13 | 0.47 | 0.086 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R crawl** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 23 | 0.0520 | R19 | R34 | R19 | 0.47 | 0.070 | Normal |
| 24 | 0.0672 | R13 | R36 | R19 | 0.47 | 0.083 | High |
| 25 | 0.0720 | R13 | R33 | R19 | 0.47 | 0.083 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 26 | 0.0560 | R21 | R36 | R5 | 0.47 | 0.103 | Normal |
| 27 | 0.0728 | R13 | R36 | R5 | 0.47 | 0.121 | High |
| 28 | 0.0760 | R13 | R34 | R5 | 0.47 | 0.121 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R heated-slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 29 | 0.0560 | R21 | R47 | R5 | 0.47 | 0.101 | Normal |
| 30 | 0.0728 | R13 | R42 | R5 | 0.47 | 0.120 | High |
| 31 | 0.0760 | R13 | R38 | R5 | 0.47 | 0.120 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R floor** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 32 | 0.0480 | R19 | R47 | R19 | 0.35 | 0.065 | Normal |
| 33 | 0.0728 | R19 | R36 | R19 | 0.47 | 0.077 | High |
| 34 | 0.0560 | R13 | R34 | R19 | 0.47 | 0.077 | High |

**Table B-2 Prescriptive packages, Non-electric Heat, Insulating Sheathing**

| Package | Glazing Factor | R wall | R ceiling | R basement | U door | U overall | HVAC Equipment Efficiency |
|---|---|---|---|---|---|---|---|
| 35 | 0.0370 | R20, I | R42 | R7 | 0.35 | 0.073 | Normal |
| 36 | 0.0363 | R28, I | R38, RT | R5 | 0.35 | 0.073 | Normal |
| 37 | 0.0552 | R18, I | R44 | R10 | 0.35 | 0.073 | Normal |
| 38 | 0.0560 | R20, I | R47 | R10 | 0.35 | 0.073 | Normal |
| 39 | 0.0560 | R23, I | R34 | R10 | 0.35 | 0.073 | Normal |
| 40 | 0.0560 | R18, I | R47 | R11 | 0.35 | 0.073 | Normal |
| 41 | 0.0616 | R23, I | R42 | R11 | 0.35 | 0.073 | Normal |
| 42 | 0.0546 | R18, I | R44 | R11 | 0.35 | 0.073 | Normal |
| 43 | 0.0672 | R23, I | R40 | R13 | 0.35 | 0.073 | Normal |
| 44 | 0.0720 | R25, I | R36 | R13 | 0.35 | 0.073 | Normal |
| 45 | 0.0504 | R18, I | R40 | R5 | 0.35 | 0.086 | High |
| 46 | 0.0560 | R19, I | R47 | R5 | 0.35 | 0.086 | High |
| 47 | 0.0560 | R23, I | R38 | R5 | 0.47 | 0.086 | High |
| 48 | 0.0600 | R25, I | R38 | R5 | 0.47 | 0.086 | High |
| 49 | 0.0680 | R26, I | R42 | R5 | 0.35 | 0.086 | High |
| 50 | 0.0680 | R28, I | R47 | R5 | 0.47 | 0.086 | High |
| 51 | 0.0672 | R26, I | R47 | R5 | 0.35 | 0.086 | High |
| 52 | 0.0672 | R28, I | R38 | R5 | 0.35 | 0.086 | High |
| 53 | 0.0720 | R20, I | R42 | R7 | 0.47 | 0.086 | High |
| 54 | 0.0855 | R18, I | R36 | R11 | 0.35 | 0.086 | High |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 55 | 0.0896 | R23, I | R33 | R11 | 0.47 | 0.086 | High |
| 56 | 0.0861 | R18, I | R36 | R13 | 0.47 | 0.086 | High |
| 57 | 0.1000 | R23, I | R33 | R13 | 0.47 | 0.086 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R crawl** | **U door** | **U overall** | **HVAC Equipment Efficiency.** |
| 58 | 0.0546 | R18, I | R38 | R19 | 0.47 | 0.070 | Normal |
| 59 | 0.0784 | R15, I | R30 | R19 | 0.47 | 0.083 | High |
| 60 | 0.0880 | R15, I | R38 | R19 | 0.47 | 0.083 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 61 | 0.0640 | R23, I | R36 | R5 | 0.47 | 0.103 | Normal |
| 62 | 0.0896 | R15, I | R36 | R5 | 0.47 | 0.121 | High |
| 63 | 0.0960 | R15, I | R38 | R5 | 0.47 | 0.121 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R heated-slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 64 | 0.0640 | R23, I | R34 | R5 | 0.47 | 0.101 | Normal |
| 65 | 0.0840 | R15, I | R31 | R5 | 0.47 | 0.121 | High |
| 66 | 0.0920 | R15, I | R33 | R5 | 0.47 | 0.121 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R floor** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 67 | 0.0480 | R20, I | R44 | R19 | 0.35 | 0.065 | Normal |
| 68 | 0.0728 | R20, I | R36 | R19 | 0.47 | 0.077 | High |
| 69 | 0.0560 | R14, I | R38 | R19 | 0.47 | 0.078 | High |

