4300201 PIPE CULVERTS
COMMENTS FROM INTERNAL/INDUSTRY REVIEW

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Comment: (1-6-14)
Thank you for the opportunity to provide specification review on the addition of SRPE pipe into the Florida Standards. We are providing below what we feel are valid comments and concerns with respect to this addition.

1. If product specific research is not performed, we would request FDOT only allow SRHDPE in 50 year service life applications until FDOT has a performance history of at least 10 years before this new product is allowed to be considered for 100 year service life applications.

Response: Your comment will be forwarded to FDOT Roadway Design Office for their consideration. No changes made.

2. 430-9.2, "Installation Requirements" allows 5% deflection in the field. The research for HDPE pipe incorporated the resulting stress at 5% deflection into the test requirements for the 100 year protocol. There has been no such correlation for the SRPE pipe.

Response: The changes in this specification deal with material issues. Your comment will be forwarded to the FDOT Roadway Design Office for their consideration. No changes made.

3. There is clearly a difference in the way the pipe performs, when you review the AASHTO and ASTM product standards and note that unlike HDPE pipe, the shape stability limit decreases with increase in pipe diameter. The shape stability limits indicate that it is incorrect to assume the same level of circumferential stress in the pipe wall at 5% that was utilized in the determination of the HDPE drainage pipe protocol.

Response: Please see response to Comment #2.

4. The shape stability limits further indicate that this pipe is more susceptible to buckling than HDPE at lower deflections. Therefore, the stresses in the PE resin are beyond what are experienced in standard HDPE drainage pipe by virtue of the PE being required to stabilize the much stronger steel reinforcement contained within it.

Response: Please see response to Comment #2.

5. Page 9 of the SRPE presentation during the last PAG meeting indicated the product would have a cell class of 345464C per ASTM D3350. Neither the ASTM F 2562, nor AASHTO MP 20-13 specifications referenced in the Florida standard requires this cell classification. This should be the minimum cell class allowed for a product that has no information regarding the applied stress when it is in the installed condition.

Response: Approval for 100 year service life of any plastic pipe is resin, profile, and fabrication facility specific. Approval does not allow producer to change resin unless new testing is done fulfilling the requirements of the specification and approved by the State Materials Office. No changes made.

6. The Florida standard is allowing a resin of 435400 with no hydrostatic design basis. However, even the referenced standard AASHTO MP 20-13 has a hydrostatic design basis of 1000 psi. How can Florida expect a 100 year service life with lower resin requirements than the basic AASHTO standard?

Response: Service life is determined using the same test methods and requirements used for AASHTO M294 for corrugated HDPE already in FDOT specification 948. Your comment will be forwarded to the FDOT Roadway Design Office for their consideration. No changes made.

7. The steel design strength of 80 ksi used by the manufacturer of this product, is well above the standard 33 ksi typically used for cmp design. The general threshold for steel fatigue is 24 ksi. When designing with 33 ksi steel, the ratio of design strength to fatigue strength of 33/24 = 1.375 is less than the 1.75 live load factor. Therefore, fatigue stress has never been a required evaluation in AASHTO. However, with a yield stress to fatigue stress ratio of 80/24 = 3.33, the statement in Article C12.5.3 of AASHTO that, "Buried structures have been shown not to be controlled by fatigue." no longer applies. This product needs to be evaluated for fatigue; especially if you are intending it for a 100 year service life.

Response: Please see response to Comment #2.

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Comment: (1-6-14)
1. Per the proposed SSRBC Sections 430 and 948, it appears that FDOT has approved steel-reinforced thermoplastic pipe on the condition that it meets AASHTO MP 20 and ASTM F2562. During the October 30 2013 Pipe Advisory Group (PAG) meeting presentation on steel-ribbed thermoplastic pipe by Contech and its consultant Rod Powers, we and others asked a lot of questions about how the pipe is to be installed and inspected to get acceptable performance. At that time, we had the feeling that FDOT was struggling with some of the same curiosities and concerns as us on design, construction, inspection, and performance. Hence, it came to our surprise that the proposed specifications were posted for industry review during the Christmas holiday and at a time which most likely restricted the available audience of CEIs, contractors, and engineers down to a relatively small pool of other competing pipe producers, myself included – hardly a representative cross-section of the men and women that will be earning a wage and staking their integrity on the design, installation, and inspection of this relatively unknown product.

Response: The cycle used for specification industry review is the procedure the FDOT State Specification Office has in place for all proposed revisions. There was no timing chosen to exempt or minimize number of folks reviewing the document.

