**Improved Method for Repairing Wooden Structural Beams in CCC NHL District**

In 2010 the Historic Preservation Division at Bandelier National Monument (BAND-HP) received a grant from the National Center of Preservation Technology and Training to develop an improved methodology for replacing the deteriorated ends of structural roof beams commonly called vigas. Vigas are an essential element in the Pueblo Revival style that defines the 31 buildings in the National Historic Landmark District of Bandelier. The vigas extend through the vertical walls of the buildings, are roughly finished and are exposed to sunlight and weather which deteriorates the ends of the beams. In order to preserve the vigas the beam ends must be replaced before the deterioration reaches the interiors of the buildings and causes additional damage.

The existing method for repairing the vigas ends is irreversible and requires large quantities of specially formulated epoxy resin which is difficult to control and cannot be renewed without further damage to the historic fabric. Using this method, the first step is to remove the deteriorated viga end to just inside the vertical plane of the wall. A 2-inch diameter hole is bored into the remaining beam and a 1-inch diameter threaded fiberglass rod is cast inside the hole with epoxy which has to be carefully controlled as it follows any natural splits in the wood and often spills out on historic fabric in unpredictable ways.

A replacement beam end is selected from log stock and is prepared by boring a similar 2-inch hole. The hole is then fitted with a temporary segment of the same 1-inch threaded fiberglass rod treated with a release agent around which more epoxy is cast. When the epoxy cures the temporary threaded rod is removed leaving behind a permanently cast threading inside the replacement end. The replacement end is then threaded on to the existing beam and the repair is complete.

The new methodology eliminates the use of any chemicals and decreases repair time by up to 75 percent. Instead of using epoxy to anchor a threaded rod into the existing beams and casting threading in the replacement ends with epoxy, a custom-built drill guide and thread cutting tool are employed to allow preservationists to accurately drill and thread a 1” dia. hole 12” long directly into the remaining viga and the replacement end. The replacement end is then attached to the viga with a 24” long threaded fiberglass rod. In addition to not introducing any non-reversible materials into the historic fabric this repair allows for easy cyclic maintenance of the viga ends. After the threaded rod has been installed into the viga it is simply a matter of fashioning a replacement end and screwing it onto the existing beam whenever the end has deteriorated to the point of requiring replacement.

This project was funded by both a grant from the National Center for Preservation Technology and Training as well as the NPF. Through this generous funding BAND-HP was able to successfully design and build a drill guide and threading tool to use in the improved methodology for replacing viga ends.
Initially, the design was discussed by several members of BAND-HP who had been involved in the old method of repairing viga ends and ideas for a prototype drill guide and threading tool were collected and evolved. Various commercial products were examined and elements of their designs were incorporated into the BAND viga tool design. It was decided that the drill guide would be constructed from a combination of cast aluminum for strength and light weight and steel components where wear and durability were of concern.

The cast parts were drawn to scale in a CAD software package called Rhino 4.0 and were then cut out in foam through the use of a CNC router. The foam parts were subsequently covered in a thin shell of plaster and packed in sand where they were directly cast into aluminum through a technique known as lost foam casting. It took several iterations to develop a casting process that gave a satisfactory finished product. Once the aluminum pieces were fabricated they were delivered to a machinist to drill the appropriate holes accurately in them and steel bushings were press fit into place. As the aluminum parts were being machined, steel guide rods were knurled and threaded and a shaft for the drill guide carriage was fabricated on a metal lathe at BAND. After all the drill guide components were constructed they were assembled and the drill guide was tested. There was a slight wobble in the chuck of the drill guide which was corrected by making a new shaft that had a shoulder on it that allowed the chuck to be seated more accurately.

Once the drill guide was working satisfactorily the threading tool was constructed. The threading tool consists of a commercial 1” dia. x 8 thread-per-inch tap that is fitted to a 16” extension which has been fabricated with a square hole on one end to hold the tap. On the other end of the extension is a hole for a T-handle to start the threading by hand as well as a ½” shaft so that the threading can be finished with a hand drill. The drill guide and threading tool are designed to break down so that they can be packed into a toolbox that has been outfitted with foam insets that hold the components securely.

Overall the project went smoothly and was completed on time and on budget. All the goals of the project were met successfully. Three sets of drill guides and threading tools were constructed to be used by the preservation crews of BAND-HP. The methodology and tools will also be shared with others in the preservation community. The drill guide and the threading tool both work very well and produce professional results. They will allow BAND-HP to perform viga repairs efficiently and more in keeping with the Secretary of the Interior’s guidelines for historic preservation. Visitors to BAND will be able to continue to view the buildings in the Historic Landmark District and gain an appreciation for this vital Southwestern architectural vernacular style.
Photos

Foam mold for carriage with plaster shell

Mold packed in sand
Drill guide plate casting prototype before machining

Drill guide assembled
Tap assembled

Routing viga replacement end to make it square
Confirming that the log is level and plumb after routing

Attaching drill guide plate
Drilling into the viga end

Finishing the hole
Starting to thread the hole by hand

Finishing the threading with the drill
Inserting the fiberglass rod

Confirming that the rod is square to the log