**Table B-3 Prescriptive packages, Electric Heat, Structural Sheathing Only**

| Package | Glazing Factor | R wall | R ceiling | R basement | U door | U overall | HVAC Equipment Efficiency |
|---|---|---|---|---|---|---|---|
| E 70 | 0.0396 | R21 | R37, RT | R19 | 0.35 | 0.059 | Normal |
| E 71 | 0.0429 | R21 | R42, RT | R19 | 0.35 | 0.059 | Normal |
| E 72 | 0.0520 | R21 | R49 | R13 | 0.35 | 0.068 | High |
| E 73 | 0.0640 | R19 | R42, RT | R19 | 0.35 | 0.068 | High |
| E 74 | 0.0693 | R21 | R49, RT | R19 | 0.47 | 0.068 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R crawl** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| E 75 | 0.0429 | R21 | R54, RT | R30 | 0.35 | 0.054 | Normal |
| E 76 | 0.0480 | R21 | R45, RT | R19 | 0.35 | 0.062 | High |
| E 77 | 0.0627 | R21 | R54, RT | R30 | 0.47 | 0.062 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| E 78 | 0.0396 | R26 | R51, RT | R10 | 0.35 | 0.083 | Normal |
| E 79 | 0.0480 | R21 | R49 | R7 | 0.35 | 0.095 | High |
| E 80 | 0.0528 | R21 | R49, RT | R5 | 0.35 | 0.095 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R floor** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| E 81 | 0.0363 | R21 | R54, RT | R30 | 0.35 | 0.052 | Normal |
| E 82 | 0.0520 | R21 | R49 | R30 | 0.35 | 0.060 | High |
| E 83 | 0.0528 | R21 | R44, RT | R30 | 0.47 | 0.060 | High |

**Table B-4 Prescriptive packages, Electric Heat, Insulating Sheathing**

| Package | Glazing Factor | R wall | R ceiling | R basement | U door | U overall | HVAC Equipment Efficiency |
|---|---|---|---|---|---|---|---|
| E 84 | 0.0480 | R25, I | R48, RT | R16 | 0.35 | 0.059 | Normal |
| E 85 | 0.0495 | R25, I | R48, RT | R16 | 0.35 | 0.059 | Normal |
| E 86 | 0.0462 | R28, I | R40 | R16 | 0.35 | 0.059 | Normal |
| E 87 | 0.0429 | R25, I | R36 | R18 | 0.35 | 0.059 | Normal |
| E 88 | 0.0528 | R23, I | R58, RT | R18 | 0.35 | 0.059 | Normal |
| E 89 | 0.0462 | R25, I | R42 | R18 | 0.35 | 0.059 | Normal |
| E 90 | 0.0560 | R25, I | R46, RT | R10 | 0.35 | 0.068 | High |
| E 91 | 0.0640 | R23, I | R48, RT | R13 | 0.35 | 0.068 | High |
| E 92 | 0.0600 | R25, I | R42 | R13 | 0.35 | 0.068 | High |
| E 93 | 0.0600 | R23, I | R37 | R18 | 0.47 | 0.068 | High |
| E 94 | 0.0759 | R25, I | R46, RT | R18 | 0.47 | 0.068 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R crawl** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| E 95 | 0.0429 | R25, I | R48, RT | R23 | 0.35 | 0.054 | Normal |
| E 96 | 0.0520 | R23, I | R38 | R23 | 0.35 | 0.062 | High |
| E 97 | 0.0561 | R25, I | R44 | R23 | 0.47 | 0.062 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| E 98 | 0.0396 | R25, I | R48, RT | R10 | 0.35 | 0.083 | Normal |
| E 99 | 0.0560 | R23, I | R44 | R7 | 0.35 | 0.095 | High |
| E 100 | 0.0594 | R25, I | R46, RT | R5 | 0.47 | 0.095 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R floor** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| E 101 | 0.0429 | R25, I | R46, RT | R30 | 0.35 | 0.052 | Normal |
| E 102 | 0.0560 | R23, I | R44 | R30 | 0.35 | 0.060 | High |
| E 103 | 0.0627 | R25, I | R44, RT | R30 | 0.47 | 0.060 | High |

# Default Assembly R and U Value Tables

(All U–values include framing factors, finish materials and air films.)

