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Report on the Open Web Steel Joist Remediation Program for the Province of Newfoundland and Labrador
VOLUME 1 - REPORT

Prepared by:

fga **Consulting Engineers Limited**
2 Hunt's Lane
St. John's, Newfoundland
A1B 2L3

Gary Follett, P. Eng.

On behalf of:

The Open Web Steel Joist
Task Review Board

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Preface

This report was substantially completed prior to March 2003. Since that time CSA W47.1 has been revised and reissued in December 2003. Two changes that have been incorporated in the new CSA W47 are:

1) *It is no longer required that a certified company have an engineer responsible for design. It continues to be a requirement that certified companies have an engineer responsible for procedures and practice.*

2) *The new CSA W47 allows the certified company to use pre-qualified procedures for flare bevel welds, which was not previously permitted.*

This report is written on the basis of the codes and standards which were current during the time when the Open Web Steel Joist Task Review Board was most active (1996 to 1999), which coincides with the time when the majority of the remediation projects were designed and construction completed.

TABLE OF CONTENTS
VOLUME 1 - REPORT

1.0 INTRODUCTION PAGE 1

2.0 DISCUSSION PAGE 2

2.1.1 The OWSJ Task Review Board PAGE 2
2.1.2 Snow Removal Guidelines PAGE 2

2.2 The Role of the Consultants PAGE 3
2.2.1 Stage I Inspection PAGE 3
2.2.2 Stage II Inspection PAGE 3

2.3 Problem Definition and Safety PAGE 4
2.3.1 National Building Code (NBC) PAGE 4
2.3.2 CSA S16, CSA W59 and CSA W47.1 PAGE 5
2.3.2.1 Flare Bevel Weld PAGE 6
2.3.2.2 Puddle Welds PAGE 7
2.3.3 Probability of Weld Failure PAGE 8
2.3.4 Connection Failure v.s. Member Failure PAGE 10
2.3.5 Failure Statistics PAGE 10
2.3.6 Review of Facts PAGE 12

2.4 Phase I Open Web Steel Joist Testing Program PAGE 13

3.0 RESOLUTION OF SAFETY ISSUES PAGE 16

3.1 NBC Commentary K PAGE 16

3.2 Recommended Minimum Remediation PAGE 17
3.2.1 Level I PAGE 17
3.2.2 Level II, III and IV PAGE 18

3.3 Phase II Open Web Steel Joist Testing Program PAGE 18
3.3.1 Level I Remediation Test PAGE 18
3.3.2 Level II Remediation Test (IIB) PAGE 20
3.3.3 Level IIA Remediation Test (Test IIC) PAGE 20
3.3.4 Test Program Summary PAGE 22

3.4 The Consultants Professional Responsibility PAGE 22

3.5 A Typical Remediation Program PAGE 23
3.5.1 School Description PAGE 23
3.5.2 Stage I Identification PAGE 23
3.5.3 Stage II Inspection PAGE 24
3.5.4 Stage II Remediation PAGE 24
3.5.4.1 Designer's Interpretation of Remediation Requirements PAGE 26

3.6 Cost of Remediation PAGE 28
3.6.1 Introduction PAGE 28
3.6.1.1 Phase I: Identification PAGE 28
3.6.1.2 Phase II: Inspection and Emergency Repair PAGE 28
3.6.1.3 Phase III: Remediation PAGE 28
3.6.1.4 OWSJ Load Testing Program PAGE 29
3.6.1.5 OWSJ Task Review Board PAGE 29
3.6.2 Project Cost and Estimates PAGE 29
3.6.2.1 Phase I and II Cost PAGE 29
3.6.2.2 Phase III Cost PAGE 29
3.6.2.3 Joist Test Program PAGE 30
3.6.2.4 OWSJ Task Review Board PAGE 30
3.6.3 Total Cost PAGE 30
3.6.4 Comparative Unit Costs PAGE 36

4.0 CONCLUSION PAGE 37

5.0 RECOMMENDATIONS PAGE 39

5.1 Current Status PAGE 39
5.1.1 Unidentified Buildings Containing Robb Joists PAGE 39

5.2 Measures to Avoid Reoccurrence PAGE 40

1.0 INTRODUCTION

On February 09th, 1987 a partial collapse occurred in a St. John's shopping mall. Under the weight of ice and snow, approximately 700m^2 of roof collapsed, causing an additional 400m^2 of the 2nd floor to collapse as well.

Following the collapse, the Association of Professional Engineers and Geoscientists of Newfoundland (APEGN)* requested information from the mall owners, the City of St. John's and others, regarding the cause of the collapse. Access to information was denied by all parties despite considerable efforts, including legal channels, by APEGN, to obtain same.

Through the process of investigation, inspection, modeling and discussion, a number of professional engineers assisting in the litigation efforts, concluded that the main cause of the mall collapse was due to the faulty welding of the open web steel joists (OWSJ) which are secondary truss like members supporting the roof and floors.

The fabricator of the mall OWSJ's was a company from Amherst, Nova Scotia named "Robb Engineering Division Dominion Bridge Company Limited". Hereinafter, the open web steel joists may be referred to as "Robb Joists".

In January 1995, there was a second partial collapse of the roof of a warehouse in Donovan's Industrial Park, which is on the outskirts of St. John's. This building also had Robb Joists and the inferior quality of the welding was again a serious issue.

Having had its suspicions concerning Robb Joists, following the second collapse APEGN wrote the Province of Newfoundland and Labrador and other building owners to inform them of their concern with respect to Robb Joists. In August of 1996, APEGN obtained from Robb Engineering, a list of buildings constructed between 1970 and 1985, containing Robb Joists. APEGN forwarded the list to Government.

The Province in turn constituted a "Technical Evaluation Board", to which the author was appointed. Refer to Item "1" in Appendix I, Correspondence.

*** APEGN is now called "Professional Engineers and Geoscientists of Newfoundland and Labrador" – PEG-NL**

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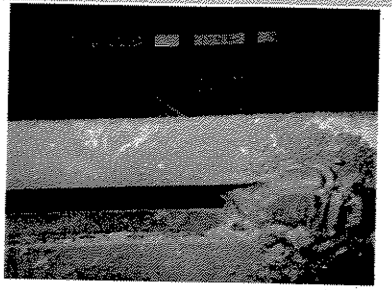
2.0 DISCUSSION

2.1.1 The OWSJ Task Review Board



Originally called the "Public Building – OWSJ Assessment Technical Evaluation Board", on November 6, 1996 there were five (5) persons appointed whom included:

1. Ingrid Sheppard, P. Eng., Dept. of Works, Services & Transportation – who acted as Chair;
2. Gunar Leja, P. Eng., Dept. of Works, Service & Transportation;
3. Gerry Moores, P. Eng., APEGN;
4. Lloyd Short, P. Eng., Structural Consultants Limited; and,
5. Gary Follett, P. Eng., *fga* Consulting Engineers Limited.

After a short period of time, Dave Burt, P. Eng. replaced Lloyd Short, P. Eng.

The board became known as, "The OWSJ Task Review Board" and its mandate included:

- the promotion of a consistent approach for the Stage II investigation of buildings containing Robb Joists;
- to provide advice with respect to risk management, public interest, concerns and operational guidelines; and,
- to provide clarification of technical requirements to proponents responding to the Request for Proposals for the Stage II inspection of buildings containing Robb Joists.

There were two (2) collapses in the St. John's area in buildings that were constructed with Robb Joists. It was the opinion of a number of informed engineers that these collapses were mainly due to the poorly welded open web steel joist connections. In order to reduce the possibility of a collapse before the extent of any deficiencies could be investigated it was decided to issue an immediate directive to the persons responsible for the public buildings, to remove snow and ice from buildings. The Guideline so developed dated December 10th, 1996, and subsequently amended February 15th, 1997, is included in Appendix II.

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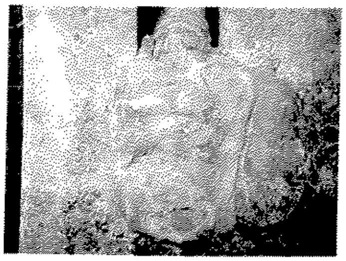


2.2 The Role of the Consultants

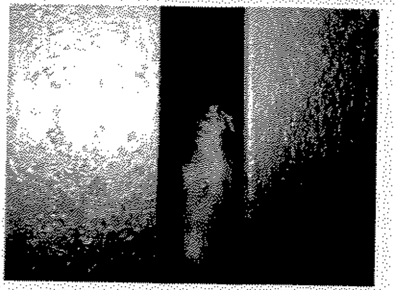
2.2.1 Stage I Inspection

The original list of buildings that APEGN had obtained from "Robb" and provide to the Province was broken down into six (6) geographic areas. The first chore was to confirm that the joists in each building were in fact "Robb Joists". This was confirmed primarily by removing metal tags from the joists and matching the number stamped thereon with the job number on the list provided by Robb Engineering Division.

Because the Robb List was not sufficiently descriptive to clearly identify many buildings which were constructed between 1970 and 1985, virtually all buildings containing Open Web Steel Joists were subjected to a stage I inspection, to determine whether the joists were fabricated by Robb. As outlined in the letter from APEGN, Item 4 in Appendix I, 16 buildings from the Robb list have not been identified as of the date of this report. Considering the level of effort during stage I inspection, it is not anticipated these buildings are currently owned by Government.

The initial inspections were completed by Department of Works, Service and Transportation or school and hospital board employees, as well as a small group of appointed consultants, in the later months of 1996.

From the stage I process a Request for Proposals was developed for the six (6) geographic areas for, the remaining stage I identification and the stage II inspections.



The main purpose of the stage II inspections was to carry out sufficient inspections to determine if a problem existed, the extent of the problem, and to identify and correct any immediate emergency situations.

2.2.2 Stage II Inspections

The main purpose of the stage II inspection was to carry out sufficient inspections to determine if a problem existed, the extent of the problem, and to identify and correct any immediate emergency situations. Some buildings, which had not received a stage I inspection, were also added to the consultants lists.

In late 1996 and early 1997 teams of professional engineers and CSA W178.2 certified welding inspectors were deployed to six (6) separate geographic areas of Newfoundland and Labrador. A list of the buildings and consultants for each area is included in the data base in Appendix III.

Originally the inspections were limited to a sample of 30% of the joists, paying particular attention to 30% of the connections towards the ends of the joists, which were considered to be the more highly stressed areas. If a failure was found, the inspection was expanded to 100% of available joints. Through this process as many buildings as possible would receive, at least an initial assessment, as quickly as was reasonable. The definition of failure developed by the Task Force (Minutes of Meeting, January 8th, 1997) is included as Item 2 Appendix I. Also refer to memo dated January 11th, 1997, which is included as Item 3 Appendix I.

Failure was essentially defined as:

1) broken or no weld;
2) buckled top chord; or,
3) bent web member complete with other evidence of failure.

At first the consultants were tagging and identifying failed joints but a decision was made to empower the consultants to hire certified welding firms and then re-weld failed joints when they were discovered.

Through the stages of inspection, the consultants reported considerable statistical information. This information was complied and included in the "Open Web Steel Joist Load Testing and Inspection Program" report, which will be discussed later.

2.3 Problem Definition and Safety

Were the buildings containing Robb Joists safe? Furthermore, what do we mean by "safe"?

2.3.1 National Building Code (NBC)

The Standard most widely accepted for structural safety in Canada is the "National Building Code" (NBC). While the Province of Newfoundland and Labrador has not formally adopted this code, the engineering profession follows it. It is also noted that Government departments require that design and construction to conform to the requirements of the National Building Code of Canada. Quoting from the NBC preface:

The Standard most widely accepted for structural safety in Canada is the "National Building Code" (NBC).

> *"The NBC is essentially a code of minimum regulation for public health, fire safety, and structural sufficiency with respect to the public interest. It establishes a standard of safety for the construction of buildings including extensions or alterations, undergoing a change of occupancy and upgrade of buildings to remove an unacceptable hazard".*

Further NBC states:

> *"...... requirements for workmanship related to aesthetics only are not considered appropriate for the code although requirements for quality and durability that affect health and safety are appropriate".*

> *"...... its primary purpose is the promotion of public safety through the application of appropriate uniform building standards throughout Canada".*

Therefore it is concluded to categorically call a building, "safe", would require the building to be constructed in accordance with the National Building Code of Canada, as a minimum.

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2.3.2 CSA S16, CSA W59 and CSA W47.1

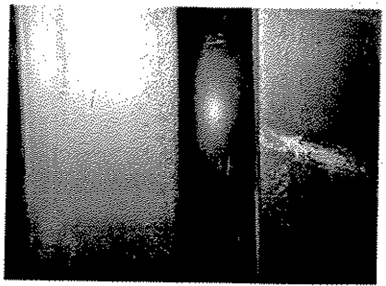
The NBC requires structural member made of structural steel to conform to CSA S16.1, "Limit States Design of Steel Structures" (formally called "Steel Structures for Buildings"). CSA S16.1 requires welding design and practice to conform to CSA W59, "Welded Steel Construction", and that the welding be carried out by a company certified to CSA W47.1, "Certification of Companies for Fusion Welding of Steel Structures".

Essentially, for structural steel units such as OWSJ's to be termed "safe" it should have at least been welded by a company certified to CSA W47.1 who should have followed welding procedures which were approved by the Canadian Welding Bureau (CWB) as the W47.1 Standard administrator. Through the approval process for these procedures, the company should have verified that a competent weld could be produced. The certified company should have then used welders who had current certificates of competency, certifying that they were capable of completing the required weld. This should have been done under the supervision of a welding supervisor who was accepted by CWB as possessing sufficient knowledge and experience as stipulated by CSA W47.1.

Essentially, for structural steel units such as OWSJ's to be termed "safe" it should have at least been welded by a company certified to CSA W47.1 who should have followed welding procedures which were approved by the Canadian Welding Bureau (CWB) as the W47.1 Standard administrator.

The company should also have had a professional engineer responsible for welding design, welding procedures and practices, who was accepted by CWB as possessing the necessary experience and training in accordance with CSA W47.1. An immediate and demonstrable effect of the above is that welding should have met a minimum acceptable level of workmanship as required by CSA W59. For instance Clause 11.5.4.1 "Visual Examination" states:

"......welding should have met a minimum acceptable level of workmanship as required by CSA W59. For instance Clause 11.5.4.1 "Visual Examination" states:"



"All welds shall be visually inspected. A weld subject only to visual inspection shall be acceptable if visual inspection shows:

1. *No surface cracks;*
2. *No visible lack of fusion between welds and base metal;*
3. *No craters;*
4. *Weld profiles in accordance with Clause 5.9;*
5. *That the sum of diameters of visible porosity does not exceed 10 mm in any linear 25 mm length of weld and does not exceed 20 mm in any 300 mm length of weld. Any individual pore shall have a dimension not exceeding 2.5 mm; and,*
6. *Irrespective of length, undercut does not exceed the value shown in Figure 11-4 for the primary stress of direction category applicable to the area containing the undercut. Further, the undercut may be twice the value permitted by Figure 11-4 (for the applicable load category) for an accumulated length of 50 mm in a 300 mm length of weld, but in no case may undercut be greater than 1.6 mm. For weld lengths of less than 300 mm, the permitted accumulated length of undercut shall be proportional to the actual length of weld.*

Essentially, there were two (2) types of weld used to connect the OWSJ round rod web member to the double angle top and bottom chords. These welds were "flare bevel welds" and non-standard welds, which have been termed "puddle welds".

2.3.2.1 Flare Bevel Weld

A flare bevel weld is defined as, a weld in a groove formed by a member with a curved surface in contact with a planar member.

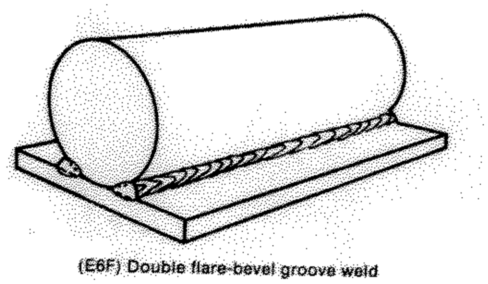
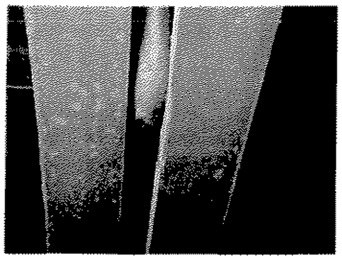


Figure 1: Flare Bevel Weld

Flare bevel welds receive special treatment by CSA W59. Because of the relative size of round solid bars with respect to the weld, the potential exists for rapid cooling which may have a quenching effect and which may in turn, promote cracking. Another issue with flare bevels is the difficulty in measuring a surface that could be confidently related to a structural capacity or effective throat. The effective throat is defined as, the minimum distance from the root of a weld to its face less any reinforcement, as shown in Figure 2 below.



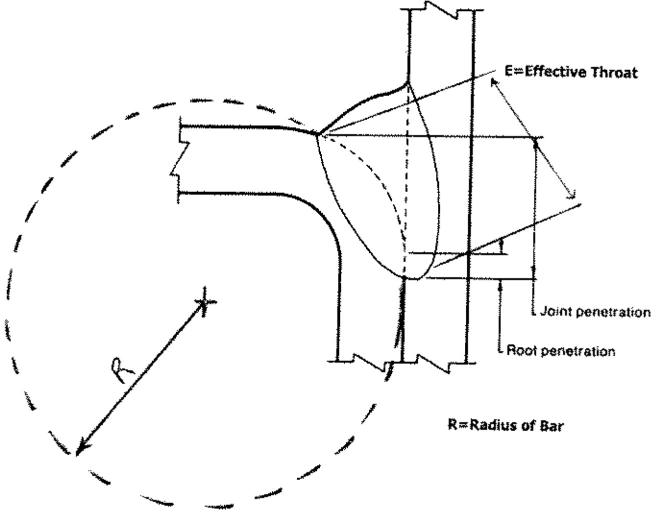
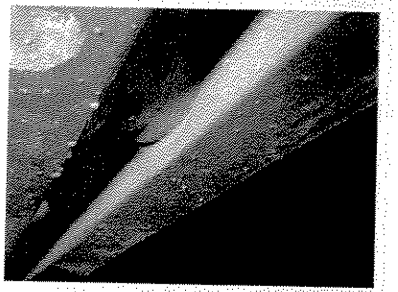


Figure 2: Flare Bevel Weld X-Section

CSA W59 required that the fabricator, through welding procedure qualification, establish the required effective throat for flare bevel welds but that in no case shall the effective throat be less than 0.25 R where R is the radius of the round bar.

2.3.2.2 Puddle Welds



"Puddle Weld" is the term that has been very loosely applied to the weld that Robb used to weld the joint created by two (2) adjacent ends of round rod web members. Robb fabricated their web members using sections mechanically formed in the shape of a "W" or in some cases a "V". Wherever a "V" or "W" met at the top chord a "puddle weld" was created. This is illustrated in the lefthand detail at the bottom of Figure 3 below.

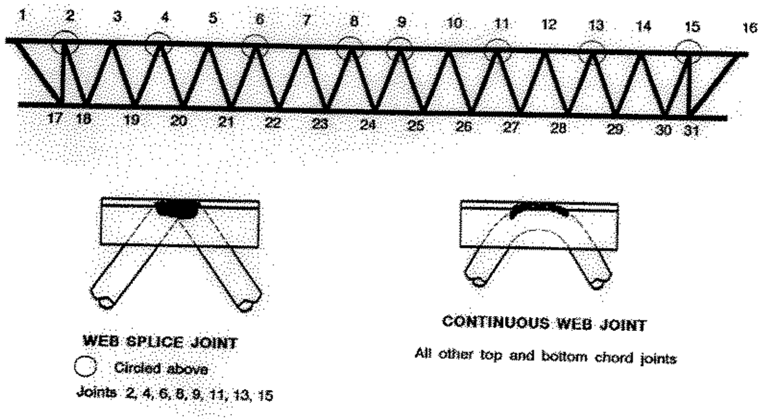


Figure 3: Puddle Weld Location

The fact that the "puddle weld" was not specifically covered by the normal requirements of CSA W47.1 or CSA W59 does not mean that it could not be qualified. But it does mean that the onus was on the fabricator to demonstrate through testing that it could develop a welding procedure that would result in a consistent weld to provide the intended resistance to known stress levels. A separate set of parameters or welding procedure data sheet would be required for each set of variables such as:

- type of base materials;
- thickness limits;
- web rod diameters;
- welding electrode type and size;
- position;
- welding process, etc.

".....the onus was on the fabricator to demonstrate through testing that it could develop a welding procedure that would result in a consistent weld to provide the intended resistance to known stress levels."

For information purposes, a typical welding procedure specification and related data sheets for various joint configurations are included in Appendix IV.

A non-standard welding procedure would also require that each welder demonstrate her/his proficiency with the specific joint, and if successful the candidate would receive a nontransferable identification card. Re-testing would be required at least every two (2) years, or less if there was any doubt as to welders proficiency.

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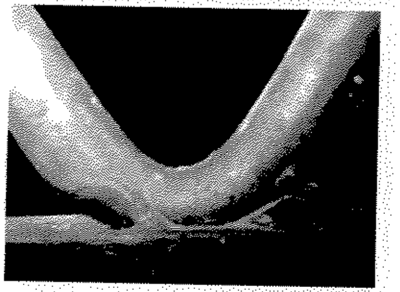
2.3.3 Probability of Weld Failure

Statistically, how many weld failures may be expected in any particular group of joists fabricated in accordance with the National Building Code of Canada?

Structural Standards referenced in NBC are probability based. The graph below presents the probability of failure for hypothetical frequency distribution curves for the effect of loads on a structural element and the load resistance of the same element. If the applied load is higher than the available resistance, i.e. any point within the shaded area, then structural failure will occur.



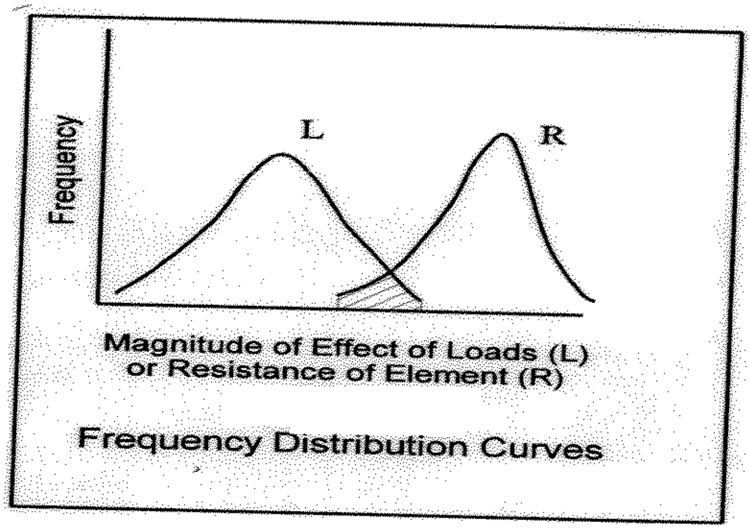


Figure 4: Frequency Distribution Curves

Stated Mathematically, in Section 4 of NBC:

$$\varphi \mathbf{R} \geq \alpha_D \mathbf{D} + \gamma\, \psi(\alpha_L \mathbf{L} + \alpha_W \mathbf{W} + \alpha_T \mathbf{T}) \qquad \text{Eqn. 1}$$

φ = Resistance Factor
R = Nominal Resistance
φR = Factored Resistance

α_D = Dead Load Factor
D = Dead Load

γ = Importance Factor
ψ = Load Combination Factor

α_L = Live Load Factor
L = Live Load

α_W = Wind Load Factor
W = Live Load Due to Wind

α_T = Temperature Load Factor
T = Live Load Due to Temperature Change
(Resistance ≥ Factored Applied Load)

where φ, α, γ and ψ are factors applied to the resistance (R), dead load (D), live load (L) wind load or earthquake (Q) and temperature, settlement or preload (T). These factors are determined in part by the safety index (β). As the safety index is increased the probability of failure is decreased.

From an article published by T.V. Galambos and M.K. Ravindra in the Canadian Journal of Civil Engineering Vol. 4, No. 2, June 1977, the value of (β) for fasteners including welding is taken as 4.5, which compares to 3.0 for structure steel member designs. J.G. MacGregor, in an article in Vol. 3, No. 4, December 1976 equates the above value of (β) to a probability failure equal to 3 x 10^{-6} or 1 in 333,333.

After 20 years the probability of a weld failure reduces to 1 in 16,666. Assuming an average of 26 joints there will be 52 welds which means 1 in 320 joists could have a weld failure. This equates to approximately 0.3% of the joists.

The current CSA S16.1, Limit States Design of Steel Structures is based upon a 1 in 100,000 probability against structural failure according to an article by Dr. D.J.L Kennedy, published in 1974.

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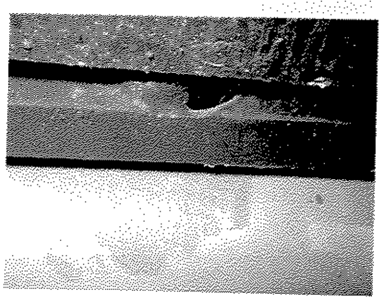
While the above discussion is partially mathematical and partially subjective it at least gives an indication of the order of magnitude of failures that may be encountered, from a statistics perspective. In practice a failure would only occur through human error, material flaws, or over stressing.



2.3.4 Connection Failure v.s. Member Failure

In the current edition of CSA S16, the commentary on Clause 13.13.1 "Welds", states:

"In the resistance expressions, $Ø_w$ is taken as 0.67 so that, as for bolts, the weld has a larger reliability index and reduced probability of failure as compared to the member itself".

This statement is indicative of a philosophy that is fundamental to structural design, which is that members should yield before connections fail in an overload situation. A connection failure can happen suddenly and without warning, and sometimes quickly pass the load it was supporting to an adjacent member thus causing it or its connection to fail, and so on. A member failure, however, will usually yield and stretch, long before collapse, thus providing time for occupants to escape and owners to react.

For resistance expressions associated with member design, $Ø = 0.9$. Therefore, for a properly designed and constructed joist, there should be yielding in members associated with connection failures. For the Robb Joists inspected, member yielding was seldomly detected with the numerous connection failures found. This was very worrisome and indicative of a gross connection problem as opposed to an overload issue.

Buildings with Robb Joists were likely candidates for catastrophic failure.

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Another point worth noting is that without associated evidence of member yielding there should be virtually no connection failures.

2.3.5 Failure Statistics

Connection failures, and bent members were recorded by each consultant and communicated to the Open Web Steel Joist Task Review Board. The information was complied in various statistical formats and presented in the document titles, "OWSJ Load Testing and Inspection Program".

A key statistic was: *"8.3% of all joists inspected has one or more broken welds".*

"......8.3% of all joists inspected had one or more broken welds".

In structural terms, and in the context of safety inherent in NBC, this is a very abnormal number of failures. It is over 27 times greater than the 0.3% discussed in Clause 2.3.3 herein and when it is considered with the fact that there was very little evidence of member yielding, this multiplier could be increased drastically. Another statistic that is very revealing with respect to the adequacy of the connections is: *"0.4 % of all joists inspected had more than five (5) broken welds".*

"...0.4% of all joists inspected had more than five (5) broken welds".

The random location of the failures was another indicator that there was a gross and widespread welding problem with Robb Joists. A characteristic nature of truss-like structural members such as open web steel joists, is that the stress on joints, when uniformly loaded, is the highest at each end and theoretically the lowest at the center of the joist. Given that the amount of welding did not consistently vary with location in the joist, it would be expected that the incidence of connection failure would increase proportionately with distance from the center of the joist span. A review of the following charts taken from the report, "OWSJ Load Test and Inspection Program", reveals that the failures were very random in nature. It should be noted that the spike at the centre of the charts represents more than one (1) joint. The random location of the weld failures without evidence of member yielding, was very conclusive evidence that Robb Joists had an inherent connection/welding deficiency. See Figure 5 below.

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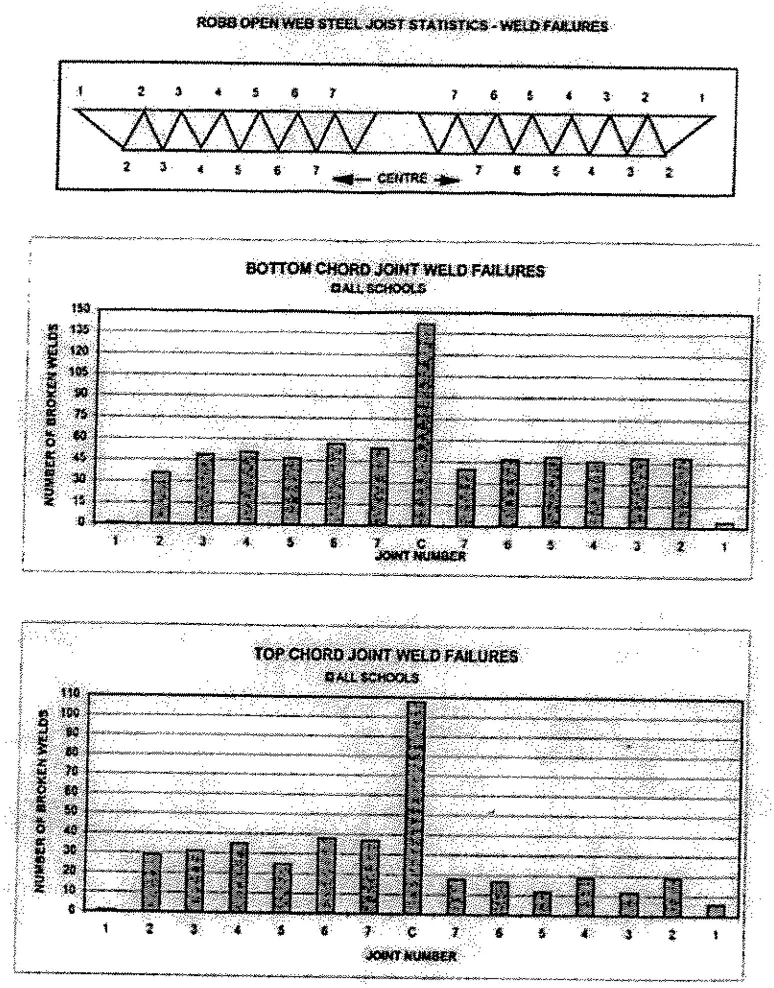
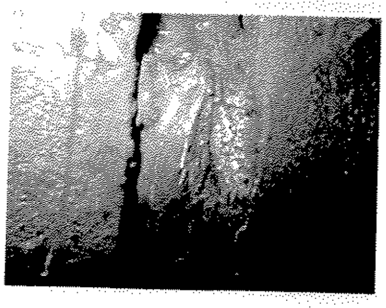


Figure 5: Weld Failure Charts

2.3.6 Review of Facts



1. Two (2) buildings containing Robb Joists partially collapsed, in the St. John's Area, between 1987 and 1995.

2. It was the opinion of a number of professional engineers that the primary reason for these collapses was faulty welding of the open web steel joist connections.

3. In August of 1996, APEGN issued a general warning regarding Robb Open Web Steel Joists.

4. Structural safety is defined by the National Building Code of Canada, which requires that welding be carried out in accordance with CSA 59 by a fabricator certified to CSA W47.1, Division 1 or 2.

5. Robb Engineering Division, Dominion Bridge Company Limited, the open web steel joist fabricator, was certified to CSA W47.1 (formally CSA W47).

6. Certification to CSA W47.1 requires that welding procedures be developed for each type of joint etc. to prove that following a specific set of parameters will result in a sound weld in accordance with the requirements of CSA W59. It also requires that welding be carried out by welders that have a "proven level of competence" for these specific parameters.

7. The type of welds used to fabricate Robb Joists required special attention, stipulated by CSA W47.1 and CSA W59. This is particularly true of the so called "Puddle Weld" which is a non-standard weld.

8. To the best of our knowledge Robb did not have CWB approved procedures, nor specifically approved welders for their open web steel joists.

9. The probability of failure for a properly welded joist fabricated in accordance with NBC and its referenced standards is estimated to be less than 0.3% for an average joist 20 years old containing an average of 26 joints.

10. CSA S16.1 is based upon a 1:100,000 probability against structural failure.

11. Canadian Standards are based upon the philosophy that members should yield before connections fail, in an overload situation.

12. 8.3% of all Robb Joists inspected had one (1) or more broken welds.

13. **0.4% of all Robb Joists inspected had more than five (5) broken welds.**

14. **Failed welds were located randomly throughout the joists and were not usually associated with member yielding.**

15. **Connection failure can lead to catastrophic collapses.**

Therefore, "Were the buildings containing Robb Joists safe?"

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The Answer:

In our opinion the answer was clear, that they were not safe. The welding quality was well below the caliber expected by the National Building Code. This was confirmed not only by the inspection reports on approximately 7,000 joists that were inspected and reported on by a certified CSA W178.2 welding inspector, but also by the fact that two (2) partial collapses has already occurred and that in excess of 700 failed welds had been found.

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2.4 Phase I Open Web Steel Joist Testing Program

The "Open Web Steel Joist Investigation and Testing Program" was developed to provide additional information about Robb Joists. It was never meant to be the sole process upon which decisions were made. First of all there was no need to prove that Robb Joists were not safe, two (2) collapses, and 700 weld failures had already established that fact. Furthermore, the author had coordinated and witnessed the testing of five (5) Robb Joists shortly after the St. John's mall collapse wherein five (5) joists were tested and two (2) failed.

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As stated in the "Final Report" dated September 1997:

"3.5.1 Phase I:

The purpose of the Phase I tests was:

1. *gather information respecting the capacity of existing joists in their current (near existing) condition;*
2. *to determine if any level of confidence can be placed in the identified open web steel joists as total units; and,*
3. *to determine the effects of various connection imperfections to the joist unit including "puddle" weld.*

The joist testing program was carried out to help minimize costs. As explained in Clause 3.1 of the Final Report.

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"The challenge was to determine the minimum reasonable level of remediation or repair that must be performed in order to have confidence that the structures meet the intention of current codes and standards with respect to strength, stability, integrity and safety."

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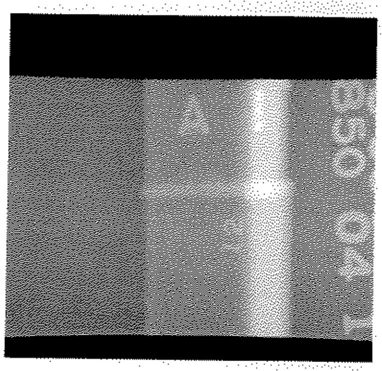
As explained in the "Final Report" 6 of the joists for testing were obtained from Holy Cross School, Ricketts Road, St. John's and 16 joists were obtained from the collapsed section of the St. John's Mall (1987 Collapse). These joists were inspected to ensure there were no failed joints or other major defects, and where necessary, they were repaired. Therefore at the Phase I testing stage, the joists were similar to a situation where a building had received its Phase II inspection by the consultant/inspector and repairs completed, with one (1) fundamental difference, all joints were available for inspection. In the field top chord joints did not have ready access because of metal deck, or the worse case, wood deck, and therefore inspection was difficult or impossible in some cases.



The six (6) Holy Cross School joists which were considered to be of better quality then the average joist seen in the field, generally accepted the loads for both member and connection design. This was good news as it suggested that if Robb Joists were truly 100% inspected, including top chord joints, found to be reasonably welded, and had failed joints and members repaired, some level of confidence could be placed in their ability to meet the intent of the National Building Code. It was also interesting to note that despite some very irregular macro sections (pictures of sliced internal surfaces) the puddle welds reacted favorably during testing.

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Ten (10) of the joists which had been obtained from the collapsed section of the St. John's shopping mall and which had been 100% inspected and repaired, reacted well, up to the load for member design. One (1) of the shorter span joists (9.8 m) failed just above the load required for member design but well below the load required for connection design. All three (3) of the longer span joists failed at loads above member design but below that required for connection design.

