



Identifying Structures of Irregular Shape and Additional Limitations

For conventional light-frame design and construction in accordance with the 2003 International Residential Code®
Seismic Design Category D₂

Northern
Nevada
Chapter
International
Code
Council

The 2003 International Residential Code® (IRC) regulates the design and construction of one- and two-family dwellings and their accessory structures. The Seismic Design Category for structures regulated by this code is D₂ in Washoe County, City of Reno and City of Sparks.

Conventional light-frame construction is not permitted in irregular portions of structures in Seismic Design Category D₂. Only irregular portions of structures must be designed in accordance with accepted engineering practice to the extent such irregular features affect the performance of the conventional framing system.

Explanatory Notes: “Designed in accordance with accepted engineering practice” refers to a design typically prepared by a Nevada Licensed Engineer or Nevada Registered Design Professional.

A PORTION OF A BUILDING IS CONSIDERED IRREGULAR WHEN ONE OR MORE OF THE FOLLOWING CONDITIONS OCCUR:

1. When exterior shear wall lines or braced wall panels are not in one plane vertically from the foundation to the uppermost story in which they are required. (Figures 1.1 and 1.2)

Exception: For wood light-frame construction, floors with cantilevers or setbacks not exceeding four times the nominal depth of the wood floor joists are permitted to support braced wall panels that are out of plane with braced wall panels below provided that:

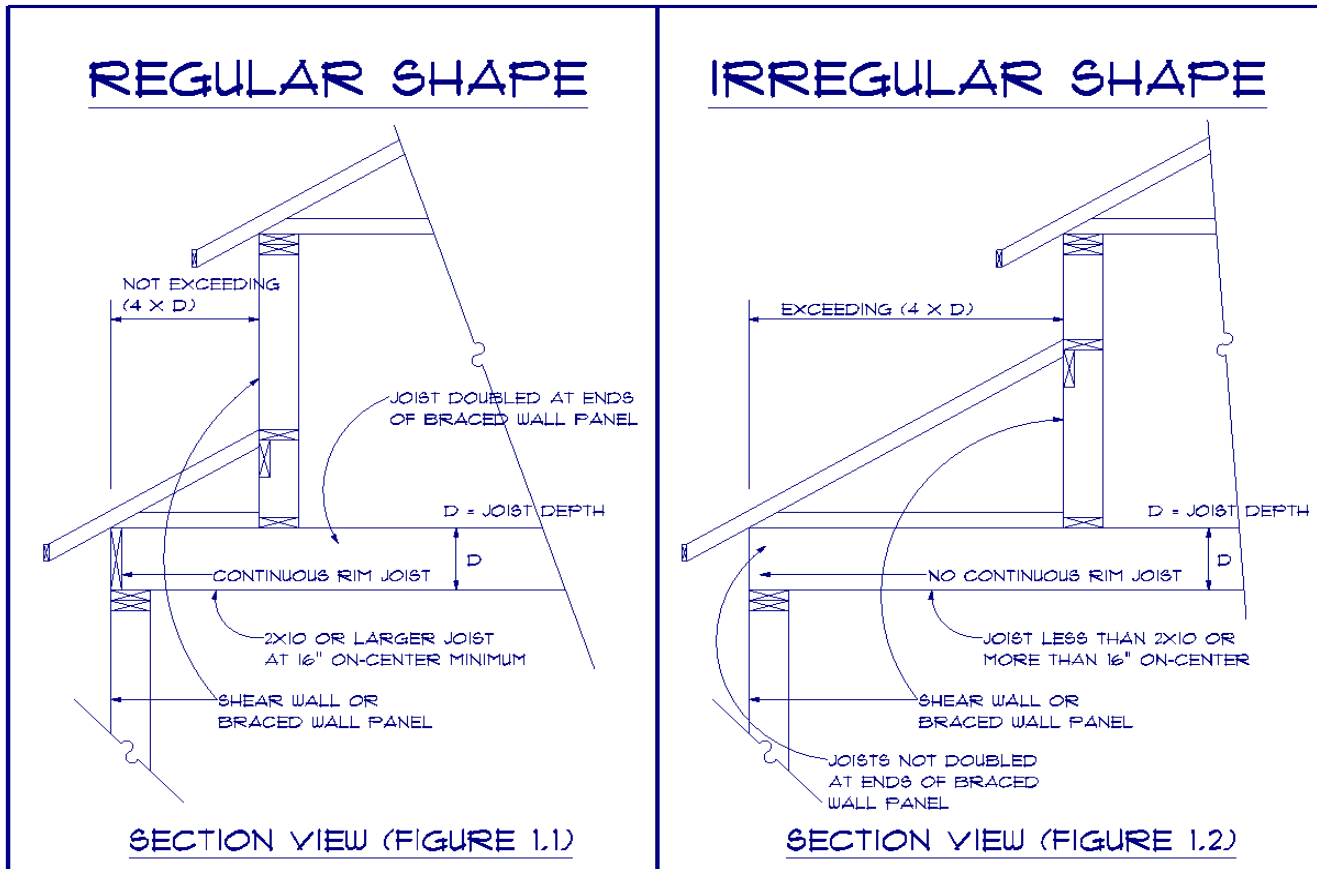
- a. Floor joists are nominal 2 inches by 10 inches or larger and spaced not more than 16 inches on center.
- b. The ratio of the back span to the cantilever is at least 2 to 1.
- c. Floor joists at ends of braced wall panels are doubled.
- d. For wood-frame construction, a continuous rim joist is connected to ends of all cantilever joists. When spliced, the rim joists shall be spliced using a galvanized metal tie not less than 0.058 inch (16 gage) and 1½ inches wide fastened with six 16d nails on each side of the splice or a block of the same size as the rim joist of sufficient length to fit securely between the joist space at which the splice occurs fastened with eight 16d nails on each side of the splice; and
- e. Gravity loads carried at the end of cantilevered joists are limited to uniform wall and roof load and the reactions from headers having a span of 8 feet or less.

