

Independent Expert Review of Certain Girders Manufactured for the Rt. Hon. Herb Gray Parkway

Supplementary Report of Independent Expert Review Committee

Committee Chair:

Harvey J. Kirsh

Committee Members:

Dr. Husham Almansour

Carlos Laborde-Basto

Dr. Shamim Sheikh

Dr. Dagmar Svecova

Legal Counsel to Committee:

Ronald D. Manes

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INTRODUCTION

On Monday, September 30, 2013, the Ontario government's Independent Expert Review Committee ("**IER Committee**") submitted its Interim Report to the Minister of Transportation and Minister of Infrastructure relating to certain prestressed concrete girders which had been designed, fabricated and supplied to the Windsor Essex Mobility Group GP ("**ProjectCo**"), for use on the Rt. Hon. Herb Gray Parkway (the "**Parkway**") project in Windsor, Ontario.

That Interim Report focussed on 500 of the 935 girders which had been fabricated by Freyssinet Canada Limitée ("**Freyssinet**"). Another 548 girders, also required for the Parkway project, were to be fabricated by a second precaster, Prestressed Systems Incorporated ("**PSI**").

This Supplementary Report is intended to deal specifically with the girders fabricated by PSI.

On Wednesday, October 2, 2013, Hon. Glen Murray, Ontario's Minister of Transportation and Infrastructure, issued the following statement:

“In July, I asked a committee of independent experts to review certain concrete girders on the Rt. Hon. Herb Gray Parkway and provide recommendations on their safety and durability. On Monday [September 30, 2013], the experts released an interim report, now available online at www.independentexpertreview.ca.

The government’s Chief Engineer has recommended the government proceed to implement Option B. I have accepted that recommendation.

For the last two days, representatives of the Ministry of Transportation, Infrastructure Ontario and the contractor, Windsor Essex Mobility Group, have been reviewing the report and working towards implementation.

I am pleased the government and its partners have reached an agreement in principle that best serves the people of Ontario and the Windsor community. The Rt. Hon. Herb Gray Parkway is a vital economic link and provides employment for many Windsor residents. I want to thank the residents of Windsor and Essex County for their patience during this process.

On behalf of the people of Ontario, I extend my appreciation to the Chair, Harvey Kirsh, and panel members Dr. Dagmar Svecova, Dr. Shamim Sheikh,

Carlos Laborde-Basto, and Dr. Husham Almansour for their dedication and commitment in undertaking this review.

The work of the expert review committee will conclude by Oct. 31 with a supplementary report.

Until then, the North Talbot Road Bridge will remain closed.”

COMPLIANCE

Compliance with the applicable codes, standards and regulations by the precast fabricators of the prestressed concrete girders has been a live issue for the IER Committee.

Section 8.5.3.1(c) of the Canadian Highway Bridge Design Code (CSA S6-2006) (“**CHBDC**”) provides that tack welding of reinforcing steel is not permitted, unless it has been approved in writing¹ by a “Regulatory Authority”², in this case, Ontario’s Ministry of Transportation (“**MTO**”).

¹ Section 1.3.2 of the CHBDC defines “*Approved*” to mean “*approved in writing by the Regulatory Authority*”

² Section 1.3.2 of the CHBDC defines “*Regulatory Authority*” to mean “*the federal, provincial, or territorial Minister having governmental jurisdiction and control, his or her nominee, or the local authority to whom this authority is delegated*” (in this case, MTO).

Although the CHBDC is an industry Code, it is in fact legislatively mandated and is now the law of Ontario. Section 2(1) of Ontario Regulation 104/97 under Ontario's *Public Transportation and Highway Improvement Act*³, which deals with "*Standards for Bridges*", provides that "(w)here any person undertakes or causes to be undertaken the design, evaluation, construction or rehabilitation of a bridge, the design, evaluation, construction or rehabilitation shall conform to the standards set out in the *Canadian Highway Bridge Design Code*".

The IER Committee, in its Interim Report, determined that Freyssinet's welders had used tack welds when assembling the reinforced steel cages for the girders⁴, without Freyssinet having obtained the requisite prior approval⁵ by MTO.

³ R.S.O.1990, c. P.50

⁴ Tack welding is used for the purpose of assembling the reinforcing cage so that it is easier to move the cage into the steel formwork before the concrete is poured

⁵ The following comment is included in Item #10 of ProjectCo's "factual corrections" arising from a review of the Transcript of PSI's October 16, 2013 presentation to the IER Committee (submitted by counsel for ProjectCo to IER Committee on October 28, 2013): "*There is no temporal restriction on the approval referenced in CHBDC section 8.5.3.1.*". The IER Committee, however, does not agree with this comment. According to Robert Milne of Acuren (ProjectCo's testing company), a "*Regulatory Authority*" such as MTO "*would want to know what the materials were to make sure they were weldable without any sort of special precautions. They would [also] want to know that the welders were qualified*" (see Transcript of September 17, 2013 presentation by ProjectCo (per Robert Milne) to the IER Committee, at page 234, line 9ff. Code clauses with conditionality invariably mean that approval may be granted subject to certain requirements being met. Until the requirements have been met, approval may not be granted, so retroactivity to a conditional approval is never conceded. Examples of such requirement for pre-approval are also found in the legislation and industry standards of other jurisdictions (e.g., see "*Ministry of Transport U.K. Highways Agency - Design Manual for Roads and Bridges, Vol. 1, Sec. 3 BA40/93 - Tack Welding of Reinforcing Bars*", where tack welding approval is conditional upon the contractor