Once again some level of confidence was gained provided joists were fully inspected and major defects repaired. The failure of all three (3) longer span joists below connection design loads implied that the structural integrity of the joists decreased with an increase in length. Furthermore, to the structural engineer, connection failure is considered a serious matter due to its link with catastrophic failure, or progressive collapse.

The failure of all three (3) larger span joists below connection design loads implied that the structural integrity of the joists decreased with an increase in length. Furthermore, to the structural engineer, connection failure is considered a serious matter due to its link with catastrophic failure, or progressive collapse

It is pointed out that the "Open Web Steel Joist Load Testing and Inspection Program" was information that was compiled to assist the professional engineers who were responsible for the remediation of Robb Joists and the protection of the public, to exercise "engineering judgement".

It was noted by most of the engineers responsible for the stage II inspections that quite often, for no apparent reason, failures would occur in pods. Fifty (50) consecutive joists may have been inspected with no failures and then the next six (6) adjacent joists many all have cracked welds. Sometimes, welds that were more visually acceptable than others were the ones that failed, in may instances the failures occurred in the least stressed areas of the joists.

What were the variables that initiated the actual failure? It is of little doubt that the poor welding practices of Robb Engineering was the main cause or else there would have been problems with joists fabricated by all other joist manufacturers. But what causes one weld to fail versus another, next to it?

It is of little doubt that the poor welding practices of Robb Engineering was the main cause or else there would have been problems with joists fabricated by all other joist manufactures.

In order to answer this question numerous variables would have to be isolated:

- welder capability;
- material thickness;
- heat input;
- electrode diameter;
- electrode storage conditions
- material strengths;
- type of electrode;
- shop conditions;
- joint configuration;
- stress level;
- transportation and handling;
- erection practices;
- eccentricity;
- length of weld;
- size of weld;
- span of joist;
- depth of joist;
- deck attachment;
- bridging spacing

and so on. Considering the number of welds, it would have been functionally impossible to determine whether or not any single weld of the hundreds of thousands of Robb welds, was adequate or not. The testing program was another piece of the information puzzle, albeit an important piece.

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At this point there were various options before the engineers responsible for public safety, such as:

- **Repair cracked joints and failed members without knowing the exact reason the cracks occurred at one location versus another, and whether other cracks will develop in the future.**

- **Remediate all connections on the basis of the lack of confidence in Robb Joists.**

- **Treat the joist as a unit and develop a rational approach to meet the intent of the National Building Code of Canada considering Commentary K.**

3.0 RESOLUTION OF SAFETY ISSUES

Prior to the appointment of the OWSJ Task Review Board, two buildings which had significant collapses were remediated. In one case, the engineer involved designed a very extensive remediation system, where many joists had 100 % of the welds rewelded or made redundant.

In the other case there were a number of separate engineering consultants involved in the remediation program. In the absence of a detailed testing program, the consensus was reached and philosophy adopted to repair all cracked welds and bent members, and then to remediate each joint of all joists starting from the ends of the joist and then proceeding toward the center of the joist to a point where the shear stress in the joint was less than or equal to 50% of the maximum shear stress. The remediation consisted of adding new steel plates at the connection and then rewelding or else installing new web members.

The question to be resolved was:

"Following the extensive OWSJ Testing and Inspection Program, and considering the remediation carried out to that point, what would be a reasonable remediation program that would give due consideration to safety, as well as cost?"

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3.1 NBC Commentary K

To assist in the evaluation of structures containing Robb Joists reference was made to structural Commentary K of NBC, titled " Applications of NBC Part 4 for the Structural Evaluations and Upgrading of Existing Buildings." A discussion paper was included in Appendix II of the OWSJ Load Testing and Inspection Program final report, and is also included here in Appendix V.

Commentary K states that safety is the first and foremost consideration and that current codes and standards should be followed. The commentary also makes the point, structural evaluation and field review are necessary for the professional engineer to exercise his engineering judgement. It also states that in order for an evaluation to be based upon past performance there must be no evidence of significant damage, distress, or deteriorations and furthermore the building must have satisfactorily performed for 30 years or more.

The steps taken by the Open Web Steel Joist Task Review Board in inspection and testing were consistent with Commentary K. This was also confirmed with the National Research Council of Canada during discussion held in Ottawa in 1997.

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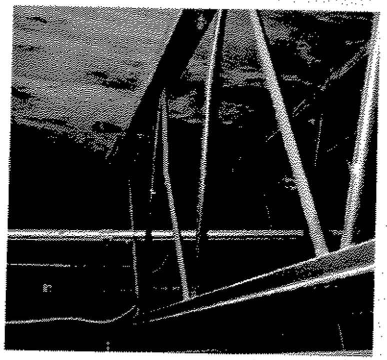
3.2 Recommended Minimum Remediation



Subsequent to the Phase I OWSJ load testing program but before Phase II a group of structural engineers assembled who were members of the OWSJ Task Review Board or else had specific experience with Robb Joist failures. These engineers included:

Gary Follett,	P. Eng.	*fga* Consulting Engineers Ltd.
Ken Tobin,	P. Eng.	*fga* Consulting Engineers Ltd.
Dave Burt,	P. Eng.	Structural Consultants Ltd.
L. Short,	P. Eng.	Structural Consultants Ltd.

At that point in time these engineers were intimately knowledgeable of the Robb joist issues, having inspected thousands of joists, remediated buildings, developed the OWSJ load testing program and participated as a consultant or a member of the Task Review Board.

Relying on their experience, the Phase I results of the OWSJ load testing program and the inspection reports from the various consultants, a preliminary four level remediation program was developed, the final version of which is included in Appendix VI.

3.2.1 Level I

Level I was the most extensive remediation, and was applicable to joists.

1. With a span exceeding 30', or
2. In a snow build-up area, or
3. In an area with excessive failures, or
4. That has more than two failed joints

To these joists it was suggested that the engineer:

1. Carry out structural analysis and then upgrade to CSA S16.1.
2. Install top chord spacers as required by S16.1-94 but a minimum of 4 mid panel locations.
3. Reinforce members/panel points on each end of the joists until the resulting shear force ≤50% of end value (i.e. 50% of the maximum).

Thirty (30) feet was chosen as an intermediate length between short span and longer span joists. It was agreed that, in general, observed conditions were worse with the longer span joists. Furthermore both collapses that occurred in St. John's included spans longer than 30', and finally the longer span joists in the load testing program did not react as well as the shorter span joists.

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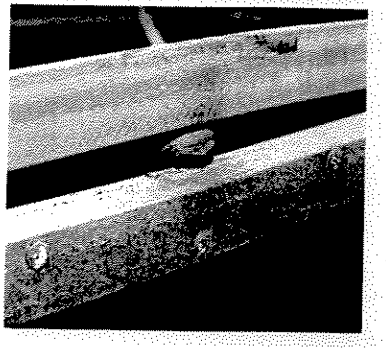
The decision to install four (4) top chords spacers at mid joist locations as a minimum, was not done to reflect a deficiency in member design. It was because of the lack of confidence in the welds to provide lateral support to the top chords at the mid span, where bending related compressive forces on the chords are normally the greatest.

Also because of the difficulty of inspecting the top chord due to the over lying metal or wood deck, the chances of missing a cracked weld were certainly significantly greater. From a lateral stability point of view the capacity of a chord member is drastically reduced if it is not supported with a dependable weld, at the connection.



The philosophy behind reinforcing panel points on each end of the joist to a point where the resultant shear force is ≤50% of the end diagonal shear value was an attempt to reinstate the structural safety level inherent in the National Building code. The maximum shear force that a weld has to transfer from a web member to a chord and vice versa, normally occurs at the end diagonals. These shear forces decrease to near zero at the mid spans of the joist. Because there was no apparent difference in the amount of weld seen by the various engineers and inspectors at a typical end panel point versus at a typical other panel point, reinforcing the welds up to the 50% of maximum shear is somewhat equivalent to reinstating a two times safety factor. This is similar to the "Implied factor of safety" for connection design of 2.14 as determined in Clause 3.2 of the "Load Testing and Inspection Program-Final Report"

3.2.2 Level II, III and IV

The Level I remediation was the basic remediation scheme and philosophy that was recommended. Level II and III were both derivatives of Level I with reduced requirements for shorter spans and lighter loads. Level IV addressed a special case for roofs that were designed for a snow load of 0.6 times ground snow load versus the more conservative and more commonly used 0.8 times ground snow load.

Finally for floor joists, recognition was given to the fact that live loads were more controllable, joist spacing was usually smaller and the deck and floor system were more capable of providing lateral support.

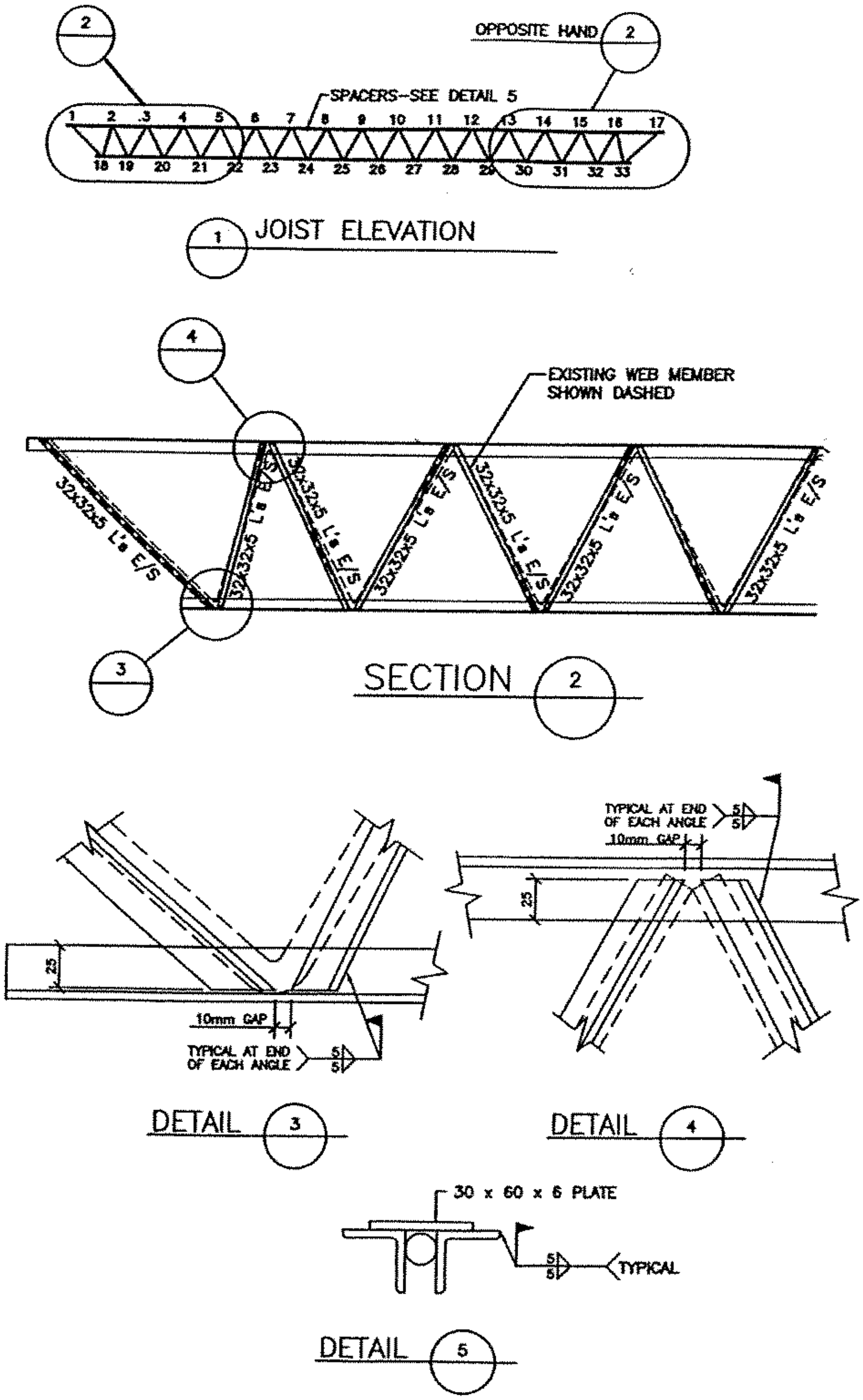
3.3 Phase II Open Web Steel Joist Testing Program

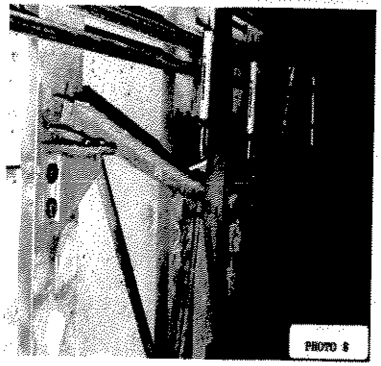
The purpose of the Phase II testing was to model the level I and II remediation schemes to determine their effectiveness and as well the sensitivity of the remediated joists to undetected cracks.

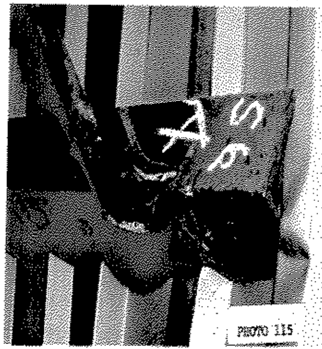
3.3.1 Level I Remediation Test

Prior to remediation, the welding was subjected to a visual examination and major deficiencies corrected. The web diagonals and their connections were then remediated by adding steel angles on each side of the web members and were welded to the top and bottom chords, to the 50% shear point previously discussed and as indicated in Figure 6 on the next page. Spacers were also welded to the top chords about the joist mid span point.

Figure 6: Typical Level 1 Remediation







The factored loads were then applied for member design and then connection design. These forces were then relaxed, a crack was induced in the top chord and the procedure repeated. The procedure was then repeated again and again, until a failure occurred. The above testing program is explained more thoroughly in the "OWSJ Load Testing and Inspection Program - Final Report".

The shorter span Holy Cross School joists reacted very favorably. One joist did not fail until after four induced cracks and the second joist, after six induced cracks. The two longer span shopping mall joists both failed after the second induced crack.

Therefore, the above testing was considered to have supported the proposed Level I Remediation Scheme. There was some indication that the longer span joists were more sensitive to top chord bending, however, other variables such as weld quality would have to have been considered before this could be conclusively stated.

3.3.2 Level II Remediation Test (Test IIB)

Similar to the Level I Remediation Test, the joists were first inspected and major deficiencies corrected. The web diagonals and their connections were remediated to the second bottom chord panel point, as indicated in Figure 7 on the next page. The loads were applied in the same manner as described in the previous Load I test.

The remediated joists once again reacted favourably. The two shorter span Holy Cross joists only failed after the third induced crack in one case, and the second induced crack in the other.

The longer span shopping mall joists reacted even more favourably with failure after the second induced crack and forth induced crack.

Once again, this test was considered to have supported the Level II Remediation Scheme.

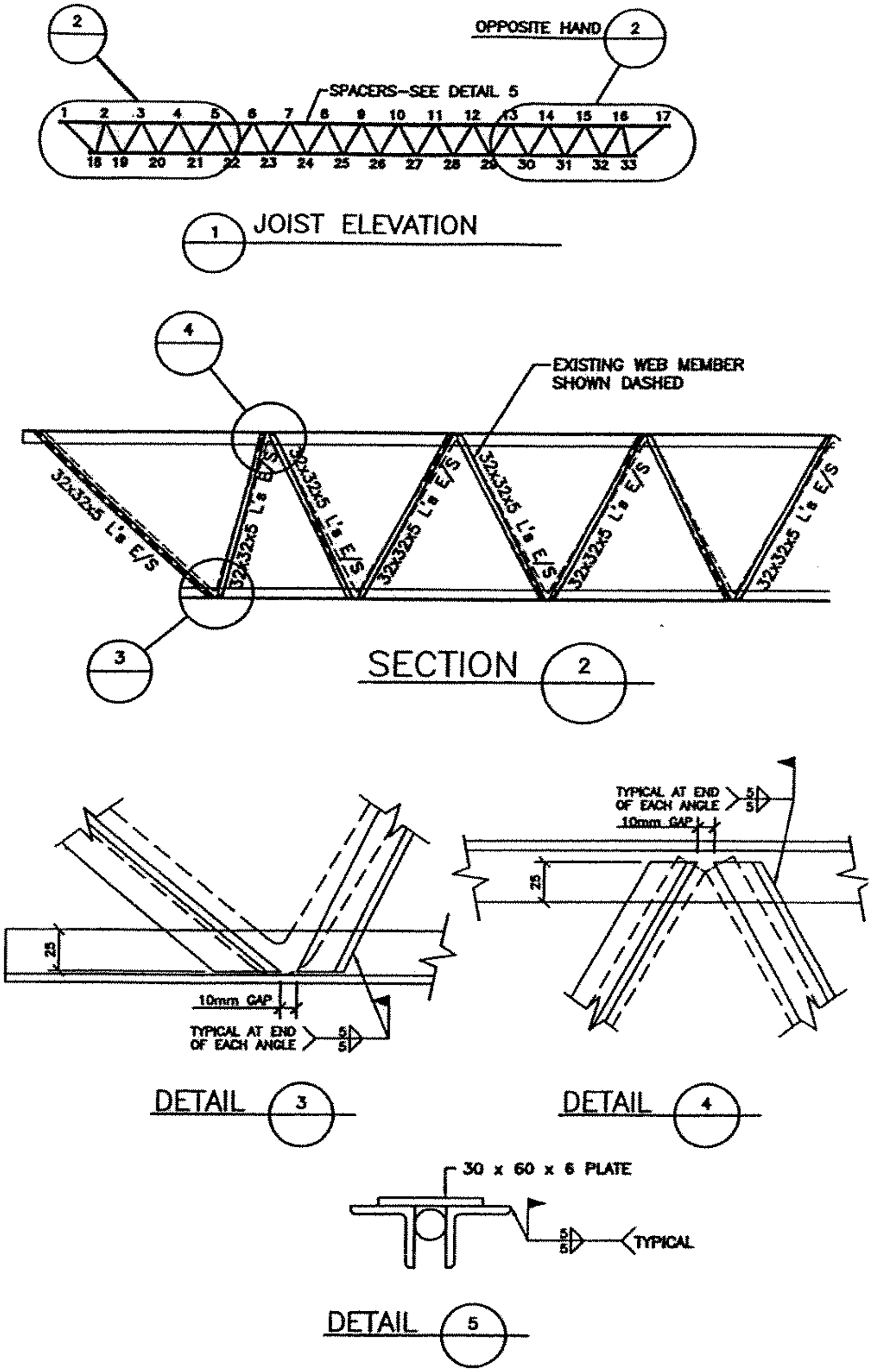
3.3.3 Level IIA Remediation Test (Test IIC)

Following a thorough inspection and remediation of major deficiencies, spacers were welded to the top chord of four joists which were then loaded in a similar manner to the previous test for Levels I and II.

After one crack was induced, all joists failed above the loads for member design, but below the loads for connection design.

Considering these joists were 9.6m (31.5 ft), this series of tests provided some confidence that shorter span joists could still support loads in excess of the loads for member design even with an undetected top chord crack.

Figure 7: Level II Remediation



3.3.4 Test Program Summary

Following the Phase I Testing, three options were basically considered which represent:

1. The minimum amount of work, i.e. repair cracked joints and failed members.
2. The maximum amount of work, i.e. remediate all connections.
3. The moderate level of work, i.e. a rational approach to meet the safety intent of the National Building Code of Canada.

It is believed that "The suggested Minimum Criteria for Roof Joist Remediation" (refer to Appendix VI) represents the moderate level, while still providing the necessary protection to the public and a level of safety that is commensurate with the intent of the NBC.

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3.4 The Consultants Professional Responsibility

The Code of Ethics for the Professional Engineers says:

1. A professional engineer or geoscientist shall recognize that professional ethics are founded upon integrity, competence and devotion to service and to the advancement of human welfare. This concept shall guide the conduct of the professional engineer or geoscientist at all times.

A professional engineer or geoscientist shall:

2. have proper regard in all his or her work for the safety, health and welfare of the public;
3. endeavor to extend public understanding of engineering and geoscience and their role in society;
4. where his or her professional knowledge may benefit the public, seek opportunities to serve in public affairs;
5. not be associated with enterprises contrary to the public interest;
6. undertake only such work as he or she is competent to perform by virtue of his or her education, training and experience;
7. sign and seal only such plans, documents or work as he or she has personally prepared or which have been prepared or carried out under his and her direct professional supervision;
8. express opinions on engineering or geoscientific matters only on the basis of adequate knowledge and honest conviction.

The five (5) professional engineering consultants were basically being asked by the Province to design a remediation system that would allow them to certify that the buildings they caused to be remediated were safe for public use. Such decisions cannot be made lightly or flippantly. It is other people's health, safety and lives that are at stake.

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After having spent the better part of five months crawling around the ceiling space of numerous schools and public buildings, the consultants were all assembled in a joint meeting with the Open Web Steel Joist Task Review Board and the Regional Managers of the Department of Works, Services and Transportation. This meeting was an opportunity to compare notes and exchange views. A summary of the extent and significance of connection and member failure was discussed and as well, a detailed presentation of the results of the OWSJ Testing Program was delivered.

The Task Force provided the "Suggested Minimum Criteria for Roof and Floor Joist Remediation" to the consultants. However, it was made clear that the remediation scenarios were suggested only, and that it was up to each consultant to satisfy themselves that the level of remediation for their respective projects was adequate. Each consultant would have to accept full professional responsibility for their projects.

The "Suggest Minimum Criteria for Roof and Floor Joist Remediation", included herewith in Appendix VI, was reviewed and accepted by the five (5) consultants hired by the Province of Newfoundland, as well as the other Professional Engineers involved in the remediation process, as the appropriate basis upon which to upgrade the affected buildings to the level of safety intended by the National Building Code.

3.5 A Typical Remediation Program

Jackson Walsh Elementary School in Western Bay has been arbitrarily chosen from these schools that were inspected and remediated under the direction of *fga* Consulting Engineers Limited as a typical example of a remediated school. It is pointed out that this example represents one (1) consultant's interpretation and that other consultant's remediation scheme may vary accordingly.

3.5.1 School Description

Jackson Walsh is a 2045 m^2 single-storey school, constructed with open web steel joists on bearing walls. The joists support a corrugated metal deck and flat roof system. The building was constructed around 1972.

3.5.2 Stage I Identification

The Stage I Inspection was carried out by E.K. Jerrett and Associates in the Fall of 1996. It verified that the joists were supplied by Robb Engineering of Amherst, Nova Scotia under project number 4828.

3.5.3 Stage II Inspection

In early January 1997, ***fga*** completed the Stage II detailed inspection of all joists. The results of the Phase II Inspection are compiled in a report completed March 31, 1997 titled "Phase II Inspection of Open Web Steel Joists Jackson Walsh Elementary, Western Bay". A copy of the report is appended herewith in Appendix VII. Of the 153 joists in the building a total of six (6) joints had partially or completely failed and three (3) web members were recorded as being bent. It was also noted that weld characteristics were consistent with Robb joists of other inspected buildings, i.e. slag had not been removed in many cases, undercut was prevalent and puddle welds were observed at alternate top chord joints.

3.5.4 Stage II Remediation

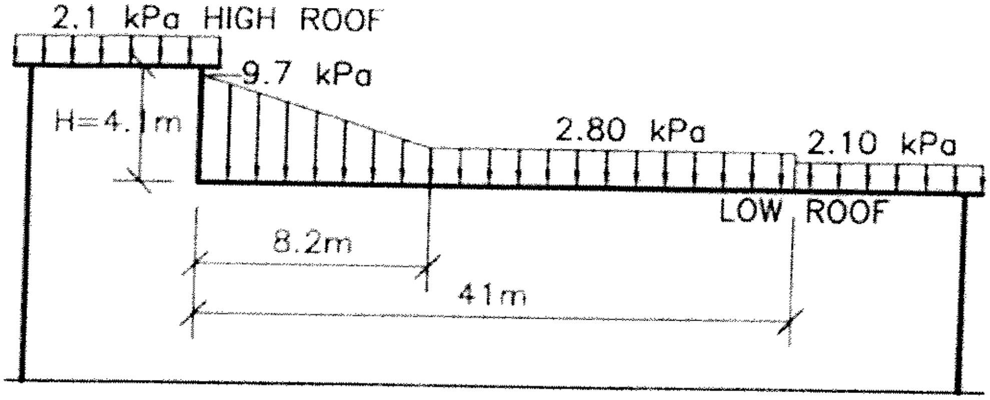
In May of 1997 a tender package was developed which included, amongst other buildings, Jackson Walsh Elementary. The drawings for the Jackson Walsh tender are included in Appendix VIII, and include the following:

1.	Drawing No. S22	Roof Framing Plan
2.	Drawing No. S23	Architectural Plan
3.	Drawing No. S24	Partial Roof Framing Plan
4.	Drawing No. S25	Joist Remediation Diagrams
5.	Drawing No. S26	Joist Remediation Details
6.	Drawing No. S27	Joist Remediation Details

The portion of the school shown on Drawing No. S22 is actually an extension to the existing school. The junction between the extension and existing building, forms a high/low roof, with the extension being the lower roof. It is a requirement of the National Building Code (NBC) that design snow loads account for the drifting that occurs on the low roof, of a high/low roof location. Depending on the height differential between roofs, this can result in design snow loads, four (4) to five (5) times greater that the basic design snow load.

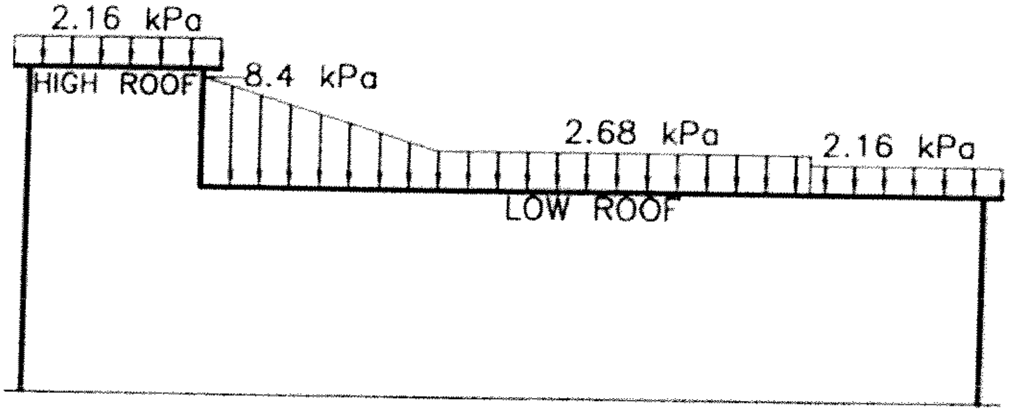
In the 1970's when this school extension was constructed, the basic design snow load coefficient was 0.8. Therefore, for a typical flat roof without parapets or penthouses etc. the design snow load would be 0.8 times the ground snow load. The closest place to Western Bay where meteorological information is available is St. John's. In the 1970 NBC the ground snow load was 72 PSF or 3.5 kPa which would result in a design snow load of (3.5) (0.8) = 2.8 kPa. For roofs that were completely exposed to wind, snow load could be reduced by a further 25% to 2.1 kPa, or 0.6 times the ground snow load. The reduction for an exposed roof could not be used for a distance from a high low roof junction equal to 10 times the roof height differential, when determining loads for the lower roof. The above can be shown schematically for Jackson Walsh School which has a roof height differential of 4.1m, as indicated in Figure 8 on the next page.

Figure 8: Jackson Walsh Snow Load Diagram Based on 1970 NBC



Using the requirements of the 1995 NBC the above diagram would be slightly different as indicated in Figure 9 below.

Figure 9: Jackson Walsh Snow Load Diagram Based on 1995 NBC



As can be seen on Drawing S22 in Appendix VIII, for the remediation program the designer chose to use the 1995 NBC to determine snow loads. The choice of the 1995 NBC as opposed to the 1970 NBC had very little effect on cost because the differences in load is relatively small. Furthermore, while the maximum drift load is higher for the 1995 Code (9.7 kPa v.s. 8.4 kPa) the evenly distributed loads are lower (2.68 kPa v.s. 2.8 kPa) in one area for the 1995 NBC, and only slightly higher (2.16 kPa v.s. 2.10 kPa) in other areas.

3.5.4.1 Designer's Interpretation of Remediation Requirements

Through discussion with the designer, following a review of the Phase III Contract Documents, the following is a comparative review of the "Suggested Minimum Criteria for Roof Joist Remediation" as recommended by the "OWSJ" Task Review Board", versus the designer's requirements.

The engineer chose Joist J-99 (refer to Drawing S22 in Appendix VIII) to carry out a design review, based on the original design load. The analysis verified that the member sizes, ie. the chord and web members were properly designed. This was consistent with his findings for other schools. Because of the many varying conditions and because there was no practical way to measure the welds, no attempt was made to check weld design.

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Because of the heavy snow load at the high/low roof location, the engineer was suspicious about the capacity of the metal deck which spanned from joist to joist. His suspicions were well founded, as upon a design review the spacing between joists proved to be too long for the particular gauge of metal deck. This required that intermediate members be installed in the areas of heavier snow load. Steel channel was used as indicated on Drawing S24 (Appendix VIII) and in Sections 1 and 2 on Drawing S27 (Appendix VIII).

For remediation purposes, the joists were separated into three (3) types as indicated on Drawing S25 (Appendix VIII).

Joists J1 to J8:

The span was greater than 9.12m (30 ft) plus the joists were in a snow build-up area therefore the engineer chose a Level I remediation (Refer to Appendix VI) which required a minimum of four (4) top chord spacers distributed about the joist centerline as well as the reinforcement of connections on each end of the joist, to a point where the resultant shear in the connection is equal to or less that 50% of the shear in the joists end connection. The remediation of Joist J1 to J8 is indicated on the top of Drawing S25 (Appendix VIII). The vertical web members shown therein were required to connect the additional steel channels in the high snow build-up areas previously discussed. Because channel supports were only required on one (1) end of Joists J3 to J8, two (2) additional vertical web members per joist (12 total) are indicated on the Drawings in error.

The span was greater than 9.12m (30 ft) plus the joists were in a snow build-up area therefore the engineer chose a Level I remediation (Refer to Appendix VI) which required a minimum of four (4) top chord spacers distributed about the joist centerline as well as the reinforcement of connections on each end of the joist, to a point where the resultant shear in the connection is equal to or less that 50% of the shear in the joists end connection.

Joist J10 to J37; J69 to J105; J130 to J155:

The span for these joists was less than 9.12m (30ft) and the spacing greater than 5; therefore the engineer chose a Level II remediation (refer to Appendix II) wherein he included the top chord spacers similar to the Level I remediation. The reinforcement of connections on each end of the joists was reduced to reinforcing web members to the second bottom chord panel point. The remediation of these joists is indicated on the centre joist shown on Drawing S25 (Appendix VIII). As can be seen on Drawings S22 (Appendix VIII) many of the joists in this roof were designed using a 0.6 snow load factor (2.16 kn/m^2) and therefore the designer had the option of upgrading the joists to 0.8 snow load factor (2.68 kn/m^2)., as stipulated by the Level IV category of the suggested Remediation Program. In his opinion, however, the level of deterioration did not warrant upgrading these joists, consequently they were treated as Level II for remediation purposes.

The span for these joists was less than 9.12m (30ft) and the spacing greater than 5; therefore the engineer chose a Level II remediation (refer to Appendix II) wherein he included the top chord spacers similar to the Level I remediation.

Joist J64 to J68:

The span of these joists was less that 9.12m (30 ft) and the spacing greater than 5', but the joists were in a snow build-up area, therefore the engineer chose a Level I remediation (refer to Appendix VI). He also reported that the snow build-up was not indicated on the original design drawings and therefore carried out a design check for these joists. The design check verified that the joists were under-designed for the heavier snow loads and therefore additional reinforcement of the top and bottom chord was necessary. Extra rods and plates were added to the top and bottom chords respectively as indicated in details "E" and "G" on Drawing S26 (Appendix VIII). Vertical web members were added to Joists J64 and J65 to support the additional steel channel as previously discussed. The remediation of these joists is indicated on the bottom joist shown on Drawing S25 (Appendix VIII).

The span of these joists was less that 9.12m (30 ft) and the spacing greater than 5', but the joists were in a snow build-up area, therefore the engineer chose a Level I remediation (refer to Appendix VI). He also reported that the snow build-up was not indicated on the original design drawings and therefore carried out a design check for these joists. The design check verified that the joists were under-designed for the heavier snow loads and therefore additional reinforcement of the top and bottom chord was necessary.

Joist J38 to J63; J106 to J128:

These joists all have short spans of approximately 3.05m (10ft) and are therefore included in the Level III remediation category (refer to Appendix VI). This category requires inspection and repair only. The only exception are Joists J38 to J41 which are in a high snow build-up area. The designer elected to split the deck span for these joists by installing new channels (refer to Drawing S24) and thereby decreasing the load by 50% on each of these joists.

These joists all have short spans of approximately 3.05m (10ft) and are therefore included in the Level III remediation category (refer to Appendix VI). This category requires inspection and repair only.

In general the design engineer followed the recommendations of the Open Web Steel Joist Task Review Board's Suggested Remediation. Some additional work was required because the original design and construction did not adequately address the snow build-up condition for the low roof, where they joined the higher wing of the building.

3.6 Cost of Remediation

3.6.1 Introduction

The total cost to correct the Robb Open Web Steel Joist deficiency was composed of five (5) main components.

3.6.1.1 Phase I: Identification

The identification stage consisted of the internal review of drawings and contract documents, as well as site visits to schools and other Government Buildings around the Province. The Province of Newfoundland and Labrador used a combination of own forces, school and hospital board personnel and engineering consultants, to complete this task.

3.6.1.2 Phase II: Inspection and Emergency Repair

The Province invited a number of consultants, who were considered to have appropriate credentials and experience, to respond to a request for proposal (RFP).

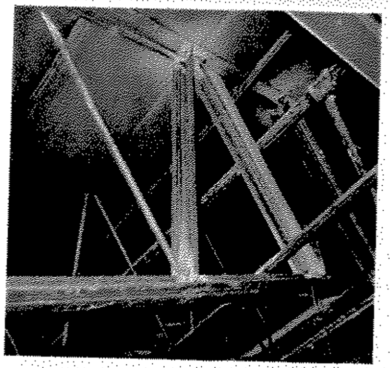
The Province invited a number of consultants, who were considered to have appropriate credentials and experience, to respond to a request for proposal (RFP). The RFP's were divided accordingly to geographic locations. As previously described, the inspection started out as a sample consisting of 30% of the joints of 30% of the joists, but soon grew to a 100% inspection of all available joints, due to the number of failed welds that were found. Also included in this component was the repair of failed joints and other emergency repairs. While the Province and school boards had administrative costs, the bulk of this work was sub-contracted to professional engineering consultants, who were empowered to hire contractors for welding etc, where emergency repairs were deemed necessary.

During this stage buildings containing Robb Joists were upgraded to meet the intent of the National Building Code.

3.6.1.3 Phase III: Remediation

During this stage Robb Joists were upgraded to meet the intent of the National Building Code. Buildings were grouped based on seven (7) geographical areas, which were then further sub-divided into manageable contract sizes.

The Province effectively acted as the manager for each area to oversee the project. Each consultant that had been appointed for the Phase II Inspection was reappointed to design a solution for which she/he could accept responsibility and then to prepare contract documents. Tenders were then called with the contracts being administrated by the applicable professional engineering consultant. In some cases emergency repairs were carried under Phase III as opposed to Phase II.



3.6.1.4 Open Web Steel Joist Load Testing Program:

This program was contracted to the Engineering Department at Memorial University. *fga* Consulting Engineers Limited and Structural Consultants developed and managed the project on behalf of the OWSJ Task Review Board. A final report was developed which was expanded to include the definition and background of the Robb Open Web Steel Joist problem, the failure statistical information from the Phase II Inspection, as well as the OWSJ Load Testing and Inspection Program description and results.