Explanatory Notes: “Shear Wall” is a general term for walls that are designed and constructed in accordance with accepted engineering practice to resist racking from seismic and wind forces, also known as lateral loads. “Braced Wall Panel” is the prescriptive equivalent to a shear wall that is constructed in accordance with the IRC for wood framing.

Conventional light-frame construction typically allows cantilevers, offsets, etc. within certain limits in order to accommodate common design features and options. These features are not well suited to resisting earthquake

forces. This becomes more of a concern in areas of higher seismic hazard where it is preferable that the building, or more importantly the lateral-force-resisting system, be more box-like or regular.

Out-of-plane offsets in exterior braced wall lines have been recognized as a factor in buildings damaged by earthquakes. Where an offset occurs, the earthquake forces must be transferred through the floor framing. Thus, item 1 stipulates that exterior shear-wall lines or braced wall panels that are not in one plane vertically from the foundation to the uppermost story in which they are required constitute an irregularity as illustrated in Figure 1.2. The exception, Figure 1.1, allows out-of-plane offsets not exceeding four times the nominal depth of the wood floor joists supporting the braced wall line above. The additional limitations of (a) through (e) must be met to assure the adequacy of the supporting floor framing. Use of this exception is limited to light-frame wood construction.

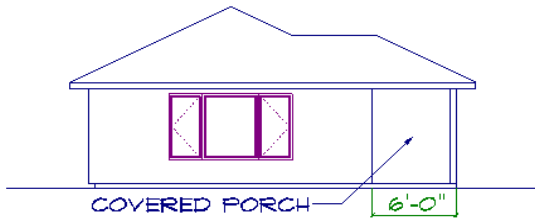


2. When a section of floor or roof is not laterally supported by shear walls or braced wall lines on all edges. (Figures 2.1, 2.2, 2.3 and 2.4)

