

**FLORIDA DOT
STATEWIDE DISPUTE REVIEW BOARD
FINDINGS & RECOMMENDATIONS**

**REGARDING ALLEGED DEFICIENCIES ENCOUNTERED
ON
NEWLY INSTALLED TRAFFIC SIGNAL MAST ARM STRUCTURES
ALONG TWO SUCCESSIVE
DESIGN-BUILD CONSTRUCTION PROJECTS ON I-75
IN
BROWARD COUNTY
DISTRICT FOUR**

SR 93/I-75 EXPRESS LANES – SEGMENTS C & D

**FINANCIAL PROJECT NOS. 421707-4-52-01, & 02
FEDERAL AID PROJECT NOS. 07541751 & 07541771
CONTRACT NOS. E4N98 & E4P08**

OCTOBER 31, 2018

RECOMMENDATIONS OF STATEWIDE DISPUTE REVIEW BOARD

POINTS OF CONSIDERATION:

1. First we would like to collectively say we three Board Members are of the strong opinion the Department's Construction Engineering Inspection (CEI) forces have achieved a remarkably excellent performance in carrying out their responsible tasks on these two Design-Build construction projects.
2. The fact that out of a total of 128 mast arms, 111 passed inspection the first time visited would imply that nothing is wrong with the Department's Standard Specifications. So what happened that 17 did not pass initially? And after corrective actions these 17 all passed! Why the deficiencies occurred was not explored and could, if found, be the reason to deny the Contractor's claim. Why, for example, were loose bolts found even after the installation was done by the Specification? Is there a need to revisit the Specification? Also, Mr. Matos' assertion that after dismantling the connection and finding that the surfaces were warped but within Specification needs to be addressed. How can this be explained?
3. It appears all persons associated with the subject projects, including the three of us Board Members, on first reading the Specifications were initially of the opinion that "full contact" meant 100% of the faces of the two plates. Only after reading subsequent correspondence regarding the Department reverting to AASHTO LRFD Bridge Design Specifications (AASHTO 6.13.2.8 which is entitled "Slip Resistance") was "full contact" relaxed to only an area of the faying surface "one bolt diameter width immediately adjacent to each bolt", defined as "one-bolt diameter." This seems like an easing of the initial hard specification reading, in favor of the Contractor.

Since the issue of full contact is clearly a critical component of the arguments, it is important to understand what this means.

Upon further and careful reading, it was clear that the Specifications do indeed contain a definition for "full contact" of the faying surfaces:

- a) Section 649-5 Installation, 3rd paragraph, 2nd sentence: "Tighten nuts to a snug tight condition to bring the faying surfaces of the assembly into full contact which is referred to as snug-tight." Hence, the nuts being tightened to a snug-tight condition defines full contact! Nothing is said about whether a gap still exists or not. If the issue of a gap is important, then the Specification needs to state it clearly and state how it will be measured.
- b) Section 460-5.4.8.2 Snug-Tight Condition: In the turn-of-the-nut method, first bring all the fastener assemblies of the connection to a "snug-tight" condition to ensure that all parts of the connection are in firm contact with each other. For the purpose of this specification, "firm contact" shall mean the condition that exists on a faying surface when the plies are solidly seated against each other, but not necessarily in continuous contact. Aside from stating that continuous contact is not a necessary condition, the issue is further confused by the introduction of a new term, "firm contact"!

4. Historically, specifications and design literature have taught us engineers that the "no gap" requirement is most important in Florida because of the following factors:

For safety to prevent eventual damage to the steel elements from salty airborne mists depositing harmful moisture into the gaps causing, in the long term, failures to the steel support members. Even though galvanized, the steel surfaces do get marred in handling, transport and during erection activity. Besides, all Florida environs being constantly exposed to salt air, highway smog conditions caused by

heavy vehicular traffic, and sea bird droppings (evident from viewing project photographs in the Position Papers), potentially add to the acidic peril.

Mast arm lengths are getting larger, longer and heavier. Florida environs are subject to receive extremely strong wind gusts from major storms. Structural specialists tell us that bolts alone cannot support the loads and there must be additional (in fact most) support from the tightened plates acting in unison. FHWA guidelines explain that only 20% of the load is transferred through the bolts alone and the other 80% must be through faying surfaces (properly tightened).

Also, the proper bolt tightening pattern must be precisely followed to achieve a correctly tightened fit.

However, even with all the fabrication issues and other aspects of construction, obtaining a “gap free” product is almost impossible. To reiterate: If the gap issue is important?

5. We three Board Members are of the opinion the Florida DOT Specifications are somewhat deficient on the subject matter and need to be updated. First, the Specs do not address strongly enough how to achieve “flatness” of the mating plates that are to be tightened to act as one member. There is no mention of the likely need to machine finish the contact surfaces of the plates to be assured of a “totally flat” surface. The surfaces of rolled steel plates are not “flat”. Perhaps the Specs should “require” machine-finished plate surfaces of the standard rolled stock steel plates specified, even knowing these steel elements will be subject to damage afterward during handling, shipping and assembly.

We believe all of the steel members need to be fully trial assembled at the fabrication point for assurance of complete and proper fit. And the sensitive “flat plates” (after achievement) be wrapped for protection during shipping and handling, to be assured of a proper fit coming from the assembly origination point. Also, wording in the Specs of the need for the totally-flat surface fit and the necessity to attain a proper union and 100% tight fit between the plates be added so all parties are fully aware of the importance and future safety issue. And the method of measuring for gaps should be addressed in the Specs and the commercial measuring tools that are acceptable.