The final report was titled "Open Web Steel Joist Load Testing and Inspection Program" dated September 1997.

3.6.1.5 OWSJ Task Review Board:

This board acted on behalf of the Province in overseeing the total project. It met regularly during peak project activity and provided, expertise, direction, opinion and guidance to all parties involved. As previously stated it consisted of professional engineers from the Province, APEGN and independent consulting firms.

3.6.2 Project Cost and Estimates

3.6.2.1 Phase I and II Cost

The bulk of the cost for Phase I Identification were internal costs, although some consultants were hired as well. For Phase II Inspection and Emergency Repair, Consultants were contracted to assist in this effort. The costs associated with Phase I and Phase II are summarized in Table I, herein. The information was gained through discussion with the Province of Newfoundland. Confirmation through timesheets, expense accounts, receipts, etc. can be provided when required. The final cost for the Phase I was $38,116.59 and for Phase II it was $1,153,619.07.

3.6.2.2 Phase III Cost

The Open Web Steel Joist Task Review Board completed an initial preliminary estimate of cost of remediation. This preliminary estimate was based on the total number of joists in the affected buildings.

Following Phase I identification, and in most cases Phase II inspection, each consultant was asked to estimate the cost of Phase III remediation. At this stage the consultants had spent considerable time in each school consequently these estimates should be more accurate than the preliminary version.

The purpose of these estimates was to help ensure that construction costs were controlled as much as possible through comparative analysis. Each consultant was requested to complete the following "Construction Cost Estimate Form" for each building requiring remediation.

Following Phase I identification, and in most cases Phase II inspection, each consultant was asked to estimate the cost of Phase III remediation. At this stage the consultants had spent considerable time in each school consequently these estimates should be more accurate than the preliminary version.

The purpose of these estimates were to help ensure that construction costs were controlled as much as possible through comparative analysis.

Phase III represents the majority of the actual remediation. In order to obtain the most competitive price possible, tenders were broken down into groups of one (1) to five (5) buildings, which were generally in close proximity. The final cost for each tender is included in Table I herein, items 3 to 31. As can be seen, the total cost for the Phase III remediation program is $6,040,466.80. A further breakdown of each tender by building is included in Appendix IX.

3.6.2.3 Joist Test Program

The cost associated with the OWSJ Testing Program carried out at Memorial University of Newfoundland is included in line item 33 in Table I, "OWSJ Task Review Board". The consultants developed and project managed the program. Memorial University carried out the physical testing and M & M Offshore prepared the joists for testing and fabricated the structural components of the testing assembly.

3.6.2.4 OWSJ Task Review Board

Finally, line item 34 of Table I is a summary of all costs incurred by or on behalf of the OWSJ Task Review Board, including the joist test program as explained above. The total cost for the OWSJ Task Review Board was $382,227.59.

3.6.3 Total Cost

The total cost of the Robb Open Web Joist Remediation project to the Province of Newfoundland was $7,614,430.05, (refer to line item 35 in Table 1).

CONSTRUCTION COST ESTIMATE

Building:

Date:

Location:

Joists:

Ceiling Area (m^2):

Item	Activity	Labour	Equipment	Material	Miscellaneous	Total
1.0	MOBILIZATION					
2.0	REMOVE CEILING					
3.0	STRUCTURAL					
4.0	MECHANICAL					
5.0	ELECTRICAL					
6.0	REPLACE T-BAR					
7.0	CLEAN-UP					

TABLE I COSTS

ITEM	DESCRIPTION	ACTUAL COST
1.	**Phase I Identification**	**$38,116.59**
2.	**Phase II Inspection and Emergency Repair**	**$1,153,619.07**
	Phase III Costs	
3.	Remediation Contract 1A/1	
	Construction Cost	$255,105.65
	Contract Administration	$35,806.50
	Contract 1A/1 Total Cost	**$290,912.15**
4.	Remediation Contract 1B/1	
	Construction Cost	$79,068.00
	Contract Administration	$27,297.18
	Contract 1B/1 Total Cost	**$106,365.18**
5.	Remediation Contract 1B/2	
	Construction Cost	$24,845.00
	Contract Administration	$16,602.31
	Contract 1B/2 Total Cost	**$41,447.31**
6.	Remediation Contract 1B/3	
	Construction Cost	$ 45,220.36
	Contract Administration	$ 176,195.55
	Contract 1B/3 Total Cost	**$ 221,415.91**
7.	Remediation Contract 2A/1	
	Construction Cost	$424,632.03
	Contract Administration	$67,273.22
	Contract 2A/1 Total Cost	**$491,905.25**
8.	Remediation Contract 2A/3	
	Construction Cost	$229,692.59
	Contract Administration	$27,674.41
	Contract 2A/3 Total Cost	**$257,367.00**
9.	Remediation Contract 2A/4	
	Construction Cost	$90,567.78
	Contract Administration	$24,026.32
	Contract 2A/4 Total Cost	**$114,594.10**
10.	Remediation Contract 3A/1	
	Construction Cost	$396,329.89
	Contract Administration	$41,510.67
	Contract 3A/1 Total Cost	**$437,840.56**
11.	Remediation Contract 3A/2	
	Construction Cost	$297,807.42
	Contract Administration	$52,779.03
	Contract 3A/2 Total Cost	**$350,586.45**

TABLE I COSTS

ITEM	DESCRIPTION	ACTUAL COST
12.	Remediation Contract 3A/3	
	Construction Cost	$84,000.00
	Contract Administration	$27,678.87
	Contract 3A/3 Total Cost	**$111,678.87**
13.	Remediation Contract 3B/1	
	Construction Cost	$187,831.20
	Contract Administration	$47,039.32
	Contract 3B/1 Total Cost	**$234,870.52**
14.	Remediation Contract 3B/2	
	Construction Cost	$143,224.11
	Contract Administration	$32,151.27
	Contract 3B/2 Total Cost	**$175,375.38**
15.	Remediation Contract 4A/1	
	Construction Cost	$255,367.10
	Contract Administration	$56,862.85
	Contract 4A/1 Total Cost	**$312,229.95**
16.	Remediation Contract 5A/1	
	Construction Cost	$349,390.30
	Contract Administration	$172,759.93
	Contract 5A/1 Total Cost	**$522,150.23**
17.	Remediation Contract 5A/2	
	Construction Cost	-
	Contract Administration	$52,146.14
	Contract 5A/2 Total Cost	**$52,146.14**
18.	Remediation Contract 5A/3	
	Construction Cost	$260,288.52
	Contract Administration	$91,230.10
	Contract 5A/3 Total Cost	**$351,518.62**
19.	Remediation Contract 5A/4	
	Construction Cost	$24,255.00
	Contract Administration	$48,270.61
	Contract 5A/4 Total Cost	**$72,525.61**
20.	Remediation Contract 5A/5	
	Construction Cost	$54,552.00
	Contract Administration	$3,624.22
	Contract 5A/5 Total Cost	**$58,176.22**

TABLE I COSTS

ITEM	DESCRIPTION	ACTUAL COST
21.	Remediation Contract 6A/1	
	Construction Cost	$133,737.00
	Contract Administration	$60,450.77
	Contract 6A/1 Total Cost	**$194,187.77**
22.	Remediation Contract 7A/1, 3031 & 3029	
	Construction Cost	$718,969.28
	Contract Administration	$74,063.78
	Contract 7A/1, 3031 & 3029 Total Cost	**$793,033.06**
23.	Remediation Contract 3014	
	Contract Administration	$12,456.00
	Contract 3014Total Cost	**$12,456.00**
24.	Remediation Contract 3021	
	Construction Cost	$136,572.59
	Contract Administration	$42,699.08
	Contract 3021Total Cost	**$179,271.67**
25.	Remediation Contract 3117(A)	
	Construction Cost	$107,115.00
	Contract Administration	$27,768.60
	Contract 3117(A) Total Cost	**$134,883.60**
26.	Remediation Contract 3117(B)	
	Construction Cost	$214,715.78
	Contract Administration	$38,762.46
	Contract 3117(B) Total Cost	**$258,478.24**
27.	Remediation Contract 3119	
	Construction Cost	$71,771.00
	Contract Administration	$16,928.80
	Contract 3119Total Cost	**$88,699.80**
28.	Remediation Contract 3120	
	Construction Cost	$35,400.00
	Contract Administration	$16,597.20
	Contract 3120Total Cost	**$51,997.20**
29.	Remediation Contract 4-00	
	Construction and Contract Administration	$44,749.19
	Contract 4-00Total Cost	**$44,749.19**
30.	Remediation Contract 40023	
	Construction Cost	$38,173.57
	Contract Administration	$22,972.75
	Contract 40023Total Cost	**$61,146.32**

TABLE I COSTS

ITEM	DESCRIPTION	ACTUAL COST
31.	Remediation Contract 9877	
		$18,458.50
Contract 9877Total Cost		**$18,458.50**
32.	**Phase III Totals**	**$6,040,466.80**
33.	**OWSJ Testing Program (MUN)***	
34.	**OWSJ Task Review Board**	**$382,227.59**
35. TOTAL ACTUAL COST LINE ITEM 1 TO 34		**$7,614,430.05**

*** included in item 34**

3.6.4 Comparative Remediation Costs

As previously stated, being armed with inspection and testing information, and having had the benefit of discussion and debate, permitted the professional engineers responsible for remediation design to refine their design solutions and hence reduce costs.

The shopping mall in St. John's, which had partially collapsed, had both the floor and roof of the non-collapsed areas remediated. The remediation scheme was developed following considerable consultation between a number of engineering firms, but before the testing program was carried out at Memorial University of Newfoundland. The remediation program was developed following discussion and debate between a number of prominent structural engineers such as, Mr. Jerry Jablonsky, Mr. Bud Julicher (USA), and Mr. Chester Poczyniak to name a few, who were in addition to the professional engineers employed by the project consultant. The design philosophy adopted, permitted remediation be limited to approximately 50% of each joists.

The next building to be remediated was the warehouse in Mount Pearl that also had a collapse in a roof section. The remediation scheme for this building was developed by a single consultant, which in the absence of research information, which was subsequently available, required remediation to 100% of the joints of all joists.

The first school remediated for the Province of Newfoundland and Labrador was Persalvic Elementary School in Victoria. The remediation scheme was developed following an in-depth inspection of the building under the direction of a consultant but prior to the formation of the Open Web Steel Joist Task Force, and before the Joist Testing Program. The level of remediation was significantly greater compared to that developed by the task force.

Once the extent of the joist deficiencies were better understood and, when the Joist Testing Program was completed, the professional engineers responsible for design, were encouraged to discuss remediation schemes. These developments resulted in a more efficient design. The cost of remediation for the program supported by the Open Web Steel Joist Task Review Board was reduced significantly. Not only was the remediation limited to 50% of selected joists but the extent of remediation was further reduced for joists which were of shorter spans, closer spacing. The net effect was a significantly reduced cost of remediation.

4.0 CONCLUSION

Structural design is conservative by nature, for good reasons. Structural collapses can cause death and injury. If a building were properly designed and constructed in accordance with Canadian codes and standards, the real chances of failure would be near negligible, except for very extreme conditions. Faced with the fact that there had been at least two documented partial collapses of buildings containing Robb Joists, coupled with the fact that inspection had disclosed in excess of seven hundred failed welds, the engineers responsible, had to do something to correct the situation. The question was, "to what extent was remediation necessary?" There was no totally objective text book answer to this question. On the contrary, the answer was and still is very subjective. It required an opinion, an opinion tempered by the engineer's duty of care to the public, on one hand, and by the fiduciary responsibility to the client on the other.

In order to enable the engineer to give an educated opinion, additional information was necessary. Questions needed to be answered such as:

- What was the extent of the problem?
- Were the failures design related or load related?
- Were the failures span related?
- Were they limited to a specific fabrication period?
- Were they affected by location?
- Were they related to a fabrication process?
- etc.

Hence the requirements of the inspection and testing program.

Armed with significant information regarding the extent of the problem and the enhanced capacity of remediated joists, the professional engineers were in a better position to formulate an opinion concerning the extent of remediation necessary. The consensus amongst the professional engineers involved at the time, was the, **"Suggested Minimum Criteria for Roof/Floor Joist Remediation."** While there were some variations from building to building, and from engineer to engineer, the basic method and extent of remediation was widely accepted amongst those involved.

Was the chosen solution the only one available? No! Such is the nature of subjective opinions. It was the opinion of those involved that the remediation solution was reasonable considering all the facts. Furthermore, it stood up to the scrutiny of consulting engineers charged with the responsibility for public safety and accepting the liability; it stood up to the scrutiny of professional engineers working for the Province of Newfoundland and Labrador charged with the responsibility of spending public money wisely; and it stood up to the scrutiny of the Association of Professional Engineers and Geoscientists of Newfoundland, the body responsible for governing the practice of engineering (and geoscience) in the Province of Newfoundland and Labrador.

Once the remediation design was accepted, the actual work proceeded efficiently and expeditiously, being substantially completed within one construction season. Considerable care was exercised to maintain schedule and control cost. As reported herein this resulted in a reduction in the cost of remediation to less than 50% of the cost of remediating all welds.

The deficient Open Web Steel Joists fabricated by Robb Engineering Division Dominion Bridge Company Ltd. from 1970 onward created an indeterminate, but serious safety hazard in more than 76 public buildings in the Province of Newfoundland and Labrador. In cooperation with the "Open Web Steel Joist Task Review Board," this problem was reviewed, discussed, researched, and solved to the extent that the professional engineers responsible for the remediation are confident that the repaired buildings currently meet or exceed the level of safety implied by the National Building Code of Canada.

5.0 RECOMMENDATIONS

5.1 Current Status

While the Open Web Steel Joist Task Review Board accomplished a tremendous amount of work, with minimal interruption, in a short period of time, there are loose ends which require further attention.

5.1.1 Unidentified Buildings Containing Robb Joists

In the list of buildings containing Robb joists there were 16 buildings that have not yet been located, refer to the letter from APEGN, Item "4" in Appendix I. Because the list of buildings which had been provided to APEGN by Robb Engineering, only covered the period 1970 to 1985, there are surely buildings both prior to, and since that period that have not been identified.

The Government of Newfoundland and Labrador has inspected, and where required, remediated 55 buildings which were known to be constructed with Robb Joists, during the period 1963 to 1985. The Government also issued a public advisory to advise all other building owners about the Robb Joist issue, a copy of same is included in Appendix I, Item 4. Through the Department of Employment and Labour Relations, the Government is continuing to identify and cause action to be taken for privately owned buildings containing Robb Joists.

Information regarding post 1985 structures, including schools and other government buildings, has been difficult to obtain. Yet there is some evidence that open web steel joists fabricated after 1985 may be of inferior quality similar to those fabricated earlier. Some schools and Government buildings have been identified and addressed. School Boards which did not respond to earlier requests for information regarding post 1985 structures have been recently written a letter requesting the information again. Refer to Appendix I, Item 5.

Recommendation 1: The Government provide the necessary resources to identify and ensure appropriate action is taken, for private buildings containing Robb Joists which may pose a threat to public safety.

Recommendation 2: The Government take measures to require all school boards and hospital boards respond to the letter dated February 3, 2005 requesting they identify post 1985 structures and then take action to inspect and remediate where appropriate.

5.2 Measures to Avoid Reoccurrence

What checks and balances are necessary to help ensure a situation similar to the Robb Joist problem does not reoccur? On the surface it would appear the checks and balances are already in place. National Building Code requires a fabrication company to be certified to CSA W47.1, which in turn requires that welders certify their proficiency and welding procedures be tested to prove competence. There are welding supervisors, who are charged with the responsibility to ensure that the appropriate welders are used and that they follow the approved welding procedures. W47.1 also requires that the company have an Engineer available, who is responsible for welding procedure and practices. The Canadian Welding Bureau is supposed to regularly audit certified companies to ensure they are conforming to the requirements for certification.

In addition to W47.1 certification requirements there is the structural engineer who may be required by the levels of government to verify a structure is constructed in accordance with drawings, specifications, codes and standards. The structural engineer may in turn hire an inspection firm to confirm that the finished product meets the specified requirements.

With all of these opportunities to circumvent a fabrication deficiency, how could a problem have occurred to the extent of the Robb Joist problem, and could a similar issue occur today?

A structural steel fabricator, like most construction firms, is motivated in part by the desire to earn a return on its investment. In a "lowest tender" society this can cause a company to cut corners and tender to the lowest common denominator. In most cases, the fear of liability, concern for reputation, and third party inspection help counter balance any such tendencies. However, should a company attempt to cut cost to the point of affecting quality, can lower quality products get to the market? The answer is, "yes! Inferior products could get to the market and be used in public structures". Where are the loop holes?

Welder certification, and welding procedure qualification as currently stipulated by Canadian codes and standards, are near adequate. The welder however, will normally do as instructed by the employer and when left to his/her own, will often cease to follow procedural requirements. The welding supervisor (as required by CSA W47.1) is normally given the responsibility to ensure welder certifications are current and that procedures are approved and then followed.

The supervisor, however, is also employed by the certified company and may not be a person who can be held professionally accountable for actions, or lack thereof. The (welding) engineer who is a person who may be held professionally accountable can be either full time or retained by the company. The extent of the engineer's involvement is determined by the company (at least in the opinion of the CSA W47.1 Technical Committee).

While CSA W47.1 clearly specifies that the certified company must have a professional engineer responsible for "Welding procedures and practices" and "Welding design", it does not generally say what the responsibilities are, or that the engineer is responsible for virtually anything. The opinion of the CSA W47.1 Technical Committee is demonstrated in the following series of questions and answers which were communicated to Structural Consultants Ltd. in April of 1993. To the very best of our knowledge there has been no communication from the CSA W47.1 Technical Committee contradicting these opinions.

Question 1 *Could you please outline the responsibilities of a welding engineer as it relates to connection design?*

Committee Response *The responsibilities of an engineer are regulated by the relevant Association of Professional Engineers, and for buildings, may also be specifies in the relevant building code.*

Question 2 *Is a professional engineer who is not a welding engineer as classified under the W47 code permitted to do a welded moment connection design (beam to a column)?*

Committee Response *Yes.*

Question 3 *Is it necessary for a fabricators welding engineer to check and approve the design of the connection prepared by another professional engineer?*

Committee Response *In the context of Clause 6.7, CSA Standard W47.1-1983, it is not* necessary. *The fabricator must employ or retain one or more professional engineers, for purposes of certification in Division 1 or 2, but the Standard does not stipulate what these engineers must do. The fabricator, as a matter of business practice, may wish to have his employed or retained engineer review the design of the connection, and, if it seems appropriate, suggest an alternative design.*

Question 4 *As an engineering consulting firm are we permitted to design welded connections which would form part of the tender drawings?*

Committee Response *Yes*

Question 5 *As an engineering consulting firm are we permitted to show or indicate welds on our tender design drawings? (i.e. reinforcing a steel beam or upgrading a welded connection to get a greater capacity).*

Committee Response *Yes.*

Question 6 *While the fabrication company is certified, is the welding engineer responsible for all connection design, including that designed by another professional engineer, even if it was not reviewed by the welding engineer?*

Committee Response *No.*

Question 7 *If moment connections were not designed or reviewed by a fabricators welding engineer does this mean the building is not in accordance with the requirements of the CSA W47.1?*

Committee Response *No. (The question is not really appropriate since W47.1 is a certification standard for companies and does not govern buildings. The design and construction of building are governed by the relevant Provincial building code and CSA Standard S16.1).*

CSA W47.1 is worded as follows with respect to the engineer's responsibility.

"4.3.1.1 To be certified in Division 1, the company shall employ full time a registered professional engineer(s) responsible to the company for
(a) Welding design; and
(b) Welding procedures and practice."

"4.4.2 Division 2.1
To be certified in Division 2.1, the company shall retain part-time a registered professional engineer(s) responsible to the company for
(a) Welding design; and
(b) Welding procedures and practice."

Whether the above phrases are sufficiently ambiguous to cast doubt as to whom is responsible for the company's welding matters, it can easily be seen how a structural engineer or owner would assume that the responsibility for welding procedure and practices, as well as design, is being accepted by the company's (welding) engineer. But if not appropriately instructed by the company, the engineer may be responsible for naught, leaving only the company/fabricator responsible. Contrary to what many structural engineers and owners understand, the company can exclude the welding engineer, if it is so inclined to do so.

The next opportunity to catch a delinquent company would be through a CWB audit. The CWB audits certified companies approximately on an annual basis. These audits are very superficial and would only become more in-depth if the Bureau was suspicious of the Certified firm, for some reason. These audits can hardly be depended upon as a prime component for ensuring quality, due to their infrequency and nature.

The Structural Engineer of Record (SER) may be intimately involved with the fabrication process. This engineer may require erection drawing, fabricator drawings, and connection design calculations. The SER may, in some cases, have a representative in the fabrication shop during fabrication, and likewise at site during erection. With the exception of very large projects the above, however, is not usually the case. Some structural engineers appear to assume that the company's welding engineer is involved with the fabrication process, and therefore only require erection drawings. The SER may only be mandated to visit the site during monthly progress meetings and may otherwise depend upon an inspection company who is often hired by the company/fabricator and who may be requested to do little more than a plumb and alignment check. Even in cases where welding inspection is a stated part of the inspector's work, Open Web Steel Joists may be treated as proprietary items and the welding never inspected.

The Canadian system is less litigious than our American counter part's system. Our codes and standards rely on professional input and third party inspection. Unfortunately our confidence in the ability of our codes, standards, and regulations to produce quality results, may not be well founded. In fact there are many loop holes. The chance of obtaining quality results and safe structures may only be as good as the integrity of the company that submitted the lowest bid.

What can be done to help ensure conformance to codes and standards thus resulting in safer structures?

<u>**Recommendation 3:**</u> **The Province of Newfoundland and Labrador develop, implement, and provide resources that apply to a Provincial Building Act which:**

1. **Incorporates the National Building Code of Canada, as appropriate;**

2. **Reinforce or clarify the requirements of codes and standards where necessary, to ensure professional responsibility is clear;**

3. **Ensure that contract documents clearly outline the contractor/fabricator's responsibility to construct/fabricate in accordance with the requirements of the National Building Code, provincial regulation and/or municipal regulations; and**

4. **Require the contractor/fabricated to provide a certificate of compliance.**

Recommendation 4: **The Province recognize that the current passive system is not necessarily effective in assuring the level of safety and integrity implied by the NBC. The Province provide guidance to municipalities to ensure this deficiency is addressed.**

Recommendation 5: **The Building Act govern and be administered by the appropriate Government Department for areas outside of municipalities.**

Recommendation 6: **PEG-NL develop performance standards (or change their existing structural guidelines to performance standards) to clearly state the Structural Engineer of Record (SER) is responsible for ensuring the design of structural steel assemblies, including connections, are designed by a Professional Engineer.**

Recommendation 7: **In the development of acts, regulations, and performance standards, it be clearly defined and understood who is responsible for inspection. Open Web Steel Joists and other secondary structural members should be included under the inspector's mandate.**

The recommendations made in this report will significantly decrease the chance of structural deficiencies going unnoticed and steadily increase public safety.

fga

Report on the Open Web Steel Joist Remediation Program for the Province of Newfoundland and Labrador

VOLUME 2 – APPENDICIES

__Prepared by:__

fga **Consulting Engineers Limited**
2 Hunt's Lane
St. John's, Newfoundland
A1B 2L3

Gary Follett, P. Eng.

__On behalf of:__

The Open Web Steel Joist
Task Review Board

Date: March 2003
Revised: May 2005

File No. 1850-04

TABLE OF CONTENTS
VOLUME 2 - APPENDICES

Appendix I Correspondence
Appendix II Guidelines for Snow and Ice Removal on Roofs and Floor Loadings
Appendix III Robb Joist Buildings Data Base
Appendix IV Typical Welding Procedure and Data Sheets
Appendix V A Discussion of NBC Commentary K and it's Applicability
Appendix VI Suggested Remediation Program
Appendix VII Typical Phase II Inspection Report
Appendix VIII Jackson Walsh Elementary School Remediation Tender Drawings
Appendix IX Remediation Cost Report

APPENDICES

APPENDIX I

"CORRESPONDENCE"

ITEM "1"

Correspondence Re:
"Technical Evaluation Board"

GOVERNMENT OF
NEWFOUNDLAND AND LABRADOR

**Department of
Works, Services
and Transportation**

Design & Construction Division

1850-04

1996 11 06

Mr. Gary Follett, P. Eng.
FGA Consulting Engineers Ltd.
P.O. Box 9688
St. John's, NF
A1A 4J6

Dear Mr.Follett:

RE: PUBLIC BUILDING - OWSJ ASSESSMENT TECHNICAL EVALUATION BOARD

The Department is the lead agency in directing and managing an inspection of some 60 public buildings, which are believed to contain Robb Engineering open web steel joists fabricated and installed during the period of 1970 to 1985.

Request for proposals have been solicited for the provision of consultant services to perform Stage 2 detailed structural inspections, predominantly on public schools.

Up to six different structural firms may be engaged by the Department on this project. It is important that a common approach be followed by the participants to ensure a consistency of analysis. In addition, risk management, public interest concerns, and operational guidelines are issues which will arise. These issues will be the responsibility of a technical evaluation board set up for the project. It is proposed initially that the group comprise of 5 professional engineers - 1 representing APEGN, 2 from the structural consulting community, and 2 from the Department.

I am pleased to be informed that you have agreed to be a member of the technical evaluation board.

.../2

P.O. Box 8700, St. John's, Newfoundland, Canada. A1B 4J6

Two of the initial tasks of this board will be:

1. to provide clarification of technical requirements to proponents responding to the Request for Proposals.
2. to consider operating guidelines for the upcoming winter.

Please liaise with our Project Manager, Ms. Ingrid Sheppard (729-2496 regarding the board's agenda.

Yours truly

George Greenland

GEORGE GREENLAND, P. ENG.
Assistant Deputy Minister (Works)

/lm

cc: I. Sheppard

c:\gunar\letter\follett.wpd

ITEM “2”

“Minutes of Meeting, January 8th/97”

draft

Minutes of Meeting
O.W.S.J. Task Review Board
January 08, 1997

Those in Attendance

I. Sheppard	D.W.S.& T.
G. G. Leja	D.W.S & T
L. Short	Structural Consultants Ltd.
G. Follett	F.G.A. Consulting Engineers Ltd.
G. Moores	A.P.E.G.N.

Special Guest: Kas Talabany, Howley Talabany and Associates Ltd

OLD BUSINESS

1) Legal Advise

The Department will have someone appointed from the Department of Justice.

2) Chair

Ingrid Sheppard has been appointed Chair of the Task Review Board.

3) Canadian Institute of Steel Construction and the Canadian Welding Bureau

The Department concurs with the Board questioning the above organizations with respect to this potential problem.

4) Discussion Paper on OWSJ's and Safety

This information has been received and will be distributed by FGA.

Action: G.F.

5) Pretrial Testing

The Board now has 23 joists available to test. Six were removed from Holy Cross Elementary and 17 will be purchased. The latter joists are available and are presently stored. The cost of these joists will not exceed $3000.00 and FGA was authorized to purchase them.

6) Minutes of Meeting of December 23, 1996

The minutes of the December 23, 1996 meeting were tabled and the necessary revisions will be made.

NEW BUSINESS

1) Report from Mr. Kas Talabany and Policy on Failed Joists

Mr. Talabany was asked to attend the meeting at this point to outline for the Board some of his findings to date with respect to his inspection of joists. Mr. Talabany has found failed joists in one of the two Robb buildings he has inspected.

The Chair of the Board invited Mr. Talabany to the meeting with the intent of establishing guidelines for Mr. Talabany and the other consultants working for the Department, when failed joists are found. The Task Force was not expected to critique the detailed actions of Mr. Talabany but to establish general policy for failed joists.

To date Mr. Talabany has inspected three buildings on behalf of the Department.

Swift Current All Grade - No failures were noted in the 30% inspection but the lack of weld quality typical of Robb joists of this type was a factor.

Clarenville Depot - This building does not contain Robb joists and no further inspection was done.

Bishop White All Grade School Port Rexton - This school contained Robb joists and failures were recorded. Based on the existence of failed joists Mr. Talabany mobilized a team on January 04, 1997 and repaired seven failed joists. The necessity of this action prompted the Project Manager to bring the issue to the Task Force for development of general policy guidelines.

As a result of the forgoing discussion the Task Force developed the following criteria to define a failed joist.

1)it has broken welds

2)it has a buckled top chord

3)it has bent web members in combination with other evidence of failure

It was also agreed by the Task Force that the discovery of one failed joist would necessitate the inspection of 100% of the remainder of the joists for the purpose of finding and correcting failed joists. A welding inspector would not be required for this inspection.

It was agreed that the Chair would draft for the Board a policy statement for the consultants doing inspections on behalf of the Department.

Action: I.S.

Due to a lack of time Mr. Talabany's debriefing was terminated and the remaining agenda items were deferred to the next meeting Friday January 10 th @ 2:00 p.m. It was noted that Mr. Gerry Moores had another commitment. It was agreed that Mr. Moores would be forwarded minutes of the meeting for his perusal.

Mr. Talabany will provide the Department's Project Manager with a complete report of his findings.

Closing Remarks

The meeting adjourned at 4:30 P.m.

Please note any errors or omissions to the undersigned.

Ingrid Sheppard, P.Eng.
Chair, Open Web Steel Joist
Task Review Board

ITEM "3"

"Memo dated January 11th/97"

GOVERNMENT OF
NEWFOUNDLAND AND LABRADOR

Department of Education

Department of
Works, Services & Transportation
Design and Construction Division

FACSIMILE COVER PAGE

TO:	*Structural Consultants Ltd.*	*FAX NO: 726-1823*
	Howley Talabany and Associates	*FAX NO: 747-2254*
	FGA Consultants Ltd.	*FAX NO: 753-7011*
	Nova Consultants Inc.	*FAX NO: 753-1514*
	Bridger Design Associates	*FAX NO: 739-7601*
	Florence Delaney, Dept. of Education	*FAX NO: 1330*
	Gary Hatcher, Dept. of Education	*FAX NO: 5896*
	Gunar Leja, D.W.S.& T.	*CC:*
	George Greenland, D.W.S. & T	*CC:*
FROM:	*Ingrid Sheppard, P. Eng.*	*FAX NO: (709) 729-2011*
	Chair Task Review Board/	
	Project Manager	
	School Construction Engineer	*PH: NO: (709) 729-2496*
RE:	*Failures in Open Web Steel Joists Which Require Immediate Repair*	

MESSAGE: Please be advised that at the January 10 th, 1997 meeting of the Task Review Board it was decided that the following procedures should be followed if failed open web steel joists are encountered. All failed joists must be repaired or secured immediately. A joist is determined to have failed and requires immediate repair if:

1) it has broken welds or no weld

2) it has a buckled top chord

3) it has bent web members in combination with other evidence of failure

P.O. Box 8700, St. John's, Newfoundland, Canada, A1B 4J6, Telephone (709) 729-5097, Facsimile (709) 729-5896
http://www.gov.nf.ca/edu

If failed members are discovered which require immediate repair:

1) Secure the area by preventing the area from being occupied until

- *a) temporary support is put in place*

  or

- *b) the failure is repaired*

2) Report the required action to the School Board

3) Report the failure to the Project Manager

4) Discuss with the Project Manager the costs involved in completing #5) below.

5) Commence as soon as possible

- *a) the repair of all failed joists*

  and

- *b) the inspection for failures in 100% of the joists.*

6) Photograph typical conditions before and after the repair.

7) Ensure the welding is carried out by a firm certified to CSA W47.1. Division 1 or 2

8) Ensure the welding firm as Comprehensive Liability Insurance $1,000,000.

9) Protect the area from damage. Make good any damage.

10) The assistance of a welding inspector will not be required for this extra work.

If you have any concerns or questions regarding this procedure please contact the undersigned.

NO. OF PAGES: (INCLUDING COVER PAGE)

DATE: January 11, 1997 *SIGNATURE:*

ITEM "4"

Letter from APEGN Re: "Unidentified Robb Buildings"

Association of
Professional Engineers
and Geoscientists
of Newfoundland

RECEIVED
FGA CONSULTING
ENGINEERS LIMITED
AUG 21 2001

1850-04

FAX MEMORANDUM

TO: *Members of the OWSJ Task Force*
Jackie Manuel, P. Eng., OHS
Bob Newhook, P. Eng., M & PA
Ingrid Sheppard, P. Eng.
Gunar Leja, P. Eng.
Gary Follett, P. Eng.
Dave Burt, P. Eng.

FROM: Gerry Moores, P. Eng.
Professional Standards Director

DATE: August 21, 2001

SUBJECT: *List of Unidentified Robb Buildings*

At our meeting on August 20, 2001, it appeared that members of the Task Force did not recall receiving my memo of April 30.

Attached is a copy of that memo with the fax numbers of members to whom it was sent. Please acknowledge receipt of this memo.

GWM

jef
Attachment

P.O. Box 21207, St. John's, NF, Canada, A1A 5B2 Phone: (709) 753-7714 Fax: (709) 753-6131 E-mail: main@apegn.nf.net

Association of
Professional Engineers
and Geoscientists
of Newfoundland

FAX MEMORANDUM

To: **Members of the Open Web Steel Joist Task Force**
Ingrid Sheppard, P. Eng.
Gunar Leja, P. Eng.
Gary Follett, P. Eng.
Dave Burt, P. Eng.

From: Gerry Moores, P. Eng.
Professional Standards Director

Date: April 30, 2001

At our meeting on April 20, 2001, I agreed to provide the Task Force with a list of buildings (projects) that we have been unable to identify from the original Robb list. Herein is that information:

Robb Tag #	Location	Customer	Description	Tons	Year
4817	St. John's	Fishery Products		3.7	1971
4986*	Port Aux Basques	Sheaves Constr.		0.4	1971
5095	St. John's	Hillcrest Constr.	25 short span joists	10.4	1972
5246	St. John's	Hillcrest Constr.	Roof 50'x37'	2.1	1972
5324	St. John's	Fishery Products		2.2	1972
5463	St. John's	Hillcrest Constr.	Commercial Bldg.	8.9	1973
5564	St. John's	Parsons Eng.	45'x35' floor	1.9	1973
5578	St. John's	Hillcrest Constr.	Warehouse Ext.	1.0	1973
5627	Carbonear	Saunders Howell	Avco Finance	0.8	1973
5980*	Port Aux Basques	East Coast Marine		1.2	1975
6005*	Port Aux Basques	East Coast Marine		0.5	1975
6022		Pinsent Constr.		1.9	1975
6299	St. John's	Parsons Eng.	Processing Plant	9.0	1976
7081	St. John's	Assoc. Constr.		4.8	1980
7193	St. John's	Burnett Constr.	Quad Pro Bldg.	3.3	1980
7367	Gander	Jenkins Industries		1.9	1982

*Conversation with Lloyd Short Jan 21/97. This amount of steel would indicate mezzanine floors.

I also have notes about some of the other projects such as conversations with Hillcrest, Parsons Eng., etc.

I would suggest that in order to resolve the present situation we seem to be into regarding who is responsible for what, we form a small committee to sort through all the information we have compiled to date on private buildings. I would be prepared to work on such a committee and suggest that GSL should be considered since they have a lot of information and also Workplace Health and Safety since it seems they have the enforcement power.

ITEM "5"

"Letter re Post 1985 Buildings"

FAX
Gary Follett
753-7011
Ingrid Clarke
DATE: 05/02/11

GOVERNMI
NEWFOUNDLAND AND LABRADOR

Department of Education

February 3, 2005

To: Directors of Education

Some of you may recall in 1997 the Minister of Works, Services and Transportation issued a public advisory on buildings constructed with joists manufactured by Robb Engineering Limited of Amherst, Nova Scotia between 1963 -1985. This action was prompted by the collapse at the Village Shopping Centre and the Centrac Warehouse in Donovan's Industrial Park. The issue was faulty welding and in response to the issue being brought to Government's attention the Open Web Steel Joist Task Review Board was established and Ingrid Clarke, P.Eng. acted as chair to the Review Board.

