

August 14, 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)”
Match-Cast Surface Criteria

Ms. Fitch –

During a recent meeting with Kenway Corporation at their facility in Augusta, ME on August 4, clarification of what constitutes a match-cast surface was requested. Specifically, Kenway has requested tolerance requirements for the joining surface between adjacent pontoons. This letter is being provided to clarify the match-cast requirements.

Background:

A match-cast surface condition was included in the project requirements (Special Provisions Section 71f, paragraph 4) to create a uniform friction plane and to provide a generally watertight seam over concerns of ice lens formation and subsequent ice growth (wedging) between pontoons. Match-casting is primarily recognized in the segmental concrete industry as casting successive segments against previous sections to ensure uniformity and fit-up in the field.

During the preconstruction meeting, and subsequently followed up with a formal RFI on April 14, 2014, Kenway questioned the need to match-cast pontoons and requested permission to fabricate the first pair of pontoons, mate and inspect them, and determine from that point onward if match-casting would be necessary to control geometry for remaining pontoon fabrication. The request was conditionally approved, noting that separation between pontoons would either leave them subject to repair or rejection and remaining pontoons would then need to be match-cast. However, a specific criterion for an allowable separation was never provided as it was inferred that a match-casting process removed all potential separation between surfaces.

After fabrication of Pontoons 1 and 2, it was recognized that shrinkage within a resin fillet at the base of the vertical wall was causing the wall to rotate inward, thereby creating a tall narrow ‘V-shape’ between adjoining pontoons. The overall opening of the ‘V-shape’ was greatly reduced through the use of temporary bracing and foaming operations as well as installation of transverse bulkheads. However, small separation between pontoons remains (0” – ½”) and the question of acceptability has been raised.

Match-Cast Criteria

T.Y. Lin International has investigated the necessary contact surface between pontoons, both from a strength and serviceability perspective. Through these investigations, the following requirements should be imposed:

- The minimum required contact surface between pontoons shall be greater than 4% of the overall contact surface, or approximately 880 in². This requirement applies to roughened surfaces with a coefficient of friction (static, wet conditions) greater than 0.45. Please refer to the attachment for calculations and assumptions made in this determination.
- The maximum separation between adjoining surfaces shall be less than 1/16". For adjoining surfaces meeting the minimum contact surface criteria noted above but having localized separation values greater than 1/16", the gap shall be filled with an inert material that will not degrade in the anticipated environmental settings and will not impose stresses on the FRP due to differences in stiffness or due to thermal or swelling behavior. The selected material shall be submitted by the Contractor for approval.

Alternate Criteria:

Through discussions with you, we understand that the Agency is now amenable to using an adhesive between pontoons. This allowance would be in-lieu of a roughened surface and match-cast criteria, but is subject to approval prior to implementation. Use of an adhesive should require the following:

- The adhesive shall have strength properties that will meet the design criteria noted in Special Provisions Section 71(e). A Resistance Factor (phi factor) of 0.50, Moisture Reduction Factor of 0.85, and Time Effect Factor of 0.90 shall be concurrently applied to the strength of the adhesive in determining necessary coverage.
- The Contractor-selected adhesive shall be appropriate for wet-use conditions and shall have a history of satisfactory performance in environmental conditions similar to this Project. The adhesive shall not impose stresses on the FRP due to differences in stiffness or due to thermal movements.
- The adhesive shall be submitted for approval. Included in the approval shall be the appropriate technical information for review as well as a narrative and/or drawing(s) that identifies the intended application procedure.
- The required use of transverse threaded rods shall remain unchanged, but the installation tension value may be reduced to meet specific adhesive application/installation needs.
- With the use of adhesive as the main source of connectivity between pontoons, no measureable or visual gap shall be allowed between adjoining surfaces.

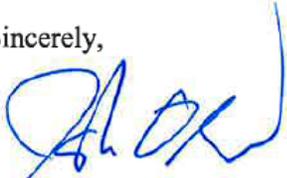
TYLININTERNATIONAL

engineers | planners | scientists

At this time, we request that Kenway be made aware of these criteria and, if desired, they should submit an update to Nonconformance Report 2 that details a proposed corrective action.

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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Determination of Minimum Contact Surface

(Match-Cast Requirements)

Ref's:

- 1) ASCE Pre-Standard for Load and Resistance Factor Design (LRFD) for Pultruded Fiber Reinforced Polymer (FRP) Structures (Final)
- 2) AASHTO LRFD Bridge Design Specifications 2012 6th Ed.
- 3) Project Contract Plans and Special Provisions
- 4) Email from Jake Marquis at Kenway Corporation with resin compressive properties, dated August 11, 2014

Note: It is assumed that the neat resin noted herein was tested under uniform pressure. The methodology used herein to determine an appropriate contact surface requirement investigates crushing of the resin micro-surface that is created as a result of grit blasting methods to achieve a friction coefficient required of the project.

Material Properties, Geometry, and Loads:

$\sigma_n := 15955\text{psi}$

Neat resin compressive strength

$N_{PT} := 3$

Number of PT bars per raft

$F_j := 55\text{kip}$

Jacking force per transverse rod

$A_{ratio} := 0.10$

Assuming only 10% of nominal surface will be bearing after roughened. This is in comparison to the neat resin sample which was likely not roughened and much smoother.

Load and Resistance Factors:

$\lambda_1 := 0.40$

Time effect factor for permanent loads (ASCE Table 2.3-1)

$C_M := 0.85$

Reduction Factor for sustained in-service moisture (ASCE Table 2.4-1)

$\phi_c := 0.50$

Resistance Factor for Compression (Using 0.50 since this is a typical value in connections)

$\gamma := 1.25$

Maximum load factor for dead load, Strength - using 1.25 and not 1.0 to account for stress operations occurring using a hand-turned torque wrench

Contact Surface Requirements

$$\sigma_r := \lambda_1 \cdot C_M \cdot \phi_c \cdot \sigma_n = 2.71 \cdot \text{ksi}$$

Factored resistance of resin

$$A_{\text{req}} := \left(\frac{\gamma \cdot F_j \cdot N_{PT}}{\sigma_r} \cdot \frac{1}{A_{\text{ratio}}} \right)$$

Required Contact Surface Area, rounded up

$$A_{\text{per}} := \text{Ceil} \left(\frac{A_{\text{req}}}{36\text{in} \cdot 51\text{ft}}, 1\% \right) = 4 \%$$

Percent of surface between pontoons requiring contact

$$\sigma_{\text{avg}} := \frac{\gamma \cdot F_j \cdot N_{PT}}{A_{\text{per}} \cdot 36\text{in} \cdot 51\text{ft}} = 234.03 \text{ psi}$$

Average pressure on contacting surfaces due to transverse rod tensioning