From the information presented, it is obvious that thousands of mast arms have been installed throughout the state with, apparently, no problems until now. We were told that no other District has had any issue with installation until this project. Therefore, our earlier comment regarding why the problem has come up now is pertinent and should have been explored in more detail than merely the conclusion that the Contractor did not follow the Specifications. The Contractor claimed that he did follow the Specifications

We realize the Contractor building these two projects has performed this type work of installing Traffic Signal Mast Arm Structures long-term and is widely known to be an outstanding specialist in this field, and who is very proud of his work and reputation. It appears he has performed the work of these two projects to be up to par with his normal production and thus cannot believe this work at hand is not acceptable. We also believe the DOT has lately taken a firmer stance on production and installation of these type structures, realizing the increased safety issue involved as structure designs continue to produce longer and heavier arms, and the extreme important need to strictly enforce the Specifications.

Because of these two factors we cannot find either party totally at fault and believe the proper decision would be a 50%-50% finding of fault. And in this resolution, FDOT should strengthen and update its Specifications and so, issue the usual written notice to the construction community, and thence future Proposers can bid accordingly.

We recommend that the FDOT take the following actions to attempt to prevent any future problems with the design, fabrication, construction and maintenance of these structures:

1. All three divisions of the FDOT should meet to resolve the basic issues involved:
 - a. Design: Is the mast arm connection a slip-critical connection or not? If it is, then fabrication tolerances have to be more stringent than currently called for in the Specifications. If not, then the designers have to be aware of the issues involved in designing a snug-tight, bearing type connection.
 - b. Fabrication/Construction: The Construction Specifications need to be more definitive and clear in describing what “full contact” or “firm contact” means. Also, and more importantly, what effect does a more stringent control of the fabrication have on the overall cost of the mast arms? What is the cost-benefit of having more exacting machined components?
 - c. Maintenance: If indeed FDOT Maintenance is concerned about the durability of the mast arm components in our environment, even though they are galvanized, and a gap is almost unavoidable, are there other means of resolving the issue other than more sophisticated manufacturing? For example, use of epoxy fillers after the mast arm is in place.
2. Once the three FDOT Divisions have resolved the issues above, issuance of a clear and non-conflicting Specification and Design Guidelines should be issued to the Contracting and Consulting industries, possibly with presentations at both Design Conferences and Contractor Conferences.

FURTHER FINDINGS:

We agree that the Connection of mast arm to the pole is covered in Section 460 - Structural Steel and Miscellaneous Metals and Section 460-5 – Bolted Connections in particular. Section 460-5.4 covers the assembly of bolted connections:

Section 460-5.4.1 General – Verify that the faying surfaces are in accordance with contract documents, are free of dirt or other foreign materials...

Section 460-5.4.2 Preparation of Faying Surface: ... Provide certification to the Engineer that galvanized faying surfaces meet or exceed a Class C slip critical classification, unless a different classification is required elsewhere in the contract documents ...

Section 460-5.4.8 Turn-of-Nut Tightening:

Section 460-5.5.8.1 Snug-Tight Condition: In the turn of nut method, first bring all the fastener assemblies of the connection to a ‘snug tight’ condition to ensure that all parts of the connection are in firm contact with each. For the purposes of this specification “firm contact” shall mean the condition that exists on a faying surface when the plies are solidly seated against each other, **but not necessarily in continuous contact. Regard snug-tight as tightness required to produce the bolt tension, which following the final applied rotation, produces at least 1.05 times the minimum required bolt tension in accordance with Table 460-6, Minimum Required Fastener Tension:**

Table 460-6, Minimum Required Fastener Tension	
Bolt Size, inch	Tension ASTM A 325 bolts, kips
5/8	19
3/4	28
7/8	39
1	51
1 1/8	56
1 1/4	71
1 3/8	85
1 1/2	103

The important sections are 460-5.4.11 Inspection and 460.5.4.11.1 for Turn of the nut tightening:


- 1) Start by testing 10% of fastener assemblies to ensure snug-tight torque
- 2) If tested fasteners do not obtain the job inspection snug-tight torque, **test all the remaining using a calibrated torque wrench until minimum testing stated above is performed favorably**
- 3) Following confirmation of snug-tight condition, perform turn of nut tightening. The engineer will accept the connection as fully tightened when all of the following conditions are met:
 - a. The rotation specified in Table 460-7 has been achieved
 - b. There are no loose assemblies in the connection
 - c. **All plies of the connection are in firm contact**
 - d. There are no indications that excessive stretching or yielding has occurred in fastener assembly
 - e. Bolt stick-through is consistent per lot

In our opinion the Contractor did not pass Section 460.5.4.11.1 and the FDOT Project Engineer (Mr. Matos' team) did not follow 460.5.4.11.1 (3) ---- may be why they were checking 3) – c. However, there has been no identification of what firm contact is and as a result we find the 50%-50% blame, due to lack of specification.

In conclusion and to recapitulate the DRB's experience, the meeting began with an erroneous understanding of the Specification (100% full contact meaning absolutely no gap between the faying surfaces) and ending in only a certain portion of the faying surfaces needing to be in "full" contact (within a specified distance around the bolt); then, only a small percentage of the mast arms failed on this project and those that failed eventually met the FDOT's requirements; this issue, apparently, had never come up in any other District even though thousands of mast arms have been built around the state. The conclusion we have arrived at is that the reason why there was a failure to begin with was not dealt with as it should have been; neither the Specifications nor the intent of the Specifications was clear; apparently what FDOT Maintenance considered critical (gaps) was not properly addressed so that a contractor could reasonably bid and build the intended structure.

Although our focus is on the dispute arising on this one project, our intent is to provide some guidance to avert any such future conflicts on future projects. The end goal is for the riding public in this state to be assured that the structures are safe, efficient, durable, economical, and fulfill their intended design.

THE ABOVE IS OUR UNANIMOUS DECISION ALONG WITH OUR RECOMMENDATIONS:

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