Table 1. Ceiling U–Values[a]

| Insulation R–Value | Standard Truss U–Value | Raised Truss[b] U–Value | Insulation R–Value | Standard Truss U–Value | Raised Truss[b] U–Value |
|---|---|---|---|---|---|
| R–0 | 0.568 | 0.568 | R–33 | 0.033 | 0.029 |
| R–7 | 0.119 | 0.119 | R–34 | 0.032 | 0.028 |
| R–8 | 0.108 | 0.108 | R–35 | 0.032 | 0.028 |
| R–9 | 0.098 | 0.098 | R–36 | 0.031 | 0.027 |
| R–10 | 0.089 | 0.089 | R–37 | 0.031 | 0.026 |
| R–11 | 0.082 | 0.082 | R–38 | 0.030 | 0.025 |
| R–12 | 0.076 | 0.076 | R–39 | 0.030 | 0.025 |
| R–13 | 0.070 | 0.070 | R–40 | 0.029 | 0.024 |
| R–14 | 0.066 | 0.066 | R–41 | 0.029 | 0.024 |
| R–15 | 0.062 | 0.061 | R–42 | 0.028 | 0.023 |
| R–16 | 0.059 | 0.058 | R–43 | 0.028 | 0.023 |
| R–17 | 0.056 | 0.055 | R–44 | 0.027 | 0.022 |
| R–18 | 0.053 | 0.052 | R–45 | 0.027 | 0.022 |
| R–19 | 0.051 | 0.049 | R–46 | 0.027 | 0.021 |
| R–20 | 0.048 | 0.047 | R–47 | 0.026 | 0.021 |
| R–21 | 0.047 | 0.045 | R–48 | 0.026 | 0.020 |
| R–22 | 0.045 | 0.043 | R–49 | 0.026 | 0.020 |
| R–23 | 0.043 | 0.041 | R–50 | 0.026 | 0.020 |
| R–24 | 0.042 | 0.040 | R–51 | 0.025 | 0.019 |
| R–25 | 0.040 | 0.038 | R–52 | 0.025 | 0.019 |
| R–26 | 0.039 | 0.037 | R–53 | 0.025 | 0.019 |
| R–27 | 0.038 | 0.035 | R–54 | 0.025 | 0.018 |
| R–28 | 0.037 | 0.034 | R–55 | 0.024 | 0.018 |
| R–29 | 0.036 | 0.033 | R–56 | 0.024 | 0.018 |
| R–30 | 0.035 | 0.032 | R–57 | 0.024 | 0.018 |
| R–31 | 0.034 | 0.031 | R–58 | 0.024 | 0.017 |
| R–32 | 0.034 | 0.030 | R–59 | 0.024 | 0.017 |

(a) R–values represent the sum of the ceiling cavity insulation plus the R–value of insulating sheathing (if used). For example, R–19 cavity insulation plus R–2 sheathing is reported as R–21 ceiling insulation. For ventilated ceilings, insulating sheathing must be placed between the conditioned space and the ventilated portion of the roof (typically applied to the trusses or rafters immediately behind the drywall or other ceiling finish material).

(b) To receive credit for a raised truss, the insulation must achieve its full insulation thickness over the exterior walls.

