Lessons at Yellowstone National Park

By Samantha Fox

The start of a career as a young engineer is a continual information overload. The facts to remember and considerations to take when making design decisions are overwhelming. Keeping up with tight deadlines leaves little extra time to spend understanding the process and building confidence in making decisions. Brand new engineers lack the basis to distinguish which design checks are necessary, which are extraneous, and how to be efficient in calculations and designs. Knowledge can come slowly over time with repetition, or it can come from first-hand experiences. In my case, knowledge about snow loading came in the form of experiencing winter in Yellowstone National Park.

When I started as an intern, I was the fourth person in a small branch office. At that time, I was working on several log and timber structures in heavy snow regions and getting the hang of snow loads, log design, and timber frame connections. Unbalanced snow, eave loading, drifting, and sliding snow – developing these loads seemed daunting at the time. When should these conditions be considered? What is the appropriate way to handle valleys and dormers? I worked through these questions, trying to include critical conditions but also trying to be efficient. This often meant spending less time in developing loads and more time in designing mortise and tenon connections.

Several of these projects happened to be located in Yellowstone National Park. The design ground snow load for much of Yellowstone is 200 pounds-per-square-foot. With an approximate density of 19 pounds-per-cubic-foot, that is over ten feet of snow on the ground. Before seeing this snow accumulation for myself, I imagined that the design ground snow value had a large degree of conservatism and that designing structural members to near capacity was appropriate. My attempts at efficient design were complicated by the high snow load since timber truss designs were controlled by large unbalanced snow loads and seismic forces were driven by the roof snow.

During the winter months, the only way into many remote project sites in Yellowstone is through a gate with a combination lock and often on a snowmobile or snow coach if the plows have not started for the season. This is truly an amazing time to see the park. During my first winter trip, I was shocked at the amount of snow on the ground and even more amazed by the amount of snow on the roofs of the structures. There was easily ten feet of snow on the ground in several locations. Unbalanced snow, drifting on low roofs, drifting against parapets and walls, and eave loading could all be observed. It was not an unusually big snow year or even the most snow that the structures had seen in Yellowstone in that particular season.

Additionally, many of the structures in Yellowstone are winterized every season, meaning that they remain unheated for nearly six months out of the year. One project in our office involved splicing new log rafter tails to existing framing as part of a roof structure retrofit. The existing tails were deteriorated and were to be cut off so that new, matching tails could be spliced on and blended into the existing structure. The depth of snow that I witnessed on the eaves in Yellowstone justified the loading conditions that previously seemed conservative.

Site visits to Yellowstone National Park were excellent learning experiences in my young career. Those experiences helped me gain understanding and confidence to make practical design decisions and taught many lessons that I continue to incorporate into practice:

- The creation of snow maps for more complicated roof structures as part of the analysis. Sketching out each snow load condition on a roof plan can be helpful to visualize the potential behavior and effects of the snow loading on the roof structure.
- The inclusion of several snow cases in finite element models. Spending additional time at the front-end of a project in creating several load cases can help ensure that certain checks are not missed in design, particularly when changes are made.

Spring time eave loading in Yellowstone National Park.

- Adoption of tools and spreadsheets that have made these checks easier and more efficient. In particular, drift load checks are simplified by comparing each drift condition side by side in a spreadsheet.
- Placing importance on observing engineering loading conditions and construction practices in the field. Any of these opportunities are valuable for a young engineer.
- Understanding that engineering judgment is gained from first-hand experiences, as well as traditional learning from textbooks and training received from other engineers and managers. It takes time to develop engineering judgment.▪

*Samantha Fox is a Project Engineer at BCE Structural in Bozeman, Montana, and sits on the NCSEA Young Member Group Support Committee. Samantha can be reached at **sam@bceweb.com**.*