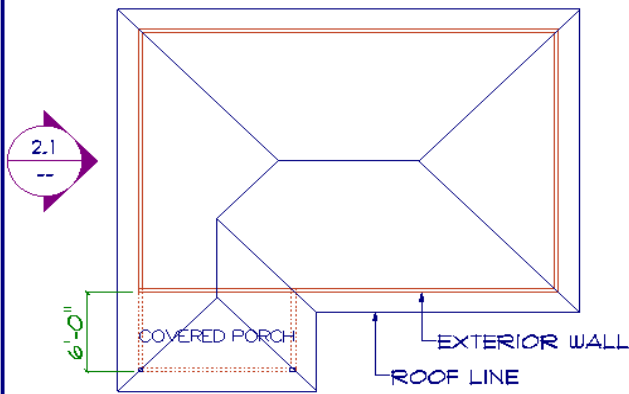
Exception: Roofs and portions of floors that do not support shear walls or braced wall panels above are permitted to extend no more than 6 feet beyond a shear wall or braced wall line.

Explanatory Notes: Typically, braced wall lines are located around the perimeter of floors and walls where forces are greatest. An irregularity occurs where a portion of a floor or roof is not laterally supported by shear walls or braced wall lines on all edges. Figures 2.1 and 2.2 (an example of a building of regular shape) illustrate a roof that is not supported by shear walls or braced wall panels and DOES NOT extend more than 6 feet beyond the shear wall or braced wall line, in this case the exterior wall. Figures 2.3 and 2.4 (an example of a building of irregular shape) illustrates a roof that is not supported by shear walls or braced wall panels and DOES exceed 6 feet beyond the shear wall or braced wall line.

REGULAR SHAPE

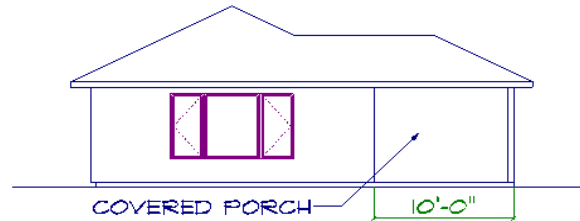


ELEVATION VIEW (FIGURE 2.1)

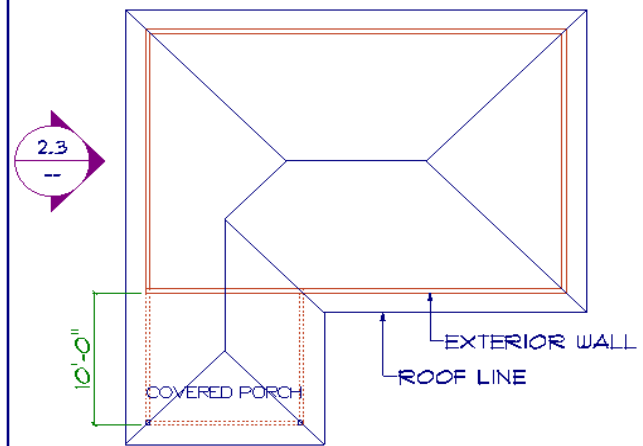


PLAN VIEW (FIGURE 2.2)

IRREGULAR SHAPE



ELEVATION VIEW (FIGURE 2.3)



PLAN VIEW (FIGURE 2.4)

3. When the end of a braced wall panel occurs over an opening in the wall below and ends at a horizontal distance greater than 1 foot from the edge of the opening. This provision is applicable to shear walls and braced wall panels offset in plane and to braced wall panels offset out of plane as permitted by the exception to Item 1. (Figures 3.1 and 3.2)

Exception: For wood light-frame wall construction, one end of a braced wall panel is permitted to extend more than 1 foot over an opening of not more than eight feet in width in the wall below provided that the opening includes a header in accordance with the following:

- The building width, loading condition, and member species limitations of IRC Table R502.5(1) must apply; and
- Not less than 1-2x12 or 2-2x10 for an opening not more than 4 feet in width; or
- Not less than 2-2x12 or 3-2x10 for an opening not more than 6 feet in width; or
- Not less than 3-2x12 or 4-2x10 for an opening not more than 8 feet in width; and
- The entire length of the braced wall panel must not occur over an opening in the wall below.

