

July 31, 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 2 – Inclined web line, timber bracing, pontoon length

Ms. Fitch –

T. Y. Lin International has reviewed Project Non-conformance Report (NCR) 2 and are summarizing our observations, opinions, and recommendations on the issues herein. From reading the report prepared by Kenway Corporation dated July 28 and discussions held during a subsequent onsite meeting with Jake Marquis on July 29, it’s apparent that the issues presented in NCR 2 are resulting from the same underlying behavior: shrinkage of the FRP material as it cures.

Other aspects of the fabricated-to-date components were observed and discussed during the noted onsite meeting as noted in the attachment – opinions and recommendations on these additional items are also provided herein as they seem relevant to the overall decision to accept non-conforming pontoons.

NCR 2, Item 1 – Match Casting Procedure:

The procedure proposed by Kenway will attempt to provide surfaces that will result in complete contact between pontoons 1 and 2 in the formation of Raft 1. The strength of the fill material is unknown at this time, but will generally increase the total thickness if the central web line of the raft and overall weight of the raft. The proposed procedure will occur outside of the fabrication facility.

The procedure appears to be reasonable as a solution to the out-of-plumb mating surfaces, but additional information and documentation is necessary prior to concurrence. Procedures outlining the intended production efforts including substrate preparation, equipment setup, process implementation methods, environmental considerations during production, and potential repairs as well as additional technical data identifying material properties need to be submitted for consideration.

NCR 2, Item 2 – Permanent Timber Bracing:

To correct the bending (out-of-plumb) web line, Kenway installed timber bracing in each of the pontoon cells. This bracing helped reduce the severity of the distortion of the web lines, but was also left in place during foaming operations. Timber bracing is not shown in the approved Fabrication Drawings and likely would not have been accepted. However, the contract requirements do not specifically prohibit its use and the bracing appears to only be necessary for a temporary duration until the spray applied foam cures.

The timber will be enclosed by foam in a watertight pontoon and is therefore unlikely to rot. If the timber does rot, the foam is present to resist any potential wall movement and distortion of the FRP is not anticipated.

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NCR 2, Item 3 – Addition of FRP Stiffener Plates:

This item is not a non-conforming item, but rather a potential solution to aid in shrinkage issues that created the above to items. FRP stiffeners are allowed by the project. If stiffeners are incorporated into the fabrication of the remaining pontoons, Fabrication Drawings should be updated accordingly and submitted for approval prior to implementation. Included with the submittal should be a detailed description of how they will be installed and an updated overall pontoon weight.

NCR 2, Item 4 – Hand Layup to Correct Pontoon Length:

The overall lengths of Pontoons 1 and 2 are slightly lower than that allowed by Project tolerance limits and Kenway has proposed using a hand lay method to extend the end flanges approximately 1/8” each to bring the pontoon lengths within tolerance.

Hand lay methods are not considered to be equivalent quality as the vacuum infusion process and are only acceptable for repair areas that do not pose structural or serviceability concerns. The addition of hand laid plies at the extreme ends of the flange tips also will not improve the structural nature of the connection regions of the pontoons and therefore the extensions are not considered acceptable. The lengths of the pontoons will remain deficient and a proposed means/method to meet overall floating span length requirements needs to be identified.

Onsite Observations and Discussions:

While onsite discussing NCR 2, general visual observations of pontoon 1 were made and discussed with Jake Marquis (Kenway) and Joel Silk (Golder Associates and VTrans Representative). Refer to the attachment for a summary of that meeting.

- Pontoon 1 was outside of the facility during the meeting with the top plate loosely resting on the remainder of the pontoon. The top plate was not attached to the pontoon, presumably due to outstanding questions/decisions on how to resolve the out-of-plumb web line. The approved Fabrication Drawings identify all pontoon assembly to occur inside Kenway’s facility and only pontoon pairing and bolt hole drilling occurring outdoors. Two concerns are raised with the current staging:
 - The environmental factors during adhesive placement cannot be easily controlled (temperature, cleanliness of the surfaces, moisture, etc).
 - There is a potential for moisture or rain water to enter the pontoon if not properly covered and secured. This latter concern may not be an issue, as observations of the pontoon were occurring as Kenway was moving the pontoon and plans to cover the pontoon with waterproof tarps or other methods may have already been considered.

- The bag side of the top flange was considerably uneven and was noticeably outside the Project tolerance limit of $+1/16$ ” in overall thickness as well as perhaps the flatness criteria of $1/4$ ” in 48”. The thickness tolerance limit was set to avoid excessive and undesirable weight increases compared to approved submittals ahead of fabrication as well as to prevent exceeding the Project stiffness requirements of Special Provisions Section 71(f). Due to the behavior of the floating span, an increased stiffness will attract additional forces. Design forces identified in the plans are bound by stiffness parameters in the Special Provisions and exceeding these values may result in forces beyond those already designed which is primarily a concern at field splice connections.

It is unknown if other portions of the hull show similar deviations in thickness. Plate thicknesses should be logged for top and bottom flanges to determine an average thickness of each component and subsequent section properties determined to check if the pontoons are within the stiffness limitations required of the project. Kenway should be reminded that their QC plan requires detailed documentation of fabricated part tolerances and to take corrective action for aspects found to be nonconforming – it appears this aspect of their QC plan was not followed through.

- Jake noted Kenway was considering using premade foam blocks to help expedite the fabrication process. It was noted this is acceptable, but the exact material and general geometrics need to be submitted to VTrans for approval.