Table 2. Wood–Frame Wall U–Values[a,b]

| Insulation R–Value[c] | 16–in. O.C. Wall U–Value | 24–in. O.C. Wall U–Value |
|---|---|---|
| R–0 | 0.238 | 0.241 |
| R–7 | 0.105 | 0.104 |
| R–8 | 0.099 | 0.097 |
| R–9 | 0.094 | 0.092 |
| R–10 | 0.090 | 0.088 |
| R–11 | 0.089 | 0.087 |
| R–12 | 0.085 | 0.083 |
| R–13 | 0.082 | 0.080 |
| R–14 | 0.079 | 0.077 |
| R–15 | 0.077 | 0.074 |
| R–16 | 0.066 | 0.064 |
| R–17 | 0.064 | 0.062 |
| R–18 | 0.062 | 0.060 |
| R–19 | 0.060 | 0.059 |
| R–20 | 0.059 | 0.057 |
| R–21 | 0.057 | 0.056 |
| R–22 | 0.056 | 0.054 |
| R–23 | 0.055 | 0.053 |
| R–24 | 0.054 | 0.052 |
| R–25 | 0.053 | 0.051 |
| R–26 | 0.052 | 0.050 |
| R–27 | 0.051 | 0.049 |
| R–28 | 0.050 | 0.048 |

(a) U–values are for uncompressed insulation.
(b) U–values in this Table were developed for wood–frame walls, but the 16–in. O.C. Wall U–Value column can also be used for above–grade concrete, masonry, and log walls. Mass wall R–value to U–value conversion tables are planned for future versions of the MECcheck Manual. TM
(c) Wall R–values are the sum of the cavity insulation plus insulating sheathing (if used).

Table 3. 16–in. O.C. Metal–Frame Wall U–Values and Equivalent Prescriptive Package Wall R–Values (Use the U–values below for the System Design Method of the Energy Worksheet. Use the equivalent R–value below to choose an Energy Worksheet Prescriptive Package with a wall R–value that is less than or equal to it. If you have an equivalent R–value without an "I" listed after it, then you must use a Package wall R–value without an "I" designation.)

| Cavity R–Value | Insulating Sheathing R–Value | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | R–0 | R–1 | R–2 | R–3 | R–4 | R–5 | R–6 | R–7 | R–8 | R–9 | R–10 |
| R–0 | U–0.270 | U–0.258 | U–0.205 | U–0.170 | U–0.146 | U–0.127 | U–0.113 | U–0.101 | U–0.092 | U–0.084 | U–0.078 |
| R–11 | U–0.120 | U–0.118 | U–0.106 | U–0.096 | U–0.087 | U–0.080 | U–0.074 R15 | U–0.069 R15I | U–0.065 R16I | U–0.061 R18I | U–0.057 R20I |
| R–13 | U–0.114 | U–0.111 | U–0.100 | U–0.091 | U–0.084 | U–0.077 R15 | U–0.072 R15 | U–0.067 R15I | U–0.063 R17I | U–0.059 R19I | U–0.056 R22I |
| R–15 | U–0.109 | U–0.107 | U–0.096 | U–0.088 | U–0.081 | U–0.075 R15 | U–0.070 R15 | U–0.065 R16I | U–0.061 R18I | U–0.058 R19I | U–0.054 R22I |
| R–19 | U–0.101 | U–0.099 | U–0.090 | U–0.083 | U–0.077 R15 | U–0.071 R15 | U–0.066 R15I | U–0.062 R17I | U–0.059 R19I | U–0.055 R20I | U–0.052 R22I |
| R–21 | U–0.098 | U–0.096 | U–0.088 | U–0.081 R13 | U–0.075 R15 | U–0.070 R15 | U–0.065 R16I | U–0.061 R18I | U–0.058 R19I | U–0.054 R20I | U–0.052 R22I |
| R–25 | U–0.094 | U–0.093 | U–0.085 | U–0.078 R13 | U–0.073 R15 | U–0.068 R15I | U–0.063 R17I | U–0.060 R19I | U–0.056 R20I | U–0.053 R20I | U–0.051 R23I |

Table 4. 24–in. O.C. Metal–Frame Wall U–Values and Equivalent Prescriptive Package Wall R–Values (Use the U–values below for the System Design Method of the Energy Worksheet. Use the equivalent R–value below to choose an Energy Worksheet Prescriptive Package with a wall R–value that is less than or equal to it. If you have an equivalent R–value without an "I" listed after it, then you must use a Package wall R–value without an "I" designation.)

