desirable to design such girders with a smaller deflection limit to control floor vibration, particularly when girder and floor spans have more than a 20-foot total combined span (i.e., span of girder plus span of supported floor joist).

For metal-plate-connected wood trusses, strong-backs are effective in reducing floor vibration when they are installed through the trusses near the center of the span. A strong-back is a continuous bracing member, typically a 2x6, fastened edgewise to the base of the vertical web of each truss with 2-16d nails. For longer spans, strong-backs may be spaced at approximately 8-foot intervals across the span. Details for strong-backs may be found in the *Metal Plate Connected Wood Truss Handbook* (WTCA, 1997). Alternatively, a more stringent deflection criteria may be used for the floor truss design.

Shrinkage

The amount of wood shrinkage in a structure depends on the moisture content (MC) of the lumber at the time of installation relative to the equilibrium moisture content (EMC) that the wood will ultimately attain in use. It is also dependent on the detailing of the structure such as the amount of lumber supporting loads in a perpendicular-to-grain orientation (i.e., sill, sole, top plates, and joists). MC at installation is a function of the specified drying method, jobsite storage practices, and climate conditions during construction. Relatively dry lumber (15 percent or less) minimizes shrinkage problems affecting finish materials and prevents loosening or stressing of connections. A less favorable but acceptable alternative is to detail the structure such that shrinkage is uniform, dispersed, or otherwise designed to minimize problems. This alternative is the "defacto" choice in simple residential buildings.

Shrink and swell across the width or thickness of lumber can be estimated by the equation below from ASTM D1990 for typical softwood structural lumber (ASTM, 1998a). Shrinkage in the longitudinal direction of the member is practically negligible.

[ASTM D1990•App. X.1]

$$d_2 = d_1 \left(\frac{1 - \frac{a - 0.2M_2}{100}}{1 - \frac{a - 0.2M_1}{100}} \right)$$

d_1 = member width or thickness at moisture content M_1
d_2 = member width or thickness at moisture content M_2

$a = 6.0$ (for width dimension)
$a = 5.1$ (for thickness dimension)

5.4 Floor Framing

The objectives of floor system design are

- to support occupancy live loads and building dead loads adequately;
- to resist lateral forces resulting from wind and seismic loads and to transmit the forces to supporting shear walls through diaphragm action;
- to provide a suitable subsurface for floor finishes;
- to avoid owner complaints (e.g., excessive vibration, noise, etc.);
- to serve as a thermal barrier over unconditioned areas (e.g., crawl spaces); and
- to provide a one- to two-hour fire rating between dwelling units in multifamily buildings (refer to local building codes).

5.4.1 General

A wood floor is a horizontal structural system composed primarily of the following members:

- joists;
- girders; and
- sheathing.

Wood floor systems have traditionally been built of solid sawn lumber for floor joists and girders, although parallel chord wood trusses and wood I-joists are seeing increasing use, and offer advantages for dimensional consistency, and spans. Floor joists are horizontal, repetitive framing members that support the floor sheathing and transfer the live and dead floor loads to the walls, girders, or columns below. Girders are horizontal members that support floor joists not otherwise supported by interior or exterior load-bearing walls. Floor sheathing is a horizontal structural element, usually plywood or oriented strand board panels, that directly supports floor loads and distributes the loads to the framing system below. Floor sheathing also provides lateral support to the floor joists. As a structural system, the floor provides resistance to lateral building loads resulting from wind and seismic forces and thus constitutes a “horizontal diaphragm” (refer to Chapter 6). Refer to Figure 5.2 for an illustration of floor system structural elements and to *Cost-Effective Home Building: A Design and Construction Handbook* for efficient design ideas and concepts (NAHBRC, 1994).