To date, the task force has identified the steel joist suppliers in about 323 public buildings. Approximately 74 of those buildings contained some or all Robb steel joists. Sixty six of these buildings were schools, four were public buildings, one was a board office and three were nursing homes. The repair of these joists started in January 1997 and is complete. The last repair was completed recently.

On July 2, 1998, Ingrid wrote the eleven Directors of the former School Districts and asked them for a list of buildings or sections of buildings in their districts which contained open web steel joists, constructed after 1985. A copy of the memorandum is attached. Only one response was received, that being from the former School District 7. Since the memo was issued, the Task Force has discovered faulty joists in one post 1985 structure and it has been remediated.

The Task Force would like to wind up its work but the issue of the condition of the welding in "Robb" buildings constructed after 1985 is still in question. It may be that no response was given to the memo because the school district did not have any buildings in the categories specified. In the absence of a response to the memo it is unknown for sure if any problem buildings exist.

P.O. Box 8700, St. John's, Newfoundland, Canada, A1B 4J6, Telephone (709) 729-5097, Facsimile (709) 729-5896
http://www.gov.nf.ca/edu

It would be appreciated if you reviewed this matter and advised this office of your findings by March 15, 2005.

If you have any questions please contact Ingrid at 729-2496.

Sincerely,

Gary Hatcher
Senior Director
School Services & Facilities

cc: Ms. Ingrid Clarke, P.Eng.,
Chair Open Web Steel Joist Task Review Board.
Mr. Allan Layte, Government Services & Lands

GOVERNMENT OF
NEWFOUNDLAND AND LABRADOR

Department of
Works, Services & Transportation
Design and Construction Division

To : Directors of School Districts

CC : Gary Hatcher, Dept. of Education
: Gunar Leja, Dept. of Works Services and Transportation

From : Ingrid Sheppard, Chair OWSJ Task Review Board

Date : July 02, 1998

Subject: Open Web Steel Joists

The Task Review Board on Open Web Steel Joists reconvened last Thursday. The Task Force believes that it would be prudent to audit some buildings which were constructed after 1985 to ensure that the same joist problem does not exist after the published dates. Could you have one of your staff provide me with a list of buildings or sections of buildings which were built after 1985 that would have open web steel joists in them. A reply by July 31, 1998 would be appreciated.

Ingrid Sheppard

Ingrid E. Sheppard, P.Eng.
Chair OWSJ Task Review Board

APPENDIX II

“GUIDELINES FOR SNOW AND ICE REMOVAL ON ROOFS AND FLOOR LOADINGS”

File

GOVERNMENT OF
NEWFOUNDLAND AND LABRADOR

Department of
Works, Services
and Transportation

December 10, 1996

Roy Dawe
Director of Facilities Planning
Dept. of Health

Florence Delaney,
Assistant Deputy Minister
Finance and Administration
Dept. of Education

Dean Osmond, P.Eng.
Regional Director (L)
D.W.S. & T

Re: Snow Accumulation on Roofs
<u>Buildings Containing O.W.S.J's</u>

Dear Sirs/Madame:

As you are aware this Division is conducting inspections and analysis of open web steel joists in building or sections of buildings by a particular joist fabricator constructed between 1970-85. Contracts will soon be awarded to engineering firms to assist us in this extremely large task. Until we complete the inspections and analysis, precautions will have to be taken to protect buildings and occupants from potential structural failures. As a precautionary measure snow and ice must be removed from roofs in accordance with the following guidelines. Regional Director(L) W.S. & T. and the Hospital Boards can use the guidelines provided for the School Boards to determine allowable accumulation depths for various geographical areas of the Province. Please contact the appropriate individuals or Boards to ensure these measures are carried out. If you have any questions please contact the undersigned.

Yours truly,

Ingrid Sheppard

Ingrid E. Sheppard, P. Eng.
School Construction Engineer/Project Manager

cc: Gunar Leja, Director of Design and Construction
George Greenland, Assistant Deputy Minister (W)
Gary Hatcher, Director of School Services and Professional Development, Dept. of Education

GUIDELINES FOR SNOW AND ICE REMOVAL ON ROOFS

.1 These guidelines apply to all roof sections of public buildings containing "Robb" or "Suspect Robb" joists erected between the period 1970-1985.

.2 The attached listing identifies buildings that are known to have "Robb" or "Suspect Robb" open web steel joists in your buildings.

.3 These guidelines remain effective until the Department of Works, Services and Transportation advises otherwise.

.4 Maintenance staff are to conduct a visual inspection of each roof to monitor snow and ice accumulation. Inspect immediately after major winter storms where more than 200 mm (8") of snow fall and/or 50 mm (2") rain fall has occurred in a 24 hour period.

.5 Do not allow accumulation of snow and ice to be any greater than 50 per cent of the design load. Permissible snow accumulation on roofs should not exceed the following depths as indicated by geographical location. See Maps 1 and 2 attached. Limit ice and water to 50 mm (2").

.6 Remove snow accumulations, where high and low roofs meet and around roof top mechanical units.

.7 Roofs over gymnasiums are normally greater than 40 feet, and only require snow removal if the joists are constructed of round rod diagonal members.

.8 Take care in the removal of snow and/or ice accumulation to prevent damage to the roof membrane. Avoid removal within 50 mm (2") of the surface of the roof membrane.

.9 Inspect roof drains and ensure drains are in proper working order.

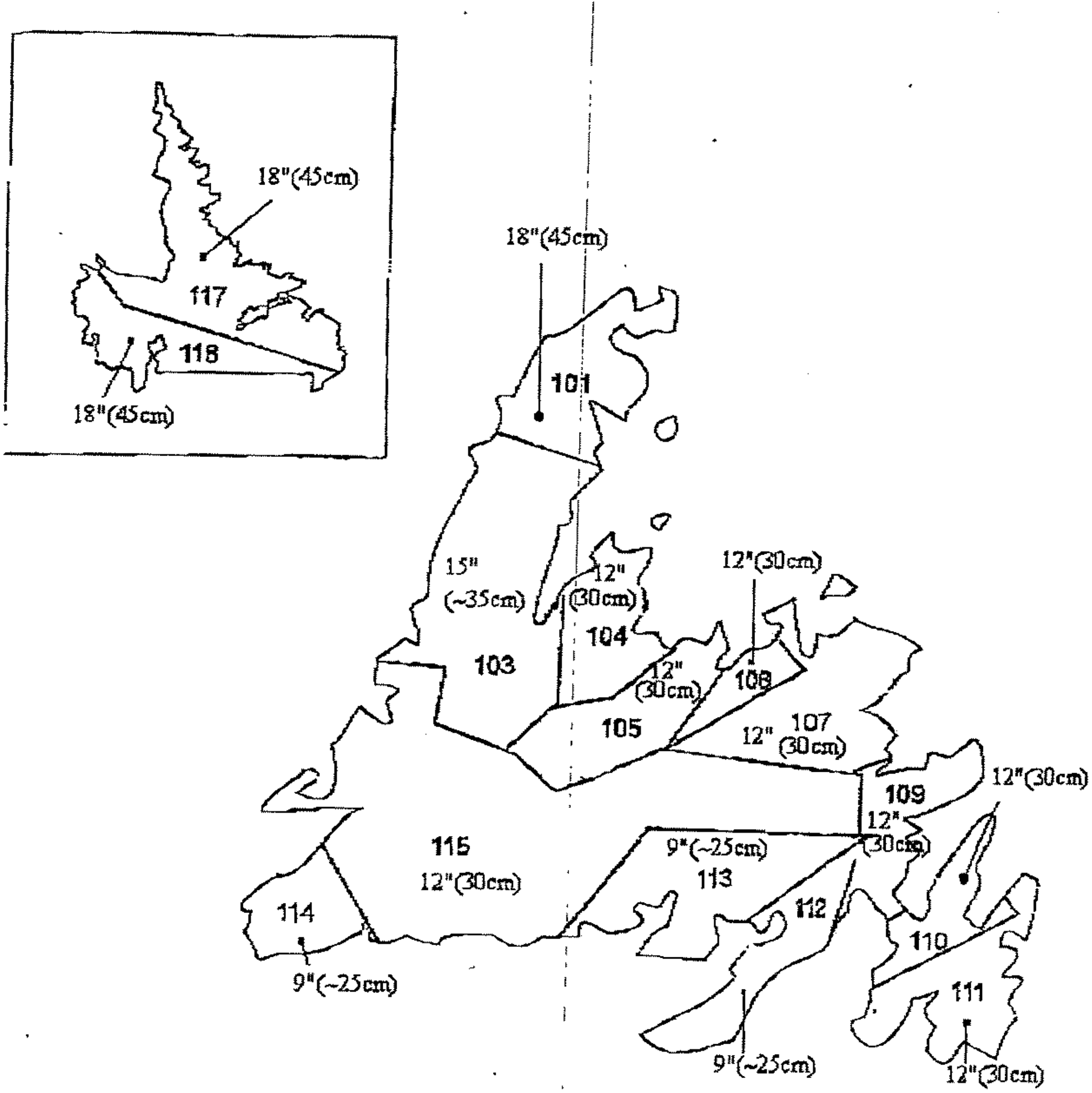
.10 When removing snow from one section of roof, avoid travelling over and compacting snow on adjacent roof sections.

.11 Maintenance personnel shall monitor snow and ice accumulation more closely during periods when "wet snow", or snow followed by rain is forecasted. Buildings shall be closed immediately if accumulations of wet snow exceed 200 mm (8").

96 12 10

Map # 2

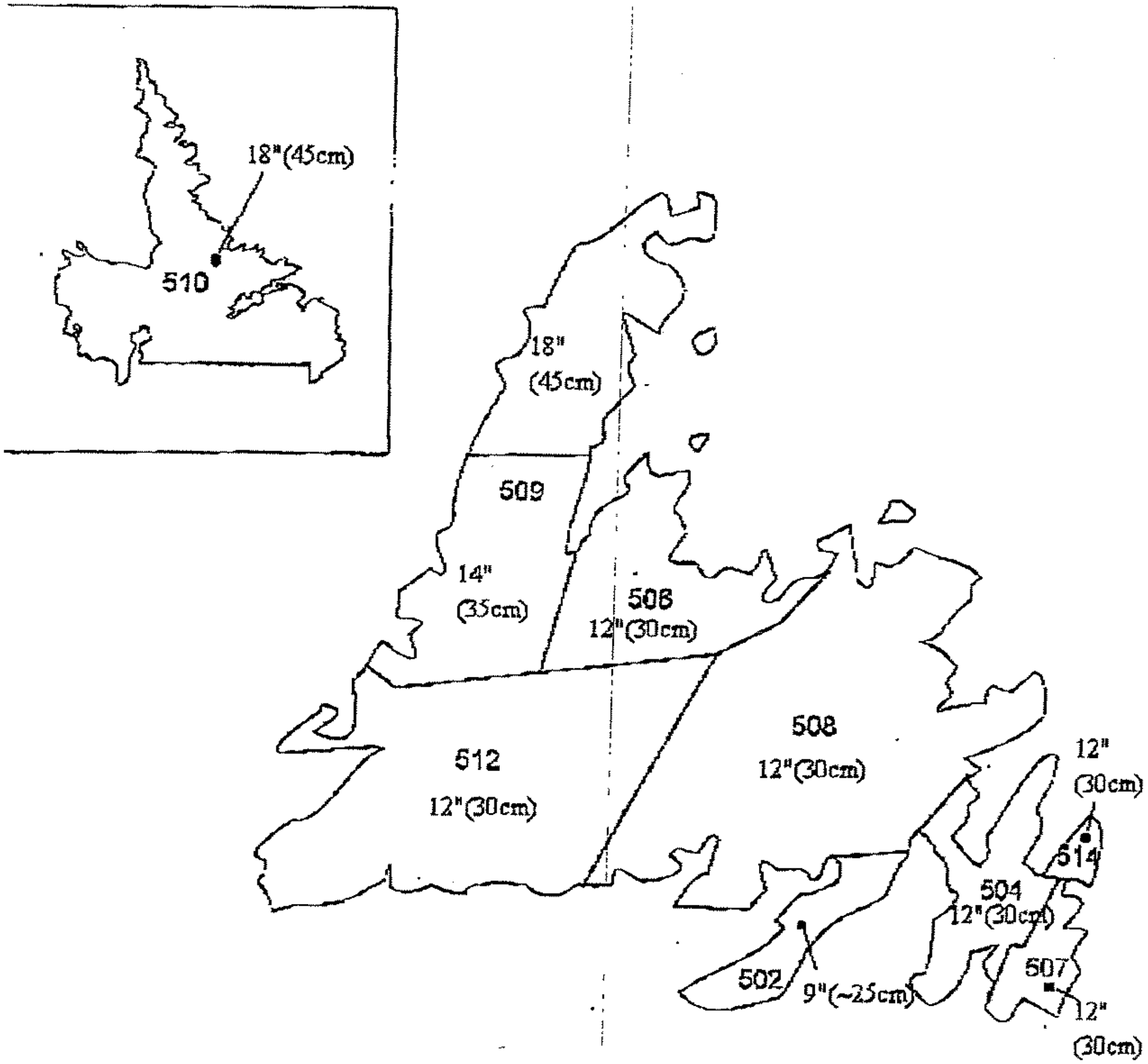
Integrated School Districts



Pentecostal Assemblies Board and Seventh-Day Adventist Boards please judge snow depths based on geographical locations.

Map # 1

Roman Catholic School Districts



Note: Labrador is not drawn to scale

Pentecostal Assemblies Board and Seventh-Day Adventist Boards please judge snow depths based on geographical locations.

GUIDELINES FOR SNOW AND ICE REMOVAL ON ROOFS

1. These guidelines apply to all roof sections of school buildings located in Newfoundland and Labrador.

2. These guidelines remain effective until the Department of Education advises otherwise.

3. Maintenance staff are to conduct a visual inspection of each roof to monitor snow and ice accumulation. Inspect immediately after major storms where more than 20 cm (8 inches) of snow fall and/or 50 mm (2 inches) of rain fall has occurred in a 24 hour period.

4. Do not allow accumulation of snow and ice to be any greater than the depth indicated on the attached maps. Permissible snow accumulation on roofs should not exceed these depths. Limit ice and water to 50 mm (2 inches).

5. Remove snow accumulations, where high and low roofs meet and around roof top mechanical units where the snow accumulation exceeds the depths indicated.

6. Take care in the removal of snow and/or ice accumulation to prevent damage to the roof membrane. Avoid removal within 50 mm (2 inches) of the surface of the roof membrane.

7. Inspect roof drains and ensure drains are in proper working order.

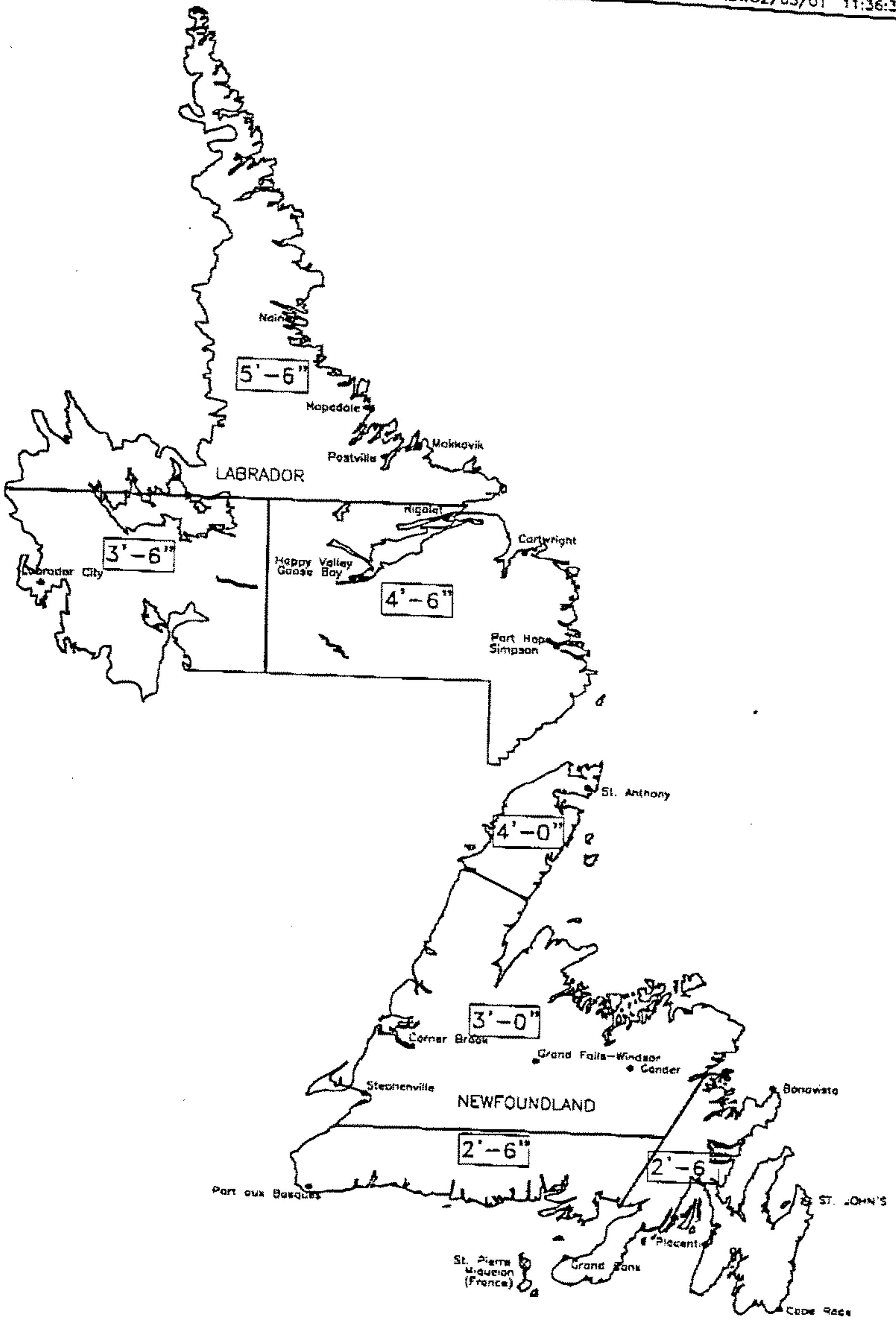
8. When removing snow from one section of roof, avoid travelling over and compacting snow on adjacent roof sections.

9. Maintenance personnel shall monitor snow and ice accumulation more closely during periods when "wet snow" or snow followed by rain is forecasted. For these situations, the maximum depths indicated on the attached maps shall be decreased by 25 percent.

10. When the maximum depth is reached from the contribution of many snowstorms, decrease the maximum depths indicated on the attached maps by 25 percent.

11. The assumed snow density used in the preparation of these maps was 320 kg/m^3 (20 lbs/ft^3). If snow densities in excess of this value are measured, notify the Department immediately.

AMENDED FEB 15/97



NO	REVISIONS	DATE

PROJECT: SNOW & ICE REMOVAL GUIDELINES

TITLE: MAXIMUM DEPTH OF SNOW

JOB NO: 2001-020
DATE: 2001FEB.
DWN: RCK
SCALE: N.T.S.
DWG. #: SK-1

Structural Design Inc.
Suite 209 North, Elizabeth Towers
P.O. Box 21302
St. John's, NF A1A 5G5
Tel: (709) 726-3468
Fax: (709) 726-3422
Email: info@sdi.nf.ca

APPENDIX III

“ROBB JOIST BUILDINGS DATA BASE”

Robb Joist Summary

Building	Location	Joist Mnftr	Phase Yr.	RobbType	RobbList/Contract#	Inspection	Work Compl
Avoca Collegiate	Badger	Robb	1978	RF	55/7030	Nova Consultants	Phase 3 completed
Beaconsfield Junior High (now Hazelwood Elem)	St. John's	Robb	1974	F	45/5826	Structural Consultants	Phase 3 completed
Belanger Memorial	Codroy	Robb	1982	R	59/7357	Bridger Design	N/R Wood truss built over in 1999
Beothuk Collegiate	Baie Verte	Robb	1971	A	18/5012	Nova Cons.	Work completed
Bishop White All Grade	Port Rexton	Robb	1973	F	41/5707	K. Talabany	Phase III complete
Blackmore Elementary*	Pilley's Island	Robb	1971	A	13/4901	Nova Consultants	Sold, Board advised to advise owner
Board Office	Grand Falls/Windsor	Robb	1972		5205	A E Consultants/FGA Consulting Engineers	Work completed
Botwood Academy (Primary)	Botwood	Robb	1971/2	A	A4898	Nova Consultants	No Bldg Sold, Board advised to advise owner
Charisma Complex	Springdale	Robb	1974/75	F	44/57/5803	Bridger Design	Phase III completed. Letter sent.
Coaker Academy	Virgin Arm	Robb	1972	Suspect A	6/4842	C. Hillier	Phase 3 completed
Coley's Point Primary	Coley's Point	Robb	1972		5208	FGA Consultants	Phase 3 completed
Comfort Cove School*	Comfort Cove	Robb	1971	Suspect A	7/4843	C. Hillier	Sold, was to be dismantled
Davis Elementary	Carbonear	Robb	1963-66		2919	S.E. Moores Ltd./ Structural Consultants Ltd	Phase 3 completed

Robb Joist Summary

Building	Location	Joist Mnftr	Phase Yr.	RobbType	RobbList/Contract#	Inspection	Work Compl
Deckwood Elementary	Woodstock	Robb	1971	A	11/4899	H. Sparkes	Phase 3 Completed
Deer Lake Clinic	Deer Lake	Robb	1971		5024	FGA Consultants	Phase 3 completed
Durrell's Arm School Ext.*	Durrells	Robb	1972	Suspect F	25/5239	C. Hillier	Sold, Owner advised
Ecole St. Gerard	St. John's	Robb	1972	F	34/5470	Structural Consultants	Phase 3 completed
Elwood Elementary	Deer Lake	Robb	1985		7657	E. Reed Manager	Work complete
Fatima All Grade	St. Brides	Robb	1982		5410	Structural Consultants	Phase 3 not req'd.
G. C. Rowe	Corner Brook	Robb	1973	F	35/5536	Bridger Design	Phase 3 Completed Letter sent
Gander Academy	Gander	Robb	1971	Suspect A	9/4849	W. Gilbert (Maintenance)	Phase III Complete
Gander Campus	Gander	Robb	1973		No tags on joists.	K.Talabany	Ph III complete
GFA Primary	Grand Falls-Windsor	Robb	1973	F	38/5577	Nova Consultants	Phase 3
Glenwood Elementary	Glenwood	Robb	1971	Suspect A	8/4848	B. Rideout	Sold & Dismantled
Greenwood Elementary	Loon Bay	Robb	1974-5		5951	K. Talabany	Sold, Board advised to advise new owners
H. G. Fillier All Grade	Englee	Robb	1971	Suspect A	15/4988	P. Manuel	Work Complete

Robb Joist Summary

Building	Location	Joist Mnftr	Phase Yr.	RobbType	RobbList/Contract#	Inspection	Work Compl
Hare Bay Junior High	Hare Bay	Robb	1971	Suspect A	4/4809	B. Rideout	Sold & dismantled
Harriot Curtis Collegiate	St. Anthony	Robb	1976	F	54/6344	Nova Consultants	Work Completed
Helen Tulk Elementary	Bishop's Falls	Robb	1976	F	58/6285	Nova Consultants	Work Completed
Henry Gordon Academy	Cartwright	Robb	1969		3927	Nova Consultants	Phase 3 not required Work Completed
Hillside Elementary	LaScie	Robb	1972	F	20/5108	H. Sparkes	Phase 3
Holy Cross Elem. (now Holy Cross Jr. High)	St. John's	Robb	1971	A	17/5005	Structural Consultants	Phase 3 completed
Holy Cross Elementary	Holyrood	Robb	1975	F	53/6248	Structural Consultants	Phase 3 completed
Holy Cross School Comp.	Eastport	Robb	1971	A	3/4808	K. Talabany	Phase 3 completed. Board advised to fix joist shoe
Holy Trinity Regional High	Heart's Content	Robb	1973	F	39/5584	FGA	Phase 3 completed
Inter-Island Academy	Summerford	Robb	1972	Suspect F	19/5097	K. Talabany	Phase III done
Jackson Walsh Elementary	Western Bay	Robb	1971	A	5/4828	FGA	Phase 3 completed
Jen Haven Memorial School	Nain	Robb	85/86		7572	Nova Consultants	Phase 3 complete
L. S. Eddy Academy Ph II	Stephenville	Robb	1972	A	16/5000	Bridger Design	Phase 3 completed Letter sent

Robb Joist Summary

Building	Location	Joist Mnftr	Phase Yr.	RobbType	RobbList/Contract#	Inspection	Work Compl
L. S. Eddy Academy Ph II	Stephenville	Robb	1975	F	51/6095	Bridger Design	Phase 3 completed Letter sent
Labrador College	Goose Bay	Robb	1972		4860	Nova Consultants	Work completed
Labrador College Dormitory	Goose Bay	Robb	1972 or 1978 (Nova)		6592	Nova Consultants	Work completed
Lake Melville School	North West River	Robb	1970-1		4354	Nova Consultants	Phase 3 not req'd. Work completed.
Leading Tickles Elementary	Leading Tickles	Robb	1971	A	4696	Nova Consultants	Work completed
Lewisporte High	Lewisporte	Robb	1986		7652	K. Talabany	Phase 3 completed
Lourdes Elementary Ph II	Lourdes	Robb	1970	A	1/4595	Bridger Design	Phase 3 completed Letter sent
Newville School	New World Island	Robb	1970	A	56/4586	K. Talabany	Phase 3 completed
North Haven Manor	Lewisporte	Robb	1974	F	5820	G. W. Prince & FGA	Work Completed
Notre Dame Academy	Grand Falls-Windsor	Robb	1972	F	30/5351	Nova Consultants	Phase 3 completed
Our Lady of Mercy	St. George's	Robb	1973	F	40/5646	Bridger Design	Phase 3 completed Letter sent
Pasadena Primary*	Pasadena	Robb	1970	A	2/4727	E. Reid	No, Building Dismantled
Peacock Elementary	Happy Valley Goose Bay	Robb	1968-9		3973	Nova Consultants	Phase 3 not req'd. Work Completed

Robb Joist Summary

Building	Location	Joist Mnftr	Phase Yr.	RobbType	RobbList/Contract#	Inspection	Work Compl
Peacock Elementary	Happy Valley Goose Bay	Robb	1960's		2657	Nova Consultants	Phase 3 not req'd. Work Completed
Peenamin McKenzie	Sheshatshit	Robb			J15494 Not on Robb List	Nova Cons.	Phase 3 complete
Perlwin Elementary	Winterton	Robb	1972	F	22/5192	FGA Consultants	Phase 3 completed
Persalvic Elementary School	Victoria	Robb	1974	F	43/5797	Structural Consultants	Phase 3
Point Leamington Academy	Point Leamington	Robb	1973	F	32/5454	Nova Consultants	Phase 3 completed
Ricketts Elementary	Seal Cove	Robb	1971	A	12/4900	H. Sparkes	Work completed
Rocky Harbour Elementary	Rocky Harbour	Robb	1975-6	F	46/6021	E. Reed Manager	Work Completed
Roncalli Elementary	St. John's	Robb	1974	F	42/5768	Structural Consultants	Phase 3 completed
St. Anne's Elementary	Codroy	Robb	1968		4263	Bridger Design	School to close
St. Anne's Elementary	Codroy	Robb	1971	A	10/4887	Bridger Design	School to close
St. Anthony Elementary	St. Anthony	Robb	1972	F	26/5271	Nova Consultants	Work Complete
St. Francis Central High	Harbour Grace	Robb	1973	F	37/5567	Structural Consultants	Phase 3 not reqd
St. Francis Central High	Harbour Grace	Robb	1972	F	29/5338	Structural Consultants	Phase 3 not reqd

Robb Joist Summary

Building	Location	Joist Mnftr	Phase Yr.	RobbType	RobbList/Contract#	Inspection	Work Compl
St. Francis of Assissi	Logy Bay	Robb	1970		No tags on joists	Structural Consultants	Phase 3 completed
St. Genevieve School	Brig Bay	Robb	1971	A	14/4982	P. Manuel	Phase 3 not req'd.See e-mail to Gary.
St. Joseph's All Grade	Harbour Breton	Robb	1983	R	60/7403	Nova Consultants	Phase 3 not reqd work completed
St. Joseph's*	Harbour Main	Robb	1976	Suspect F	52/6247	M. Griffen	School Sold. Board wrote & advised to tell new owners.
St. Stephen's Elementary Ph II	Stephenville	Robb	1984	P	61/7478	Bridger Design	Phase 3 completed Letter sent
St. Theresa's	St. John's	Robb	1970		3749	Structural Consultants	Phase 3 completed
St. Thomas Aquinas Elem.	Port au Port East	Robb	1986		7743	C. Butt	No
Student Dorm (5004)	North West River	Robb	1970		4652	Nova Consultants	Work Completed
Swift Current All Grade	Swift Current	Robb	1972	F	21/5190	K. Talabany	Gable Roof Trusses Repaired
Tricon Elementary	Bay de Verde	Robb	1973	F	33/5457	FGA	Phase 3 completed
Twillingate Elementary	Twillingate	Robb	1970		4695	K. Talabany	Phase 3 completed
Valley Vista Senior Citizen's Home	Springdale	Robb	1983		7454	G. W. Prince	Work completed
Valley Vista Senior Citizen's Home	Springdale	Robb	1975	F	6133	G. W. Prince	Work completed

Robb Joist Summary

Building	Location	Joist Mnftr	Phase Yr.	RobbType	RobbList/Contract#	Inspection	Work Compl
Woodland Elementary	Dildo	Robb	1972	F	24/5231	FGA	Phase 3 completed

APPENDIX IV

"TYPICAL WELDING PROCEDURE AND DATA SHEETS"

WELDING PROCEDURE SPECIFICATION 2200

ELECTRODE: E48018 (E7018)

Prepared for:

Company Name
Company Address
City, Province
Canada XXX XXX

Prepared by:

fga Consulting Engineers Limited
2 Hunt's Lane
St. John's, Newfoundland
Canada A1B 2L3

REV	DATE	BY	DESCRIPTION	Canadian Welding Bureau	Engineer's Stamp
0	mmm d/yy	XXX	For Approval		

1.0 SCOPE

.1 This Welding Procedure Specification covers welding and related operations in accordance with CSA Standard W59-M1989 and has been prepared to meet the requirements of Clause 7.3 of CSA Standard W47.1-92.

.2 A change in any of the essential variables contained in succeeding paragraphs or detailed on applicable Welding Procedure Data Sheets shall require a new Specification and/or new Data Sheets.

2.0 WELDING PROCEDURE

.1 The welding shall be done manually using the Shielded Metal Arc Welding (SMAW) process.

.2 The joints shall be made by single or multiple pass welding, from one or both sides, as indicated on the Data Sheets referring to this Specification.

3.0 BASE METAL

.1 The base metals shall normally conform to the specifications for Steel Groups 1, 2 or 3 in accordance with Table 11-1 of CSA Standard W59.

.2 Base metals other than those listed in Table 11-1 of CSA Standard W59 may be welded under this Specification when approved by the Engineer, provided approved Data Sheets have been qualified for these materials.

.3 Base metal thickness shall be a minimum of 3 mm (1/8") with no limitation on maximum thickness, provided approved Data Sheets exist for the thicknesses to be welded.

4.0 **PREPARATION OF BASE METAL**

.1 Preparation of the base metal profile shall conform to the requirements of the applicable Data Sheets. End preparation may be accomplished by oxy-acetylene cutting, shearing, machining, gouging, grinding or a combination of these methods. Both shop and factory prepared ends shall be smooth, uniform and free from fins, tears, cracks and other defects that would adversely affect the quality or strength of the weld. Surfaces to be welded must be clean within 50 mm of any weld locations and free from all slag, paint, oil, grease, moisture, rust, scale and other material likely to be detrimental to welding immediately prior to the commencement of the welding process.

5.0 **FILLER METAL**

.1 The filler metal shall be E48018 (E7018) approved to the requirements of CSA Standard W48.1, Carbon Steel Covered Electrodes for Shielded Metal Arc Welding. Electrodes shall be certified by the Canadian Welding Bureau.

.2 Storage of electrodes shall be in accordance with Clause 5.2.2.4.1 to 5.2.2.4.7 of CSA Standard W59 for E48018 (E7018) electrodes (see Clause 4.9 of the Welding Engineering Standards).

6.0 **POSITION**

.1 The welding shall preferably be done in the flat position. The horizontal, vertical or overhead positions may be used provided approved Data Sheets referring to those positions and this Specification are followed. Unless called for otherwise on a specific Data Sheet, vertical welds shall be made with the progression of each pass in an upward direction. If welds are to be made in a vertical down sequence, the Data Sheet shall first be qualified, followed by welder qualification in accordance with Clause 9.5.2 and 9.5.4 of CSA Standard W47.1.

7.0 PREHEAT AND INTERPASS TEMPERATURES

.1 The minimum preheat and interpass temperature shall be in accordance with Table 5-3 of CSA Standard W59 (see Clause 4.3 of the Welding Engineering Standards).

.2 If welding is interrupted for some time such that the temperature of the base metal falls below the minimum specified, the preheat shall be re-established prior to recommencing welding.

.3 Welding shall not be carried out when the ambient temperature is less than -18 °C, except with the express consent of the Owner's Engineer.

8.0 ELECTRICAL CHARACTERISTICS

.1 The welding current shall be direct current or alternating current in accordance with the applicable Data Sheet. The polarity shall be reverse (electrode positive) when direct current is used.

.2 The power source shall be constant current type.

.3 In the absence of specific manufacturer recommendations, the amperage and voltage ranges shall be as follows:

E48018 (E7018) ELECTRODE: RECOMMENDED AMPERAGE AND VOLTAGE RANGES

Diameter (mm)	Amperage Range			Voltage Range
	Flat/Horizontal	Vertical	Overhead	
2.5	75 - 110	75 - 110	75 - 110	22 - 26
3.2	110 - 160	100 - 150	100 - 150	22 - 28
4.0	150 - 220	135 - 200	135 - 200	24 - 30
5.0	215 - 300	-	200 - 275	24 - 34
6.0	275 - 360	-	-	28 - 36

Note: (1) The above ranges may vary slightly with manufacturer.

9.0 WELDING TECHNIQUE

.1 The maximum tolerances on the amperage listed on the Data Sheets referring to this Specification shall be in accordance with the above table or manufacturer recommendations.

.2 The maximum tolerances on the voltage listed on the Data Sheets referring to this Specification shall be in accordance with the above table or manufacturer recommendations.

.3 The maximum thickness of layers shall be in accordance with Table 10-1 of CSA Standard W59.

.4 The maximum electrode size shall be in accordance with Table 10-1 of CSA Standard W59.

.5 The maximum single pass fillet weld size shall be in accordance with Table 10-1 of CSA Standard W59.

.6 The maximum width of single pass layers shall be such that weaving of the electrode is limited to 2½ times the electrode diameter. Stringer beads are preferred to weaving.

.7 The arc shall be initiated and maintained as follows:
With the machine set at the appropriate amperage, strike the arc and proceed to weld hold as short an arc as possible. The tip of the electrode may be touched to the work to serve as a guide to arc length. In all positions, use a straight forward progression, weaving as required up to a maximum of 2½ times the electrode diameter. Do not use a long arc since it encourages the entry of air and promotes porosity. Attention must be paid at the start of the bead to obtain full coverage with slag in order to prevent porosity. Inspection, cleaning and necessary corrections must be done after each pass.