| Cavity R–Value | Insulating Sheathing R–Value | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | R–0 | R–1 | R–2 | R–3 | R–4 | R–5 | R–6 | R–7 | R–8 | R–9 | R–10 |
| R–0 | U–0.270 | U–0.258 | U–0.205 | U–0.170 | U–0.146 | U–0.127 | U–0.113 | U–0.101 | U–0.092 | U–0.084 | U–0.078 R13 |
| R–11 | U–0.106 | U–0.104 | U–0.095 | U–0.086 | U–0.080 R13 | U–0.074 R15 | U–0.069 R15I | U–0.064 R17I | U–0.060 R18I | U–0.057 R20I | U–0.054 R20I |
| R–13 | U–0.100 | U–0.098 | U–0.090 | U–0.082 R13 | U–0.076 R15 | U–0.071 R15 | U–0.066 R15I | U–0.062 R17I | U–0.058 R19I | U–0.055 R20I | U–0.052 R22I |
| R–15 | U–0.094 | U–0.093 | U–0.085 | U–0.078 R13 | U–0.073 R15 | U–0.068 R15I | U–0.063 R17I | U–0.060 R19I | U–0.056 R20I | U–0.053 R20I | U–0.051 R23I |
| R–19 | U–0.088 | U–0.086 | U–0.080 R13 | U–0.074 R15 | U–0.069 R15I | U–0.064 R17I | U–0.060 R19I | U–0.057 R20I | U–0.054 R20I | U–0.051 R23I | U–0.049 R24I |
| R–21 | U–0.085 | U–0.084 | U–0.077 R15 | U–0.072 R15 | U–0.067 R15I | U–0.063 R17I | U–0.059 R19I | U–0.056 R20I | U–0.053 R20I | U–0.050 R23I | U–0.048 R24I |
| R–25 | U–0.081 R13 | U–0.080 R13 | U–0.074 R15 | U–0.069 R15 | U–0.064 R17I | U–0.060 R19I | U–0.057 R20I | U–0.054 R20I | U–0.051 R23I | U–0.049 R23I | U–0.046 R24I |

Table 5. Floor U–Values

| Insulation R–Value | Floor U–Value |
|---|---|
| R–0 | 0.249 |
| R–7 | 0.096 |
| R–11 | 0.072 |
| R–13 | 0.064 |
| R–15 | 0.057 |
| R–19 | 0.047 |
| R–21 | 0.044 |
| R–26 | 0.037 |
| R–30 | 0.033 |

Table 6. Basement U–Values(a)

| Insulation R–Value | Basement Wall U–Value | Insulation R–Value | Basement Wall U–Value |
|---|---|---|---|
| R–0 | 0.360 | R–10 | 0.072 |
| R–1 | 0.244 | R–11 | 0.067 |
| R–2 | 0.188 | R–12 | 0.062 |
| R–3 | 0.155 | R–13 | 0.059 |
| R–4 | 0.132 | R–14 | 0.055 |
| R–5 | 0.115 | R–15 | 0.052 |
| R–6 | 0.102 | R–16 | 0.050 |
| R–7 | 0.092 | R–17 | 0.047 |
| R–8 | 0.084 | R–18 | 0.045 |
| R–9 | 0.077 | R–19 | 0.043 |
| | | R–20 | 0.041 |

(a) Insulation R–values represent the sum of exterior and/or interior insulation. Basement walls must be insulated from the top of the basement wall to 10 ft below ground level or to the floor of the basement, whichever is less.

Table 7. Slab F–Values

| Perimeter Insulation R–Value | Slab F–Value | |
|---|---|---|
| | 24–in. Insulation Depth | 48–in. Insulation Depth |
| R–0 | 1.04 | 1.04 |
| R–1 | 0.91 | 0.89 |
| R–2 | 0.86 | 0.83 |
| R–3 | 0.83 | 0.79 |
| R–4 | 0.82 | 0.76 |
| R–5 | 0.80 | 0.74 |
| R–6 | 0.79 | 0.73 |
| R–7 | 0.79 | 0.71 |
| R–8 | 0.78 | 0.70 |
| R–9 | 0.77 | 0.69 |
| R–10 | 0.77 | 0.68 |
| R–11 | | 0.68 |
| R–12 | | 0.67 |
| R–13 | | 0.66 |
| R–14 | | 0.66 |
| R–15 | | 0.65 |
| R–16 | | 0.65 |
| R–17 | | 0.65 |
| R–18 | | 0.64 |
| R–19 | | 0.64 |
| R–20 | | 0.64 |