Explanatory Notes: Where the end of a braced wall panel occurs over an opening in the wall below, an irregularity will be present if the panel extends a horizontal distance greater than 1 foot from the edge of the opening. This applies to braced wall panels offset out of plane as well as in plane. An exception for wood light-framed construction permits a braced wall panel to extend more than 1 foot over an opening in the wall

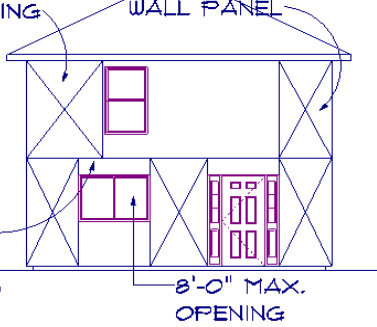
below provided the opening includes a header in accordance with this exception, and the entire length of the braced wall panel does not occur over the opening.

REGULAR SHAPE

ENTIRE LENGTH OF BRACED WALL PANEL DOES NOT OCCUR OVER OPENING

INDICATES BRACED WALL PANEL

HEADER REQUIRED PER EXCEPTION IF THE PANEL EXTENDS MORE THAN 1'-0" OVER OPENING



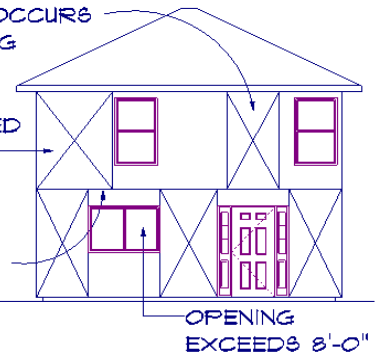
ELEVATION VIEW (FIGURE 3.1)

IRREGULAR SHAPE

ENTIRE LENGTH OF BRACED WALL PANEL OCCURS OVER OPENING

INDICATES BRACED WALL PANEL

NO HEADER PER EXCEPTION AND PANEL EXTENDS MORE THAN 1'-0" OVER OPENING



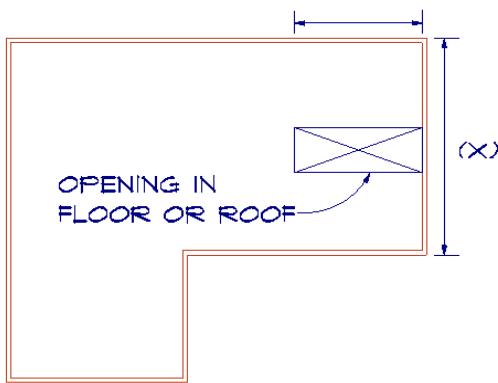
ELEVATION VIEW (FIGURE 3.2)

4. When an opening in a floor or roof exceeds the lesser of 12 feet or 50 percent of the least floor or roof dimension. (Figures 4.1 and 4.2)

Explanatory Notes: Openings in floors are required in most buildings to provide for stairways, skylights, chimneys, equipment chases, etc. If the size of the opening is large compared to the size of the floor or roof diaphragm, earthquake forces may overstress portions of the diaphragm. Since this could result in premature failure of the diaphragm and thus constitute an incomplete load path, the code limits the size of such openings allowed under conventional light-frame construction. Figure 4.2 illustrates the irregularity created by an opening in a floor or roof that exceeds the lesser of 12 feet or 50 percent of the least floor or roof dimension.

REGULAR SHAPE

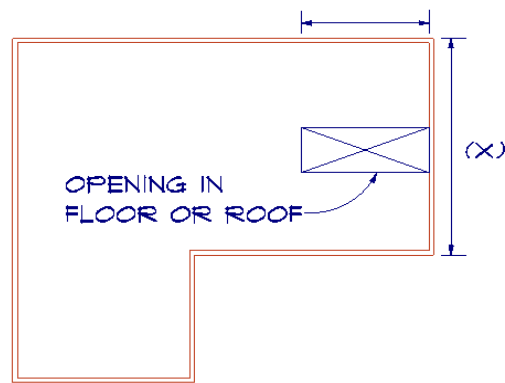
LESS THAN OR EQUAL TO $(X/2)$ OR 12'-0"



PLAN VIEW (FIGURE 4.1)