10.0 TREATMENT OF UNDERSIDE OF WELDING GROOVE

.1 Prior to depositing weld metal on the underside of a joint, the root shall be back gouged to sound metal unless otherwise specified on the applicable Data Sheet.

.2 Back gouging shall produce a groove contour substantially conforming to the prequalified single U-joint and its depth shall be adequate to ensure complete penetration into the previously deposited weld metal for the welding process to be used (see sketch of typical Back Gouge Geometry on the applicable Data Sheet).

11.0 WELD METAL CLEANING

.1 All slag or flux remaining after a pass is deposited shall be removed by wire brushing and/or mechanical means before applying the next covering pass.

.2 Special care shall be exercised in cleaning tack welds.

.3 Slag shall be removed from all finished welds.

12.0 QUALITY

.1 Cracks or blowholes that appear on the surface of any pass shall be removed before depositing the next covering pass. The procedure and technique shall be that undercutting of base metal or adjacent passes is minimized.

.2 The reinforcement in groove welds shall not exceed 3 mm and shall have a gradual transition to the plane of the base metal surface. Undercut shall be within the limits of Clause 11.5.4.1(f) and/or Clause 12.5.4.1(h), as applicable, of CSA Standard W59. All welds shall be free from overlap.

.3 In general, the weld profile and quality shall be such as to meet the requirements of Clause 11.5.4 and/or Clause 12.5.4, as applicable, of CSA Standard W59.

13.0 REPAIR

.1 Welding repair shall be in accordance with an approved Welding Repair Procedure.

CWB CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

SHEET 1 OF 1

No. 2211F
REV. 0
DATE XXX. XXXX
W47.1

COMPANY NAME ____________________
ADDRESS ____________________

WLDG. PROCEDURE SPECIFICATION No. 2200
APPLICABLE STANDARDS CSA W59-M1989 CSA W47.1-92

WELDING PROCESS ☒ SHIELDED METAL ARC (SMAW) ☐ GAS METAL ARC (GMAW) ☐ GAS TUNGSTEN ARC (GTAW) ☐ FLUX-CORED ARC (FCAW) ☐ SUBMERGED-ARC (SAW) ☐ OTHER ____________

ELECTRODE (WIRE) CLASSIFICATION E48018
SHIELDING GAS OR FLUX N/A

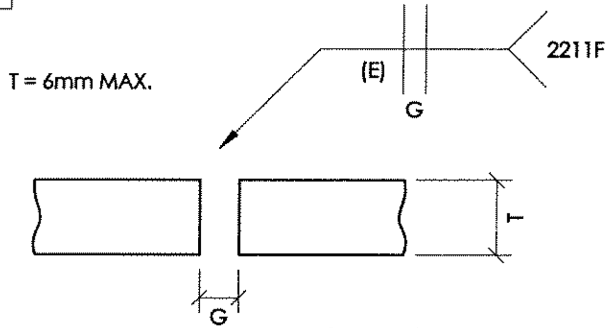
PROCESS MODE ☒ MANUAL ☐ MACHINE ☐ SEMI-AUTOMATIC ☐ AUTOMATIC

TUNGSTEN TYPE N/A
TUNGSTEN SIZE N/A
WELDING POSITION FLAT

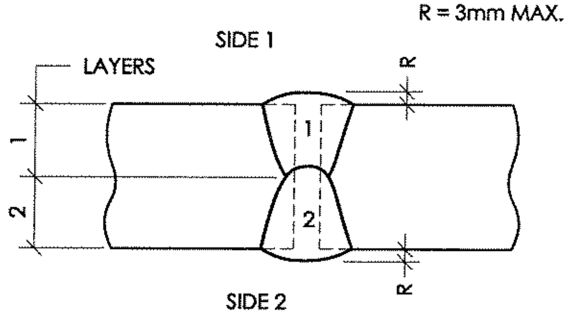
MATERIAL DESIGNATIONS AS PER TABLE 11-1, CSA W59, STEEL GROUPS 1, 2 & 3

PREHEAT TEMP. 10 °C
MIN. INTERPASS TEMP. 10 °C
MAX. INTERPASS TEMP. 300 °C

M1-3



Gmin = T/2
EFFECTIVE THROAT (E) = T



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD
☐ Back Gouged to Sound Metal
☒ Welded Both Sides without Back Gouging
☐ Welded onto Steel Backing
☐ Welded onto other than Steel Backing
☐ Welded from One Side without Backing

☐ Partial Joint Penetration Groove Weld (Specifiy Effective Throat)
☐ Fillet Weld

JOINT TYPE
☒ BUTT ☐ TEE
☐ CORNER ☐ EDGE
☐ LAP

Automatic,Semi-Automatic or Machine
Electrical Stickout N/A
Shielding Gas Flow Rate: N/A

Mat'l Thk.	Weld Size/ ETT	Side No.	Layer Number	Pass Number	Electrode Size	Current Polarity	Amperes	Wire Feed Speed	Volts	Arc Travel Speed
3	3	1 & 2	1 & 2	1 & 2	3.2 mm	DCRP	110 - 160			
5	5	1 & 2	1 & 2	1 & 2	4.0 mm	DCRP	150 - 220			
6	6	1 & 2	1 & 2	1 & 2	5.0 mm	DCRP	215 - 300			

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No.	DATE	BY	EXPLANATION
0	XXX.XX/XX	XXX	FOR APPROVAL

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CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

SHEET 1 OF 1

No. 2212-1F | REV. 0 | DATE XXX. XXXX | W47.1

COMPANY NAME ____________________

ADDRESS ____________________

WLDG. PROCEDURE SPECIFICATION No. 2200

APPLICABLE STANDARDS CSA W59-M1989 CSA W47.1-92

WELDING PROCESS ☒ SHIELDED METAL ARC (SMAW) ☐ GAS METAL ARC (GMAW) ☐ GAS TUNGSTEN ARC (GTAW) ☐ FLUX-CORED ARC (FCAW) ☐ SUBMERGED-ARC (SAW) ☐ OTHER ______

ELECTRODE (WIRE) CLASSIFICATION E48018

SHIELDING GAS OR FLUX N/A

PROCESS MODE ☒ MANUAL ☐ MACHINE ☐ SEMI-AUTOMATIC ☐ AUTOMATIC

TUNGSTEN TYPE N/A

TUNGSTEN SIZE N/A

WELDING POSITION FLAT

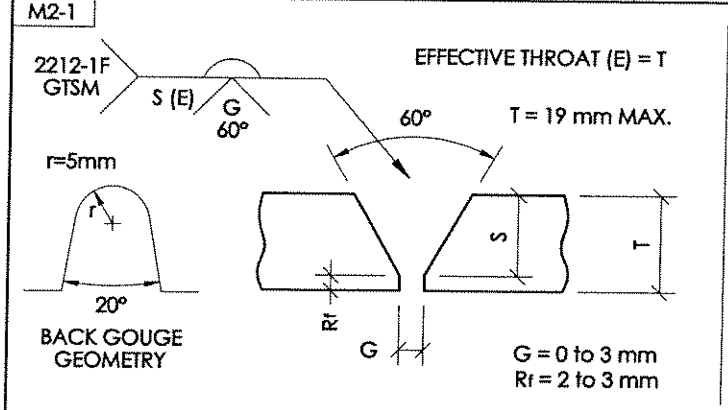
MATERIAL DESIGNATIONS AS PER TABLE 11-1, CSA W59, STEEL GROUPS 1, 2 & 3

PREHEAT TEMP. 10 °C

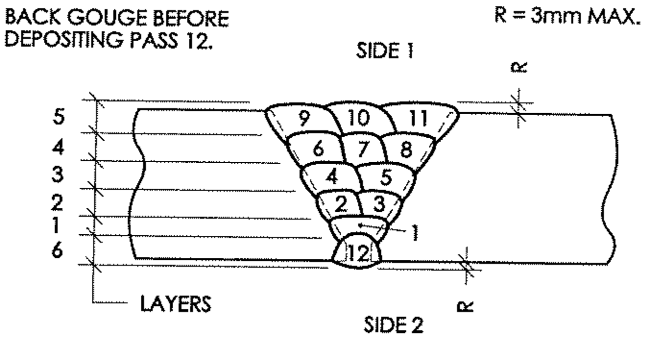
MIN. INTERPASS TEMP. 10 °C

MAX. INTERPASS TEMP. 300 °C

M2-1



SKETCH OF TYPICAL JOINT PREPARATION



TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD

☒ Back Gouged to Sound Metal ☐ Welded Both Sides without Back Gouging

☐ Welded onto Steel Backing ☐ Welded onto other than Steel Backing

☐ Welded from One Side without Backing

☐ Partial Joint Penetration Groove Weld (Specifiy Effective Throat)

☐ Fillet Weld

JOINT TYPE

☒ BUTT ☐ TEE

☐ CORNER ☐ EDGE

☐ LAP

Mat'l Thk.	Weld Size/ ETT	Side No.	Layer Number	Pass Number	Electrode Size	Current Polarity	Amperes
6	6	1 & 2	1 & 6	1 & 12	3.2 mm	DCRP	110 - 160
8	8	1 & 2	1, 2 & 6	1, 2 & 12	3.2 mm	DCRP	110 - 160
10	10	1 & 2	1, 2 & 6	1 to 3 & 12	3.2 mm	DCRP	110 - 160
13	13	1 & 2	1 to 3 & 6	1 to 5 & 12	3.2 mm	DCRP	110 - 160
16	16	1 & 2	1 to 4 & 6	1 to 8 & 12	3.2 mm	DCRP	110 - 160
19	19	1 & 2	1 to 6	1 to 12	3.2 mm	DCRP	110 - 160

Automatic,Semi-Automatic or Machine

Electrical Stickout N/A

Shielding Gas Flow Rate: N/A

Wire Feed Speed	Volts	Arc Travel Speed

NOTE:
DISTORTION CONSIDERATION MAY BE NECESSARY.

REVISIONS

No.	DATE	BY	EXPLANATION
0	XXX.XX/XX	XXX	FOR APPROVAL

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WELDING PROCEDURE DATA SHEET

SHEET 1 OF 1

No. 2222F REV. 0 DATE XXX. XXXX **W47.1**

COMPANY NAME

ADDRESS

WLDG. PROCEDURE SPECIFICATION No. 2200
APPLICABLE STANDARDS CSA W59-M1989 CSA W47.1-92

WELDING PROCESS ☒ SHIELDED METAL ARC (SMAW) ☐ GAS METAL ARC (GMAW) ☐ GAS TUNGSTEN ARC (GTAW) ☐ FLUX-CORED ARC (FCAW) ☐ SUBMERGED-ARC (SAW) ☐ OTHER

ELECTRODE (WIRE) CLASSIFICATION E48018
SHIELDING GAS OR FLUX N/A

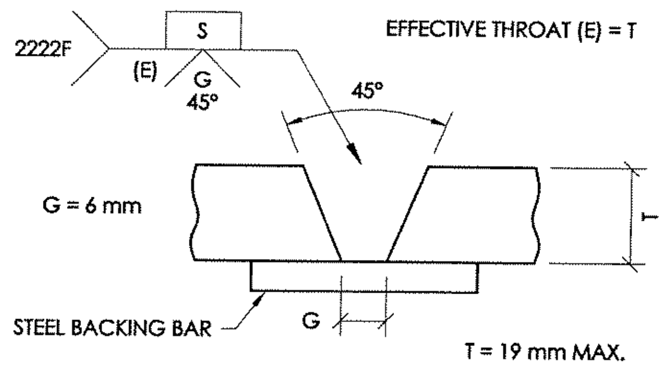
PROCESS MODE ☒ MANUAL ☐ MACHINE ☐ SEMI-AUTOMATIC ☐ AUTOMATIC

TUNGSTEN TYPE N/A
TUNGSTEN SIZE N/A
WELDING POSITION FLAT

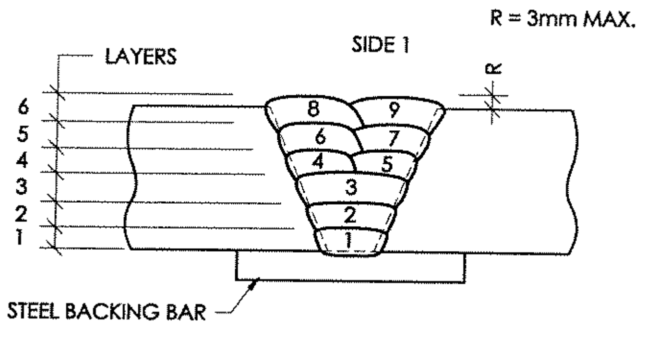
MATERIAL DESIGNATIONS AS PER TABLE 11-1, CSA W59, STEEL GROUPS 1, 2 & 3

PREHEAT TEMP. 10 °C
MIN. INTERPASS TEMP. 10 °C
MAX. INTERPASS TEMP. 300 °C

M2-2



SKETCH OF TYPICAL JOINT PREPARATION



TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD
☐ Back Gouged to Sound Metal ☐ Welded Both Sides without Back Gouging
☒ Welded onto Steel Backing ☐ Welded onto other than Steel Backing
☐ Welded from One Side without Backing

☐ Partial Joint Penetration Groove Weld (Specifiy Effective Throat)
☐ Fillet Weld

JOINT TYPE
☒ BUTT ☐ TEE
☐ CORNER ☐ EDGE
☐ LAP

Mat'l Thk.	Weld Size/ ETT	Side No.	Layer Number	Pass Number	Electrode Size	Current Polarity	Amperes	Automatic,Semi-Automatic or Machine Electrical Stickout N/A Wire Feed Speed	Shielding Gas Flow Rate: N/A Volts	Arc Travel Speed
6	6	1	1 & 2	1 & 2	4.0mm	AC or DCRP	150 - 220			
8	8	1	1 to 3	1 to 3	4.0mm	AC or DCRP	150 - 220			
10	10	1	1 to 3	1 to 3	4.0mm	AC or DCRP	150 - 220			
13	13	1	1	1	4.0mm	AC or DCRP	150 - 220			
		1	2 to 4	2 to 5	5.0mm	AC or DCRP	215 - 300			
16	16	1	1	1	4.0mm	AC or DCRP	150 - 220			
		1	2 to 5	2 to 7	5.0mm	AC or DCRP	215 - 300			
19	19	1	1	1	4.0mm	AC or DCRP	150 - 220			
		1	2 to 6	2 to 9	5.0mm	AC or DCRP	215 - 300			

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WELDING PROCEDURE DATA SHEET

SHEET 1 OF 1

No. 2227F
REV. 0
DATE XXX. XXXX
W47.1

COMPANY NAME

ADDRESS

WLDG. PROCEDURE SPECIFICATION No. 2200
APPLICABLE STANDARDS CSA W59-M1989 CSA W47.1-92

WELDING PROCESS ■ SHIELDED METAL ARC (SMAW) ☐ GAS METAL ARC (GMAW) ☐ GAS TUNGSTEN ARC (GTAW) ☐ FLUX-CORED ARC (FCAW) ☐ SUBMERGED-ARC (SAW) ☐ OTHER

ELECTRODE (WIRE) CLASSIFICATION E48018
SHIELDING GAS OR FLUX N/A

PROCESS MODE ■ MANUAL ☐ MACHINE ☐ SEMI-AUTOMATIC ☐ AUTOMATIC

TUNGSTEN TYPE N/A

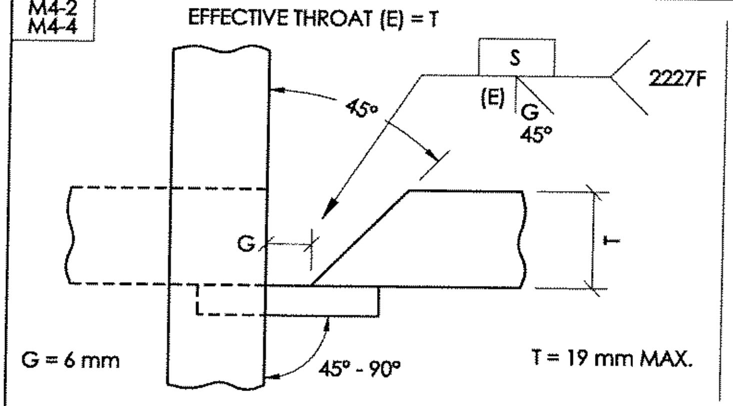
TUNGSTEN SIZE N/A

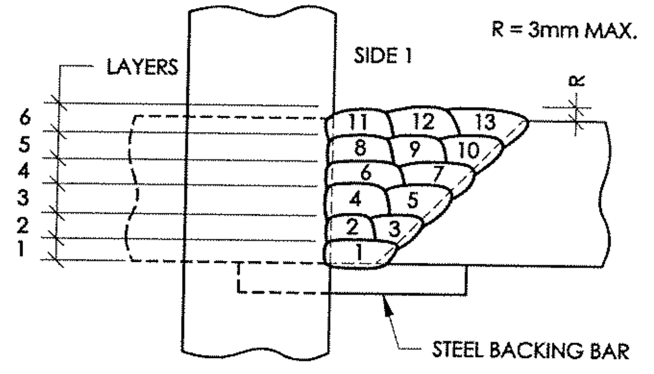
WELDING POSITION FLAT

MATERIAL DESIGNATIONS AS PER TABLE 11-1, CSA W59, STEEL GROUPS 1, 2 & 3

PREHEAT TEMP. 10 °C
MIN. INTERPASS TEMP. 10 °C
MAX. INTERPASS TEMP. 300 °C

M4-2
M4-4





SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD
☐ Back Gouged to Sound Metal
☐ Welded Both Sides without Back Gouging
■ Welded onto Steel Backing
☐ Welded onto other than Steel Backing
☐ Welded from One Side without Backing

☐ Partial Joint Penetration Groove Weld (Specify Effective Throat)
☐ Fillet Weld

JOINT TYPE
■ BUTT ■ TEE
■ CORNER ☐ EDGE
☐ LAP

<table>
<tr><th rowspan="3">Mat'l Thk.</th><th rowspan="3">Weld Size/ ETT</th><th rowspan="3">Side No.</th><th rowspan="3">Layer Number</th><th rowspan="3">Pass Number</th><th rowspan="3">Electrode Size</th><th rowspan="3">Current Polarity</th><th rowspan="3">Amperes</th><th colspan="3">Automatic,Semi-Automatic or Machine</th></tr>
<tr><th>Electrical Stickout N/A</th><th colspan="2">Shielding Gas Flow Rate: N/A</th></tr>
<tr><th>Wire Feed Speed</th><th>Volts</th><th>Arc Travel Speed</th></tr>
<tr><td>5</td><td>5</td><td>1</td><td>1 & 2</td><td>1 to 3</td><td>4.0mm</td><td>AC or DCRP</td><td>150 - 220</td><td></td><td></td><td></td></tr>
<tr><td>6</td><td>6</td><td>1</td><td>1 & 2</td><td>1 to 3</td><td>4.0mm</td><td>AC or DCRP</td><td>150 - 220</td><td></td><td></td><td></td></tr>
<tr><td>8</td><td>8</td><td>1</td><td>1 & 2</td><td>1 to 3</td><td>4.0mm</td><td>AC or DCRP</td><td>150 - 220</td><td></td><td></td><td></td></tr>
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<tr><td>13</td><td>13</td><td>1</td><td>1 to 4</td><td>1 to 7</td><td>4.0mm</td><td>AC or DCRP</td><td>150 - 220</td><td></td><td></td><td></td></tr>
<tr><td>16</td><td>16</td><td>1</td><td>1 to 5</td><td>1 to 10</td><td>4.0mm</td><td>AC or DCRP</td><td>150 - 220</td><td></td><td></td><td></td></tr>
<tr><td>19</td><td>19</td><td>1</td><td>1 to 6</td><td>1 to 13</td><td>4.0mm</td><td>AC or DCRP</td><td>150 - 220</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</table>

REVISIONS

No.	DATE	BY	EXPLANATION
0	XXX.XX/XX	XXX	FOR APPROVAL

Canadian Welding Bureau

Engineer's Stamp

CWB CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

SHEET 1 OF 1

No. 2231F REV. 0 DATE XXX. XXXX **W47.1**

COMPANY NAME

ADDRESS

WLDG. PROCEDURE SPECIFICATION No. 2200

APPLICABLE STANDARDS CSA W59-M1989 CSA W47.1-92

WELDING PROCESS ☒ SHIELDED METAL ARC (SMAW) ☐ GAS METAL ARC (GMAW) ☐ GAS TUNGSTEN ARC (GTAW) ☐ FLUX-CORED ARC (FCAW) ☐ SUBMERGED-ARC (SAW) ☐ OTHER

ELECTRODE (WIRE) CLASSIFICATION E48018

SHIELDING GAS OR FLUX N/A

PROCESS MODE ☒ MANUAL ☐ MACHINE ☐ SEMI-AUTOMATIC ☐ AUTOMATIC

TUNGSTEN TYPE N/A

TUNGSTEN SIZE N/A

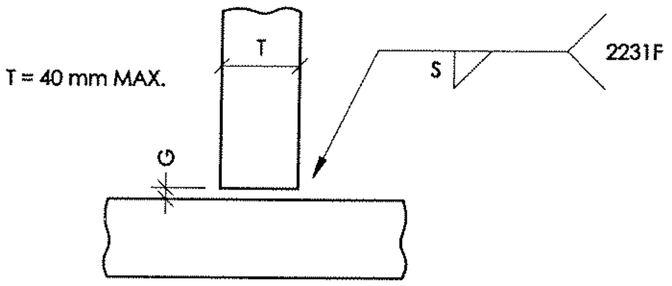
WELDING POSITION FLAT

MATERIAL DESIGNATIONS AS PER TABLE 11-1, CSA W59, STEEL GROUPS 1, 2 & 3

PREHEAT TEMP. 10 °C

MIN. INTERPASS TEMP. 10 °C

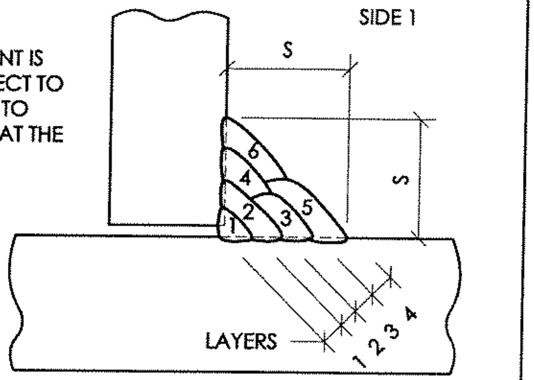
MAX. INTERPASS TEMP. 300 °C



G = 1 mm MAXIMUM; FOR LARGER GAPS, REFER TO CLAUSE 5.4.1 OF CSA W59.

SKETCH OF TYPICAL JOINT PREPARATION

NOTE: THIS TYPE OF JOINT IS NOT TO BE SUBJECT TO BENDING SO AS TO CAUSE TENSION AT THE ROOT.



TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD

☐ Back Gouged to Sound Metal ☐ Welded Both Sides without Back Gouging

☐ Welded onto Steel Backing ☐ Welded onto other than Steel Backing

☐ Welded from One Side without Backing

☐ Partial Joint Penetration Groove Weld (Specifiy Effective Throat)

☒ Fillet Weld

JOINT TYPE

☐ BUTT ☒ TEE ☐ CORNER ☐ EDGE ☐ LAP

Mat'l Thk.	Weld Size/ ETT	Side No.	Layer Number	Pass Number	Electrode Size	Current Polarity	Amperes	Automatic,Semi-Automatic or Machine		
								Electrical Stickout N/A	Shielding Gas Flow Rate: N/A	
								Wire Feed Speed	Volts	Arc Travel Speed
	6	1	1	1	4.0 mm	DCRP	150 - 220			
	8	1	1	1	5.0 mm	DCRP	215 - 300			
	10	1	1	1	5.0 mm	DCRP	215 - 300			
	13	1	1 & 2	1 & 2	5.0 mm	DCRP	215 - 300			
	13	1	1 & 2	1 & 2	6.0 mm	DCRP	275 - 360			
	16	1	1 to 3	1 to 4	5.0 mm	DCRP	215 - 300			
	16	1	1 to 3	1 to 4	6.0 mm	DCRP	275 - 360			
	19	1	1 to 4	1 to 6	5.0 mm	DCRP	215 - 300			
	19	1	1 to 4	1 to 6	6.0 mm	DCRP	275 - 360			

REVISIONS

No.	DATE	BY	EXPLANATION
0	XXX.XX/XX	XXX	FOR APPROVAL

Canadian Welding Bureau

Engineer's Stamp

CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

SHEET 1 OF 1

No. 2250F REV. 0 DATE MAY 2001 **W47.1**

COMPANY NAME

ADDRESS

WLDG. PROCEDURE SPECIFICATION No. 2200

APPLICABLE STANDARDS CSA W59-M1989 CSA W47.1-92

WELDING PROCESS ☒ SHIELDED METAL ARC (SMAW) ☐ GAS METAL ARC (GMAW) ☐ GAS TUNGSTEN ARC (GTAW) ☐ FLUX-CORED ARC (FCAW) ☐ SUBMERGED-ARC (SAW) ☐ OTHER

ELECTRODE (WIRE) CLASSIFICATION E48018

SHIELDING GAS OR FLUX N/A

PROCESS MODE ☒ MANUAL ☐ MACHINE ☐ SEMI-AUTOMATIC ☐ AUTOMATIC

TUNGSTEN TYPE N/A

TUNGSTEN SIZE N/A

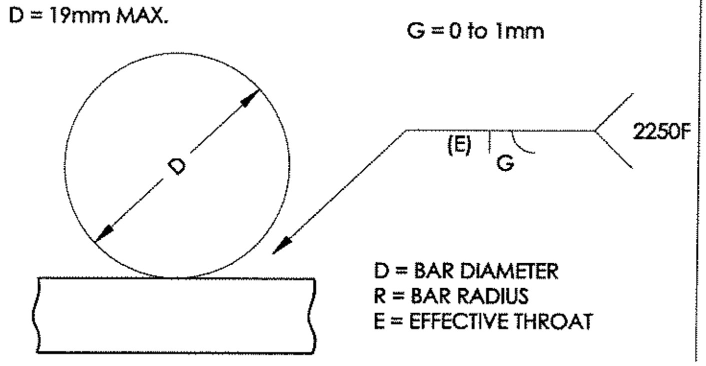
WELDING POSITION FLAT

MATERIAL DESIGNATIONS AS PER TABLE 11-1, CSA W59, STEEL GROUPS 1, 2 & 3

PREHEAT TEMP. 10 °C

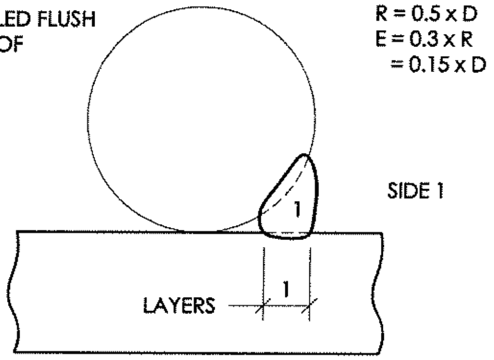
MIN. INTERPASS TEMP. 10 °C

MAX. INTERPASS TEMP. 300 °C



SKETCH OF TYPICAL JOINT PREPARATION

NOTE:
JOINT TO BE FILLED FLUSH WITH SURFACE OF ROUND BAR.



TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD

☐ Back Gouged to Sound Metal
☐ Welded Both Sides without Back Gouging
☐ Welded onto Steel Backing
☐ Welded onto other than Steel Backing
☐ Welded from One Side without Backing

☒ Partial Joint Penetration Groove Weld (Specifiy Effective Throat)
☐ Fillet Weld

JOINT TYPE
☐ BUTT ☒ TEE
☐ CORNER ☐ EDGE
☐ LAP

Mat'l Thk.	Weld Size/ ETT	Side No.	Layer Number	Pass Number	Electrode Size	Current Polarity	Amperes	Automatic,Semi-Automatic or Machine Electrical Stickout N/A Wire Feed Speed	Shielding Gas Flow Rate: N/A Volts	Arc Travel Speed
13	1.95	1	1	1	3.2 mm	DCRP	100 - 150			
16	2.4	1	1	1	3.2 mm	DCRP	100 - 150			
19	2.85	1	1	1	3.2 mm	DCRP	100 - 150			

REVISIONS

No.	DATE	BY	EXPLANATION
0	XXX.XX/XX	XXX	FOR APPROVAL

Canadian Welding Bureau

Engineer's Stamp

APPENDIX V

"A DISCUSSION OF NBC COMMENTARY K AND IT'S APPLICABILITY"

A DISCUSSION OF NBC COMMENTARY K AND IT'S APPLICABILITY TO THE ROBB OWSJ PROBLEM

As we embark upon a testing program thought must be given to strength, stability, integrity and safety.

Structural integrity is defined by the National Building Code as, "the ability of a structure to absorb local failure without widespread collapse.

The process the Task Force is presently involved in, may be termed the identification of a **Hazard**. The hazard is the risk of widespread collapse with serious consequences arising from local failure. The National Building Code states:

> *"Key components which can be severely damaged by an accident with a significant probability of occurance (approximately 10^{-4} per year or more) should therefore be identified, and measures taken to ensure adequate structural safety."*

While this clause is part of a discussion on structural integrity it does give a strong indication of the type of probability against collapse that is anticipated by the code in order to term a building, safe.

The National building also provides guidance for upgrading existing buildings in commentary K "Application of NBC Part 4 for the Structural Evaluation and Upgrading of Existing Buildings."

As stated in the Introduction of Commentary K, it concerns the structural evaluation and upgrading of an existing building to achieve a level of performance which is appropriate, based on the intent of the current NBC requirements.

While the commentary does not specifically state the circumstances which would require a structural evaluation, it cites typical examples such as "damage or deterioration, and where the safety of the building is a concern because of known or potential defects." This clearly is the situation with Robb Joists and therefore commentary K is appropriate (see copy attached).

Clause 8 points out the basic fundamental consideration of Part 4 of NBC, namely

life safety
comfort of occupants
function of the building
durability
economics

Clause 9 states that life safety is the first and foremost consideration of Part 4 of NBC.

against

Clause 10 makes the point that there can be some departure from the current code design criteria provided the probability of death or injury is generally equivalent. Or conversely, if life safety is an issue, the current code design criteria (ultimate limit states) must be followed.

Under the heading "Quality Assurance" it is stated the designer be a professional engineer and that in these type of situations more engineering judgement is generally required. A prerequisite is that an appropriate structural evaluation and field review be carried out.

The next question to be addressed is which version of the code (NBC) and resulting standards should be used for both evaluation and upgrading. An interpretation of Table K-1 makes it clear that both evaluation and upgrading shall be carried out in accordance with the 1995 Codes and Standards.

Evaluation based on past performance can be considered, provided there is no evidence of significant damage, distress or deterioration and provided the building has satisfactorily performed for 30 years or more, etc, and provided the buildings were designed and built in accordance with good construction practices. In our opinion the Robb joist generally do not meet the stated requirement to be considered on the basis of past performances. Therefore the evaluation (and upgrading) must be carried out in accordance with current codes and standards (1995) as previously stated.

The maximum probability of death or serious injury resulting from structural failure is equal to the probability of structural failure times the likelihood of death or serious injury: For the schools under consideration the risk category is termed "high" (Refer to Table K-5). The "Reliability Level" can be calculated from Table K-4 as follows:

Description	**Index**
System Behaviour	2
Risk Category	2
Past Performance	1
Reliability Index	5

Therefore there should be no relaxation in the load factors specified in sentence 4.1.3.2 (4) of the National Building Code.

A closer investigation of snow loads may be warranted for any roofs designed with the 0.6 load factor of previous codes, considering the current code is more stringent in this regard.

Finally, Commentary K states that load testing can be used for structural evaluation however it also states that it is a last resort process. In clause 60 it further states that:

> *"It is important that in a load test, the structure be exposed and accessible for visual inspection, before, during and after the test.*

Because the top chord of the joists are not accessible, in most cases, and therefore a failed joint may go undetected, load testing in situ is not an option.

In conclusion, the solution to the Robb Joist problems will require analysis using current editions of the National Codes and Standards without reduction. Any remediation will likely require considerable judgement however the goal should be to meet the "intent" of current codes if we wish to be able to term the structures as being safe. In light of the foregoing discussion, the current plan to load test similar joists under laboratory conditions (as opposed to in situ) appears to be a logical step in the evaluation of structures with Robb joists. This testing program will provide valuable information to allow the engineer to exercise sound judgement.

Gary J. Follett, P. Eng.
OWSJ Task Force

APPENDIX VI

“SUGGESTED REMEDIATION PROGRAM”

SUGGESTED MINIMUM CRITERIA FOR ROOF JOIST REMEDIATION

Category	Description	Suggested Remediation (Prel.)
Level I	Includes any joist: 1) With span exceeding 30', or 2) In a snow build up area (i.e. high low roofs), or 3) In an area with excessive failures, or 4) That has more than two failed joints.	1) Carry out structural analysis and upgrade to CSA S16.1-94. 2) Install top chord spacers as required by S16.1-94, but a minumum of 4 mid panel locations equally distribute about joist centre line. 3) Reinforce members/panel points on each end until resultant shear force ≤ 50% of end value.
Level II	Includes any joist: 1) With span between 15' and 30' inclusive, and 2) That is in a non-snow build up area, and 3a) With spacing less than 5', or	1) Carry out 100% inspection and make necessary repairs to joints, and 2) Review joist top chord spacer requirements and revise accordingly.
	3b) Spacing greater than 5'.	1) Reinforce to the second bottom chord panel point, and 2) Review joist top chord spacer requirements and revise accordingly.
Level III	Includes any joist: 1) With span less than 15', and 2) That is in a non-snow build up area.	1) Carry out 100% inspection and make repairs.
Level IV	Includes any joist: 1) Designed to 0.6 snow load factor and, 2) With failures or obvious deficiencies. Note for joist designed to 0.6 with no failures or obvious deterioration, treat at Level I, II or III above.	1) Analyze and upgrade to 0.8 snow load factor

Note: 100% inspection for joint failures must be carried out for all buildings, regardless of category.

SUGGESTED MINIMUM CRITERIA FOR FLOOR JOIST REMEDIATION

Category	Description	Suggested Remediation (Prel.)
Level I	Includes any joist: 1) With span exceeding 30', or 2) Iin a high load area (i.e. library), or 3) In an area with excessive failures, or 4) That has more than two failed joints.	1) Carry out structural analysis and upgrade to CSA S16.1-94. 2) Install spacers as per S16.1-94, plus between panel points at 4 locations near center span.
Level II	Includes any joist: 1) With span less than 30', and 2) That is in a heavy load area, and 3a) With spacing less than 4', or	1) Carry out 100% inspection and make necessary repairs to joints, and 2) Review joist spacer requirements and revise accordingly.
	3b) Spacing greater than 4'.	1) Reinforce to the second bottom chord panel point, and 2) Review joist spacer requirements and revise accordingly.

Note: 100% inspection for failed joints must be carried out for all buildings, regardless of category.

APPENDIX VII

“TYPICAL PHASE II INSPECTION REPORT”

PHASE II INSPECTION OF OPEN WEB STEEL JOISTS
JACKSON WALSH ELEMENTARY
WESTERN BAY

K. R. TOBIN

PROVINCE OF NEWFOUNDLAND
PERMIT HOLDER
CLASS "A"
This Permit Allows
FOLLETT GOSSE & ASSOCIATES LTD.

To practice Professional Engineering
in Newfoundland and Labrador.
Permit No. as issued by APEGN M 0113
which is valid for the year 1997.