Recommendations

Pontoons 1 and 2 display a number of nonconforming aspects. Web lines are not plumb, plate thicknesses are not uniform and are out of tolerance for thickness limitations, the overall pontoon lengths are below minimum requirements, and at least two repairs to Pontoon 1 to correct dry spots have occurred without known acknowledgment or approval sought.

While any individual item noted may not be grounds to consider rejection of the Pontoons, the collective group of issues makes acceptance questionable. Through onsite discussions, it is understood that Kenway plans to further detail and propose methods to maintain plumb of the web lines, methods to control flatness of laminates, and corrections to control overall pontoon length. In addition to current and forthcoming fabrication proposals, Kenway is also asking for acceptance of ‘match casting’ any pontoon pairing in which adjoining surfaces are not in complete or uniform contact.

At this time, it is recommended that Pontoons 1 and 2 be rejected. It is further recommended that a Stop Work Order be given to Kenway for production of hull and top plate members (Parts 1 and 9 in the approved Fabrication Drawings) until such a time that it can be ensured project tolerances can be met. Proofs or fabrication demonstrations in addition to forthcoming document submittals depicting changes to fabrication process should be required to prove control of tolerances exceeded during the fabrication of Pontoons 1 and 2 as well as conformance to remaining Project requirements.

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

Sincerely,



Josh Olund, P.E.
Design Engineer

Attachments

cc: Resident Engineer – Sandra Schmitt
 File

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MEETING MINUTES

Project Name/No.: Brookfield BRF FLR(2)

Meeting Location: Kenway Corporation, Augusta, ME

Meeting Date/Time: July 29, 2014 1:00 PM – 2:00 PM

Attendees: Jake Marquis, Kenway Corporation Joel Silk, Golder Associates
Josh Olund, T.Y. Lin International

Prepared by: Josh Olund, T.Y. Lin International

A meeting was held between VTrans representatives (TY Lin International and Golder Associates) and Kenway Corporation to further discuss items identified in Pontoon Fabrication Non-conformance Report #2. This document summarizes discussions held.

The bending issue of the vertical pontoon wall between adjacent rafts was further described by Jake. This issue arises from a larger than anticipated fillet of resin forming on the inside corner of the vertical and horizontal walls. This resin rich fillet has a higher shrinkage behavior than the typical fiber reinforced portions and therefore the fillet ‘pulls’ the two walls together and reduces their opposing angle from 90° to a slightly lesser value. The shrinkage distortion caused by the resin rich fillet results in the top of the vertical wall rotating inward uniformly by approximately 3/8” after releasing the vacuum. The bottom corner where the vertical and horizontal walls meet is not moving.

Jake went on to note that, through clamps near the top of the vertical wall and use of timber bracing, the vertical walls are brought back to near plumb, but the top of the vertical wall is still tipped in about 1/4” max midway between transverse stiffeners. With both pontoons 1 and 2 having similar distortions, a gap will be present when the two pontoons are paired to form a raft. This gap is planned to be filled as outlined in the NCR.

Jake noted that Kenway is looking in to a number of options to reduce the fillet size and initial shrinkage movement of the wall as well as looking in to the addition of FRP stiffeners instead of timber bracing to maintain tolerances. Josh noted that changes to fabrication need to be documented in a revised set of Fabrication Drawings and submitted for approval – this can occur concurrently with review of the NCR.

Jake also presented an idea to extend the cure time under vacuum to help maintain straightness during the initial shrinkage period. He noted pontoon 2 was held about 10-12 hours longer than pontoon 1 (due to work schedules) and resulted in slightly less shrinkage deformation

The ‘match casting’ procedure for the interface between pontoons 1 and 2 was discussed. This is accomplished by creating a putty mixture of resin and short fiber strands. This ‘putty’ will be prepackaged as noted in the NCR. Josh noted there is a concern over being able to completely fill the void between pontoons since the putty is gravity applied (poured) in to the void. A method to ensure complete coverage should be identified. Jake also noted he has inquired with vendors on strength properties of the ‘putty’.

The lengths of pontoons 1 and 2 were discussed. These pontoons are slightly shorter than required by the project. The idea of hand-laying additional laminates to the end flanges in an effort to meet geometric requirements was discussed. Josh noted that the hand-laid plies would not result in added structural length and therefore the effort does not seem warranted. Josh reminded Jake of the overall floating span tolerance and suggested that this perhaps be met by increasing the lengths of the remaining 4 rafts by approximately 1/8" each.

Also during the meeting, Jake noted that Kenway is looking in to using a combination of spray-applied foam and prefabricated foam blocks to speed up the fabrication process. If a change is planned for implementation, VTrans should be made aware ahead of incorporation for concurrence.

Josh observed that the flanges of pontoon 1 (top flange primarily) was quite wavy and also does not seem to meet tolerance. Jake noted that the flange minimum thickness meets design and the flatness can be corrected using methods similar to the match casting process. Josh noted that the steel plates bolted to the FRP member should have uniform contact and that a previous concern had been raised in that a double nut may not have enough bolt grip – the thickened plates may worsen this concern.

Josh noted that all aspects of pontoon 1 and 2 which do not meet tolerance should be logged in their entirety in a single location. This includes global tolerances as well as more localized tolerances such as the flange flatness noted previously. Joel also noted pontoon 1 had a 'dry spot' in the corner of the hull flange (outer lip). This was repaired in accordance with Kenway's Quality Plan.

Josh noted that this meeting was a first step toward better understanding the issues at hand and what is being requested in NCR #2. Final decisions with regards to NCR #2 will be forthcoming.

This is my (Josh Olund's) account of the meeting. Please send comments/questions by July 31, 2014 to jolund@tylin.com or by calling 207-347-4339.