IRREGULAR SHAPE

MORE THAN $(X/2)$ OR 12'-0"



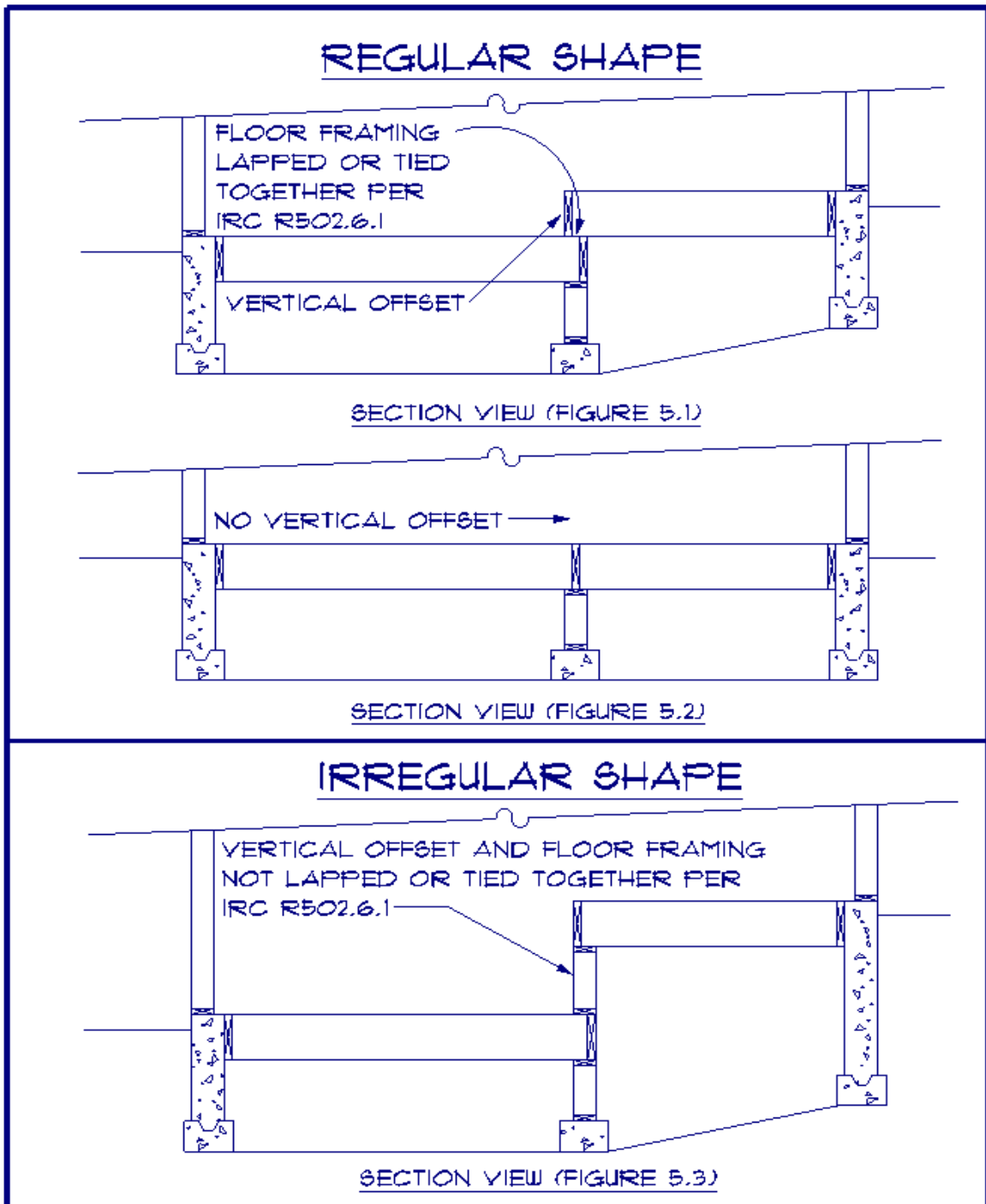
PLAN VIEW (FIGURE 4.2)