Prepared For: Department of Works Services and Transportation
Design and Construction Division
P. O. Box 8700
St. John's, Newfoundland
A1B 4J6

Prepared By: FGA Consulting Engineers Limited
2 Hunt's Lane
St. John's, Newfoundland
A1B 2L3

Date: March 31, 1997

1.0 Statement of Purpose

On December 10, 1996, the Department of Works, Services and Transportation authorized FGA Consulting Engineers Limited to proceed with a structural inspection of various public buildings based on the engineering proposal entitled **"Engineering Proposal For The Structural Assessment of OWSJ For Public Buildings - Group 4".**

The referenced proposal had been submitted based on the requirements of the **Scope of Work for Consulting Services** prepared by the Department on 96-11-13 and subsequently modified as a result of a meeting with the OWSJ Task Force committee and Structural Engineering Consultants for OWSJ Inspections.

A list of Group 4 buildings was included with the request for proposal and subsequently modified with the addition of two other structures. During the past several months, the Department has spent considerable time accumulating information on public buildings to determine if the facilities contain Robb Engineering open web steel joists. In some cases, schools were identified from a list obtained by the Association of Professional Engineers and Geoscientists of Newfoundland that had been prepared by Robb Engineering. In other cases, consultants were engaged in an effort to determine the origin of the structural steel fabricator. In many instances, schools consisted of several extensions constructed over the investigation period of 1970 to 1985.

As a result of this exercise, a province wide list of public buildings was created which identified sites with Robb joists, with suspected Robb joists or with unknown origin. During Phase I of this project, inspectors from this office visited building locations where the origin of the open web steel joists was unknown or suspected to be by a fabricator other than Robb. In the previously submitted report entitled **"Structural Assessment of OWSJ for Group 4 Public Buildings, Phase I"** it was verified that Robb joists were not present at sites marked unknown or suspect other.

Therefore, the second phase of the project commenced during the week of January 6, 1997. The inspection team consisted of Mr. Mike O'Brien, P. Eng., and Mr. John Hussey. The Curriculum Vitae of these individuals is contained in Appendix "A".

This report presents the findings of the inspection carried out on January 11, 1997 at **Jackson Walsh Elementary**.

School Name -	**Jackson Walsh Elementary**
Location -	**Western Bay**
Board Name and Number -	**Avalon North Integrated School Board Number 110**
Contact Person -	**Mr. Don Ryan**

2.0 Discussion

The present facility was constructed as a single phase in 1972, and was designed by E. K. Jerrett and Associates. The single storey structure, approximately 22,000 square feet in area, was constructed of metal roof deck, open web steel joists, exterior and interior load bearing stud walls. Concrete foundations were of wall/strip footings on the exterior and pier/isolated footings on the interior.

The entire structure was constructed utilizing Robb Engineering open web steel joists. A general layout for the school is contained in Appendix "B". The manufacturer was identified by the distinctive method of web member fabrication and welding details. Round stock was formed into "w" shapes and "puddle" welds were used at every second top chord joint. Tags were similar to those found on other known Robb buildings.

A structural analysis was completed for one typical joist. Member sizes and joist geometry were obtained from on site measurements. Design loadings were obtained from original structural drawings. The location of the studied joist can be obtained from Appendix "B", while detailed structural calculations can be reviewed in Appendix "C".

Structural drawings stipulated a dead load of 1.00 kN/m^2 (20psf) and a snow load of 2.07kN/m^2 (44 psf). Design wind pressure was not indicated. Tributary width of the joist examined was 2.0 meters, and measured 508 millimeters out to out in depth.

The selected design dead load of 1.00 kN/m^2 would normally be considered a typical value at the commencement of a project, given the uncertainty as to the materials of construction. Given the known value for the weight of roof deck and a reasonable approximation for roofing and self weight of the joists, the remaining 0.25 kN/m^2 would consist of mechanical/electrical systems, ceiling construction and miscellaneous items.

The value selected for snow corresponds to a wind swept condition, such as at the higher gymnasium roof. The design drawings provide an allowance for snow buildup adjacent to the higher gymnasium structure. Given today's code requirements, one would question the use of 2.07 kN/m^2 for a majority of the lower roof area, given the obstruction that is created by the gymnasium.. Since no design value was stipulated for wind pressure, we were unable to determine from the drawings whether net uplift had been considered. From the analysis we have concluded that all members of this joist had ample capacity to meet the current S16 requirements for gravity load. However, additional bottom chord bridging would be required to address net uplift due to wind.

A total of 46 Robb joists were originally inspected throughout the school, with thirty per cent of the joints examined in detail during Phase II. Findings of the initial inspection revealed one failed weld in one joist. Authorization was given to complete a one hundred percent structural inspection and was completed on February 19,21,24, and 25. Four additional failures on three joists were encountered, three webs members were recorded as being bent, and one joint was not welded. Details of inspection results are contained in Appendix "D" along with typical photographs in Appendix "E". Weld characteristics were consistent with Robb joists of other buildings that FGA Consulting Engineers Limited has inspected in the past. Slag had not been removed from welds, puddle welds were observed at alternate top chord joints, and undercut was prevalent.

3.0 Report of Failures and Necessary Action

As stated previously, repairs were required at several joist locations and these were completed on February 25 by Land and Sea Welding. From the design review, consideration should be given to implementing the structural recommendations of Section 2.0.

4.0 Budget

Costs to date for this site would include the per diem rates established in the original fee proposal, as well as costs for additional inspection and repair work.

Professional Fees	$13305.50
Expenses	$2275.00

Rehabilitation of the joists should include the structural recommendations above along with joist reinforcement that will come from the conclusions obtained from the load test project that has been initiated by Works, Services and Transportation. Therefore, this calculation will be postponed until results are available.

APPENDIX ‘A’

CURRICULUM VITAE

KENNETH R. TOBIN, P.ENG.
VICE PRESIDENT
***fga* CONSULTING ENGINEERS LTD.**

QUALIFICATIONS

Bachelor of Engineering, Memorial University of Newfoundland, 1977.

Member, Association of Professional Engineers and Geoscientists of Newfoundland.

Newfoundland Representative, American Concrete Institute.

Member, Canadian Society for Civil Engineers.

Director, Consulting Engineers of Newfoundland and Labrador.

EMPLOYMENT HISTORY

April 1987 - Present:	***fga* Consulting Engineers Limited** Partner, Vice President and Structural Engineering Department Head, responsible for Project Management and design of various building, bridge and precast concrete projects. Currently providing Structural Consulting Services for the Hibernia Project.
1981 - April 1987:	**BFL Consultants Limited** Structural design engineering and project engineer for structural steel, reinforced concrete, precast and timber structures. Responsibilities also included the maintenance and upgrading of current computer design programs available in design office applications. Appointed Chief Structural Engineer for New North Consultants, July 1985, a joint venture involving BFL Consultants. Responsibilities included the design of structures for three new east coast sites participating in the Long Range Radar construction project.

1977 - 1981: **McNamara Industries Limited**

Structural Engineer responsible for all in-house building and steel construction design. Project management directly involved in several large scale and numerous small scale steel erection projects.

Appointed Chief Structural Engineer, 1979.

1976: **Pitts Engineering (Co-op Engineering Program)**

Responsible for job cost control accounting and general surveying on Harbour Arterial Road Project.

1975 - 1976: **Newfoundland & Labrador Housing Corporation (Co-op Engineering Program)**

Involvement in the design and construction of Mount Pearl - Newtown Housing Development.

1974 - 1975: **IBM (Co-op Engineering Program)**

Computer Operator Assistant, Data Processing Centre and Computer Programmer for Data Processing Centre Applications.

TYPICAL PROJECT EXPERIENCE

Assembly Buildings:

- Holy Trinity School Extension
- Gonzaga High School Extension
- Nain School
- H.R. Mews Centre Renovations
- Mary Queen of Peace Church
- St. Bonaventure's College Restoration

Health Care:

- School of Nursing,
- Health Science Complex
- Corner Brook Interfaith Home
- Springdale Senior Citizens Home
- Glenbrook Lodge
- Janeway Hospital Extension

Hotels, Motels & Residential:	- Governor's Park Hotel - Corner Brook Apartments - Goodview Street Apartment Complex
Civil Projects:	- M20 Grillage Support Structure - Hibernia - Jumpform/Slipform Systems - Hibernia
Industrial:	- Sandblast/Paintshop Building, Hibernia - Erection Hall Wall modifications - Hibernia - FPI - Secondary Processing Facility - FPI - Refit Building - Browning Harvey Extension - Institute of Marine Dynamics - Catwalk - Newfoundland Tractor Building - Royal Garage - St. John's Municipal Depot Extension
Institutions:	- H.M. Penitentiary Security Wall System - R.C.M.P. Building, Stephenville
Office Buildings:	- City Hall Annex - Bally Rou Building Extension - Centennial Square Office Building
Heritage:	- O'Dwyer Block - Masonic Temple Brick Restoration
Shopping Centres:	- K-Mart Shopping Centre Extensions - Corner Brook and St. John's - Village Mall Renovations, St. John's - Villa Nova Mall - Stokes Do-it Centre - Coaker's Meadow Mall
Bridge Design:	- Eel Brook Bridge Precast - Black Brook Bridge Precast - Dunn's River Bridge - Corner Brook Container Wharf Ramp - City Hall Annex Pedestrian Bridge - Shoal Harbour Bridge Precast Girders - Terra Nova Park Golf Course Bridges

Structural	- IMD Clearwater Tank Study - Village Mall Floor Analysis
Evaluations & Analysis Service:	- Argentia Industrial Park Study - Stephenville Harmon Complex Study - Marystown Shipyard - Central Newfoundland Hospital - St. John's Memorial Stadium
Chimney Design:	- Health Science Complex Chimney Retrofit - Janeway Hospital Chimney - Roddickton Wood Chip Plant (43.0 m)
Water Tanks:	- Bishops Falls (34.0M) - Appleton (21.0M)
Precast Concrete:	- Motor Vehicle Registration Building - Earth Sciences Centre - Carino Building - Aeroflight Building
Specialty Structure:	- IceImpact Frame - Marine Simulator Ballast Control Room

CURRICULUM VITAE

MICHAEL J. O'BRIEN, P.ENG.
FGA CONSULTING ENGINEERS LTD.

QUALIFICATIONS

Bachelor of Engineering (Mechanical), Memorial University of Newfoundland, 1991.

Member, Association of Professional Engineers and Geoscientists of Newfoundland.

Member, Canadian Society for Mechanical Engineers.

Member, Welding Institute of Canada.

Member, American Welding Society.

Certified as a Level II Welding Inspector in accordance with CSA W178.2.

EMPLOYMENT HISTORY

1994 - Present:

FGA Consulting Engineers Limited

Engineer responsible for preparation of welding specifications and data sheets in accordance with ASME Boiler and Pressure Vessel Code, Section IX and CSA Standards W47.1 and W186. Responsible for maintenance of welding standards and procedures for companies certified to CSA Standards W47.1 and W186. Other duties include conducting monthly shop inspections of certified welding companies, welding design, drawing review and preparation of quality assurance documents and miscellaneous fabrication procedures.

1991 - 1994: **Boom Construction & Engineering Limited**

Project Engineer responsible for the engineering and administration of mechanical/industrial/offshore fabrication contracts. Contracts involved both shop fabrication and field installations and included industrial piping, fuel/water storage tanks, pressure vessels and structural steel. Duties related to all aspects of projects, from estimating, contract review and sub-contractor evaluation to procurement, scheduling, client liaison, and engineering.

Also charged with the responsibilities of Welding Supervisor. This included fulfilling ongoing administrative requirements, maintaining welding procedure specifications and data sheets, witnessing welding procedure and welder qualification tests and monitoring welding consumable storage and handling.

TYPICAL PROJECT EXPERIENCE

(A) WELDING ENGINEERING

Duties include welding design, preparation of welding standards and procedures and assurance of compliance with applicable codes and specifications. Welding procedures prepared for a wide variety of materials in accordance with ASME, CWB and Hibernia requirements. Client list includes:

Peter Kiewit Sons' Company Limited
Vinland Industries Limited
Marystown Shipyard Limited
D. F. Barnes Limited
Corner Brook Foundry & Machine Company
Newfoundland Dockyard Corporation
M & M Engineering Limited
M & M Offshore Limited
Gryphon Industries Limited
Corner Brook Pulp and Paper Limited
Iron Ore Company of Canada

In addition, served as Site Welding Engineer for Peter Kiewit Sons' Company Limited for the Mechanical Outfitting of the GBS on the Hibernia Project at Bull Arm, Newfoundland. Duties included maintenance of CWB certification, updating welder records, preparation of welding procedures and data sheets, review of work packages for compliance with project specifications and assignment of welding procedures, witnessing of procedure qualification tests, coordination of mechanical and non-destructive testing of qualification tests, liaising with the Owner and the Canadian Welding Bureau, and providing a trouble shooting role for all welding matters. Welding procedures prepared include structural and pipe procedures for carbon steel, stainless steel, reinforcing bar, 6 moly and titanium.

(B) CONSTRUCTION SUPERVISION

Ultramar Canada Limited

Installation of asphalt heaters, heat exchangers, pumps and associated piping involved with a multi-phase upgrading for the asphalt storage tank farm at Holyrood, Nfld.

Labatt Breweries of Canada

Installation of a new beer kegging machine along with associated CO_2, water and process piping tie-ins at the St. John's, Newfoundland, plant.

Newfoundland and Labrador Hydro

Installation of centrifugal air fans, air filters, heating coils, pumps, condensate receiver and associated steam and condensate piping involved with a new make-up air system for the thermal generating station at Holyrood, Newfoundland. Prefabrication of steam and condensate pipe spools in pipe shop for field installation.

ESI Corporation

Fabrication of a stainless steel recirculation tank and associated piping connections for shipment to the pulp and paper plant at Corner Brook, Newfoundland.

Redcliff Building Corporation

Fabrication of a 9092 L horizontal dyked tank c/w pump, filters, refuelling hose and associated piping for the RCMP Helicopter Refuelling Center in Gander, Nfld.

GBS Management Team

Shop fabrication of pipe spools for the Temporary Ballast, Grouting/Air Cushion Systems, ranging in diameters from ø2" to ø32", for installation in the Hibernia Gravity Base Platform. System designed to control the temporary ballast and air cushion for the Gravity Base Structure during tow-out of the platform.

(C) DESIGN & DETAILING

Water Storage Reservoirs

Structural and welding design of steel water storage reservoirs to AWWA D100, "Welded Steel Tanks for Water Storage." Also, responsible for CAD drafting and/or reviewing tank fabrication drawings. Tanks designed/drafted include:

- Town of Bishop Falls
- Town of New Perlican
- Town of Milltown
- Town of Bonavista
- Exploits Water Treatment Plant
- Town of Sheshatshiu

Fuel Storage Tanks

Structural and welding design of steel fuel storage tanks to API 650, "Welded Steel Tanks for Oil Storage" and ULC 601, "Standard for Shop Fabricated Horizontal Fuel Tanks." Also, responsible for CAD drafting and/or reviewing tank fabrication drawings. Tanks designed/drafted include:

- Newfoundland and Labrador Hydro (Black Tickle)
- ESSO Aviation Facility (Gander)
- Ultramar Canada (Holyrood)
- Cow Head Fabrication Facility
- RCMP Helicopter Refuelling Center (Gander)

COURSES COMPLETED SINCE GRADUATION

Canadian Welding Bureau

- Welding Supervisor's Examinations
- W178.2 Welding Inspector's Examinations (Level II)
- "Semi-Automatic Welding Processes and Shielding Gases Selection"

Memorial University of Newfoundland

- "Overview of Modern Project Management Techniques"

Welding Institute of Canada

- "Lowering Welding Costs Through Effective Design"

CURRICULUM VITAE

JOHN E. HUSSEY
***fga* CONSULTING ENGINEERS LTD.**

QUALIFICATIONS

Certificate in General Drafting from the Bell Island District Vocational School - 1967.

Certificate in Architectural Drafting (Night School Course) from the College of Trades and Technology - 1968.

Certificate in Advanced Drafting (Engineering) from the Conception Bay South District Vocational School - 1970.

Certificate Manpower Training - Drafting on the Job Program - 1972.

Certificate in C.A.D. Operations - Levels 1, 2 & 3 - Sea Limited Job Training Program - 1989.

EMPLOYMENT HISTORY

1987 - Present: ***fga* Consulting Engineers Limited**

Senior Engineering Technician duties consisting of developing computer aided drawings for various Structural and Architectural projects throughout Newfoundland and Labrador. Also required to perform field surveying, structural steel column plumb and alignment checks as well as bolt torque checks on various projects.

1991 & 1993 **NODECO**

On loan from FGA for approximately nine months. Duties - on board and CAD drawings for various phases of the Hibernia Development project.

August 1986 - December 1986 **BAE Group**

Survey Technician/Draftsman at the Hope Brook Gold Mine site. Duties consisted of field surveying, civil engineering, drafting and quantity take-offs for the roads and building construction projects at the site.

June 1985 -
August 1986

Follett Gosse & Associates Limited

Part-time employment as a Draftsman/Technician. Duties consisted of civil, architectural and structural drawings for various projects throughout Newfoundland. Also required to do field surveying, earth quantity take-offs and on-site inspection as required.

July 1981 -
February 1985

BAE Group

Draftsman/Technician with Cat Arm Consultants, St. John's. Duties consisted of drafting and quantity calculations for the powerhouse structure, roads, dams, intake structure, unwatering schemes, tunnels, canals, hydrology, geology and all phases of hydro electric development. Also required to do on-site inspection and as-built civil drawings for the Cat Arm Hydro Development.

April 1972 -
July 1981

Project Planning & Engineering Limited
(Formerly BAE Group)

Senior Civil Engineering Draftsman/Technician with this group. Duties consisted of the drafting of various civil engineering projects throughout Newfoundland and Labrador. Also required to do field surveying, on-site inspections, quantity calculations and inspection of work for these projects.

July 1971 -
August 1971

Project Design & Co-ordinators

Draftsman with this company. Duties consisted of architectural drafting for medium sized buildings throughout Newfoundland.

February 1971 -
June 1971

Public Works Canada

Draftsman at the Pleasantville office. Duties consisted of field measurements and as-built drawings of numerous public buildings throughout Newfoundland.

June 1970 -
November 1970

Acres Canadian Bechtel

Quantities Technician with this company at Orma and Sail Lakes in Churchill Falls. Duties consisted of some field surveying as well as the drafting, planimetering and estimating of dam quantities for the Upper Churchill Falls Hydro Electric Development.

June 1967 -
August 1969

Department of Municipal Affairs and Housing

Draftsman with the Provincial Planning Office, St. John's. Duties consisted of the operation and maintenance of an Oyalid print machine, plan filing, drafting of subdivisions and mainly Town Planning related projects.

TYPICAL PROJECT EXPERIENCE

Civil/Municipal:

- Blackhead Road Urban Renewal Scheme.
- Corner Brook Urban Renewal Scheme.
- Curling Neighbourhood Improvement Plan.
- Pasadena Town Plan - Paving and Municipal Services.
- Come by Chance 50 Lot Subdivision.
- Wabana Municipal Services and Paving.
- Hope Brook Road Layout - Temporary and Permanent Camp Layout and Services.
- Salmonier Nature Park Road and Camp - Layout and Services.

Architectural:

- Newfoundland Constabulary Building,
- St. John's, Newfoundland.
- H.H. Marshall Building, St. John's Office/Warehouse.
- Browning Harvey Building, St. John's P.E.T. Production Facility.
- Southern Shore Stadium.
- Marine Sales & Service Office/Warehouse, St. John's.

Structural:

- Abitibi Price Inc. - Crane Repair.
- Browning Harvey Limited.
- Canadian Coast Guard - Cape Race Lighthouse.
- Stokes Do-it-Centre.
- Corner Brook Senior Citizens Complex.
- Civic Centre, St. John's.

Plumb Alignment & Bolt Torque Inspections:

- R.C.M.P. Building, Pleasantville, NF., Goose Bay, NF.
- Cow Head Facility, Marystown NF.
- Various Light Station Towers, St. Anthony, Keppel Island, Burnt Point and Tides Cove Point, NF.
- Coast Guard Building, St. John's, NF.
- Mainland School, Port au Port, NF.
- St. Anthony Health Care Facility, St. Anthony, NF.

Hydro Electric:	- Churchill Falls - Orma and Sail Lakes - Dam Layout and Quantities. - Cat Arm - Dams, Roads, Tunnels Layout and Quantities. - Paradise River - Preliminary Layout and Soils.
Wharf Construction:	- Bell Island and Portugal Cove Wharf Repairs. - Bell Island Fishermen's Wharf Repair. - St. Shott's Slipway Repair. - Punchbowl Labrador, Service Wharf. - Wreck Cove Wharf Reconstruction.

APPENDIX 'B'

APPENDIX ‘C’

Jackson Walsh, J-99

Length = 8080

Spacing = 1828

DL = 1.0 kn/m^2 L.L = 2.0 kn/m^2
W.L = 1.0 $^{kn}/n^2$

Joist Depth = 508

Effective Depth = 483

Bottom Chord, 32 x 32 x 6.4 ╨

$T_f = 134.7$ kn	$A = 727$
or	$S = 2.98 \times 10^3$
$C_f = 25.9$ kn	$r_x = 9.4$
	$r_y = 22.3$
	$r_z = 6.19$

$$T_R = (0.9)(727)(350) / 10^3 = 229 \text{ kn} > 134.7 \quad \underline{\text{O.K.}}$$

Top Chord, 38 x 38 x 4.8 ╥

$T_f = 134.7$ kn	$A = 680$
or	$S = 3.41 \times 10^3$
$C_f = 25.9$ kn	$r_x = 11.6$
	$r_y = 24.2$
	$r_z = 7.48$

$$\frac{L_x}{r_y} = \frac{(0.9)(610)}{11.6} = 47.3$$

$$\frac{L_z}{r_z} = \frac{(610)}{24.2} = 25.2$$

$$\frac{L_x}{r_x} = \frac{(0.9)(610)}{7.48} = 73.3$$

$\lambda = 1.0$

$$C_r = (0.9)(680)(350)[1 + 1]^{-.76}/10^3$$

$C_r = 214.2$ kn > 134.7 <u>O.K.</u>

<u>Top Chord, End Panel</u>

$C_f = 41.2$ $M_f = 0.3$ kn-m

$C_r = 214.2$ kn

$M_R = (0.9)\ (3.41 \text{ x } 10^3)\ (350) = 1.07$ kn-m

$\frac{41.2}{214.2} + \frac{0.3}{1.07} = 0.47 < 1.0$ <u>O.K.</u>

<u>Web Members</u>

22 Ø Rod A = 380

$T_f = 50.9$ kn or $C_f = 9.8$ kn $r = 5.5$

$T_R = (.9)\ (380)\ (245) / 10^3 = 83.8$ kn > 50.9

$\frac{816}{5.5} = 148$

$\lambda = 1.65$

$C_r = 25.3$ kn > 9.8 <u>O.K.</u>

$C_f = 29.9$ kn or $T_f = 5.8$ kn

$\frac{L}{r} = \frac{480}{5.5} = 87.2$

$\lambda = 1.0$

$C_r = (.9)\ (380)\ (245) / [1 + 1^{2.86}]^{-.76}/10^3$

$C_r = 49.4$ kn > 29.9 <u>O.K.</u>

19 Ø Rod A = 283

r = 4.75

$C_f = 23.3$ kn or $T_f = 4.5$ kn

$$\frac{L}{r} = \frac{573}{4.75} = 120.6$$

$\lambda = 1.35$

$C_r = (0.9)(283)(245) / [1 + 1^{2.86}]^{-.76}/10^3$

$C_r = 25.6$ kn > 23.3 <u>O.K.</u>

$T_f = 17.3$ kn
or
$C_f = 3.3$ kn

$T_R = (0.9)(283)(245)/10^3 = 62.4$ kn > 17.3 <u>O.K.</u>

$$\frac{L}{r} = \frac{567}{4.75} = 119 < 200 \quad \underline{\text{O.K.}}$$

Deflection Check

$\Delta_L = 18.6$ mm $\Delta_a = 27.0$ <u>O.K.</u>

APPENDIX ‘D’

DEFLECTIONS

DEFLECTIONS

JACKSON WALSH ELEMENTARY

Row No	Member No	LD Comb No	Station m	Axial kN	Shear kN	Moment kN-m
1	1	1	0.0000	-41.1680	2.1776	0.0000
2		1	0.2200	-41.1680	0.4286	0.2867
3		1	0.4400	-41.1680	-1.3204	0.1886
4		1	0.6600	-41.1680	-3.0694	-0.2943
5		2	0.0000	-7.9229	0.4191	0.0000
6		2	0.2200	-7.9229	0.0825	0.0552
7		2	0.4400	-7.9229	-0.2541	0.0363
8		2	0.6600	-7.9229	-0.5907	-0.0566
9	6	1	0.0000	-131.5357	2.4489	-0.1716
10		1	0.2048	-131.5357	0.8203	0.1632
11		1	0.4097	-131.5357	-0.8082	0.1645
12		1	0.6145	-131.5357	-2.4367	-0.1679
13		2	0.0000	-25.3144	0.4713	-0.0330
14		2	0.2048	-25.3144	0.1579	0.0314
15		2	0.4097	-25.3144	-0.1555	0.0317
16		2	0.6145	-25.3144	-0.4690	-0.0323
17	7	1	0.0000	-134.6732	2.4428	-0.1679
18		1	0.2048	-134.6732	0.8143	0.1657
19		1	0.4097	-134.6732	-0.8143	0.1657
20		1	0.6145	-134.6732	-2.4428	-0.1679
21		2	0.0000	-25.9182	0.4701	-0.0323
22		2	0.2048	-25.9182	0.1567	0.0319
23		2	0.4097	-25.9182	-0.1567	0.0319
24		2	0.6145	-25.9182	-0.4701	-0.0323
25	8	1	0.0000	-131.5357	2.4367	-0.1679
26		1	0.2048	-131.5357	0.8082	0.1645
27		1	0.4097	-131.5357	-0.8203	0.1632
28		1	0.6145	-131.5357	-2.4489	-0.1716
29		2	0.0000	-25.3144	0.4690	-0.0323
30		2	0.2048	-25.3144	0.1555	0.0317
31		2	0.4097	-25.3144	-0.1579	0.0314
32		2	0.6145	-25.3144	-0.4713	-0.0330
33	38	1	0.0000	134.6737	0.0008	0.0273
34		1	0.2053	134.6737	0.0008	0.0275
35		1	0.4107	134.6737	0.0008	0.0277
36		1	0.6160	134.6737	0.0008	0.0278
37		2	0.0000	25.9183	0.0001	0.0053
38		2	0.2053	25.9183	0.0001	0.0053
39		2	0.4107	25.9183	0.0001	0.0053
40		2	0.6160	25.9183	0.0001	0.0054
41	39	1	0.0000	134.6737	-0.0008	0.0278
42		1	0.2053	134.6737	-0.0008	0.0277
43		1	0.4107	134.6737	-0.0008	0.0275
44		1	0.6160	134.6737	-0.0008	0.0273
45		2	0.0000	25.9183	-0.0001	0.0054
46		2	0.2053	25.9183	-0.0001	0.0053
47		2	0.4107	25.9183	-0.0001	0.0053
48		2	0.6160	25.9183	-0.0001	0.0053

DEFLECTIONS
DEFLECTIONS
JACKSON WALSH ELEMENTARY

Row No	Member No	LD Comb No	Station m	Axial kN	Shear kN	Moment kN-m
49	27	1	0.0000	50.9042	0.0000	0.0000
50		1	0.2720	50.9042	0.0000	0.0000
51		1	0.5441	50.9042	0.0000	0.0000
52		1	0.8161	50.9042	0.0000	0.0000
53		2	0.0000	9.7966	0.0000	0.0000
54		2	0.2720	9.7966	0.0000	0.0000
55		2	0.5441	9.7966	0.0000	0.0000
56		2	0.8161	9.7966	0.0000	0.0000
57	28	1	0.0000	-29.8674	0.0000	0.0000
58		1	0.1600	-29.8674	0.0000	0.0000
59		1	0.3200	-29.8674	0.0000	0.0000
60		1	0.4800	-29.8674	0.0000	0.0000
61		2	0.0000	-5.7481	0.0000	0.0000
62		2	0.1600	-5.7481	0.0000	0.0000
63		2	0.3200	-5.7481	0.0000	0.0000
64		2	0.4800	-5.7481	0.0000	0.0000
65	44	1	0.0000	-29.0282	0.0000	0.0000
66		1	0.1913	-29.0282	0.0000	0.0000
67		1	0.3826	-29.0282	0.0000	0.0000
68		1	0.5739	-29.0282	0.0000	0.0000
69		2	0.0000	-5.5866	0.0000	0.0000
70		2	0.1913	-5.5866	0.0000	0.0000
71		2	0.3826	-5.5866	0.0000	0.0000
72		2	0.5739	-5.5866	0.0000	0.0000
73	45	1	0.0000	23.0855	0.0000	0.0000
74		1	0.1889	23.0855	0.0000	0.0000
75		1	0.3779	23.0855	0.0000	0.0000
76		1	0.5668	23.0855	0.0000	0.0000
77		2	0.0000	4.4429	0.0000	0.0000
78		2	0.1889	4.4429	0.0000	0.0000
79		2	0.3779	4.4429	0.0000	0.0000
80		2	0.5668	4.4429	0.0000	0.0000
81	46	1	0.0000	-23.3068	0.0000	0.0000
82		1	0.1910	-23.3068	0.0000	0.0000
83		1	0.3821	-23.3068	0.0000	0.0000
84		1	0.5731	-23.3068	0.0000	0.0000
85		2	0.0000	-4.4855	0.0000	0.0000
86		2	0.1910	-4.4855	0.0000	0.0000
87		2	0.3821	-4.4855	0.0000	0.0000
88		2	0.5731	-4.4855	0.0000	0.0000
89	47	1	0.0000	17.2869	0.0000	0.0000
90		1	0.1892	17.2869	0.0000	0.0000
91		1	0.3784	17.2869	0.0000	0.0000
92		1	0.5676	17.2869	0.0000	0.0000
93		2	0.0000	3.3269	0.0000	0.0000
94		2	0.1892	3.3269	0.0000	0.0000
95		2	0.3784	3.3269	0.0000	0.0000
96		2	0.5676	3.3269	0.0000	0.0000

DEFLECTIONS
DEFLECTIONS
JACKSON WALSH ELEMENTARY

Row No	Member No	LD Comb No	Station m	Axial kN	Shear kN	Moment kN-m
97	48	1	0.0000	-17.4459	0.0000	0.0000
98		1	0.1908	-17.4459	0.0000	0.0000
99		1	0.3815	-17.4459	0.0000	0.0000
100		1	0.5723	-17.4459	0.0000	0.0000
101		2	0.0000	-3.3575	0.0000	0.0000
102		2	0.1908	-3.3575	0.0000	0.0000
103		2	0.3815	-3.3575	0.0000	0.0000
104		2	0.5723	-3.3575	0.0000	0.0000

DEFLECTIONS

Filename: C:\SFRAME\1850-05C\JACKSON.TEL
Description: JACKSON WALSH ELEMENTARY
Engineer: FGA CONSULTING ENGINEERS LIMITED - K. R. TOBIN

S-FRAME For Windows

Professional Version 4.12

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Head Office:
#275 - 13500 Maycrest Way
Richmond, B.C. V6V 2N8
Canada
Phone: (604)273-7737
Fax: (604)273-7731

Model Size

Joints	27	Load Cases	3
Slaves	0	Load Combs	2
Members	51	Groups	0
Shells	0	Nonlinear Springs	0
Springs	0	Time History Curves	0
Sections	4	RSA Spectra Curves	0
Materials	1	User Coordinate Sys.	0
Lumped Masses	0	Default Constraints	1, 1, 1

REACTIONS
REACTIONS
JACKSON WALSH ELEMENTARY

Row No	Joint No	LD Case No	X - Tran mm	Y - Tran mm	Z - Rot rad
1	12	1	-0.7276	-8.7996	0.0004
2		2	-1.5359	-18.5769	0.0008
3		3	0.7276	8.7996	-0.0004

REACTIONS

Filename: C:\SFRAME\1850-05C\JACKSON.TEL
Description: JACKSON WALSH ELEMENTARY
Engineer: FGA CONSULTING ENGINEERS LIMITED - K. R. TOBIN

S-FRAME For Windows

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Head Office:
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Model Size

Joints	27	Load Cases	3
Slaves	0	Load Combs	2
Members	51	Groups	0
Shells	0	Nonlinear Springs	0
Springs	0	Time History Curves	0
Sections	4	RSA Spectra Curves	0
Materials	1	User Coordinate Sys.	0
Lumped Masses	0	Default Constraints	1, 1, 1

MEMBER FORCES

Row No	Joint No	LD Case No	X-Force kN	Y-Force kN	Z-Moment kN-m
1	1	1	0.0000	7.2720	0.0000
2		2	0.0000	15.3520	0.0000
3		3	0.0000	-7.2720	0.0000
4	4	1	0.0000	7.2720	0.0000
5		2	0.0000	15.3520	0.0000
6		3	0.0000	-7.2720	0.0000

JOINT NUMBERING

Project Name: JACKSON WALSH ELEMENTARY, WESTERN BAY

Structure Description: JOIST J-99

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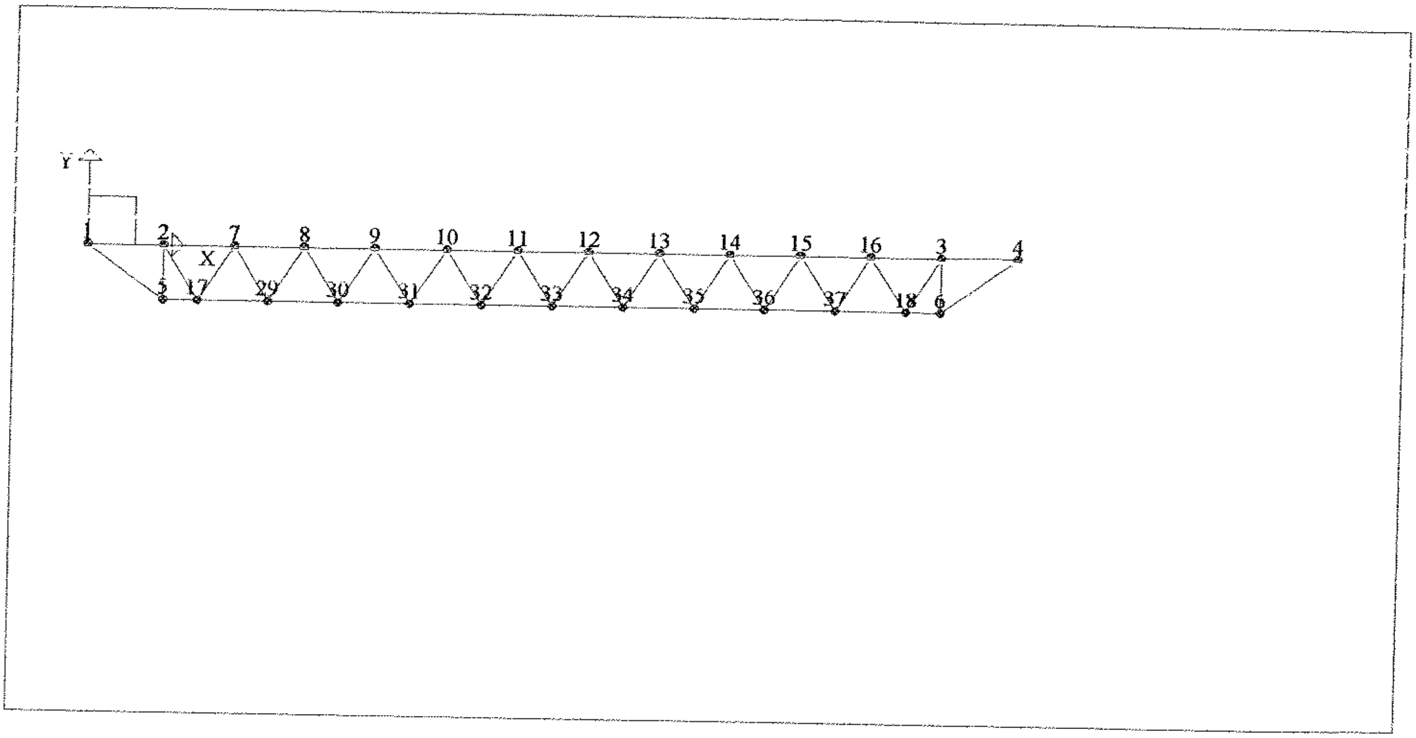