Sources of Published Specifications and Research of Steel-Ribbed Thermoplastic Pipe
We submit the below questions and concerns to the FDOT Offices of Materials, Design, and Construction for their consideration in the decision to reject, approve, or delay the proposed specification. Please note that our concerns are not only based on the minimal amount of information presented at the PAG meeting on this pipe material and known to date, but also based on the following body of documentation on the manufacture, design, construction, inspection, and performance of steel-ribbed thermoplastic pipe:

- Standard Specification for Steel-Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 1500-mm (12- to 60-in.) Diameter, AASHTO Designation MP 20-13, American Association of State Highway and Transportation Officials (AASHTO), 2013.
- Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage, ASTM F 2562 – 08, ASTM, March 1, 2008.
- AASHTO LRFD Bridge Design Specifications 2012, AASHTO, 2012.
- 2013 Interim Revisions to the AASHTO LRFD Bridge Design Specifications, Sixth Edition 2012, AASHTO, 2013.
- AASHTO Bridge Construction Specifications, 3rd Edition, 2010, AASHTO, 2010.
- 2012 Interim to the AASHTO LRFD Bridge Construction Specifications, AASHTO, 2012.
- Moser, A.P., Structural Performance of Buried Profile-Wall High-Density Polyethylene Pipe and Influence of Pipe Wall Geometry, Paper No. 98-0811, Transportation Research Record 1624, Transportation Research Board.
- Moser, A.P., Buried Pipe Design, 2nd Edition, McGraw Hill, pp. 480 – 483, 2001.
- Overview of Contech's Proposal to Florida DOT for: Approval of DurroMaxx Steel Reinforced Polyethylene Pipe for 100-Year Culvert Service Life Applications, Public Distribution Version, Presented on October 30, 2013 at Florida PAG meeting and including "market sensitive, proprietary information deleted from public distribution version," by Darrell Sanders, P.E. (Contech Engineered Solutions, LLC) and Rodney Powers (Rodney G. Powers & Associates, LLC)

2. Who (e.g., Contech) Designed the Cover Height Table for Steel-Ribbed Thermoplastic Pipe?
At the PAG meeting, Contech presented a cover height / installation depth table. It was not clear if that design was prepared by Contech, FDOT, or by an independent third pay such as SGH. If not done by a third party following the AASHTO 2013 Interim Revisions to the AASHTO LRFD Bridge Design Specifications, Sixth Edition 2012, then does the FDOT consider that a potential conflict of interest?
For example, the FDOT Structures Design Office has advised Rinker that if a concrete pipe producer wishes to submit for approval to use fibers as a steel replacement or supplement to precast concrete pipe or structures (even minimally load bearing end sections), then producers must submit a design following the available standard that must be signed and sealed by a professional engineer licensed in the State of Florida, which is a reasonable request in our opinion.

AASHTO 2013 Interim Revisions Paragraph 12.5.3 indicates that the pipe is to be designed for wall area, buckling, and flexibility limits for construction. Please confirm that this was part, or will be a part, of the cover height table design for this product.

Response: The changes in this specification deal with material issues. Your comment will be forwarded to the FDOT Roadway Design Office for their consideration.

2. Potential Design Risk to Contractors or CEIs per ASTM F 2562 Paragraph 6.2.1
Concerning design, ASTM F2562, paragraph 6.2.1 states that "… pipe profile shall be suitably designed and the actual materials used shall be specified so as to accommodate expected in-service conditions, including temporary system surcharge pressures, soil loads, and external hydrostatic pressures due to groundwater conditions." Depending upon what party did the structural design and cover height tables, is it safe to assume that the design took these factors into consideration for Florida? If not, then if a contractor or CEI were to have a structural concern following installation, then would it not be the requirement of the contractor or CEI to have required this type of analysis prior to purchasing and/or installing the pipe?

Response: Please see response to Comment #2. No changes made.

3. Is the Plastic Important to the Pipe Performance or Not, and If So, then How? Per the 2013 Interim Revisions to the AAHSTO LRFD Bridge Design Specifications, Sixth Edition, 2012 (AASHTO Interim Revisions), Paragraph 12.7.2.7 indicates that in order to assume the adequacy of the thermoplastic liner, the manufacturer of steel-ribbed thermoplastic pipe shall provide the results of a three-dimensional finite element analysis of the profile that has been calibrated against results of full-scale tests. It is not clear if this has been done or, if not, then when FDOT would require it. Assuming this AASHTO requirement has not been satisfied, how will FDOT address this?
The Contech-Rod Powers presentation at the PAG meeting stated that "steel carries the applied loads" and that there is "no contribution from HDPE." We are concerned that these statements, while somewhat accurate, tend to oversimplify the composite material and downplay the significance of the thermoplastic geometric components.
A contrary position to Contech's presentation at the PAG meeting is provided by the AASHTO Interim Revisions 12.7.2.7 and C12.7.2.7, which indicate that "while the steel ribs are the main load carrying member of the culvert, the thermoplastic profile braces the steel ribs from distortion or buckling under load is critical to the pipe performance. The liner also serves to distribute the load between ribs. A structural evaluation of the profile alone is not required. However, an evaluation of the composite system of thermoplastic liner and steel rib is necessary. It is important to assure that the tensile stresses within the profile do not exceed the long-term strain capacity for the thermoplastic material.
It was not clear to us, based on the PAG meeting and the proposed specifications, how the FDOT desires to address these sections of the AASHTO design specification. To that effect, we request further comment or discussion.