5. When portions of a floor level are vertically offset. (Figures 5.1, 5.2 and 5.3)

Exceptions:

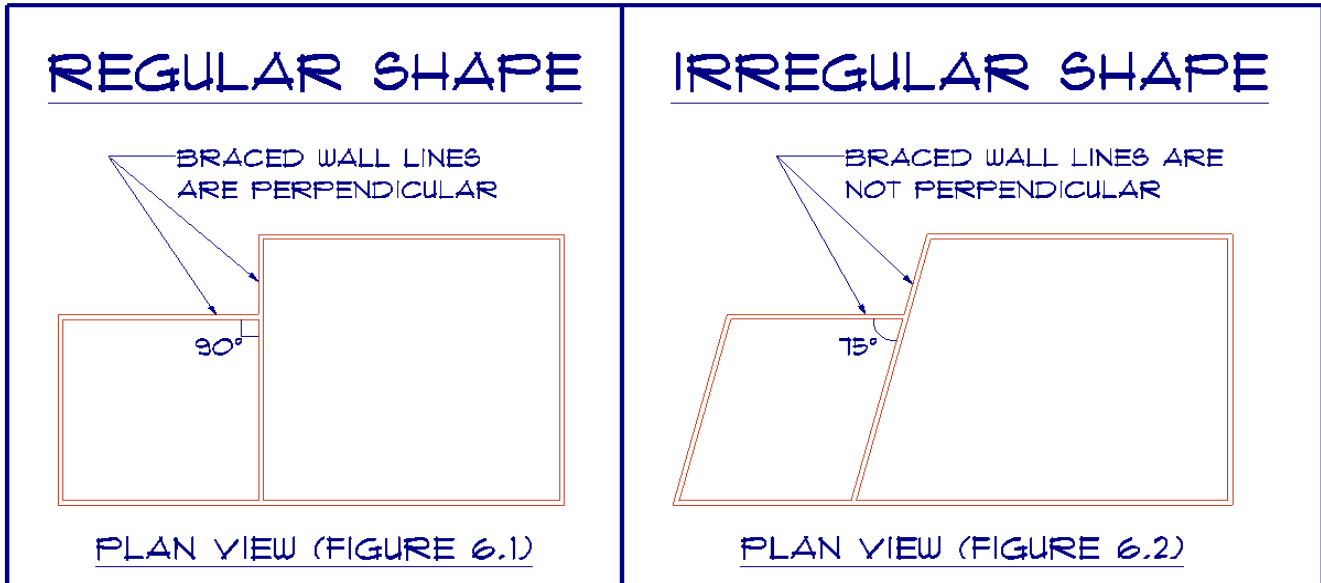
- a. Framing supported directly by continuous foundations at the perimeter of the building.
- b. For wood light-frame construction, floors are permitted to be vertically offset when the floor framing is lapped or tied together as required by IRC Section R502.6.1.

Explanatory Notes: An irregularity results where portions of a floor level are vertically offset. This limitation does not apply to framing that is supported directly by continuous foundations at the perimeter of the building. Also, in light-frame wood construction, floors may be vertically offset provided the floor framing is lapped or tied together as required by the IRC.



6. When shear walls and braced wall lines do not occur in two perpendicular directions. (Figures 6.1 and 6.2)

Explanatory Notes: More often than not, conventional light-frame buildings are regular in shape with wall lines perpendicular to one another. Figure 6.2 depicts a non-orthogonal system. This type of irregularity occurs where shear walls or braced wall lines are not oriented perpendicular to each other.



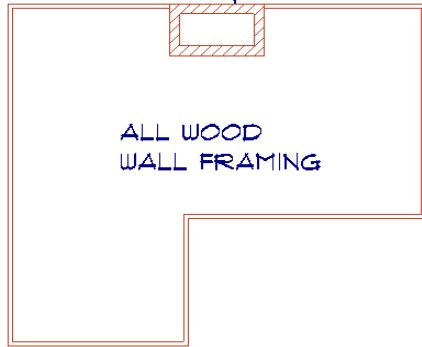
7. When stories above grade, partially or completely braced by wood wall framing in accordance with IRC Section R602, include masonry or concrete construction. When this irregularity applies, the entire story shall be designed in accordance with accepted engineering practice. (Figures 7.1 and 7.2)

Exception: Fireplaces, chimneys, and masonry veneer as permitted by the IRC.