Similarly, the IER Committee has now also determined that 54 of the PSI girders, which were installed in Tunnel T10B, and 8 of the PSI girders, which were installed in Bridge B15, were all fabricated using tack welding, without PSI having obtained prior approval by MTO.

The CHBDC, however, does not state who has the obligation to seek the requisite prior approval⁶. In its October 16, 2013 presentation to the IER Committee, PSI emphatically expressed the view that it did not have that obligation, but rather was adamant that its “customer”, ProjectCo, was fixed with the responsibility for securing such approval⁷.

By way of response, it appears to be the position of ProjectCo that (i) “PSI did not seek PIC’s [ProjectCo’s] approval [for tack welding] under the CHBDC. PSI submitted a document titled ‘Supporting Document as per OPSS 909.04.02.01 (a)’. OPSS 909.04.02.01 does not refer to approval, but to a submission for information purposes”⁸; and (ii) “PIC [ProjectCo] did not intend to grant approval under the

demonstrating to the engineer that the fatigue life, durability and other properties of the concrete member are not adversely affected by the welding).

⁶ It is not part of the mandate of the IER Committee to determine this issue

⁷ See Transcript of October 16, 2013 presentation by PSI (per Loris Collavino, Don Little and Robert Auger) to the IER Committee, at page 18, line 25 to page 20, line 1; page 20, line 6 to page 21, line 18; page 105, line 23 to page 106, line 12

⁸ See Items #4 and #7 of ProjectCo’s “factual corrections” arising from a review of the Transcript of PSI’s October 16, 2013 presentation to the IER Committee (submitted by counsel for ProjectCo to IER Committee on October 28, 2013)

CHBDC. *The focus of PIC's [ProjectCo's] review was on the OPSS and PIC [ProjectCo] understood that PSI had submitted the necessary documents pursuant to the OPSS requirements*"⁹. (emphasis added)

The IER Committee notes that, apart from the issues of safety and durability of the girders and the use of tack welding, PSI appears to have conscientiously undertaken a responsible general program of compliance and certification. In this regard, the IER Committee has been advised that PSI has been certified by The Canadian Welding Bureau ("CWB") since 1989; that it employs a CWB-certified supervisor, and CWB-certified welders who are certified to the CSA W186 reinforcing steel welding standard; that its precast concrete production plant is certified by the Canadian Precast/Prestressed Concrete Institute ("CPCI")¹⁰; and that its plant is subject to regular audits by CWB, CPCI, the Precast Association (U.S.), and IBS Engineering, an independent welding inspection company.

In any event, PSI's use of tack welding, in the fabrication of its girders, was not brought to the attention of the IER Committee until the review process was well underway, on August 23, 2013, when ProjectCo's Chief Executive

⁹ Excerpt from an e-mail from counsel for ProjectCo to the IER Committee dated October 28, 2013

¹⁰ See document 1 of Exhibit PSI #2 of the October 16, 2013 presentation by PSI to the IER Committee

Officer, Ignacio Lasa, sent a letter to Infrastructure Ontario (“**I.O.**”) “*regarding certain of the PSI girders used in Bridge B15 and Tunnel B 10 (sic)*”. Mr. Lasa’s letter enclosed another letter, bearing the same date, which he had received from the Project Director of Parkway Infrastructure Contractors or “**PIC**” (the design-build component of ProjectCo’s organizational structure, which is included in the definition of “ProjectCo” in this Supplementary Report), which letter stated:

“We are writing to advise you that in the context of our preparations for the Independent Expert Review Committee (the ‘Committee’) it has come to our attention that tack welding was used by our subcontractor, Prestressed Systems Inc. (‘PSI’), in respect of certain girders that have been installed in the following structures:

- *Bridge B15 (contains 8 girders fabricated using tack welding); and*
- *Tunnel 10B (contains 54 girders fabricated using tack welding).”*

In point of fact, however, the documentary record appears to indicate that ProjectCo knew about PSI’s use of tack welding at least 22 months earlier, in November of 2011.