Engineer: FGA CONSULTING ENGINEERS LIMITED - K. R. TOBIN

Sunday January 19 1997, 3:28:19 pm

OWSJ INVESTIGATION - GROUP 4

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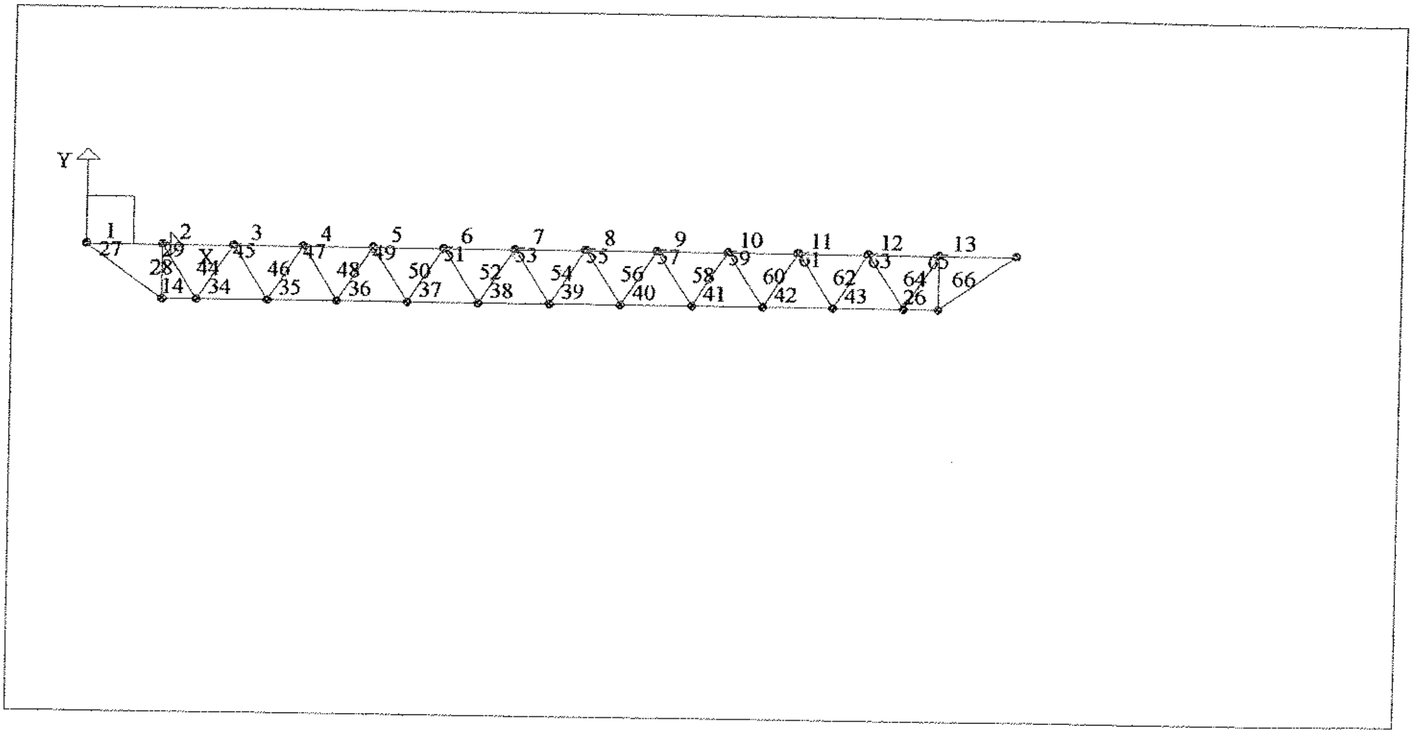

SECTION NUMBERS

Project Name: JACKSON WALSH ELEMENTARY, WESTERN BAY

Structure Description: JOIST J-99

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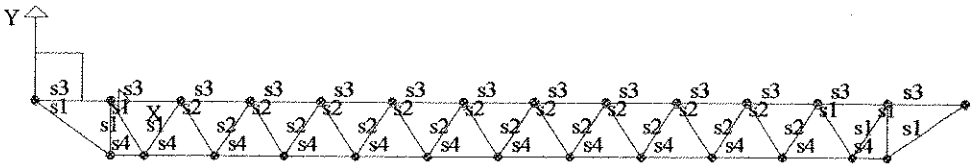

Engineer: FGA CONSULTING ENGINEERS LIMITED - K. R. TOBIN

Sunday January 19 1997, 3:30:02 pm

OWSJ INVESTIGATION - GROUP 4

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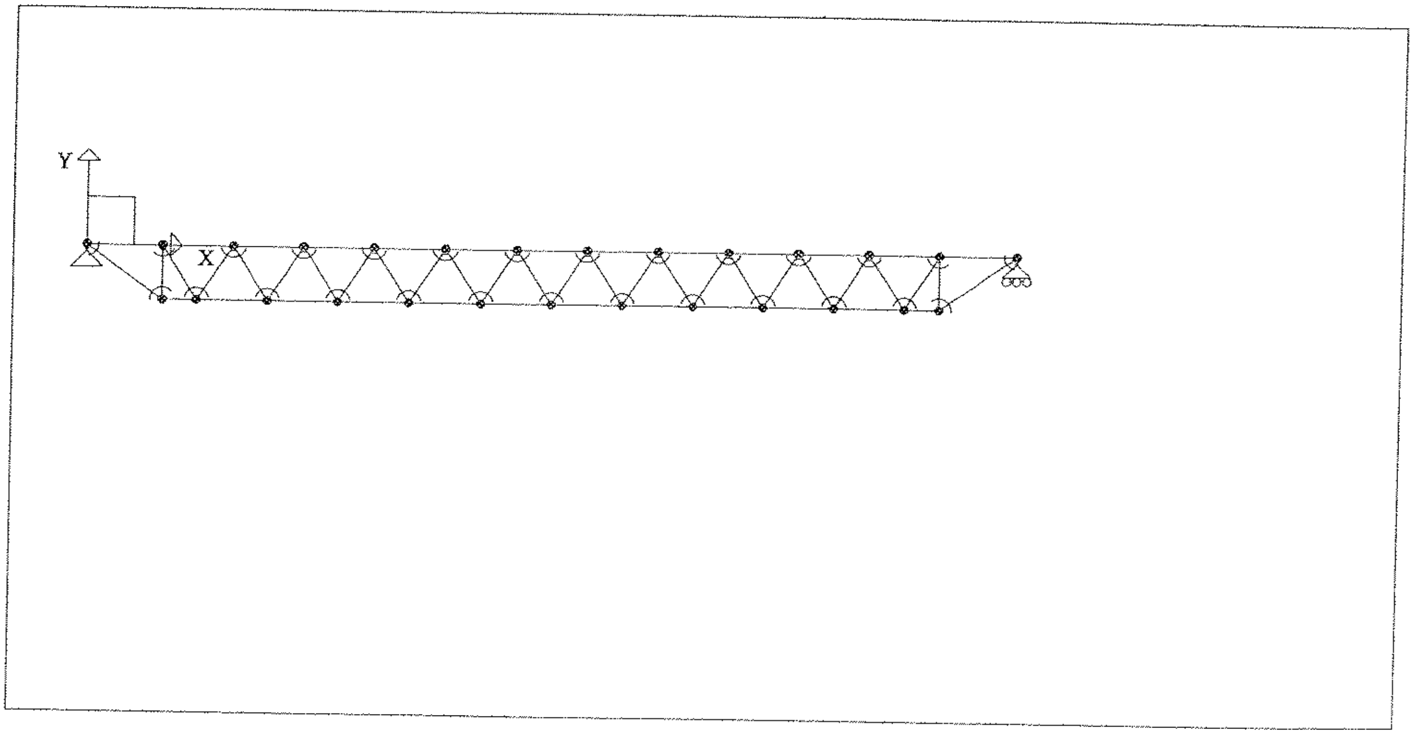
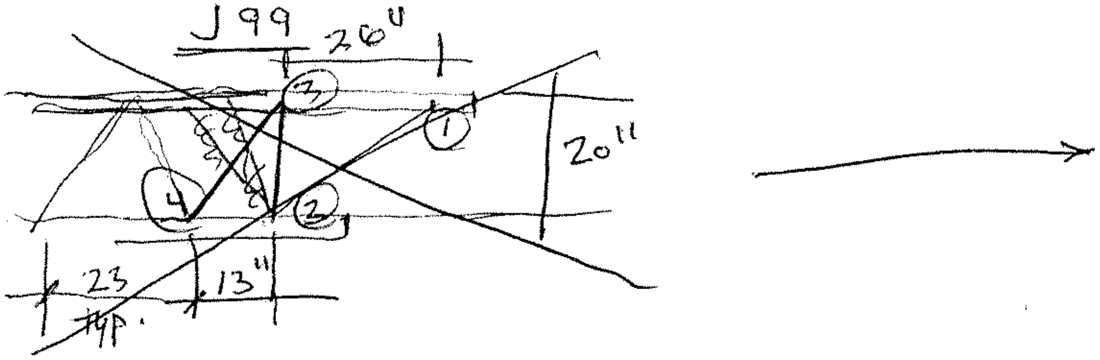
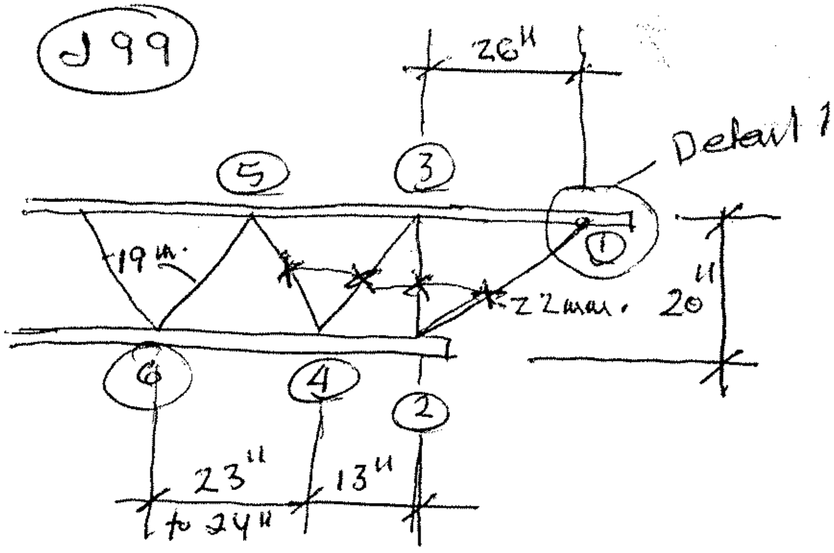


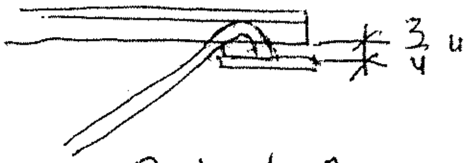




2 - 1 1/4 x 1 1/4 x 1/4 Top chord L

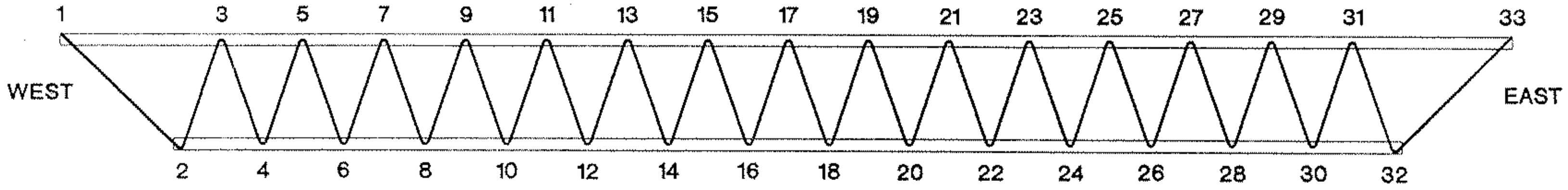
2 - 1 1/2 x 1 1/2 x 3/16 Btm. chord L

1st. 4 webs 22 mm. - Remainder 19 mm.
Bearing Pl. 1/2 x 4 1/2 x 8



Detail A

Jackson Walsh Elementary
Western Bay.



1	
2	**E**
3	**G, Puddle Weld**
4	**A, G**
5	
6	**A, G**
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	**G**
17	**G**
18	**G**
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	**A, G**
31	**G, Puddle Weld**
32	**A, G**
33	

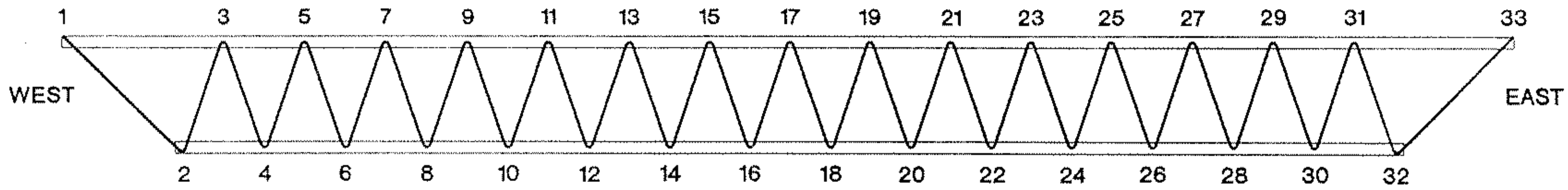
LEGEND:

A. UNDERCUT
B. POROSITY
C. NO FLARE WELD
D. INCOMPLETE FLARE WELD
E. WELD FAILURE
F. POOR PROFILE
G. SLAG NOT REMOVED
H. POOR FIT UP

EXTRA COMMENTS:

1. Undercut, poor profile and slag was evident throughout joists length.
2. Limited view of top chord panel points due to roof deck.
3. "Puddle welds" at discontinuous web panel points.
4.
5.
6.
7.
8. Joist inspected by M. O' Brien, P.Eng.

CANADIAN WELDING BUREAU
2567
MIKE O'BRIEN, P.Eng
LEVEL II
CSA W178.2
CERTIFIED WELDING INSPECTOR



1
2 **A, G**
3 **G, Puddle Weld**
4 **A, G**
5
6 **A, G**
7
8
9
10
11

12
13
14
15
16 **A, G**
17 **G**
18 **G**
19
20
21
22

23
24
25
26
27
28 **A, G**
29 **G, Puddle Weld**
30 **A, G**
31 **G, Puddle Weld**
32 **G**
33

<u>LEGEND:</u>

A. UNDERCUT
B. POROSITY
C. NO FLARE WELD
D. INCOMPLETE FLARE WELD
E. WELD FAILURE
F. POOR PROFILE
G. SLAG NOT REMOVED
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CANADIAN WELDING BUREAU
2567
MIKE O'BRIEN, P.Eng.
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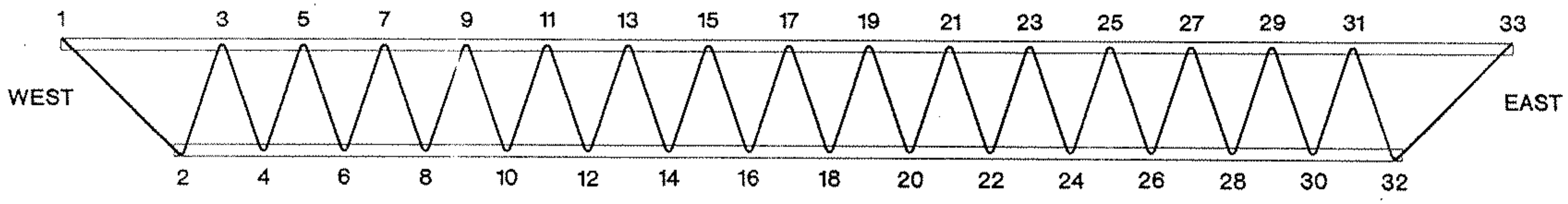
CSA W178.2
CERTIFIED WELDING INSPECTOR



1		12		23	
2	**G**	13		24	
3	**G, Puddle Weld**	14		25	
4	**G**	15		26	
5		16	**G**	27	
6	**A, G**	17	**G**	28	**G**
7		18	**A, G**	29	**G, Puddle Weld**
8		19		30	**A, G**
9		20		31	**G, Puddle Weld**
10		21		32	**G**
11		22		33	

LEGEND:

A. UNDERCUT
B. POROSITY
C. NO FLARE WELD
D. INCOMPLETE FLARE WELD
E. WELD FAILURE
F. POOR PROFILE
G. SLAG NOT REMOVED
H. POOR FIT UP

EXTRA COMMENTS:

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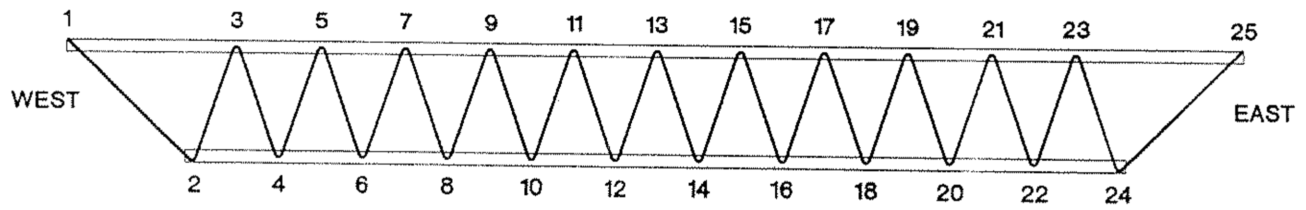
CANADIAN WELDING BUREAU
2567
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2
CERTIFIED WELDING INSPECTOR



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2 **A, G**
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4 **A, G**
5 **G, Puddle Weld**
6 **A, G**
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13 **G, Puddle Weld**
14 **A, G**
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19
20 **A, G**
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22 **A, G**
23 **G, Puddle Weld**
24 **A, G**
25

<u>LEGEND:</u>

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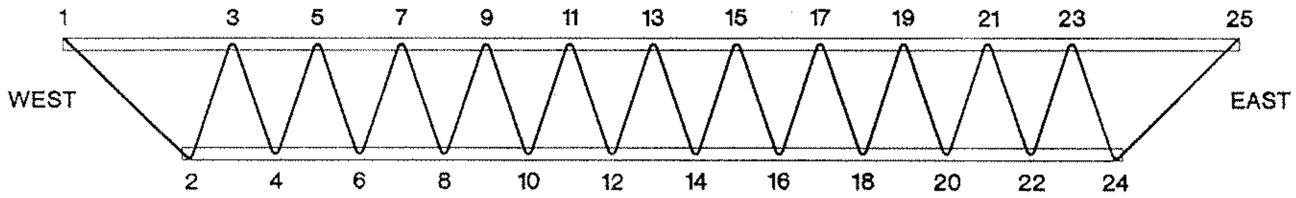

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13	**A, G, Puddle Weld**
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20	**A, G**
21	
22	**G, H (High)**
23	**G, Puddle Weld**
24	**G**
25	

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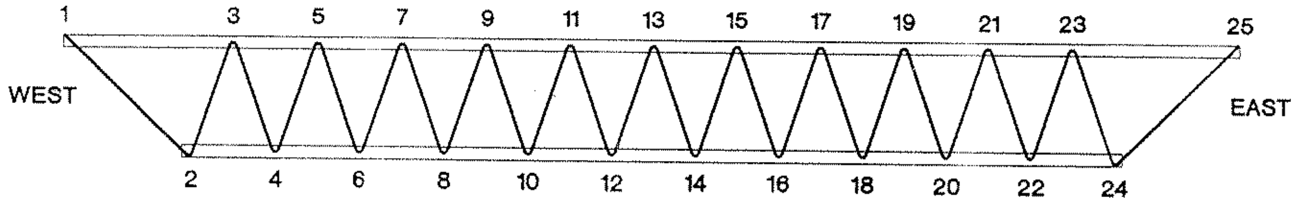

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4 **G**
5 **G, Puddle Weld**
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13 **G, Puddle Weld**
14 **A, G**
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20 **A, G**
21
22 **G**
23 **G, Puddle Weld**
24 **G**
25

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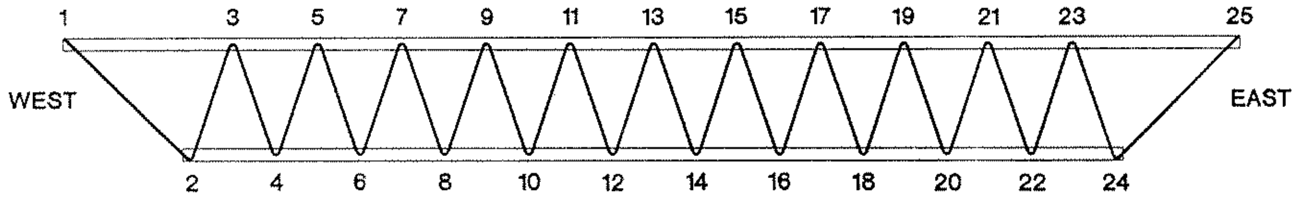

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13 **G, Puddle Weld**
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20 **A, G**
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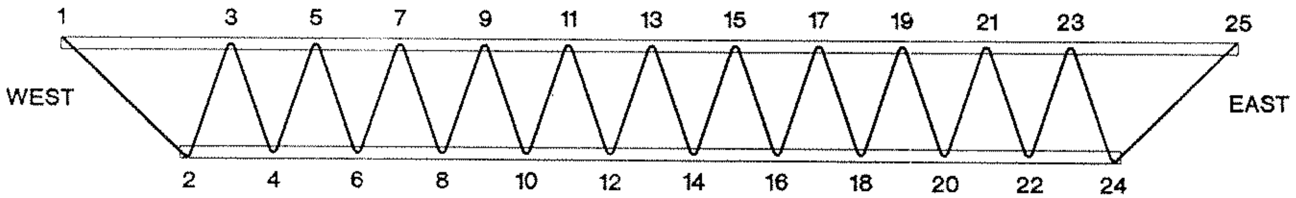

1	
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5	**A, G, Puddle Weld**
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13	**G, Puddle Weld**
14	**A, G**
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20	**A, G**
21	
22	**A, G**
23	**G, Puddle Weld**
24	**A, G**
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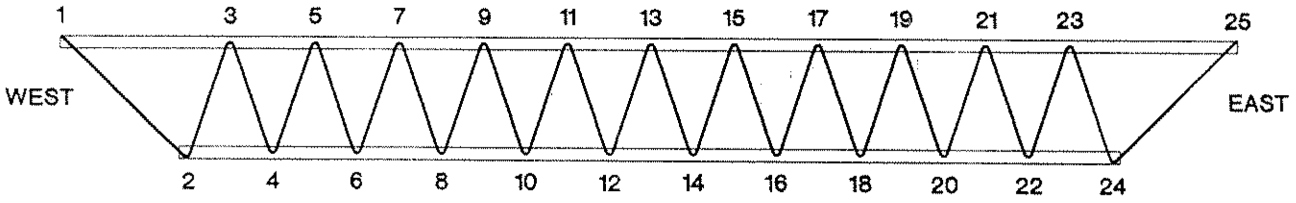

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2567
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LEVEL I I
CSA W178.2

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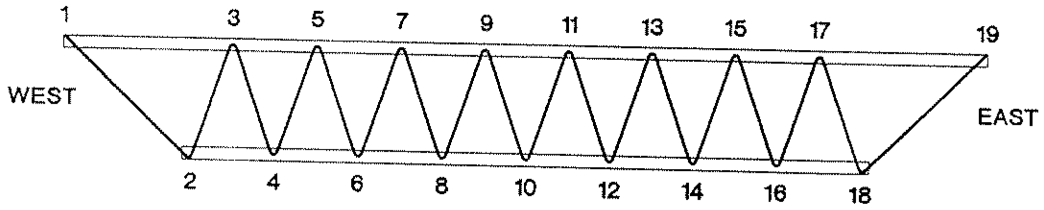

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2 **A, G**

3 **A, G, Puddle Weld**

4 **G, H (Low)**

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9 **A, G, Puddle Weld**

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15

16 **A, G**

17 **G, Puddle Weld**

18 **A, G, H (High)**

19

LEGEND:

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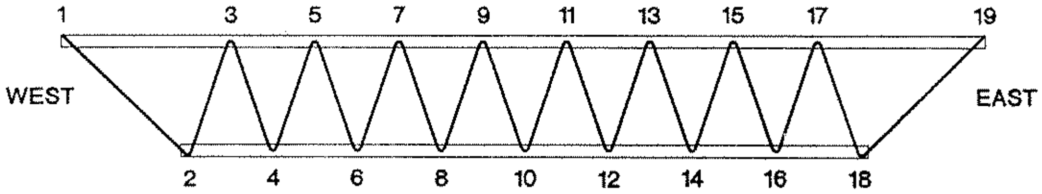
CSA W178.2



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3 **A, G, Puddle Weld**
4 **G**
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9 **G, Puddle Weld**
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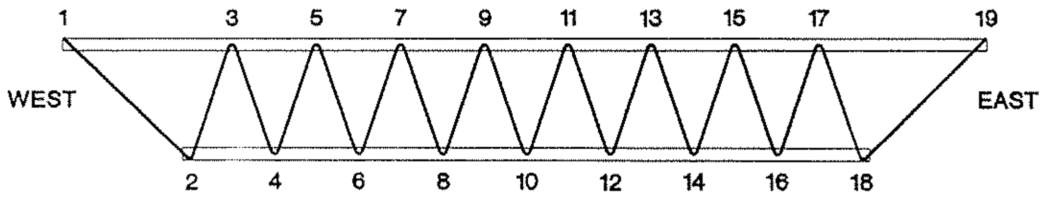

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3	**A, G, Puddle Weld**
4	**A, G**
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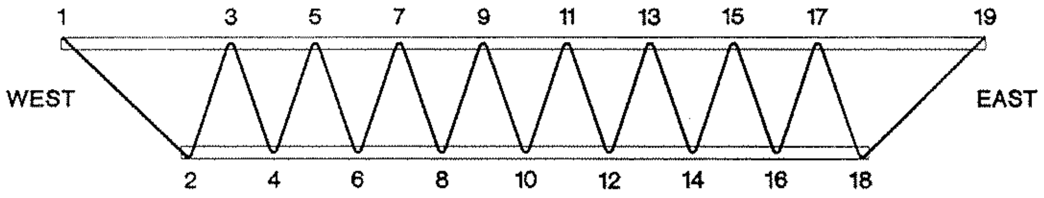

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2	**A, G**
3	**A, G, Puddle Weld**
4	**A, G**
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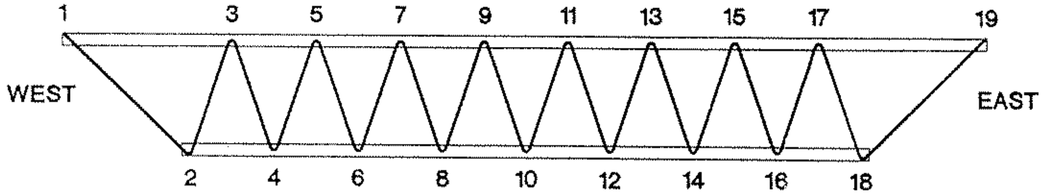

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2	**A, G**
3	**A, G, Puddle Weld**
4	**G**
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9	**G, Puddle Weld**
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15	
16	**G**
17	**G, Puddle Weld**
18	**A, G, H (High)**
19	

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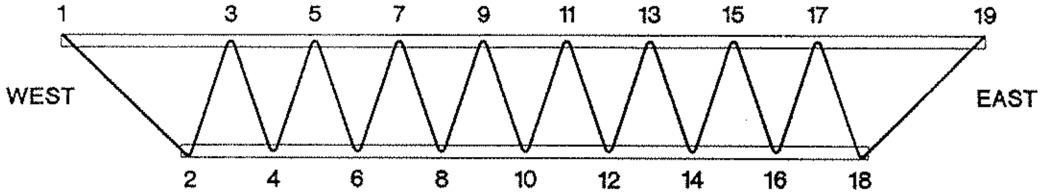

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2	**A, G**
3	**A, G, Puddle Weld**
4	**G, H (Low)**
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9	**G, Puddle Weld**
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15	
16	**G**
17	**G, Puddle Weld**
18	**A, G**
19	

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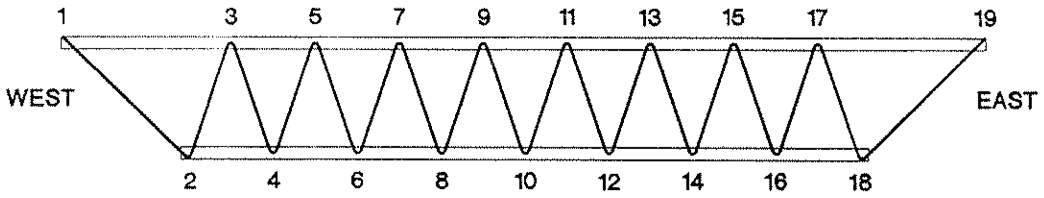

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2 **G**
3 **G, Puddle Weld**
4 **A, G**
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9 **G, Puddle Weld**
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16 **G**
17 **G, Puddle Weld**
18 **A, G**
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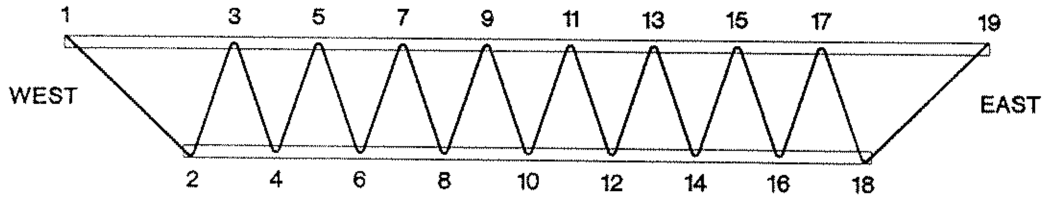

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4	**G, H (Low)**
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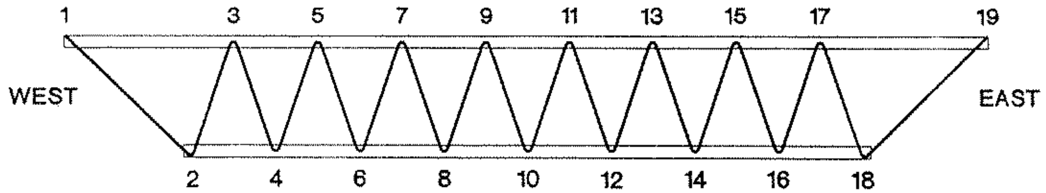

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2 **A, G**
3 **A, G, Puddle Weld**
4 **A, G**
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9 **G, Puddle Weld**
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16 **G**
17 **G, Puddle Weld**
18 **A, G**
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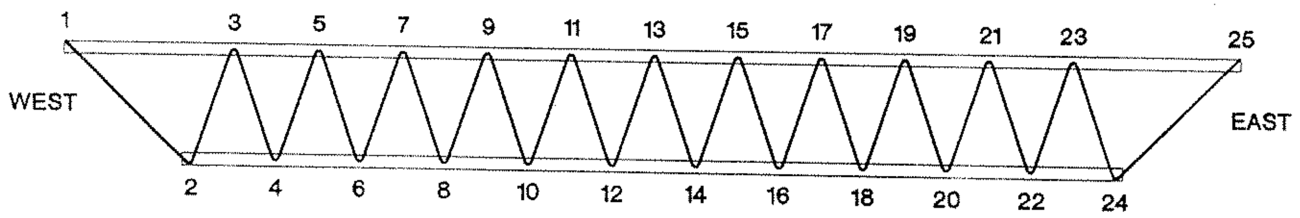

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3 **G, Puddle Weld**
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22 **A, G**
23 **G, Puddle Weld**
24 **G**
25

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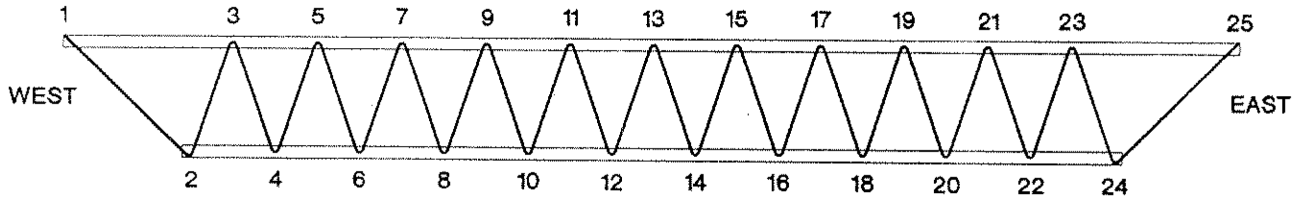

1

2 **A, B, G**

3 **G, Puddle Weld**

4 **A, G, H (High)**

5 **G, Puddle Weld**

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22 **A, G, H (High)**

23 **G, Puddle Weld**

24 **A, B, G**

25

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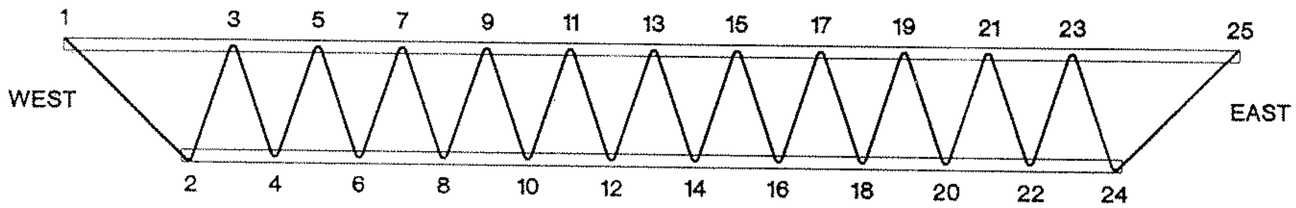

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2 **A, G**
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4 **A, G**
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6 **A, G**
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21 **G, Puddle Weld**
22 **A, G**
23 **G, Puddle Weld**
24 **A, G**
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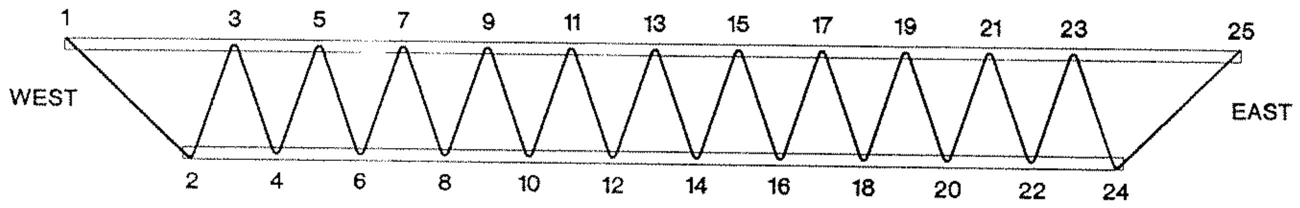
LEGEND:

A. UNDERCUT
B. POROSITY
C. NO FLARE WELD
D. INCOMPLETE FLARE WELD
E. WELD FAILURE
F. POOR PROFILE
G. SLAG NOT REMOVED
H. POOR FIT UP

EXTRA COMMENTS:

1. Undercut, poor profile and slag was evident throughout joists length.
2. Limited view of top chord panel points due to roof deck.
3. "Puddle welds" at discontinuous web panel points.
4.
5.
6.
7.
8. Joist inspected by M. O'Brien, P.Eng.