Explanatory Notes: An irregularity occurs if shear walls or braced wall lines are constructed of dissimilar bracing systems on any story above grade. This requirement applies to the underlying framing system material such as wood framed braced wall panels combined with masonry or concrete construction in the same story. Where this condition occurs, the entire story must be designed in accordance with accepted engineering practice. Masonry or concrete fireplaces, chimneys, and masonry veneer are permitted to be combined with wood framing and are not considered to be irregular.

REGULAR SHAPE

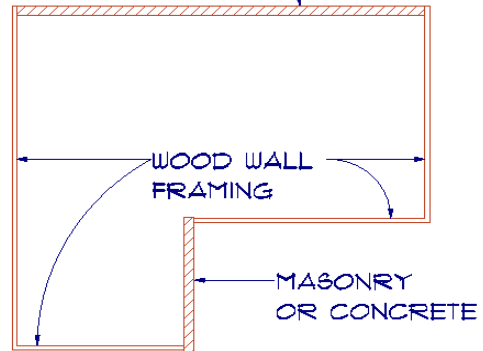
FIREPLACE OR CHIMNEY
PERMITTED PER IRC



PLAN VIEW (FIGURE 7.1)

IRREGULAR SHAPE

MASONRY
OR CONCRETE

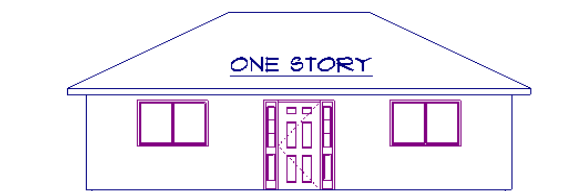


PLAN VIEW (FIGURE 7.2)

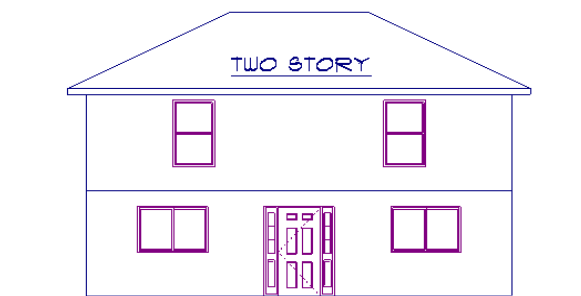
THE DESIGN AND CONSTRUCTION OF CONVENTIONAL LIGHT-FRAME STRUCTURES IN SEISMIC DESIGN CATEGORY D₂ REGULATED BY THE IRC HAVE ADDITIONAL LIMITATIONS. A STRUCTURE MUST BE DESIGNED IN ACCORDANCE WITH ACCEPTED ENGINEERING PRACTICE IF ANY THE FOLLOWING LIMITATIONS ARE EXCEEDED:

8. The structure exceeds 2-stories above grade (Figures 12.1, 12.2 and 12.3); or

REGULAR SHAPE

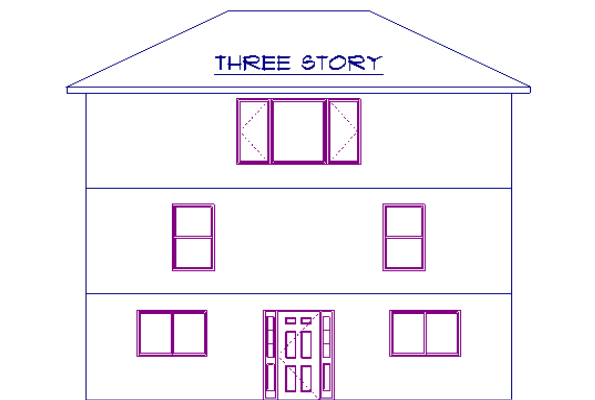


ELEVATION VIEW (FIGURE 8.1)



ELEVATION VIEW (FIGURE 8.2)