The following is a helpful chronology:

- According to Maurice Adoranti, PSI's Project Manager:

*"Discussions for tack welding started on or about November of 2011. Several meetings were held between PSI and PIC [ProjectCo] over the use of tack welding and throughout the process PIC was not opposed to the tack welding. In particular there were minutes from PSI and ProjectCo meetings held November 11, 2011 and November 28, 2011 which contain notes on tack welding and in particular it was suggested/agreed at both these meetings that perhaps a 'Note could be provided on the design drawings that Tack weld to assemble cages is allowed'."*¹¹

- By letter dated **February 17, 2012**¹², before any girders had been fabricated, PSI advised ProjectCo that it intended to use tack welds in the assembly of the reinforcing cages for the girders for Bridge B15. Enclosed with that letter was (i) an isometric sketch (SK-1) which showed tack welds at 6-8 points on the reinforcing steel of the cage,

¹¹ Memo from Maurice Adoranti to Robert Auger (PSI's In-House Legal Counsel) dated October 23, 2013, provided by Mr. Auger to the IER Committee by way of a follow-up undertaking given at the October 16, 2013 presentation by PSI to the IER Committee

¹² See document 3 of Exhibit PSI #2 of the October 16, 2013 presentation by PSI to the IER Committee (re: Bridge B15)

including where the vertical stirrups of the web met the reinforcement in the horizontal upper and lower flanges; and (ii) PSI's sealed fabrication shop drawings G-100¹³, G-101¹⁴, G-102¹⁵, G-103¹⁶, G-104¹⁷ and G-105¹⁸ for Bridge B15, each of which showed tack welds at several positions in the Type 1 Cross-section.

- By memo dated **February 29, 2012**¹⁹, ProjectCo's structural engineering consultant, Hatch Mott MacDonald ("**HMM**"), advised ProjectCo that:

"We are not comfortable with the use of tack welding for connecting reinforcing steel bars at intersecting points, and therefore do not approve this method. With so many weld points to be made, the chance of flaws that may include invisible cracks and initiation of brittle fractures is great." (emphasis added)

- In its October 16, 2013 presentation to the IER Committee, PSI advised that subsequent discussions between PSI and ProjectCo "*seem to indicate that PIC [ProjectCo] agrees with PSI that tack welding is allowed under*

¹³ See shop drawings identified collectively as document 6 of Exhibit PSI #2 of the October 16, 2013 presentation by PSI to the IER Committee (re: Bridge B15)

¹⁴ *ibid*

¹⁵ *ibid*

¹⁶ *ibid*

¹⁷ *ibid*

¹⁸ *ibid*

¹⁹ See Exhibit PSI #3 of the October 16, 2013 presentation by PSI to the IER Committee (re: Bridge B15)

OPSS 905”²⁰, but unfortunately PSI was unable to point to any document which evidenced or confirmed that agreement. Furthermore, there is no evidence that HMM pursued its express objection to tack welding, and, as indicated below, the issue fell off the radar screen²¹.

- By its written **March 16, 2012** “*answer*” to PSI’s Request for Information²², ProjectCo stated: “*Reinforced Tack Welding – In accordance with OPSS 905 and is subject to approval of PSI’s welding procedure manual*”. PSI interpreted that to signify ProjectCo’s approval to proceed with tack welding for the Bridge B15 girders.
- The first concrete for the girders for Bridge B15 was poured from **April 2-16, 2012**²³.
- By letter dated **April 17, 2012**²⁴, PSI advised ProjectCo that it also intended to use tack welds in the assembly of the reinforcing cages for the Tunnel T10B girders. Enclosed with that letter was an isometric

²⁰ See page 10 of Exhibit PSI #1 of the October 16, 2013 presentation by PSI to the IER Committee. Also see Transcript of October 16, 2013 presentation by PSI (per Loris Collavino) to the IER Committee, at page 108, lines 9-16

²¹ See Transcript of the September 17, 2013 presentation by ProjectCo (per Biljana Rajlic) to the IER Committee, at page 120, line 25 to page 121, line 4

²² See Exhibit PSI #4 of the October 16, 2013 presentation by PSI to the IER Committee

²³ See Transcript of the September 17, 2013 presentation by ProjectCo (per Biljana Rajlic) to the IER Committee, at page 112, lines 11-18

²⁴ See document 7 of Exhibit PSI #2 of the October 16, 2013 presentation by PSI to the IER Committee (re: Tunnel T10B)

sketch (SK-1) which showed tack welds at 6–8 points on the reinforcing steel cage, including where the vertical stirrups of the web met the reinforcement in the upper and lower flanges. PSI also submitted sealed fabrication shop drawings G-200²⁵ and G-201²⁶ for Tunnel T10B, each of which showed tack welds at several positions in the Type 1 Cross-section.