Table 8. Crawl Space Wall U–Values

| Insulation R–Value | Crawl Space Wall U–Value |
|---|---|
| R–0 | 0.477 |
| R–1 | 0.313 |
| R–2 | 0.235 |
| R–3 | 0.189 |
| R–4 | 0.158 |
| R–5 | 0.136 |
| R–6 | 0.120 |
| R–7 | 0.107 |
| R–8 | 0.096 |
| R–9 | 0.088 |
| R–10 | 0.081 |
| R–11 | 0.075 |
| R–12 | 0.069 |
| R–13 | 0.065 |
| R–14 | 0.061 |
| R–15 | 0.057 |
| R–16 | 0.054 |
| R–17 | 0.051 |
| R–18 | 0.049 |
| R–19 | 0.047 |
| R–20 | 0.045 |

Table 9. U–Values for Windows, Glazed Doors, and Skylights[a]

| Frame/Glazing Features | Single Pane | Double Pane |
|---|---|---|
| Metal Without Thermal Break | | |
| Operable | 1.27 | 0.87 |
| Fixed | 1.13 | 0.69 |
| Garden Window | 2.60 | 1.81 |
| Curtain Wall | 1.22 | 0.79 |
| Door | 1.26 | 0.80 |
| Skylight | 1.98 | 1.31 |
| Site–Assembled Skylight | 1.36 | 0.82 |
| Metal With Thermal Break | | |
| Operable | 1.08 | 0.65 |
| Fixed | 1.07 | 0.63 |
| Curtain Wall | 1.11 | 0.68 |
| Door | 1.10 | 0.66 |
| Skylight | 1.89 | 1.11 |
| Site–Assembled Skylight | 1.25 | 0.70 |
| Reinforced Vinyl or Metal–Clad Wood | | |
| Operable | 0.90 | 0.57 |
| Fixed | 0.98 | 0.56 |
| Door | 0.99 | 0.57 |
| Skylight | 1.75 | 1.05 |
| Wood/Vinyl/Fiberglass | | |
| Operable | 0.89 | 0.55 |
| Fixed | 0.98 | 0.56 |
| Garden Window | 2.31 | 1.61 |
| Door | 0.98 | 0.56 |
| Skylight | 1.47 | 0.84 |
| Glass Block Assemblies | 0.60 | |

(a) The U–values in these tables can be used in the absence of test U–values. The product cannot receive credit for a feature that cannot be clearly detected. Where a composite of materials from two different product types is used, the product must be assigned the higher U–value.

Table 10. U–Value Table for Non–Glazed Doors[a]

| **Steel Doors** | | |
|---|---|---|
| Without Foam Core | 0.60 | |
| With Foam Core | 0.35 | |
| **Wood Doors** | **Without Storm** | **With Storm** |
| Panel With 7/16–in. Panels | 0.54 | 0.36 |
| Hollow Core Flush | 0.46 | 0.32 |
| Panel With 1–1/8–in. Panels | 0.39 | 0.28 |
| Solid Core Flush | 0.40 | 0.26 |

(a) The U–values in these tables can be used in the absence of test U–values. The product cannot receive credit for a feature that cannot be clearly detected. Where a composite of materials from two different product types is used, the product must be assigned the higher U–value.

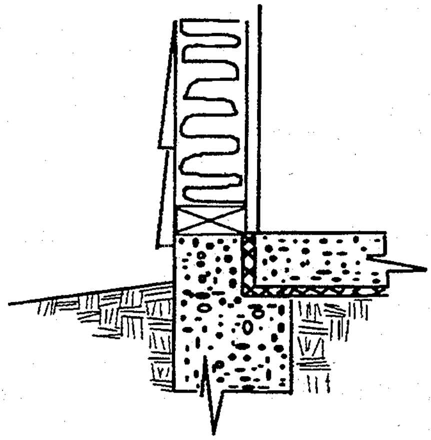
## Typical Thermal Properties of Building Materials—Design Values[a]

