Expansion of Wetted Plywood and OSB Panels

By Felix Martin, S.E.

Winter's rains provides the opportunity to examine problems caused by expansion of OSB and plywood wood panels due to excessive moisture. Design engineers tend to think of the structure as a finished product and sometimes give little attention to structural problems that may arise in the construction process.

With flat roofs (or floors exposed to weather), during extended periods of exposure to rain, wood sheathing that has not been roofed or covered has an opportunity to be kept constantly wet. Once this happens water will be absorbed by the sheathing, resulting in thickness swell and linear expansion of the sheets.

Concern has typically been focused on increases in the thickness of the panel. In plywood sheets, as the panel expands in thickness, nail heads are pulled through and, in extreme cases, punch through the top ply, rendering the panel useless in shear. Moisture penetration in plywood panels can also lead to delamination of the plies, despite the widespread use of exterior grade glues.

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In the case of Oriented Strand Board (OSB), thickness swell primarily occurs along panel edges. This is because of capillary action at end grain fibers, although OSB panels are typically surface and end sealed. OSB also tends to larger thickness swells than plywood, due to the use of a more porous wood product and to the release of compression set from the panel manufacturing process. Once the panel thickness has been expanded by wetness, when back to its original moisture content, it will not completely return to its original thickness.

However, because of the multi-layered and random direction of the wood chips, there is a smaller chance for total nail head punch-through in OSB than plywood. An American Plywood Association (APA) publication (TT-012) provides a suggested guideline for determining whether the shear capacity of a wood diaphragm has been compromised by buried nail heads caused by either overdriving or thickness swell due to moisture. The publication does not address OSB and plywood separately, although nail heads can penetrate completely through the face layer of three-ply plywood. OSB really has no definable face layer.

In 1985 the APA performed a series of tests on the effect of wetting OSB shear wall panels (test results were not published by the APA). The research involved performing static load tests on six 7/16-inch thick shear wall panels. Three panels were tested dry. The remaining three panels were wetted by placing them in an almost horizontal position and using a sprinkler to spray the sheathing approximately eight hours per day for three consecutive days. The walls were then allowed to dry approximately two weeks and tested.

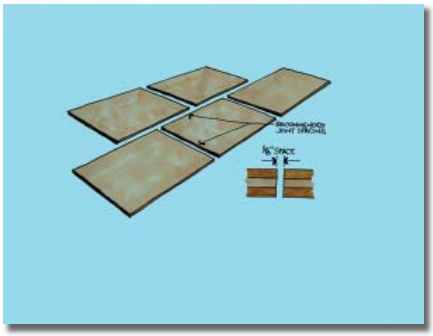
The wetted walls had an average final moisture content of 4-5% after drying, versus an average moisture content of 3-4% for the walls not wetted. The wetted walls showed a slight decrease in ultimate load capacity when compared with the dry walls. They also had increases in total deflection and permanent (residual) set. The decrease in ultimate load capacity plus the increases in total deflection and set were judged by the APA as insignificant enough to conclude that wetting of OSB shear walls, such as by rainfall during construction, did not adversely affect the strength of the walls.

These test results may be extended to horizontal diaphragms to similarly conclude that extended exposure to wetting of OSB horizontal diaphragms will not adversely affect the strength of those diaphragms.

A concern not usually taken into account is the linear expansion of the panel length and width due to moisture infiltration. Some of this expansion is taken up through partial restraint crushing along the fasteners and by panel end crushing; some is taken by allowing a small gap between sheets during installation.

OSB sheets come factory-cut to allow a 1/8-inch installation gap in both directions. The typical installation procedure used by experienced framing contractors is to drop 16d nails between the wood panels. Because 16d nails are approximately 1/8-inch in diameter, this provides a method of automatic spacing between panels.

Testing by the APA (Publication TT-028) has shown that wetted plywood/OSB panels will expand a maximum of ¼-inch in the long direction and 3/16-inch in the short direction. The APA test took the panels from an oven dry condition to complete saturation, conditions not normally encountered in the field where variations in moisture content are not so extreme. Using the APA extreme linear expansion values, for an eighty foot long roof, assuming a ¼-inch linear expansion per eight foot panel length, an average 1/8-inch gap between sheets and an average 1/8-inch fastener/end crushing per panel, would result in a net linear lengthening of the roof of zero.



However, personal experience has suggested field net linear expansion values may be larger than those calculated above. This may have been due partially to installation procedures that may have placed the panels without the 1/8-inch gap between sheets, although this alone would not account for the extent of the discrepancies observed. The APA acknowledges the potential problem in Research Report 144, by addressing the buckling potential of structural panels resulting from linear expansion. Buckling of panels from linear expansion is more likely to occur in structures restrained from lateral expansion.

A net linear expansion in laterally unrestrained diaphragms is the type of thing that pulls walls and columns out of plumb. This is more likely to happen if the linear expansion occurs in construction when the shear walls may not yet be in place; or if one end of the building is laterally restrained and the other end is free to expand. Once linear expansion has taken place, as explained before, it will not completely shrink back to its original dimensions when the sheets dry again. In other words, walls and columns stay out of plumb and may have to be forced to their original state through expensive and time-consuming mechanical means.

from experience

It is important to recognize damage due to linear expansion once it occurs, as problems associated with it can be easily misdiagnosed. Damage may first be observed in walls and columns previously installed plumb. These may be subsequently observed to be out-of-plumb following exposure of the roof plywood to rain days to a few weeks prior. Positive proof that linear expansion has taken place may be found in tight-fitting horizontal panels with crushed edges. This will indicate panel expansion has taken place, with no available expansion relief possible.

Moisture exposure is not limited to areas of high rainfall. Where the conscientious contractor covers the sheathing with plastic, the sheathing may be soaked continuously over an extended period of time even in low moisture areas. Though the plastic keeps moisture away for short periods of time, rain lasting a few days water will leak in along joints or tears in the plastic. Moisture will then be retained by the very plastic intended to keep it out.

The APA has in the past espoused the use of expansion joints in wood sheathed roofs and floors over eighty feet in length. A temporary expansion joint may be used in the middle field of a long roof when extended periods of moisture are expected or just simply included as a general specification for roof lengths eighty feet and beyond. Once the horizontal sheathing is ready to be waterproofed, the "fill-in" panels can be installed just before roofing is applied.

Although not specifically a design concern, the potential problems associated with thickness swell and linear expansion due to moisture intrusion during construction are worth considering by the design engineer. The inclusion of temporary expansion joints for long roofs or for wet weather may well avoid the possibility of frantic field calls, construction delays and expensive repairs. Anything done to assist a project to be trouble-free during construction is usually time well spent.▪

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