- By memo dated **May 17, 2012**²⁷, HMM again advised ProjectCo as follows (this time with respect to the girders for Tunnel T10B):

*“We are not comfortable with the use of tack welding for connecting reinforcing steel bars at intersecting points because HMM will not inspect any reinforcement for girders, **and therefore do not approve this method.** With so many weld points to be made, the chance of flaws that may include invisible cracks and initiation of brittle fractures is great.”* (emphasis added)

However, opposite the words “*Tack Weld*” at item 1.2 of HMM’s May 17, 2012 memo are the inserted or added words, in a different font or

²⁵ See shop drawings identified collectively as document 9 of Exhibit PSI #2 of the October 16, 2013 presentation by PSI to the IER Committee (re: Tunnel T10B)

²⁶ *ibid*

²⁷ See document 8 of Exhibit PSI #2 of the October 16, 2013 presentation by PSI to the IER Committee (re: Tunnel T10B)

stamp, “*Approved by PIC*”, which is followed by the initials “*MP*”. It is not known who added those words and initials, but PSI apparently felt justified in relying on them. The IER Committee interprets the added words and initials to mean that ProjectCo overruled the concern and non-approval expressed by HMM regarding tack welding, and essentially authorized PSI to proceed with tack welding. The initials “*MP*” are likely those of “*Marcos Peña*” of ProjectCo, who was copied on the May 18, 2012 e-mail from Johnathan Quijano to Maurice Adoranti²⁸ (both of ProjectCo) enclosing HMM’s review of the PSI shop drawings.

The IER Committee also notes the ambiguity and internal inconsistency caused by the added words “*Approved by PIC*” to HMM’s memo dated May 17, 2012 (i.e., with HMM expressly disapproving of tack welding, but with ProjectCo countermanding its own structural engineering consultant and instructing PSI to proceed). However, PSI, on receipt of that document, either ignoring or despite that ambiguity, rationalized proceeding with tack welding on the basis that ProjectCo, and not

²⁸ *ibid*

HMM, was its “customer”, and that, according to PSI, ProjectCo had the responsibility to secure MTO approval for tack welding²⁹.

As PSI stated at its October 16, 2013 presentation to the IER Committee,

“HMM, yes, they are clear that they don't really like that process. They are not our customer. Our customer is PIC [ProjectCo]. PIC specifically puts in there that it is approved by them. Whether they went back to HMM and convinced them that it is okay, that is not part of our information that they would provide to us. What is important to us is that our customer has said, ‘We have approved you to do this’, and again, we are not doing something radically different than we have done for years and years on bridgework.”³⁰

The IER Committee is of the view that PSI's reliance on ProjectCo for “approval” was genuinely held, albeit misguided; and ProjectCo, in purporting to approve tack welding, did nothing to disabuse PSI of the erroneous notion that PSI could rely upon ProjectCo for approval.

²⁹ But see pages 7-8 above, and footnotes 8 and 9, *supra*

³⁰ See Transcript of October 16, 2013 presentation by PSI (per Donald Little) to the IER Committee, at page 115, line 23 to page 116, line 9

It is to be noted, though, that, according to the CHBDC, MTO's approval had to have been "*in writing*"³¹. This was known, or should have been known, by both ProjectCo and PSI. ProjectCo in fact never sought approval, and PSI, not having received any confirmation *in writing* from MTO that ProjectCo had secured approval, nevertheless went ahead with tack welding.

- The concrete for the girders for Tunnel T10B was poured from **June 5 – August 22, 2012**³².
- In general terms, the tack welding issue was not raised again until **December 20, 2012**, when representatives of MTO, I.O., Freyssinet and ProjectCo met at the offices of the Canadian Standards Association ("**CSA**") to discuss the CSA audit of the Freyssinet plant. As Tom Woods, Contracts Director (Highway Group) of I.O., advised the IER Committee, "*There was a comment made in the CSA audit [of the Freyssinet plant] regarding the use of tack welding. It was noted that some of the bars*

³¹ Section 1.3.2 of the CHBDC defines "*Approved*" to mean "*approved in writing by the Regulatory Authority*"

³² See Transcript of the September 17, 2013 presentation by ProjectCo (per Biljana Rajlic) to the IER Committee, at page 112 lines 22-25 to page 113, lines 1-10

were undercut and some of the tack welds appeared to be of poor quality”³³. . . .

On January 28th 2013, MTO informed I.O. that the use of these tack welds in this way was a CHBDC code noncompliance.”³⁴

However, at the time of the meeting at CSA’s offices (December 20, 2012), ProjectCo had been aware for many months that PSI had fabricated its girders for Bridge B15 and Tunnel T10B using tack welding without any MTO approval. ProjectCo did not disclose this to MTO or I.O. or to the IER Committee, though, until eight months later, on August 23, 2013.

As indicated above, HMM initially registered its objection to the use of tack welding by PSI in the fabrication of the girders for Bridge B15, but HMM never followed up and the issue “*fell off the radar screen*”. That issue was resuscitated, though, in the presentation of Biljana Rajlic, a Vice-President of HMM, to the IER Committee on September 17, 2013.

³³ Transcript of the August 13, 2013 presentation by I.O. (per Tom Woods, Contracts Director, Highways Group) to the IER Committee, at page 59, line 16 to page 60, line 3

³⁴ *ibid.* at page 61, lines 16-21

In the following exchange, Ms. Rajlic confirmed that HMM reviewed the PSI girder shop drawings³⁵, recommended against the use of tack welding, and never pursued the issue of MTO non-approval because HMM thought that its recommendation had been accepted:

“THE CHAIR: Is it fair to say that before any fabrication was commenced, HMM knew that the fabrication process for PSI would include tack welding?”