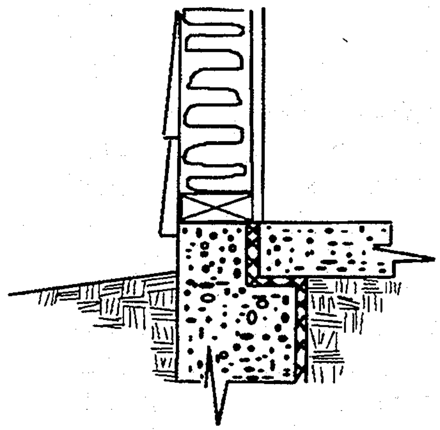
| Description | | Density, $lb/ft^3$ | Resistance (R) Per Inch Thickness $°F.ft^2.h$ | For Thickness Listed |
|---|---|---|---|---|
| **SHEATHING** | | | | |
| Gypsum or plaster board | 1/2" | 50 | — | 0.45 |
| Gypsum or plaster board | 5/8" | 50 | — | 0.56 |
| Plywood (Douglas Fir) | 1/2" | 34 | — | 0.62 |
| Plywood (Douglas Fir) | 5/8" | 34 | — | 0.77 |
| Plywood or wood panels | 3/4" | 34 | — | 0.93 |
| Vegetable fiber board | | | | |
| Sheathing, regular density | 1/2" | 18 | — | 1.32 |
| Hardboard | | | | |
| Medium density | | 50 | 1.37 | — |
| Particleboard | | | | |
| Medium density | | 50 | 1.06 | — |
| **FINISH FLOORING MATERIALS** | | | | |
| Carpet and rubber pad | | — | — | 1.23 |
| **INSULATING MATERIALS** | | | | |
| *Blanket and Batt* | | | | |
| Mineral fiber, fibrous form processed from rock, slag, or glass | | | | |
| approx. 3–4 in. | | 0.4–2.0 | — | 11 |
| approx. 3.5 in | | 0.4–2.0 | — | 13 |
| approx. 3.5 in | | 1.2–1.6 | — | 15 |
| approx. 5.5–6.5 in. | | 0.4–2.0 | — | 19 |
| approx. 5.5 in. | | 0.6–1.0 | — | 21 |
| approx. 6–7.5 in. | | 0.4–2.0 | — | 22 |
| approx. 8.25–10 in. | | 0.4–2.0 | — | 30 |
| approx. 10–13 in. | | 0.4–2.0 | — | 38 |
| *Board and Slabs* | | | | |
| Glass fiber, organic bonded | | 4.0–9.0 | 4.00 | — |
| Expanded polystyrene, extruded (smooth skin surface) | | 1.8–3.5 | 5.00 | — |
| Expanded polystyrene, molded beads | | 1.0 | 3.85 | — |
| | | 1.25 | 4.00 | — |
| | | 1.5 | 4.17 | — |
| | | 1.75 | 4.17 | — |
| | | 2.0 | 4.35 | — |
| Cellular polyurethane/polyisocyanurate | | 1.5 | 6.25–5.56 | — |
| Cellular polyisocyanurate (CFC–11 exp.) (gas–impermeable facers) | | 2.0 | 7.04 | — |
| Mineral fiberboard, wet felted | | | | |
| Acoustical tile | | 18.0 | 2.86 | — |
| *Loose Fill* | | | | |
| Cellulosic insulation (milled paper or wood pulp) | | 2.3–3.2 | 3.70–3.13 | — |
| Perlite, expanded | | 2.0–4.1 | 3.7–3.3 | — |
| | | 4.1–7.4 | 3.3–2.8 | — |
| | | 7.4–11.0 | 2.8–2.4 | — |
| Mineral fiber (rock, slag, or glass) | | | | |
| approx. 3.75–5 in. | | 0.6–2.0 | — | 11.0 |
| approx. 6.5–8.75 in. | | 0.6–2.0 | — | 19.0 |
| approx. 7.5–10 in. | | 0.6–2.0 | — | 22.0 |
| approx. 10.25–13.75 in. | | 0.6–2.0 | — | 30.0 |
| Mineral fiber (rock, slag, or glass) | | | | |
| approx. 3.5 in. (closed sidewall application) | | 2.0–3.5 | — | 12.0–14.0 |
| Vermiculite, exfoliated | | 7.0–8.2 | 2.13 | — |
| | | 4.0–6.0 | 2.27 | — |
| *Spray Applied* | | | | |
| Polyurethane foam | | 1.5–2.5 | 6.25–5.56 | — |
| Ureaformaldehyde foam | | 0.7–1.6 | 4.55–3.57 | — |
| Cellulosic fiber | | 3.5–6.0 | 3.45–2.94 | — |
| Glass fiber | | 3.5–4.5 | 3.85–3.70 | — |

