T·Y·LIN INTERNATIONAL
engineers | planners | scientists

August 19, 2014

Jennifer M.V. Fitch, P.E.
Project Manager
Vermont Agency of Transportation
1 National Life Drive
Montpelier, VT 05633

Project Name: Brookfield BRF FLBR(2)
Structure Identification: VT 65 Bridge #2 over Sunset Lake

RE: Item 900.645, "Special Provision (Fiber Reinforced Polymer Pontoons)"
NCR 7 – Pontoon 3 Hull Defects

Ms. Fitch –

After removing the hull of Pontoon 3 from its mold on Monday August 11, multiple dry spots and a region in the flange overhang with lack of fill-out were observed. T.Y. Lin International reviewed an NCR prepared by Kenway dated August 12 and subsequently recommended rejection of the unit based upon significant defects and lack of historic evidence proving longevity of repairs in the anticipated project environment. Kenway has since provided marine-based technical references indicating general industry acceptance of repairs in large-scale FRP fabrication.

This letter serves to provide an overview of further investigations in to repair adequacy and additional recommendations pertaining to the hull of Pontoon 3.

Discussion:

Kenway has provided two references that indicate secondary infusions are commonly used large-scale FRP fabrication and these references include repair procedures in their standard procedural documents. The two references are the (1) DDG-1000 Program Composite Repair Procedure and (2) the American Bureau of Shipping (ABS) Guide for Building and Classing Naval Vessels.

While both of these references indicate common use of secondary infusions or repairs, they also include statements such as the following when discussing secondary bonds:

- *Primary bonding between successive plies of a laminate creates chemical cross-linking of resin molecules and has superior strength to secondary bonds, which rely on purely mechanical bonding.*
- *In general, secondary bonds should only be used when a primary bond cannot be achieved.*
- *The processes described in this procedure are to be used only with engineering concurrence.*

While statements such as these do not preclude the allowance of secondary infusions, they do instill pause in this review process. Additional research beyond the Kenway provided documents yields similar statements as noted above. Sources have been reviewed that indicate reduced strengths across secondary

infusion regions, that engineering concurrence is necessary for any region with significant forces, and that lab testing to prove acceptability may be warranted.

Kenway additionally noted in their August 13 correspondence that repair procedures are also allowed by their identified sources in which material is entirely scarfed out and continuity of fabric does not exist. In a complete removal situation, performance of the laminate relies solely upon bonding between the different aged resin surfaces. In the case of the subject NCR, the fabric remains present within the secondary infusion and therefore continuity of the laminate will exist.

Recommendations:

The hull of Pontoon 3 is currently rejected and should remain as such. However, if Kenway wishes to continue pursuit of acceptance of this part, the following items should be addressed:

1. A lab testing program should be created and executed (by Kenway) that proves satisfactory strength and stiffness required of the design across a secondary bond plane. In addition to strength requirements, the lab test program should also investigate long-term serviceability and how prone the repair may be to leakage and delamination under the anticipated loading conditions. The lab tests should be performed on laminate configurations used in the fabrication of the hull.

2. The lab test program should be reviewed and sealed by Kenway's Engineer, indicating adequacy in the number of samples and variety of tests performed and also to indicate if the results of the noted lab test program are acceptable to their design.

3. The above two items should be shared with VTrans for review and concurrence in acceptability. Review by VTrans will in no way transfer liability of the adequacy of the breadth of the testing program and subsequent review and approval by Kenway's Engineer.

4. Non-destructive test methods shall be used on the repaired areas. These tests, at a minimum, shall investigate and satisfy the following:

    a. There shall be no open voids, pits, cracks, crazing, delaminations, or embedded contaminates in the laminate.

    b. There shall be no evidence of resin discoloration or other evidence of extreme exotherm.

    c. There shall be no dry reinforcement as indicated by white laminate.

    d. There shall be no wrinkles or voids greater than acceptable flaw criteria defined within the Project Contract Documents.

    e. The surface of the repair shall be smooth and conform to the surrounding surface contour and meet Project required flatness criteria.

    f. The degree of cure shall be within 10% of the Barcol hardness of surrounding, original materials.

Please feel free to contact me with any additional questions or clarifications.

Sincerely,

Josh Olund, P.E.
Design Engineer

Attachments
cc: [x] Resident Engineer – Sandra Schmitt
[x] File