MS. RAJLIC: Correct³⁶.

.....

“THE CHAIR: Did you provide written comments or oral comments?”

MS. RAJLIC: Yes, we provided written comments.

THE CHAIR: Those written comments, would they have included the comment that I just described?

MS. RAJLIC: Our comment in that letter was that we reviewed the shop drawings, and our recommendation is not to use the tack welds.”

(emphasis added)”³⁷

³⁵ See Transcript of the September 17, 2013 presentation by ProjectCo (per Biljana Rajlic) to the IER Committee, at page 114, lines 1-4; page 115, lines 17-20

³⁶ See Transcript of the September 17, 2013 presentation by ProjectCo (per Biljana Rajlic) to the IER Committee, at page 115, lines 21-25

.....

THE CHAIR: *You were recommending against the use of tack welding for what purpose or what reason?*

MS. RAJLIC: *We recommended in that particular letter, we stated the quality reasons, because we didn't know the whole process, and we didn't review all the documents, and our recommendation based on our past experience is not to use the tack welds. Our assumption at that point was that if that is really important, that discussion will come back, and we will discuss that again.*

THE CHAIR: *When you sent that letter with that comment on it, did you expect that comment to generate a discussion back and forth, or did you expect your comment to be observed?*

MS. RAJLIC: *We thought if it is really important, because there are a lot of issues on a project like this that generate further discussion, at that point, we thought if it is really important with the precaster, the*

³⁷ See Transcript of the September 17, 2013 presentation by ProjectCo (per Biljana Rajlic) to the IER Committee, at page 116, lines 8-17

discussion will come back, and we will have a joint discussion with HMQ. We had meetings every two weeks.

THE CHAIR: *Did your comment ever come up in conversation after you wrote that letter?*

MS. RAJLIC: *No.*

THE CHAIR: *Did you not bring it up again, since you were the one who recommended against the use of tack welds? Did you not say, "What about my comment? Have you thought about my comment? Do you have any response to my comment?"*

MS. RAJLIC: *We didn't have a -- probably there is some email correspondence about that between us and PIC that we ask about the tack welds, but at some point, because we were too busy and doing other things, we just thought that whatever our recommendation was, PIC did what we asked them to do, and we didn't really follow up on that one.*

THE CHAIR: *You didn't follow up. Did you expect them to listen to what your recommendation was and not to use tack welds?*

MS. RAJLIC: *We expected, to be honest, just to have a discussion again, yes. I would say we expected what you just said.*

THE CHAIR: *If you were met with silence at the other end, you expected they accepted your recommendation?*

MS. RAJLIC: *Yes.*

THE CHAIR: *Did you ever also comment on the fact that if they were going to use tack welds, you wanted to remind them they needed to obtain the approval of a regulatory authority under the code?*

MS. RAJLIC: *We never had that kind of discussion.*

THE CHAIR: *Why did you not raise that as an issue before fabrication began? When I say you, I mean HMM.*

MS. RAJLIC: *Because we thought that we didn't recommend tack welding and basically the issue was closed.*

THE CHAIR: *You thought it was academic as an issue?*

MS. RAJLIC: *Yes.*

THE CHAIR: *When was the first time you found out that tack welding was, in fact, used on the PSI girders?*

MS. RAJLIC: *Before we had the meeting with you guys the first time, HMM took –*

THE CHAIR: *Which meeting?*

MS. RAJLIC: *With you guys about Freyssinet, the presentation.*

THE CHAIR: *That would have been August of this year.*

MS. RAJLIC: *Before that, we advised our staff to go through the records we have and check whether there is any mentioning of the tack welds. At that point, we found that there is this correspondence that was never followed up, and because of the things that happened with the Freyssinet girders, at that point, we didn't have any immediate safety concern, and we just notified PIC, because we really don't know what happened. We just told them we had this correspondence, and it was never followed up, and what happened after, and after the meeting we had with you guys -- I think it was Thursday after the meeting –*

MS. VOGEL: *Wednesday. We received confirmation that, in fact, tack welding was used, and then on Friday the 23rd, HMQ was advised.*

THE CHAIR: *Is it fair to say that from approximately the spring of 2012 until August 1, 2013, this issue was off the table, not on anybody's radar?*

MS. RAJLIC: *Yes.*³⁸

CONDITION OF PSI GIRDERS

It is important to look at the sequence of events, some of which is re-stated from above, to understand their effect on the fabrication of the PSI girders. PSI, in a letter of February 17, 2012 to ProjectCo, requested some changes in the process of construction of the girders for Bridge B15³⁹. Two of these changes were as follows:

1. The specified strength of concrete in girder design at transfer was 42 MPa, and the request was made to change it to 35 MPa; and