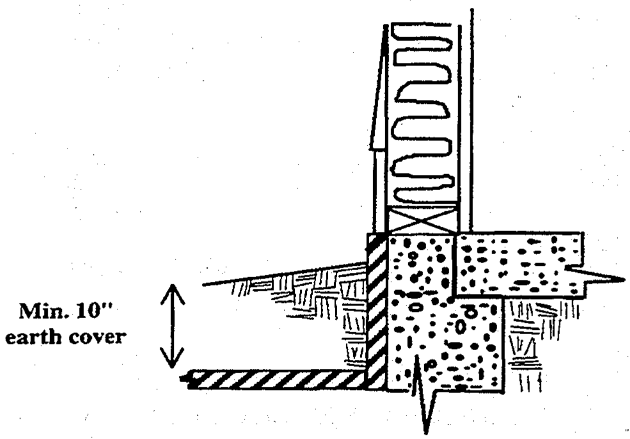
| | | | |
|---|---|---|---|
| **ROOFING** | | | |
| Asphalt shingles | 70 | — | 0.44 |
| **PLASTERING MATERIALS** | | | |
| Cement plaster, sand aggregate | 116 | 0.20 | — |
| 0.75 in. | — | — | 0.15 |
| **MASONRY MATERIALS** | | | |
| *Masonry Units* | | | |
| Brick, fired clay | 150 | 0.12–0.10 | — |
| Concrete blocks | | | |
| Normal weight aggregate (sand and gravel) | | | |
| 8 in., 33–36 lb, 126–136 lb/ft$^3$ concrete, 2 or 3 cores | — | — | 1.11–0.97 |
| Same with perlite filled cores | — | — | 2.0 |
| Same with vermiculite filled cores | — | — | 1.92–1.37 |
| 12 in., 50 lb, 125 lb/ft$^3$ concrete, 2 cores | — | — | 1.23 |
| *Concretes* | | | |
| Sand and gravel or stone aggregate concretes | 150 | 0.10 | — |
| **SIDING MATERIALS (on flat surface)** | | | |
| *Siding* | | | |
| Asphalt roll siding | — | — | 0.15 |
| Hardboard siding, 7/16" | — | — | 0.67 |
| Wood, drop, 1 by 8 in. | — | — | 0.79 |
| Aluminum, steel, or vinyl, over sheathing | | | |
| Hollow–backed | — | — | 0.61 |
| Insulating–board backed nominal 3/8" | — | — | 1.82 |
| Insulating–board backed nominal 3/8", foil backed | — | — | 2.96 |
| **WOOD** | | | |
| Maples, oak and similar materials | 45 | 0.91 | |
| Fir, pine and similar materials | 32 | 1.25 | |
| 3/4" | 32 | 0.94 | |
| 1–1/2" | 32 | 1.9 | |
| 3–1/2" | 32 | 4.4 | |
| 5–1/2" | 32 | 6.9 | |
| 7–1/4" | 32 | 9.1 | |
| 9–1/4" | 32 | 11.6 | |
| 11–1/4" | 32 | 14.1 | |

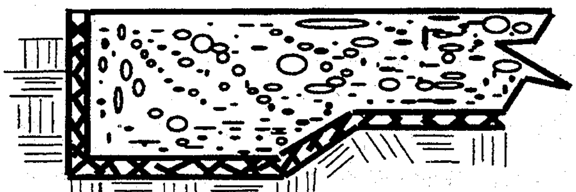
[a]Values are for a mean temperature of 75°F. Representative values for dry materials are intended as design (not specification) values for materials in normal use. Thermal values of insulating materials may differ from design values depending on their in–situ properties (e.g., density and moisture content, orientation, etc.) and variability experienced during manufacture. For properties of a particular product, use the value supplied by the manufacturer or by unbiased tests in accordance with s. Comm 22.31.

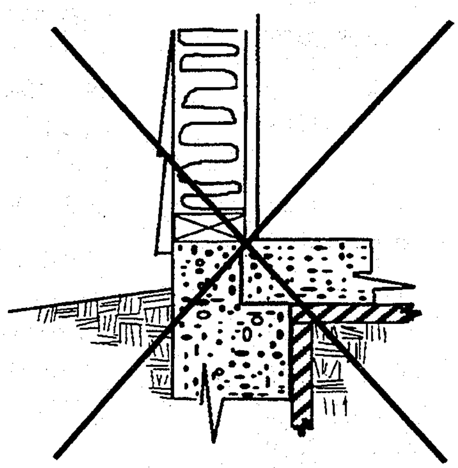
## s. Comm 22.26
## Slab-On-Grade Insulation Details









Insulation shall extend vertically and horizontally for a total of 48". In all cases the insulation shall insulate to the top edge of the floor perimeter. The last diagram is not an acceptable method.