IRREGULAR SHAPE



ELEVATION VIEW (FIGURE 8.3)

9. The maximum actual thickness exceeds 3” for anchored stone and masonry veneer with a backing of wood frame; or
10. The masonry veneer with a backing of wood frame exceeds 20’ in height above a noncombustible foundation, with an additional 8’ permitted for gabled ends; or
11. The ground snow load exceeds 20 psf. The ground snow load exceeds 20 psf in the following locations:
 - a. The Lake Tahoe Basin.
 - b. Sierra East Slope, West of Hwy 395: above 5,299 feet above sea level.
 - c. Remainder of Washoe County: above 5,500 feet above sea level; or
12. The average dead load exceeds 15 psf for roof/ceiling assemblies. The dead load for roof/ceiling assemblies is permitted to be increased to a maximum of 25 psf if the wall bracing amounts in IRC Chapter 6 are increased per IRC Table R301-2.2.2.1; or
13. The average dead load exceeds 10 psf for floor assemblies; or
14. The dead load for exterior light-framed wood walls above grade exceeds 15 psf; or
15. The dead load for interior light-framed wood walls above grade exceeds 10 psf

Explanatory Notes for items 12–15: “Dead load” is defined as the weight of all materials of construction incorporated into the building, including but not limited to construction joists, sheathing, studs, insulation, gypsum board, stairways, built-in partitions, finishes, flooring, cladding, and other similarly incorporated architectural and structural items, and fixed service equipment. Dead load does not include the weights of snow, furniture or people.

The following is a partial list of materials generally used in building construction, together with their proper weights taken from ASCE 7-02. The average figure given is suitable for general use, but when there is reason to suspect a considerable deviation from this, the actual weight should be determined. However, special cases will unavoidably arise, in which case the determination will be made by the building official. There have been numerous instances in which the actual weights of members and construction materials have exceeded the values used in design. Care is advised in the use of tabular values.

COMPONENT	LOAD (PSF)	COMPONENT	LOAD (PSF)
CEILING		FLOORS AND FLOOR FINISHES	
1/2” Gypsum board	0.28	3/4” Ceramic/quarry tile on 1/2” mortar	16
5/8” Gypsum board	0.34	3/4” Ceramic/quarry tile on 1” mortar	23
Suspended metal lath and cement plaster	15	7/8” Hardwood flooring	4
ROOF & WALL COVERINGS		1/4” Linoleum or asphalt tile	1
Asphalt shingles	2	Marble & mortar on stone-concrete fill	33
Cement tile	16	Slate (per inch)	15
Composition, 3-ply ready roofing	1	Solid or flat tile on 1” mortar	23
Composition, 4-ply felt and gravel	5.5	3/4” Subflooring	3
Composition, 5-ply felt and gravel	6	WOOD JOISTS	
2” wood decking (Douglas Fir)	5	Joist size	12” spacing
3” wood decking (Douglas Fir)	8	2 x 6	6 psf
1/2” Fiberboard	0.75	2 x 8	6 psf
Fiber glass insulation (per inch)	1.1	2 x 10	7 psf
Plywood (per 1/8”)	0.4	2 x 12	8 psf
Metal frame skylight, 3/8” wire glass	8	16” spacing	5 psf
Waterproofing membranes:		24” spacing	5 psf
Bituminous, gravel-covered	5.5	FRAME PARTITIONS	
Bituminous, smooth surface	1.5	Wood studs, 1/2” gypsum board each side	8
Single ply, sheet	0.7	Wood studs, 2 x 4, unplastered	4
Wood sheathing (per inch)	3	FRAME WALLS	
Wood shingles	3	2 x 4 @ 16” spacing, 5/8” gypsum board,	
		insulated, 3/8” siding	11
		2 x 6 @ 16” spacing, 5/8” gypsum board,	

	<i>2 x 6 @ 16" spacing, 5/8" gypsum board, insulated, 3/8" siding</i>	<i>12</i>
	<i>Exterior stud walls with brick veneer</i>	<i>48</i>
	<i>Windows, glass, frame and sash</i>	<i>8</i>