³⁸ See Transcript of the September 17, 2013 presentation by ProjectCo (per Biljana Rajlic) to the IER Committee, at page 117, line 5 to page 121, line 4

³⁹ Letter from Milenko Simic of PSI to Daniel Munoz of ProjectCo, dated February 17, 2012

2. Permission was sought to use tack welds to construct stirrups for use in the girders.

The letter from PSI was forwarded by ProjectCo to HMM, its structural engineering consultant for the project, for HMM's input on the requested changes. On February 19, 2012, HMM responded as follows⁴⁰:

1. The strength of concrete at transfer can be reduced to 38 MPa from 42 MPa; and
2. HMM *"is not comfortable with the use of tack welding for connecting reinforcing steel bars at intersecting points and therefore do not approve this method. With so many weld points to be made, the chance of flaws that may include invisible cracks and initiation of brittle fractures is great. On HMM Drawing No. S1515 (Rev B), we have specified MD103 welded wire reinforcement sheets for the top and bottom flanges of the girder. It is expected that these sheets would be factory manufactured under quality controlled conditions"*.

ProjectCo forwarded HMM's letter to PSI. As discussed above, although HMM did not approve of tack welding the steel to form cages, ProjectCo, in

⁴⁰ Letter from HMM (signed, though, by Don Oliver of ProjectCo) to Daniel Munoz (also of ProjectCo), dated February 29, 2012

an e-mail dated March 23, 2012 at 1.23 pm (from Mahmood Amar of ProjectCo), authorized PSI to use tack welding, stating "*Please proceed with welding to meet the schedule*". Based on this approval, PSI constructed the girders for Bridge B15 between April 2, 2012 and April 16, 2012 using tack welds for the stirrups.

Following the same procedure that was used for Bridge B15 girders, PSI, on April 17, 2012, asked ProjectCo for approval to use tack welding of steel for the girders to be installed on Tunnel T10B⁴¹. ProjectCo again forwarded the letter to HMM for its input and approval.

In its letter of May 17, 2012 to ProjectCo (forwarded to PSI on May 18, 2012), HMM⁴² responded to the tack welding request by stating: "*We are not comfortable with the use of tack welding for connecting reinforcing steel bars at intersecting points because HMM will not inspect any reinforcement for girders, and therefore do not approve this method. With so many weld points to be made, the chance of flaws that may include invisible cracks and initiation of brittle fractures is great. On HMM sheet No. 3061 (Rev C), we have specified MD103 welded wire*

⁴¹ Letter from PSI to Daniel Munoz of ProjectCo, dated April 17, 2012

⁴² Letter from Guo and Rajlic of HMM to D. Munoz of ProjectCo, dated May 17, 2012

reinforcement sheets for the top and bottom flanges of the girder. It is expected that these sheets would be factory manufactured under quality controlled conditions”.

Once again, however, ProjectCo appears to have overruled HMM and to have authorized PSI to use tack welding. This authorization was forwarded to PSI with the added comment, beside “*Re: Item 2. Tack Weld*” of HMM’s May 17, 2012 letter, “*Approved by PIC [ProjectCo]*”.

It is obvious that tack welding was not approved by the structural engineer of the project, HMM, or by MTO. In fact, HMM rejected the proposal for tack welding twice, based on its experience and expertise, and provided technical reasoning to ProjectCo, warning of the consequences relating to invisible cracks and initiation of brittle fractures in steel. ProjectCo, however, approved the tack welding in both instances while at the same time conveying the concerns of the structural engineer to PSI. However, as noted above, HMM approved the change of concrete strength at stress transfer from 42 MPa to 38 MPa.

SHORTCOMINGS, VULNERABILITIES AND REMEDIES

Tack welding, if used and done properly in accordance with the requirements and regulations of various codes, requires a number of checks and changes in design. One of the applicable documents is *“Welding of Reinforcing Bars in Reinforced Concrete Construction - CSA W186-M1990”* (reaffirmed 2012). Clause 6.9.1 of this code requires:

“Welds used to hold reinforcing bars together into rigid cage are permitted provided that (a) weldable reinforcement (CSA Standard G30.16M) or intermediate grade (CSA Standard G30.12M) is used and (b) each bar meets at least one of the following conditions at the weld point:

(i) each bar is an added support bar or is tack welded at a point where it is not required for structural strength

(ii) the tack weld is within ten bar diameters of the free end of the bar

(iii) the bar area is one third larger than required for structural strength and the weld is not located in regions of high stress.”

The IER Committee has concluded that the girders for Bridge B15 and Tunnel T10B do not meet the requirements listed above.

The one-third increase in the area of the bar [i.e., (iii) above] is required to compensate for the cracking and the lower fatigue resistance of welded steel and to guard against the early corrosion of steel due to welding. Some of these concerns were raised twice by the project's structural engineer, HMM, to ProjectCo, and then conveyed to PSI.

In a structure containing tack welded reinforcement, the performance at fatigue limit state ("FLS") is absolutely crucial. In its analysis, HMM⁴³ did not check the Bridge B15 girders for FLS at the weld location 4 (See Figure 1 at page 30 below: tack weld location #4 is at the top in the upper flange), stating that the structure is not cracked at that location and fatigue is thus not a concern. This statement contradicts a statement made by HMM in its inspection report (Document No 285380-03-126-0087) on the PSI Bridge B15 girders⁴⁴.

While describing weld location 4, it was stated at page 6 of that inspection report: *"However, cracks in this location are relatively common for two span continuous structures such as B-15, so it was noted that any cracks observed on B-15*

⁴³ Technical Memo from Biljana Rajlic to Daniel Munoz re: Tack Welding on PSI B-15 Girders, Document No: 285380-03-126-0086 R2, September 3, 2013

⁴⁴ Technical Memo from Biljana Rajlic to Daniel Munoz re: B-15 PSI Girders, Full Inspection Report, Document No: 285380-03-126-0087, September 6, 2013

girders in this location might be due to causes other than tack welding".

Furthermore, the report by Anil Mehta of PSI on the conditions of girders shows a large number of cracks in all Bridge B15 and Tunnel T10B girders. Some of the cracks are reported to be 0.30 mm thick and more than 700 mm long⁴⁵.

(See Figure 1. Location of Tack welds in Bridge B15 girder on next page)

⁴⁵ See Post Pour Inspection Reports, ProjectCo Exhibit Y-3, file T10B Precast Report B

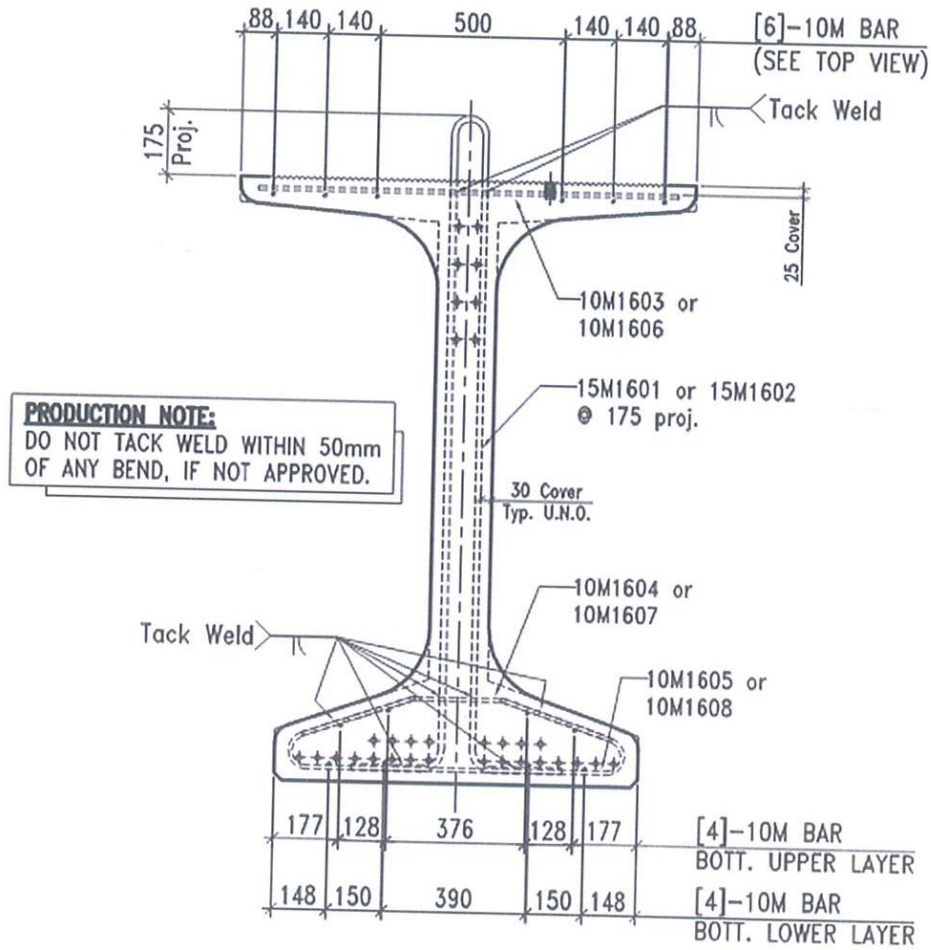


Figure 2.1: Locations of tack welds in a typical cross-section through B15 girder (extract from PSI shop drawing dated February 7, 2012).

Figure 1. Location of Tack welds in Bridge B15 girder

There are also other assumptions made in the evaluation of girders for their strength and long term performance, especially in the calculation of shear resistance. It is well known from extensive work done and reported in the literature that welding makes steel brittle, weak in fatigue, and susceptible to early corrosion.

