CHAPTER 4

DIMENSIONAL INSTABILITY IN TIMBER

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1. INTRODUCTION

Dimensional instability is one of the major impediments in the processing and use of lumber. Three separate facets need to be distinguished and considered: shrinkage on drying, movement in service, and the responsiveness of lumber to a fluctuating environment. The issues demand the attention of workers and management at every stage of manufacture. There are more complaints about the instability of lumber than any other matter and rectifying problems is expensive. Figure 4.1 provides unhappy examples of the consequences of movement in service.

Some typical moisture content values for green wood are noted in Table 3.1. These values are considerably greater than the fibre saturation point. Absorbed water at the surface will evaporate and the lumber will dry provided the surrounding atmosphere is not totally humid. Indeed the absorbed water in the lumens cannot remain there in equilibrium with the atmosphere unless the relative humidity of the air is in excess of 99\% (Table 3.3). If the wood is left under cover – keeping the rain off – it will eventually dry to a moisture content that will vary according to the temperature and humidity of the air (Figure 3.2). This moisture content will be below the fibre saturation point so all the absorbed water and some of the adsorbed water will have evaporated. If an even lower moisture content is required it is necessary to use a kiln to lower the relative humidity and raise the temperature (Figure 3.2).

2. SHRINKAGE AND SWELLING OF WOOD

Wood only shrinks when water is lost from the cell walls and it shrinks by an amount that is proportional to the moisture lost below fibre saturation point. To a first approximation the volumetric shrinkage is proportional to the number of water molecules that are adsorbed within the cell wall, and that in turn is related to the number of accessible hydroxyls on the cellulose, hemicelluloses and lignin, and to the amount of cell wall material, i.e. the basic density of the wood (Figure 4.2).

The axial, radial and tangential shrinkages, which together account for the volumetric shrinkage, are directed by features of wood structure that resist shrinkage, e.g. the quantity of ray tissue in the radial direction, or by features of the
Figure 4.1. (a) The parquet floor has lifted because the wood was dried to too low a moisture content (CSIRO, Australia). (b) Old paint is liable to crack as the wood moves.

 ultrastructure, e.g. the tendency for microfibrils to align roughly in the axial direction.

 Early in the drying process it is inevitable that the moisture content at the centre of the piece will be above the fibre saturation point while the fibres at and near the surface will be well below the fibre saturation point. There will be a moisture gradient within the wood and the system will not be in equilibrium. In this situation the surface fibres will have started to shrink and the overall volume of the piece will be reduced even though the average moisture content is above fibre saturation. This accounts for the shrinkage of the wood at mean moisture contents a little above the fibre saturation point (Figure 4.2).

 The volumetric shrinkage to the oven-dry state is determined by measuring the green and oven-dry volume: