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## DSC TECHNICAL BULLETIN 04- 05

### **Subject:** Historic Viga Restoration Using Screw-on Vigas

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#### **Discussion:**

Rehabilitation and restoration of Colonial and Pueblo style structures with structural elements (in particular vigas) exposed to the weather has always been a challenge. Treatments have either been extremely invasive (replacement of the entire viga) or non-structural, non-reversible. In the early 90s, Exhibit Specialist, Jake Barrow, of the then NPS Southwest Regional Office, and Barry Welton, NPS Denver Service Center, Structural Engineer, began experimenting with a new approach to this old problem—making viga repairs both structural and reversible. Over time this concept of attaching viga ends with threaded fiberglass rods and epoxy has evolved into a very successful solution, albeit heavily laden with technological and craftsmanship prerequisites. The trade-off, however, is beneficial as retention of significant historic fabric can be substantial. In a typical application, this approach can save an entire historic roof system from replacement. It also allows for the natural weathering (which is often the historic finish) without concern of future total roof replacement. Cyclic replacement of viga ends can be a viable option with this approach.

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#### **Recommendation:**

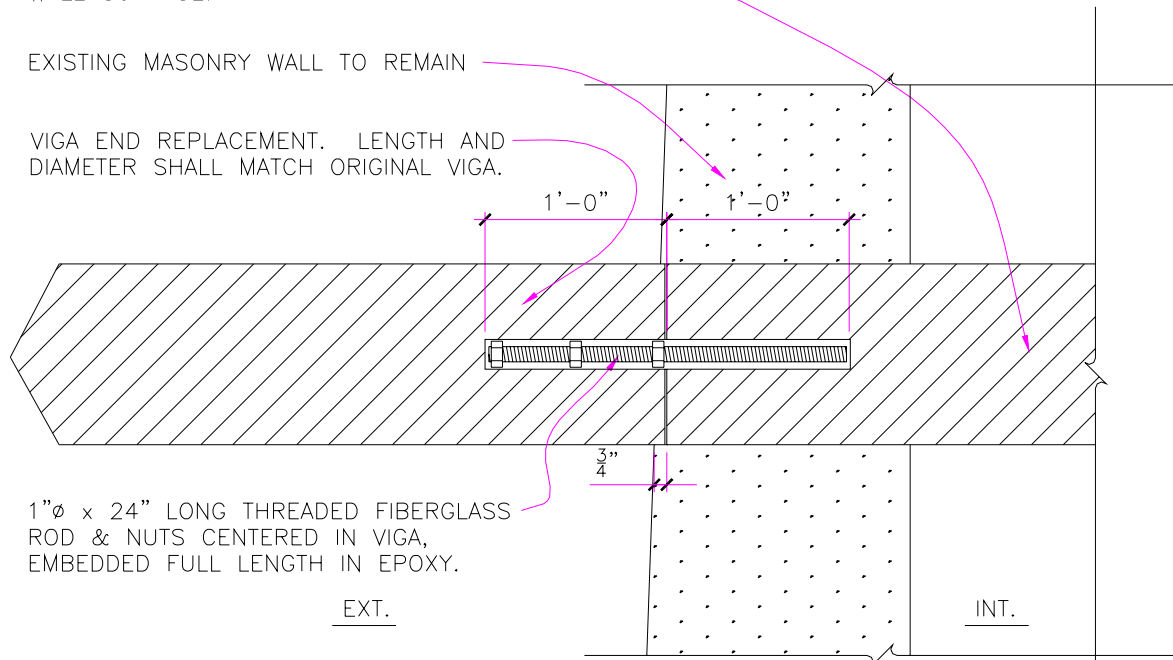
It is imperative that a craftsperson, experienced in the procedure of screw-on viga installation, be consulted if this approach is to be successful. It requires highly developed technical know-how in epoxy and wood craftsmanship, as well as, actual experience in executing this type of viga repair on historic structures. The attached drawing and specification are for information only. Currently, the best qualified consultant is Exhibit Specialist, Jake Barrow, of the NPS, Santa Fe Support Office.

Bruce Warneke,  
Chief, Technical Branch

EXISTING VIGA TO REMAIN. REMOVE DETERIORATED END TO JUST BEHIND WALL SURFACE.

EXISTING MASONRY WALL TO REMAIN

VIGA END REPLACEMENT. LENGTH AND DIAMETER SHALL MATCH ORIGINAL VIGA.



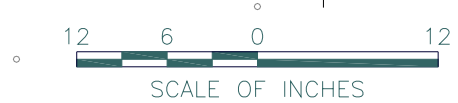
1"φ x 24" LONG THREADED FIBERGLASS ROD & NUTS CENTERED IN VIGA, EMBEDDED FULL LENGTH IN EPOXY.

EXT.

INT.



STRUCTURAL VIGA REPAIR



## PART 1 GENERAL

### 1.1 DESCRIPTION

- A. The work of this section consists of restoring a viga (log end) by a replacement technique which will result in a structural replacement. The repair method in this specification is for a removable viga end to allow future replacement if needed.

### 1.2 RELATED WORK

- A. Fastenings 1/4-inch in diameter and greater, plates and hangers 1/4-inch thick and over - Section 05120.
- B. Rough Carpentry - Section 06100.

### 1.3 SUBMITTALS

- A. As specified in Section 01330.
- B. Samples: Viga (log) replacement for each species required showing surface texture, grain and color.
- C. Shop Drawings: Show dimensions, layout of viga framing, framing connection details, fastener connection template and overall plan with numbered vigas coded by elevation and level.
- D. Inspection List: Tabular list identifying number of the viga, the number of deteriorated vigas, the species of wood, the depth of rot, the diameter and length of the viga (deteriorated portion), attachment type, the taper direction, the surface configuration, tooling marks, digital photograph number(s) and any other pertinent information (remarks section).
- E. Manufacturer's Literature:
  - 1. Submit information for epoxy.
  - 2. Submit information for fiberglass rods and fasteners indicating load capacities and evidence that products meet the requirements of this section.
- F. Preservative Treatment Literature:
  - 1. Submit information for preservative treatment used.

### 1.4 QUALITY ASSURANCE

- A. The government will provide a viga trainer to train the contractor's key personnel in viga replacement. The contractor will pay the government \$XXX to cover five days of lodging, meals, and miscellaneous incidental expenses. Account information will be provided to the contractor within ten business days of receipt of a written request for this training. The contractor shall pay all fees, including liability and collision insurance, for a mid size rental car rented from a national franchise. The rental will originate in Santa Fe New Mexico and will terminate in Santa Fe New Mexico. The government will provide three consecutive 7 hour days of on site training. The contractor shall provide the Contracting Officer a written request for this training. Once the government receives the \$XXX and the contractor provides this written request, training dates will be arranged not before twenty eight calendar days of receipt of the request but not after thirty two calendar days of receipt of the request. The contractor will be responsible for all worker's tools,

*Denver Service Center, Technical Branch, Quality Assurance Support Group*

materials and labor during training. The government trainer will provide only his own tools. Vigas replaced under the trainer's supervision during training shall be retained and protected as work samples. These samples shall be referenced as a standard of quality for accepting remaining viga replacement work.

- B. Logs: Log diameter selected shall be oversized by approximately 1/4" from original to allow for final sizing.
  - 1. Hand selected from saw mill. Either green and free of checks; or dry with checks and free of decay or insects.

## 1.5 SPECIAL CONDITIONS

- A. Techniques will vary with conditions on site. The exterior finish of the building, the structure of the building and the viga details all impact what technique should be used. Adobe has different requirements than stone. If the viga stub connection is concealed, the task is somewhat easier. When the connection is visible, the importance of the exposed joint becomes a major concern. The process can be described in a somewhat generic manner; understanding that each and every building will have attributes requiring specialized adaptation of the procedure.
  - 1. The vigas are inspected and a tabular list is drawn up which indicates the identifying number of the viga, the number of deteriorated vigas, the species of wood, the depth of rot, the diameter and length of the viga (deteriorated portion), the taper direction, the surface configuration, and any other information pertinent. (Digital- doesn't matter what kind of image)) Photography shall be used to compliment this task by getting elevation, oblique view, and close up shots.
  - 2. The existing surface and end configurations are very important as character defining features. Accurate recording will require photography. It is important to recognize nuances of tool use that might not be readily apparent. From the inspection list materials may be acquired. A sample inspection sheet is attached
- B. Replacement viga ends (logs) shall be properly seasoned and checked.

## 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Moisture Content: Notify Contracting Officer one day prior to delivery of materials to job site. Upon delivery, prior to unloading, moisture content and quality marks will be checked by Contracting Officer.
- B. Environmental Acclimation:
  - 1. Store materials a minimum of 6 inches above ground in area protected from weather. Protect with waterproof covering allowing adequate air circulation. All material shall have minimum 1/2 inch spacers. Do not store seasoned materials in wet or damp environment.
  - 2. All log replacement material shall be on site for a minimum of 90 days prior to use.

## PART 2 PRODUCTS

### 2.1 TIMBER LOGS

- A. Hand selected:

1. Moisture Content: 18 percent maximum (dry) at time of delivery cut from standing dead, air dried at the mill, or on site. Species to match existing as approved.
2. Surfacing: Hand peeled.
3. Species: Match existing.

## 2.2 PRESERVATIVE TREATMENT

- A. Bora-care by Nisus Corporation 100 Nisus Drive, Rockford, TN 37853 (800) 264-0870 ([www.nisuscorp.com](http://www.nisuscorp.com)) or approved equal:
  1. Interior and Existing Wood: Bora-care.
  2. New Viga End or fresh cut logs: Tim-bor.
- B. Impel Rods by Sashco Sealants, 10300 E. 107th Place, Brighton, CO 80601-7142, (800) 767-5656 ([www.sachso.com](http://www.sachso.com)) or approved equal.

## 2.3 WOOD SEALER

- A. X-100 Natural Seal Wood Preservative by American Building Restoration Products, Inc., 9720 S. 60<sup>th</sup> Street, Franklin WI 53132 (800) 346-7532 ([www.abrp.com](http://www.abrp.com)) or approved equal.

## 2.4 FIBERGLASS RODS AND NUTS

- A. Fibrebolt by Strongwell , Bristol, VA 24203-0580 (276) 645-8000 ([www.strongwell.com](http://www.strongwell.com)) or approved equal.

## 2.5 EPOXY

- A. Resolution Performance Products, Houston, TX 77210-4500 (877) 859-2800 ([www.resins.com](http://www.resins.com)) or approved equal (less than drum quantities, contact authorized small package distributor Miller Stephenson Distribution (800) 992-2424 ([www.miller-stephenson.com](http://www.miller-stephenson.com))):
  1. EPON Resin: 828.
  2. Curing agent: Polyimide type – EPIKURE 3140.
  3. Thinner:
    - a. HELOXY Modifier 68.
  4. Remover for liquid spills:
    - a. White Vinegar.
    - b. Acetone.
  5. Inert Fillers (Extenders): Phenolic base microballoons, fumed silica, wood fibers and dry sand.

## 2.6 ADHESIVES

- A. Weldwood Resorcinol Glue by Jamestown Distributors, 500 Wood Street Bldg #15, Bristol, RI 02809 (800) 423-0030 ([www.jamestowndistributors.com](http://www.jamestowndistributors.com)) or approved equal (a two component resin adhesive which cures to a strong, durable, completely waterproof bond).

## 2.7 FORM RELEASE

- A. Paste Wax: Briwax Woodcare Products (800) 274-9299 ([www.briwaxwoodcare.com](http://www.briwaxwoodcare.com)) or approved equal.

## 2.8 ROUGH HARDWARE

- A. Section 06100.
- B. Timber Connectors: Strong-Tie, by Simpson Strong-Tie Co., (800) 999-5099 ([www.strongtie.com](http://www.strongtie.com)), or approved equal connectors with equal or greater load capacity for all directions of loading.

## 2.9 FASTENERS

- A. Stainless Steel: No. 2 square drive stainless steel Bugle Head wood screws by Manasquan Premium Fasteners, Box 669, Allenwood, NJ (800) 542-1979 ([www.manasquanfasteners.com](http://www.manasquanfasteners.com)) or approved equal.

# PART 3 EXECUTION

## 3.1 CONDITION OF EXISTING VIGA

- A. Perform site inspection and prepare inspection list.
- B. Several methods can be used to detect rot and determine the impacted area. Probing with a long thin screwdriver or ice pick, prying out sections of rot with a chisel and drilling small diameter holes into cracks or rotted sections alternating stopping and starting and probing to feel for solid wood are various techniques. Generally these procedures are adequate to determine the presence and extent of rot.
- C. For surface deterioration a splice or dutchman piece may be used; and it may not be necessary to proceed with wholesale removal. (See dutchman repairs).

## 3.2 OTHER FRAMING

- A. Investigation of all additional framing is required in order to assure that temporary shoring has been properly installed to carry any loads that the deteriorated viga may still be under.

## 3.3 VIGA END REMOVAL AND PREPARATION

- A. Deteriorated vigas are severed at the exterior building line and the rot is removed. Usually this is best achieved by using a chainsaw. This will leave a short piece projecting out from the building since the chain saw can not cut flush with the surface.
- B. Depending on the situation, a jig or simple hand tool may be used to prepare the end of the old viga (if the joint is to be 2 inch or less behind the building facade line a router jig may be used). When the viga connection is to be approximately 1 to 2 inch behind the building line (concealed), the end of the log where the new viga tip will be attached is shaped with a circular saw, chisels, spade bits, "Forstner" type wood boring bit and/or a 4 inch diameter grinder fitted with a course

sanding disc, cutter, or circular wood rasp. It is important that the viga ends be prepared perpendicular to the viga axis and smooth to provide for solid mating:

1. Plywood mating discs, also used for the epoxy pouring process, can be used at the worked end to check for smoothness and plumb. A torpedo level may be held against this plywood surface to determine the angle.
  2. A slight angling down is desired in the final set up so the viga end will be draining away from the building.
- C. The router with jig performs the reduction task at the end of the viga providing a smooth surface. This shall be used on exposed joint situations. Exposed joints require tight end to end, edge to edge joinery with tolerances not to exceed 1/64 inch.
1. Once this is accomplished, a 2 ¼ inch hole is drilled into the center of the viga to an engineered depth, minimum 6 inches into solid wood.
  2. The center may be found by drawing tangent lines and then bisecting these lines to generate crossing lines which intersect to establish the center.
- D. When working on the building side of the viga and rot is being removed from the severed viga end towards the building interior, several tools have proved useful in hogging out rotted wood.
1. Two or three drills set up with various bits facilitate the process.
  2. Since spikes, nails, rods, etc. are often located in the logs in the building section they are usually removed to clear out the path for the drill bits. Then self feeding bits in combination with spade bits and chisels are more easily used to hog out the section. All rot shall be removed.

### 3.4 DETERIORATED WOOD REMOVAL

- A. Rotten wood is removed from the viga with hand and/or power tools, (drills, saws, chisels, gouges, knives etc.) depending on the size and shape of the wood to be removed .
- B. Sever the log as flush to the building as possible with a chain saw. This allows access to the rot from the flat end. Attention should be paid to provide a flat joining surface on the end of the log prior to proceeding. Since a hole will be drilled into the center of this section into solid wood for fiberglass rod placement, consideration should be given to drilling the hole at this stage. By deepening the hole into the deteriorated wood evenly as it progresses, a flat center base is maintained. This allows for proper alignment and minimizes drift. After rot removal, the center hole for the rod will now be drilled out to the design depth.
- C. For removal of rotten wood, inexpensive spade bits can be used with extensions to go deep if required. Pins and nails may be driven down into the log attaching latillas or decking and if a nail is hit with this type of bit the loss is minimized. When using spade bits it is useful to drill consecutive holes around the surface, overlapping each drill section so that the center spur of the bit is fully engaged at each location. Move the bit around, drilling to a depth of a half an inch or so, setting back the section more and more with each drilling. In this manner the flat section inside the log end is slowly and methodically recessed deeper and deeper until all rot is removed and a relatively flat ended chamber is created.
- D. Use compressed air to clean out holes and remove debris. Use a shop vac for dust removal.
- E. If the deterioration is on the surface only, then a splice or dutchman piece may be used; and it may not be necessary to proceed with wholesale removal. (See dutchman repairs).

### 3.5 EPOXY MIX AND APPLICATION

- A. General: Install as recommended by Manufacturer. The following guidelines shall apply unless in conflict with Manufacturer recommendations:
1. EPON 828 resin is a general purpose structural epoxy resin used for its balance of handling characteristics and performance properties.
  2. EPIKURE 3140 is a Polyimide type curing agent with low viscosity for this class of curatives. Applications include adhesives and extending pot life of highly reactive amines.
  3. Thinner: HELOXY Modifier 68 reduces viscosity (increases fluidity) with minimum loss of properties and has a low volatility.
  4. Remover: White Vinegar or Acetone can be used for liquid spills and tool clean-up so long as mixture is in liquid state.
  5. Inert Fillers (Extenders) are used to fill larger voids and consolidate internal portions of the viga. Phenolic base microballoons, fumed silica, wood fibers and dry (water accelerates the reaction and can interfere with the correct cure) sand can be used.
- B. Accelerate Cure: To accelerate the EPIKURE 3140 use 5 parts of EPIKURE 3253 to 100 parts of the EPON 828 (This is not necessarily something that will work at cold temperatures).
- C. Mix Workability can be adjusted using HELOXY modified resin. This will reduce strength properties a bit and reduce viscosity a lot. Add some HELOXY Modifier 68 for optimal mix of features (use of the HELOXY may require a slight change in mix ratio with the curative)
- D. Shrinkage: Expect approximately 2% shrinkage in the resin mix. This can be reduced slightly by the use of inert fillers.

### 3.6 SETTING FIBERGLASS ROD

- A. A structural fiberglass threaded rod is then glued into the hole with epoxy. This rod is also carefully aligned with the axis of the viga so that it is not only in the center but true to the orientation of the viga with no more than a 1/8 inch (to 1/4 inch)-too much fall per foot. Mount a removable plywood plate wrapped in polyethylene, which serves as a dam, onto the rod with fiberglass nuts each side at the selected location and at the correct orientation placed flat against the end plane of the cut viga. Check alignment by dry fitting rod and plate to log and using a level on the rod extension.
- B. Sometimes excessively deep voids will require a two stage process of splicing in a Dutchman to bring the hollow center out to the desired surface. Special work may be required to fix the pin into the hole back inside the log prior to this repair. The preferred method is to dry fit everything including wood plugs to take care of voids and construct an access hole into the viga from the top for pouring epoxy. Access may be limited to the top front of the viga.
- C. Prior to pouring epoxy into the access hole it is imperative that all areas where flow out can occur be dammed. Methods included taping the log, using clay packs, applying wood putty to cracks, and placement of consolidating epoxy (thinned epoxy or specially formulated at low viscosity) inside to stop up checks and defects. It is advisable to cover areas for protection should run out occur. Pours should be accomplished slowly at first to ensure run out is not occurring. With each successive pour, run out is reduced. Run out can often be cleaned with white vinegar subject to the set up time of the epoxy mix.



- D. After the rod is properly aligned and at the right length with the end cap in place and all possible locations for epoxy runs sealed, the section can be filled with epoxy. A plastic funnel and plastic hose may be set at the top of the viga end plate to provide access for pouring epoxy into the void. This will permanently fix the rod, repair the void, and provide structural strength for the viga end.

### 3.7 CONSTRUCTING REPLACEMENT VIGA ENDS

- A. After the preparation of the building side viga has been accomplished, ends are fabricated with the identical profiling, orientation and center drilled hole.
- B. For exposed joints replacement ends will be left approximately ¼ inch oversize in diameter to allow for final fitting and alignment. Once drilled, these are fitted with 1 inch threaded iron bolts to which a mold release agent has been applied. Coat steel bolts with wax and thread/unthread several times to distribute wax in the grooves. The bolt is suspended in the hole using a removable plywood plate and fiberglass nuts.
- C. Once the structural epoxy has set the bolt is then unthreaded. This activity usually occurs within 12 to 24 hrs after initial set at temperatures in the range of 60-70 degrees. It is important that this timing be field tested and verified since waiting too long may result in a permanent set of the steel rod. The viga stub may now be threaded onto the extending rod on the building for final fitting. Use strap (sp-shop) clamp to tighten viga stub to building side viga—strike line to fit. Remove stub and shape to size. Accomplish final sizing with viga in place.
- D. Sealing and waxing the end of the new stub is both good for preservation and installation. A waxed end allows for a tighter connection and makes for easier removal.

### 3.8 TIMBER ALIGNMENT

- A. Arrange the log connection so that cracks and checks are positioned downward and knots and other log features are arranged to align properly with the log mating end at the building. In order to achieve this goal, alignment marks shall be utilized on the viga stub, plywood end jig plates and fiberglass nuts.
- B. When the bolt is placed for casting into the stub the alignment marks are used. These same marks are also used when the rod is placed for casting into the log end on the building side.
- C. The nuts that have been marked and set face to face in the trial run shall be placed both on the building side and the stub side to be aligned. Thus the two sections will screw together as arranged by the alignment marks providing an up and down side for the viga stub. Keeping track of the nuts and ensuring their proper placement leads to proper alignment.

### 3.9 DUTCHMAN REPAIRS

- A. Dutchman repairs are used when only a portion of the viga needs replacing rather than an entire viga end. This situation may occur, for instance, when only the top of a viga end is rotten, due to a crack on top of the viga that has collected water.
- B. The rotten portion of the viga shall be removed and replaced with new wood. When removing the rotten portion, it is important to consider the shape of the void that is created because mating pieces must be fashioned from new wood. The void surfaces shall be clean, with edges straight out to the exterior surface of the void. This helps to make a close fit between old wood and the new wood patch, (the dutchman repair) that will be shaped to fit the void. The new wood selected shall closely match the original in grain configuration and ring structure to ensure equalization in swelling and shrinking.

- C. Rotten wood is removed from the viga with hand and/or power tools, (drills, saws, chisels, gouges, knives etc.) depending on the size and shape of the wood to be removed. The new wood patch is shaped using the same hand and/or power tools. The exterior surface of the new wood patch shall match the exterior surface of the surrounding original wood. This usually means no power tool marks and minimal hand tool marks on the exterior. The joints between old and new wood shall be tight, smooth, and natural in appearance.
- D. Fasten the patch using adhesives, and/or mechanical fasteners. If mechanical fasteners are used, such as wooden dowels, fiberglass rods, or metal screws, as little as possible of the fastener shall show. Any non-wood fastener shall be recessed and plugged with a wood cap.

### 3.10 ADHESIVES

- A. As recommended by manufacturer.

### 3.11 FASTENERS

- A. For attachment of dams, blocking and filler to be removed after set (remain in place).

Minimum No. 10: Obtain minimum 1 inch penetration of supporting wood member.

### 3.12 WOOD TREATMENT

- A. Bora-Care: Apply as recommended by Manufacturer.
- B. Tim-bor: Apply as recommended by Manufacturer.
- C. Impel Rods: Impel rods shall be used where viga end preparation indicates that moisture may intrude in the future. Install multiple ¼ inch diameter rods in existing viga being prepared for splice from both exterior and interior if possible. Locate outside epoxy core of threaded rod. Install as recommended by Manufacturer (Drill appropriate sized holes to accommodate rods, insert rods into the holes and plug the holes with caulk or wood plug).

### 3.13 WOOD SEALER

- A. ABR- X100 Natural Seal Wood Preservative: Apply as recommended by Manufacturer (with brush only).

END OF SECTION





New viga ends after temporary insertion of threaded rods to create threaded mold.



Existing viga ends with temporary epoxy filler tubes and permanent threaded rods installed.



New viga ends threaded in place