The requirements of *“Welding of Reinforcing Bars in Reinforced Concrete Construction - CSA W186-M1990”*, referenced above, are a defence against that vulnerability. Instead of following these requirements, an additional weakness was introduced in the PSI girders by allowing the steel pre-stress transfer at a concrete strength of 38 MPa rather than the original 42 MPa. It is true that all concretes crack, but cracking is kept within limits when the design code requirements are followed. Cracking of concrete would obviously be more pronounced when it is subjected to stresses at lower strength. Tack welding that did not meet the code requirements has made the girders deficient with respect to durability, both for fatigue and corrosion; and the reduction of the concrete strength at stress transfer from 42 MPa to 38 MPa has made matters worse.

CONCLUSIONS AND RECOMMENDATIONS

Tunnel T10B

Given the predominantly static design loading for Tunnel T10B, the 54 PSI girders used for that tunnel are not subjected to traffic loads that may cause fatigue, and their structural deficiency is therefore relatively insignificant. Based on the current use of the structure (i.e., “it has landscaping on the top”⁴⁶; and “94 percent of the tunnel deck area is for landscape purposes⁴⁷”), these girders can thus be considered to be safe against fatigue. However, any future change in the functionality and loading of the structure may affect this conclusion.

These girders, though, are susceptible to accelerated corrosion at welded zones due to tack welding. PSI’s Post Pour Inspection Reports disclose cracking of concrete at the ends of all of the 54 Tunnel T10B girders. Cracks in the web were as wide as 0.2 mm, and some of them were extending more than 600 mm in the end zone of the girders⁴⁸. From the perspective of corrosion, durability is therefore an issue.

⁴⁶ See Transcript of the September 17, 2013 presentation by ProjectCo (per Sharon Vogel) to the IER Committee, at page 5, lines 24-25

⁴⁷ See Transcript of the September 17, 2013 presentation by ProjectCo (per Daniel Ruiz) to the IER Committee, at page 45, lines 11-12

⁴⁸ See Post Pour Inspection Reports, ProjectCo Exhibit Y-3, file T10B Precast Report

Corrosion of steel, if not arrested in time, can cause spalling, and falling chunks of concrete on highway traffic. In a worst case scenario, corrosion that may not be visible to a naked eye could weaken the structure to a point that failure could take place without any warning.

Corrective measures should be taken immediately to address any issues that may affect the long-term performance of girders keeping in mind the fact that welded steel would deteriorate faster than un-welded steel.

Furthermore, the IER Committee recommends a program of structural health monitoring and an enhanced inspection regime for those 54 PSI girders, by independent professional inspectors, for the design life of the structure.

Bridge B15

The 8 girders used in Bridge B15 (which is described as “*a bridge with traffic going over the top of it*”⁴⁹) have the live traffic load of a “*regular road bridge*”⁵⁰.

Welded stirrup reinforcement in these girders, which is a crucial component

⁴⁹ See Transcript of the September 17, 2013 presentation by ProjectCo (per Sharon Vogel) to the IER Committee, at page 5, lines 22-23

⁵⁰ See Transcript of the September 17, 2013 presentation by ProjectCo (per Daniel Ruiz) to the IER Committee, at page 56, line 24

in resisting shear, is less than what is required by design codes when tack welding is used. Deficiency in stirrup reinforcement may cause failure that is brittle and without warning.

In many cases, they may also be subjected to exposure to chemicals and salts. These girders are thus seriously vulnerable to both fatigue and accelerated corrosion that may shorten their useful life.

Furthermore, PSI's Post Pour Inspection Reports disclosed cracking at the ends of the 8 Bridge B15 girders. Some of those cracks were as large as 0.3 mm, which, according to PSI⁵¹, should have been grouted. PSI's Anil Mehta wrote to ProjectCo's Marcos Pena on April 14, 2012 that he observed the existence of hairline as well as other cracks which required corrective action⁵². Thus, there is a serious concern about their long-term safety and durability.

It is recommended that these 8 PSI girders be carefully checked for deficiency in shear reinforcement in accordance with all applicable codes. If the deficiencies are extensive, the girders should be replaced; otherwise they should be strengthened as required. Furthermore, a robust structural health

⁵¹ See Transcript of the October 16, 2013 presentation by PSI (per Loris Collavino) to the IER Committee, at page 130, line 8 to page 136 line 13

⁵² See April 14, 2012 letter from Anil Mehta to Marcos Pena, ProjectCo Exhibit Y-3, file Precast Report B-15

monitoring program and an enhanced inspection regime by independent professional bridge inspectors are required, especially considering the cracks that have been observed at various locations.

These two monitoring regimes should help provide early warning of corrosion and fatigue in the girders. If at any time during monitoring and inspection, the girders show shear cracking and corrosion, they should be replaced promptly.

All of which is respectfully submitted,

Committee Chair:

Harvey J. Kirsh

Committee Members:

Dr. Husham Almansour

Carlos Laborde-Basto

Dr. Shamim Sheikh

Dr. Dagmar Svecova

Legal Counsel to Committee:

Ronald D. Manes