Response: Please see response to Comment #2.

4. What, if any, Changes are Needed to the FDOT Pipe Construction and Inspection Specifications? Per the AASHTO 2013 Interim Revisions, Paragraph 12.4.1.3 Envelope Backfill Soils was revised to state that "for thermoplastic, fiberglass, and steel-reinforced

thermoplastic culverts, bedding and backfill materials: A-1, A-2-4, A-2-5, or A-3 soils. A maximum of 50 percent of the particle sizes may pass the No. 100 sieve and a maximum of 20 percent may pass the No. 200 sieve. C12.4.1.3 notes that the restriction is to eliminate the use of uniform fine sands in pipe embedment of thermoplastic, fiberglass, and steel-ribbed thermoplastic pipe.

It is not clear if the planned use of steel-ribbed thermoplastic pipe and this embedment specification is consistent with FDOT Index 505 and SSRBC Section 125, or if further analysis and engineering opinion by an independent party, such as SGH, is warranted. For this reason, we bring this to the FDOT's attention.

Response: Please see response to Comment #2.

5. Is the FDOT 5% Deflection Limit a Reliable Indicator of Safe Performance for Steel Ribbed Thermoplastic?

In TRR 1624 and in Buried Pipe Design, Moser reports that "in ring deflection, the steel rib carries most of the load…..however, for an HDPE pipe with steel ribs, catastrophic failure is possible if the pipe is subjected to a load sufficient to cause either yielding or buckling in the steel rib." This research noted that buckling and initial stages of collapse began at low pipe deflections, such as 0.9%, 2.8%, and 3.5%, which are much lower than the standard of 5% used by CEIs in Florida.

The research continued to note that the steel-ribbed pipe behaves essentially the same as a low-stiffness corrugated metal pipe because the steel rib is much stiffer than the polyethylene material. Also, failure is much more catastrophic in the steel-ribbed polyethylene than in the case for either corrugated steel or HDPE (i.e., collapse can progress without an increase in load).

We cannot recall similar concerns about catastrophic collapse in any other pipe product. In light of these concerns, we are concerned that CEIs will administer deflection tests based on the notion that 5% is an acceptable pass-fail, however, that may not be appropriate for steel-ribbed thermoplastic. Three percent might not be acceptable. It is not clear what should be acceptable at this point, but we are very concerned with the assumption that 5% is an acceptable installed pipe deflection limit. How does FDOT feel about using 5% for steel-ribbed thermoplastic pipe?

Response: Please see response to Comment #2.

6. Will Inspectors and CEIs Know What to Inspect For?

According to the 2012 Interim to the AASHTO LRFD Bridge Construction Specifications, paragraph 25.6.7.1 was revised to require that steel-ribbed thermoplastic pipe is to be inspected prior to backfilling to ensure that the external reinforcing ribs do not lean an average of more than 15 degrees off of vertical within any 24.0-in. long continuous section of pipe. How does FDOT plan to address this AASHTO requirement for inspecting steel/plastic rib bending during backfill?

Given the important of vertical rib orientation, how important is it to inspect for signs of poor rib alignment after installation during the video inspection? Obviously, the inspector cannot see the actual ribs on the pipe exterior. But could there be other indicators/warnings that ribs may be out of alignment, such as internal dimpling, stretching, or buckling of the internal liner? If so, then inspectors and CEIs would need to be educated on what to inspector for other than simply deflection.

Response: Please see response to Comment #2.

7. Minimal Use of Steel Ribbed Thermoplastic Pipe in Florida. There is minimal history of performance of this pipe in the United States, especially not in Florida. We are aware of one installation in Florida, which was a test installation performed by the City of Orlando in 2009 at a location east of the intersection of Bruton Boulevard and Chandler Street. The 24-inch pipe traversed from the City property/ROW line under Chandler Street and into an Orange County canal. According to the City, they have not used the pipe since that test, and the pipe did incur damage that exposed the steel rib. The exposed section was reportedly mitigated using coal tar.

Response: At the request of FDOT, Contech has produced a more robust repair procedure that addresses concerns with exposed steel ribs. Addition of the repair procedure to FDOT Contract Documents is being evaluated. No changes made.

8. What installation requirements are applied to this product in other agencies across the country. It may be useful for FDOT to contact other agencies to learn of best practices concerning installation and the results, if any, of post-installation inspections. Given the minimal use in Florida, it will be a challenge for contractors and CEIs to "cut their teeth" with this product on the upcoming I-4 projects.

Response: Agree. A survey will be sent out to all DOTs across the country to get their best practices. No changes made.

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