CANADIAN WELDING BUREAU
2567
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2
CERTIFIED WELDING INSPECTOR



1
2 **G**
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4 **A, G**
5 **A, G, Puddle Weld**
6 **G**
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13 **G, Puddle Weld**
14 **A, G**
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20 **A, G**
21
22 **A, G**
23 **G, Puddle Weld**
24 **A, G**
25

LEGEND:

A. UNDERCUT
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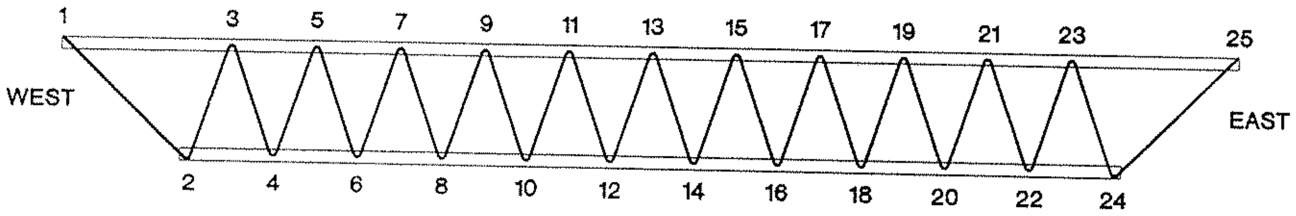
2567
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2
CERTIFIED WELDING INSPECTOR



1
2 **G**
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4 **G**
5 **G, Puddle Weld**
6 **A, G**
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13 **G, Puddle Weld**
14 **A, G**
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22 **G**
23 **G, Puddle Weld**
24 **G**
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LEGEND:

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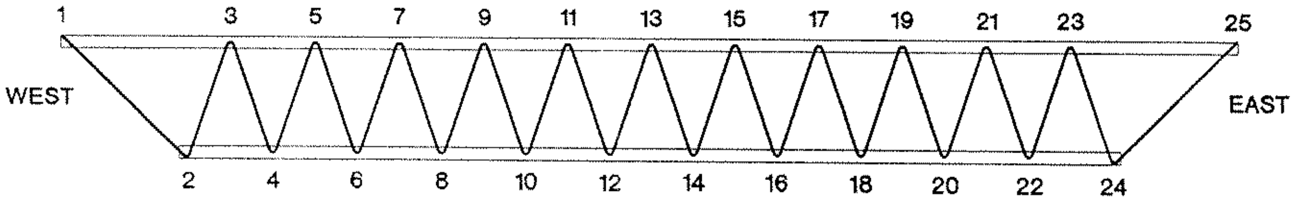
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2
CERTIFIED WELDING INSPECTOR



1
2 **A, G**
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4 **A, G**
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6 **A, G**
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13 **G, Puddle Weld**
14 **A, G**
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21
22 **A, G**
23 **G, Puddle Weld**
24 **G**
25

LEGEND:

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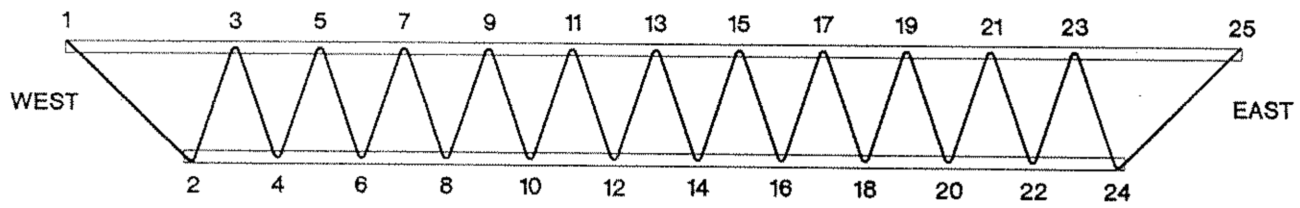
LEVEL II
CSA W178.2



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2 **A, G**
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4 **A, G**
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6 **G**
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13 **A, G, Puddle Weld**
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20 **A, G**
21
22 **G, H (High)**
23 **G, Puddle Weld**
24 **G**
25

<u>LEGEND:</u>

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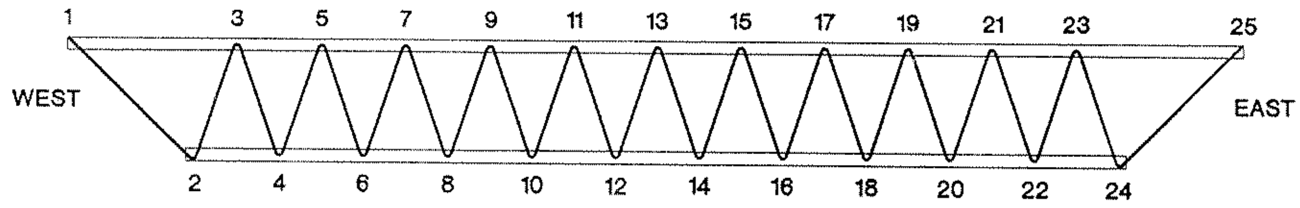

1
2 **A, G**
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4 **A, G**
5 **G, Puddle Weld**
6 **A, G**
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12 **A, G**
13 **A, G, Puddle Weld**
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20 **A, G**
21 **A, G, Puddle Weld**
22 **A, G**
23
24 **G**
25

LEGEND:

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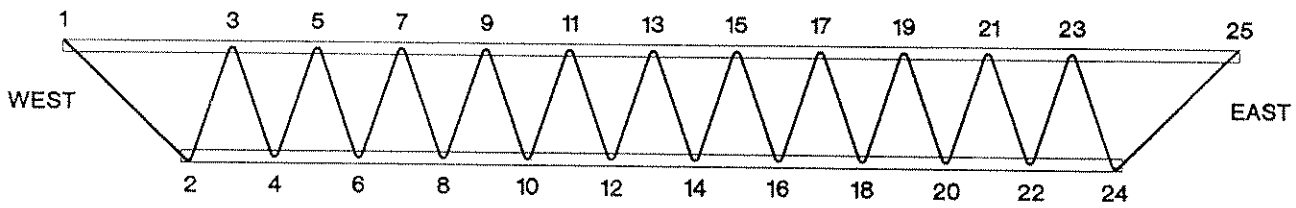
CANADIAN WELDING BUREAU
2567
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2
CERTIFIED WELDING INSPECTOR



1
2 **A, G**
3 **G, Puddle Weld**
4 **A, G, H (Low)**
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6 **A, G**
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13 **G, Puddle Weld**
14 **A, G**
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21
22 **A, G**
23 **A, G, Puddle Weld**
24 **G**
25

LEGEND:

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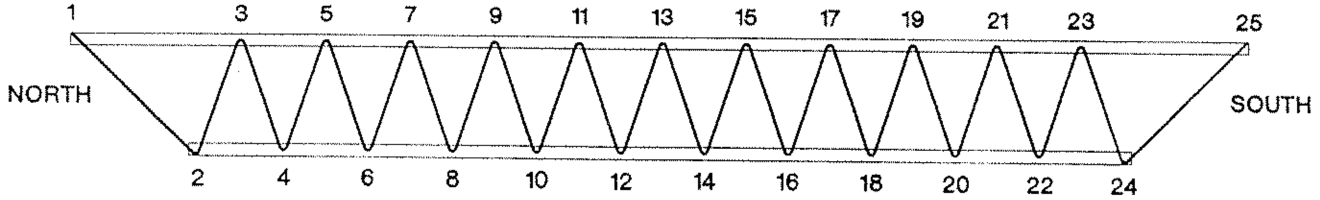
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2
CERTIFIED WELDING INSPECTOR



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5	**G, Puddle Weld**
6	**A, G**
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13	**G, Puddle Weld**
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20	**A, G**
21	**G, Puddle Weld**
22	**G**
23	
24	**G**
25	

LEGEND:

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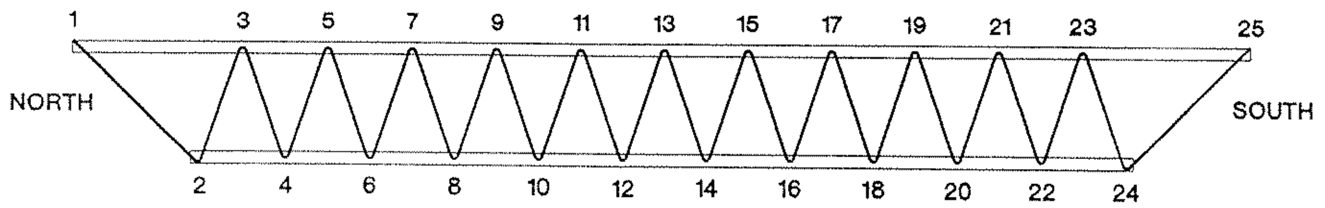
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2
CERTIFIED WELDING INSPECTOR



1
2 **G**
3 **G, Puddle Weld**
4 **A, G**
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6 **A, G**
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13 **G, Puddle Weld**
14 **A, G**
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20 **A, G**
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22 **A, G**
23 **G, Puddle Weld**
24 **A, G**
25

LEGEND:

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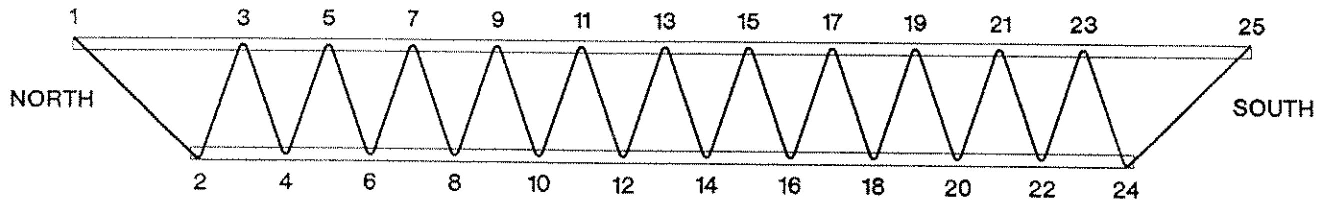
CANADIAN WELDING BUREAU
2567
MIKE O'BRIEN, P.Eng.
LEVEL I I
CSA W178.2
CERTIFIED WELDING INSPECTOR



1	
2	**G**
3	**A, G, Puddle Weld**
4	**G, H (High)**
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6	**G**
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12	**G**
13	**G, Puddle Weld**
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19	
20	**A, G**
21	
22	**G**
23	**A, G, Puddle Weld**
24	**G**
25	

LEGEND:

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H. POOR FIT UP

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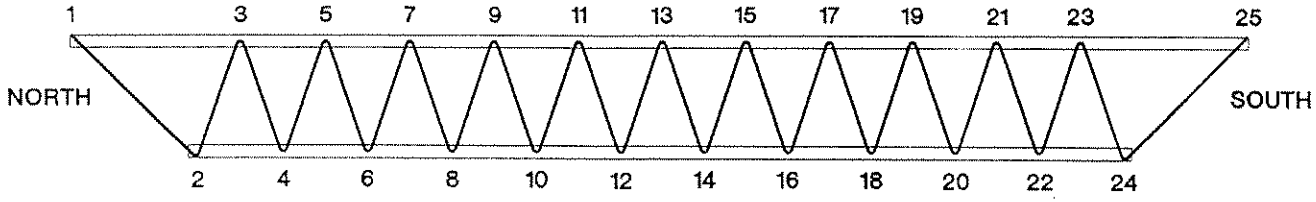
CANADIAN WELDING BUREAU
2567
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2
CERTIFIED WELDING INSPECTOR



1
2 **A, G**
3 **G, Puddle Weld**
4 **A, G**
5 **G, Puddle Weld**
6 **A, G**
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13 **G, Puddle Weld**
14 **A, G**
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20 **A, G**
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22 **A, G**
23 **G, Puddle Weld**
24 **A, G**
25

LEGEND:

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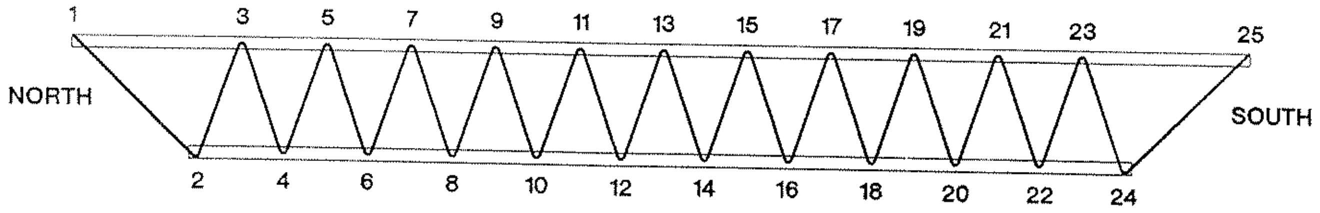
CANADIAN WELDING BUREAU
2567
MIKE O'BRIEN, P.Eng.
~~LEVEL II~~
CSA W178.2
CERTIFIED WELDING INSPECTOR



1
2 **A, G**
3 **G, Puddle Weld**
4 **A, G, H (Low)**
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6 **A, G**
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13 **G, Puddle Weld**
14 **A, G**
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17

18
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20 **A, G**
21
22 **A, G**
23 **A, G, Puddle Weld**
24 **G**
25

LEGEND:

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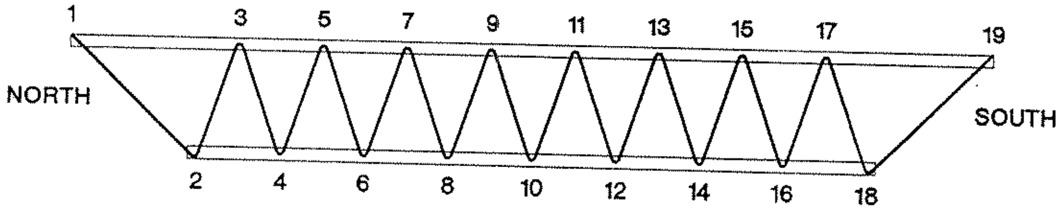
2567
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2



1
2 **G**
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4 **A, G**
5 **G**
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9 **A, G, Puddle Weld**
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14 **A, G, H (Low)**
15
16
17 **G, Puddle Weld**
18 **A, G**
19

LEGEND:

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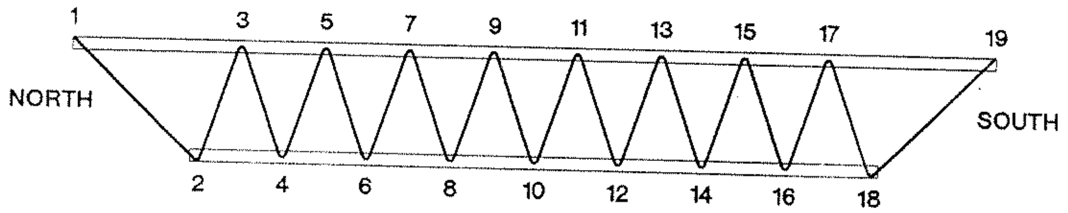
2567
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2



1
2 **G**
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4 **G, H (Low)**
5 **A, G, Puddle Weld**
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9 **G**
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16 **G**
17 **G, Puddle Weld**
18 **G**
19

LEGEND:

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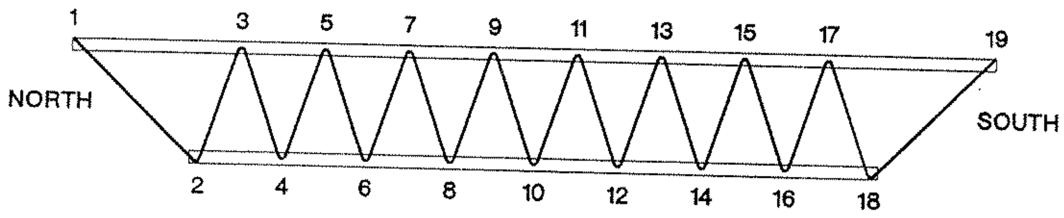

1	
2	**A, G**
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5	**G, Puddle Weld**
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9	**A, G**
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15	
16	**A, G, H (Low)**
17	**G, Puddle Weld**
18	**G, H (High)**
19	

LEGEND:

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B. POROSITY
C. NO FLARE WELD
D. INCOMPLETE FLARE WELD
E. WELD FAILURE
F. POOR PROFILE
G. SLAG NOT REMOVED
H. POOR FIT UP

EXTRA COMMENTS:

1. Undercut, poor profile and slag was evident throughout joists length.
2. Limited view of top chord panel points due to roof deck.
3. "Puddle welds" at discontinuous web panel points.
4. Web member slightly bent between panel points 15 and 16.
5. Bottom chord angles misaligned approximately 8 mm.
6.
7.
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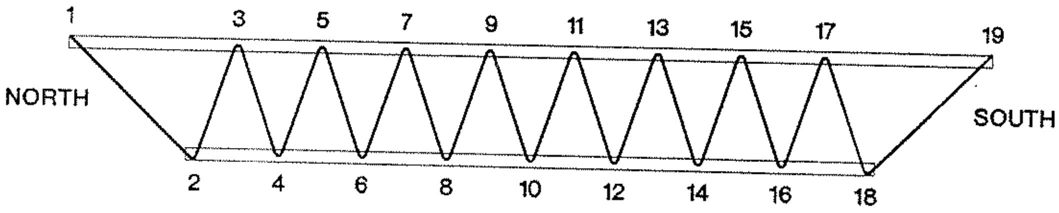
CANADIAN WELDING BUREAU
2567
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2
CERTIFIED WELDING INSPECTOR



1	
2	**G**
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4	**G**
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6	**A, G, H (Low)**
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9	**A, G, Puddle Weld**
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13	
14	**A, G**
15	
16	**A, G**
17	**G, Puddle Weld**
18	**A, G, H (High)**
19	

LEGEND:

A.	UNDERCUT
B.	POROSITY
C.	NO FLARE WELD
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LEVEL II
CSA W178.2
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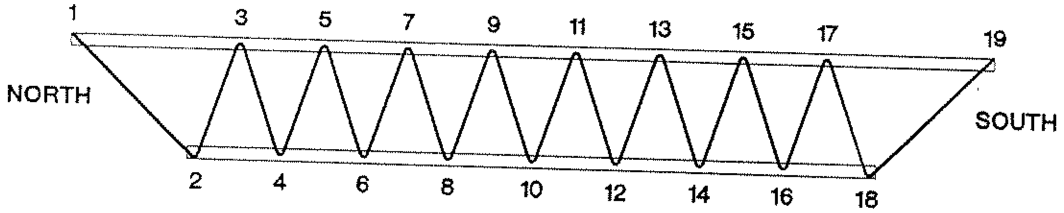

1
2 **G**
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4 **A, G, H (Low)**
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8
9 **A, G, Puddle Weld**
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14
15 **A, G**
16 **G, F, H (Low)**
17
18 **A, G**
19

LEGEND:

A. UNDERCUT
B. POROSITY
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D. INCOMPLETE FLARE WELD
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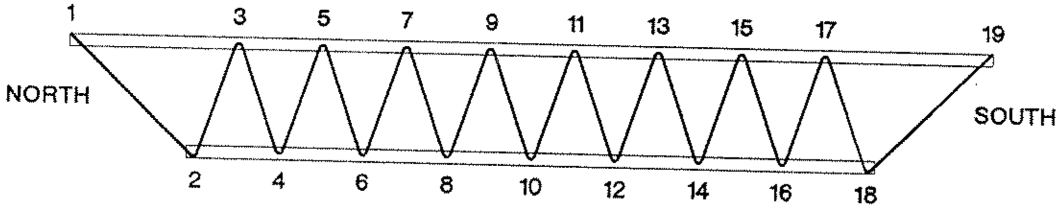
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2



1
2 **G, H (High)**
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4 **A, G**
5 **A, G**
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7

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9 **G, Puddle Weld**
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14
15
16 **G, H (Low)**
17 **G, Puddle Weld**
18 **G**
19

<u>LEGEND:</u>

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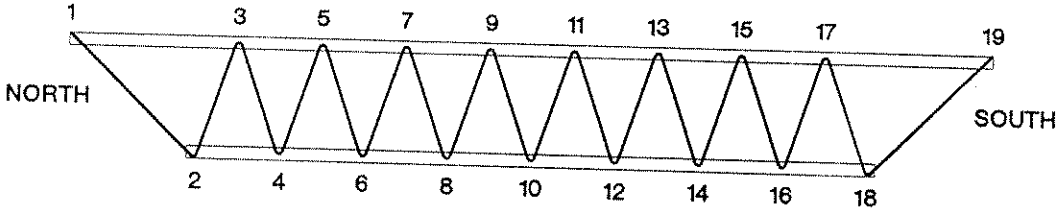
CERTIFIED WELDING INSPECTOR



1
2 **A, G**
3 **A, G, Puddle Weld**
4 **G, H (Low)**
5
6
7

8
9 **A, G, Puddle Weld**
10
11
12
13

14
15 **G**
16 **A, G, H (Low)**
17 **G, H (High)**
18
19

LEGEND:

A. UNDERCUT
B. POROSITY
C. NO FLARE WELD
D. INCOMPLETE FLARE WELD
E. WELD FAILURE
F. POOR PROFILE
G. SLAG NOT REMOVED
H. POOR FIT UP

EXTRA COMMENTS:

1. Undercut, poor profile and slag was evident throughout joists length.
2. Limited view of top chord panel points due to roof deck.
3. "Puddle welds" at discontinuous web panel points.
4.
5.
6.
7.
8. Joist inspected by M. O'Brien, P.Eng.

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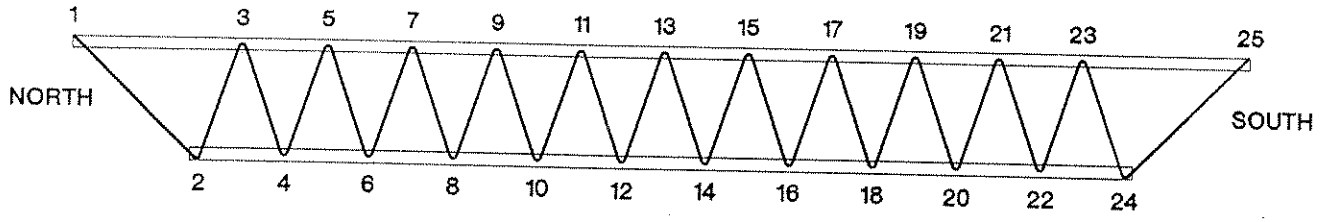
MIKE O'BRIEN, P.Eng.
LEVEL II
CSA W178.2
CERTIFIED WELDING INSPECTOR



1
2 **A, G**
3
4 **A, G**
5 **G, Puddle Weld**
6 **A, G**
7
8
9

10
11
12 **A, G, H (Low)**
13 **A, G, Puddle Weld**
14
15
16
17

18
19
20 **A, G**
21 **A, G, Puddle Weld**
22 **A, G**
23
24 **G**
25

<u>LEGEND:</u>

A. UNDERCUT
B. POROSITY
C. NO FLARE WELD
D. INCOMPLETE FLARE WELD
E. WELD FAILURE
F. POOR PROFILE
G. SLAG NOT REMOVED
H. POOR FIT UP

EXTRA COMMENTS:

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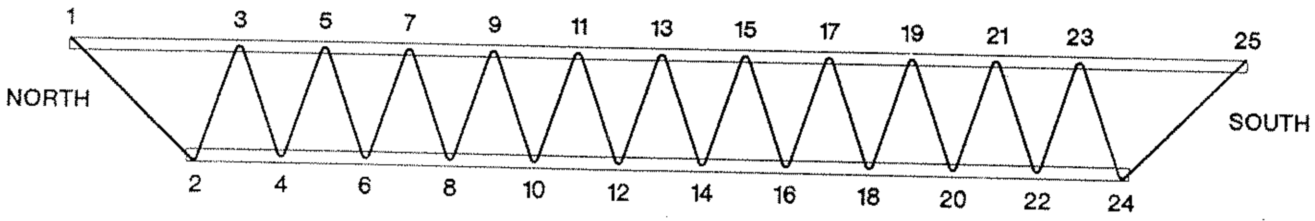
Joist J129



1
2 **G**
3 **G, Puddle Weld**
4 **A, G**
5
6 **G**
7
8
9

10
11
12
13 **G, Puddle Weld**
14 **A, G, H (Low)**
15
16
17

18
19
20 **A, F, G**
21
22 **A, G**
23 **G, Puddle Weld**
24 **A, G**
25

LEGEND:

A. UNDERCUT
B. POROSITY
C. NO FLARE WELD
D. INCOMPLETE FLARE WELD
E. WELD FAILURE
F. POOR PROFILE
G. SLAG NOT REMOVED
H. POOR FIT UP

EXTRA COMMENTS:

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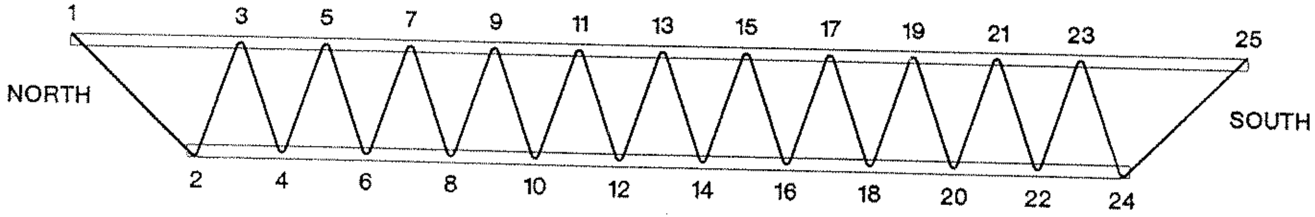

1

2 **G**

3

4 **A, G, H (High)**

5

6 **A, G, H (Low)**

7

8

9

10

11

12 **A, G**

13 **G, Puddle Weld**

14 **A, G**

15

16

17

18

19

20 **G**

21

22 **G**

23 **G, Puddle Weld**

24 **A, G**

25

LEGEND:

A. UNDERCUT
B. POROSITY
C. NO FLARE WELD
D. INCOMPLETE FLARE WELD
E. WELD FAILURE
F. POOR PROFILE
G. SLAG NOT REMOVED
H. POOR FIT UP

EXTRA COMMENTS:

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7.
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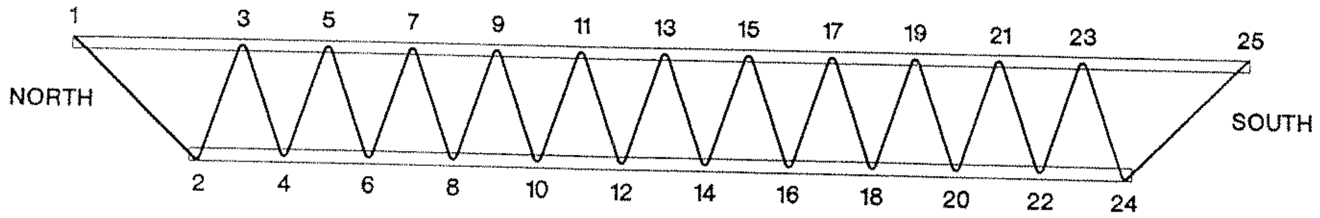
Joist J135



1
2 **A, G**
3 **G, Puddle Weld**
4 **A, G**
5
6 **A, G**
7
8
9

10
11
12 **A, G**
13 **G, Puddle Weld**
14 **A, G**
15
16
17

18
19
20 **F, G**
21
22 **F, G**
23 **G, Puddle Weld**
24 **A, G**
25

LEGEND:

A. UNDERCUT
B. POROSITY
C. NO FLARE WELD
D. INCOMPLETE FLARE WELD
E. WELD FAILURE
F. POOR PROFILE
G. SLAG NOT REMOVED
H. POOR FIT UP

EXTRA COMMENTS:

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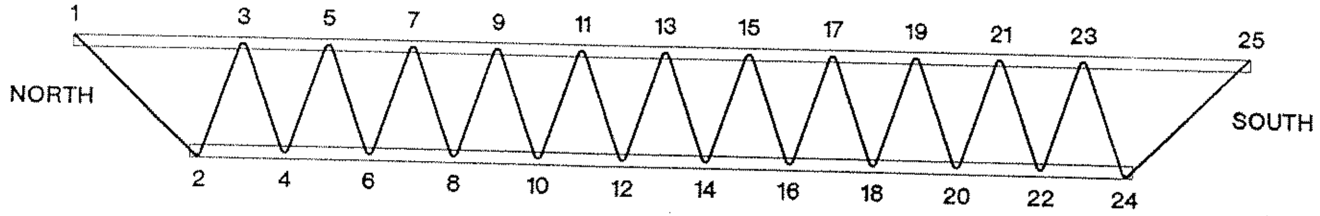

1
2 **G**
3
4 **G**
5 **G, Puddle Weld**
6 **G**
7
8
9

10
11
12 **A, G**
13 **G, Puddle Weld**
14 **A, G**
15
16
17

18
19
20 **A, G**
21 **G, Puddle Weld**
22 **A, G**
23
24 **A, G, H (High)**
25

<u>LEGEND:</u>

A. UNDERCUT
B. POROSITY
C. NO FLARE WELD
D. INCOMPLETE FLARE WELD
E. WELD FAILURE
F. POOR PROFILE
G. SLAG NOT REMOVED
H. POOR FIT UP

EXTRA COMMENTS:

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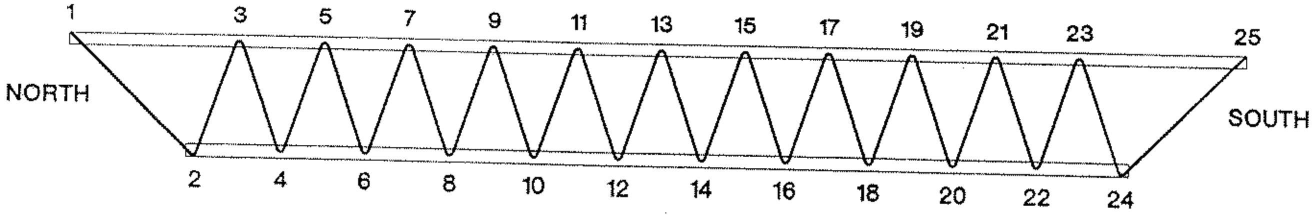
CSA W178.2



1
2 **A, G**
3 **G, Puddle Weld**
4 **A, G**
5
6 **G**
7
8
9

10
11
12
13
14 **A, G**
15
16
17

18
19
20 **G**
21
22 **G**
23 **A, G, Puddle Weld**
24 **A, G**
25

LEGEND:

A. UNDERCUT
B. POROSITY
C. NO FLARE WELD
D. INCOMPLETE FLARE WELD
E. WELD FAILURE
F. POOR PROFILE
G. SLAG NOT REMOVED
H. POOR FIT UP

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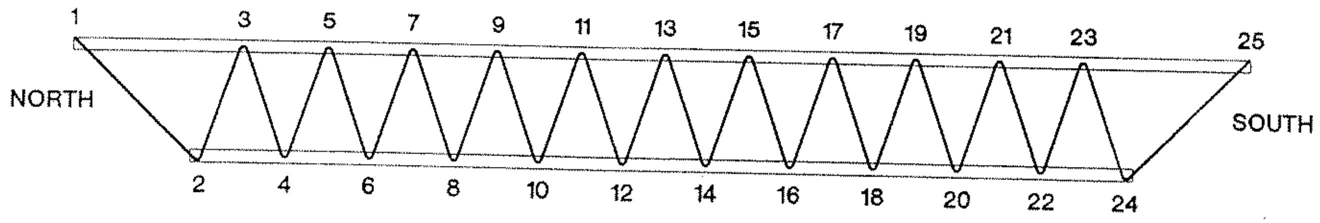

1
2 **G**
3 **G, Puddle Weld**
4 **G**
5
6 **G**
7
8
9

10
11
12 **A, G**
13 **A, G, Puddle Weld**
14
15
16
17

18
19
20 **A, G**
21 **G, Puddle Weld**
22 **A, G**
23 **G**
24 **A, G**
25

LEGEND:

A. UNDERCUT
B. POROSITY
C. NO FLARE WELD
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E. WELD FAILURE
F. POOR PROFILE
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2567
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LEVEL II
CSA W178.2
CERTIFIED WELDING INSPECTOR

APPENDIX ‘E’

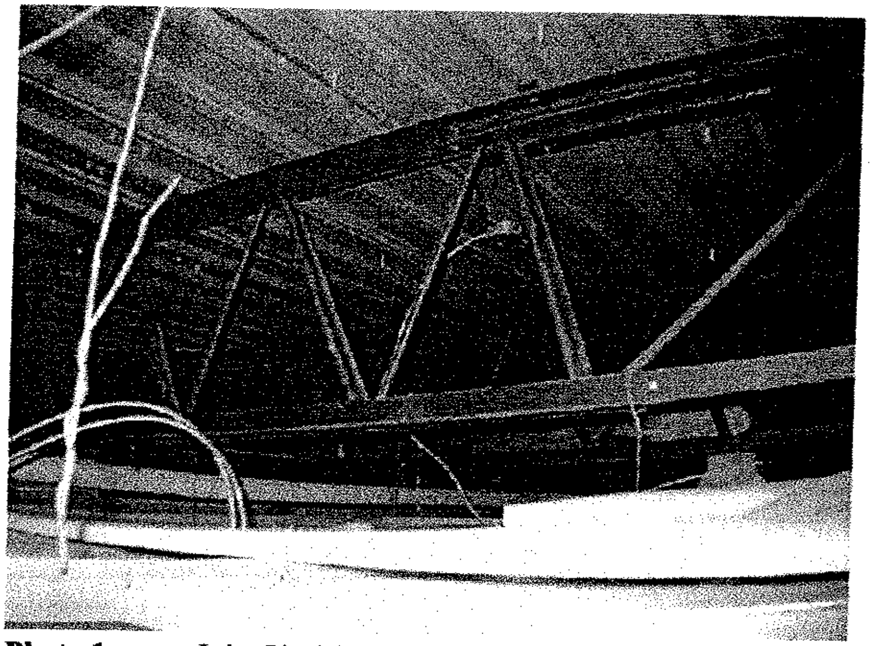


Photo 1: Joist J1 - Note Local Reinforcing Due to Transition to Two Story High School

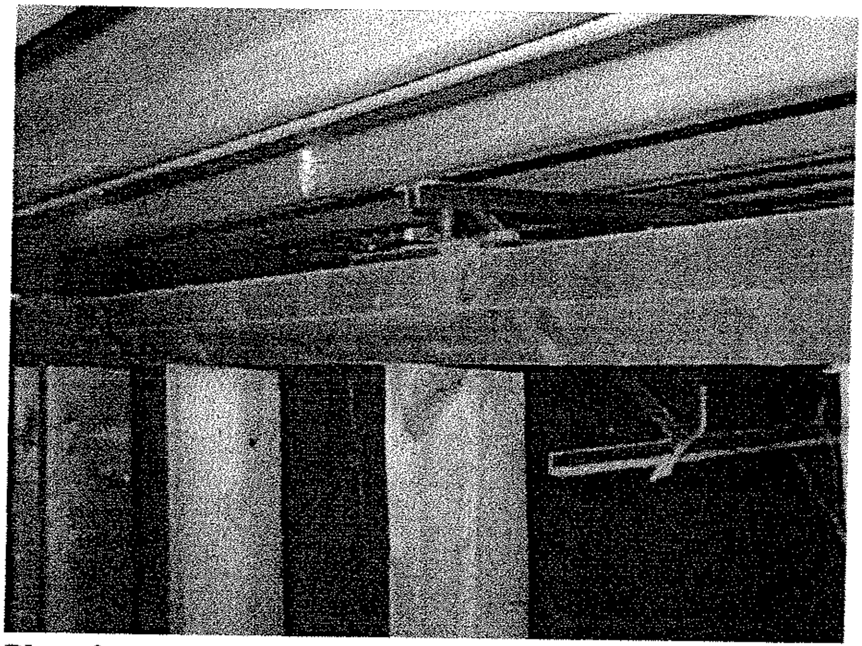


Photo 2: Typical Joist Shoe Connection to Wood Bearing Wall

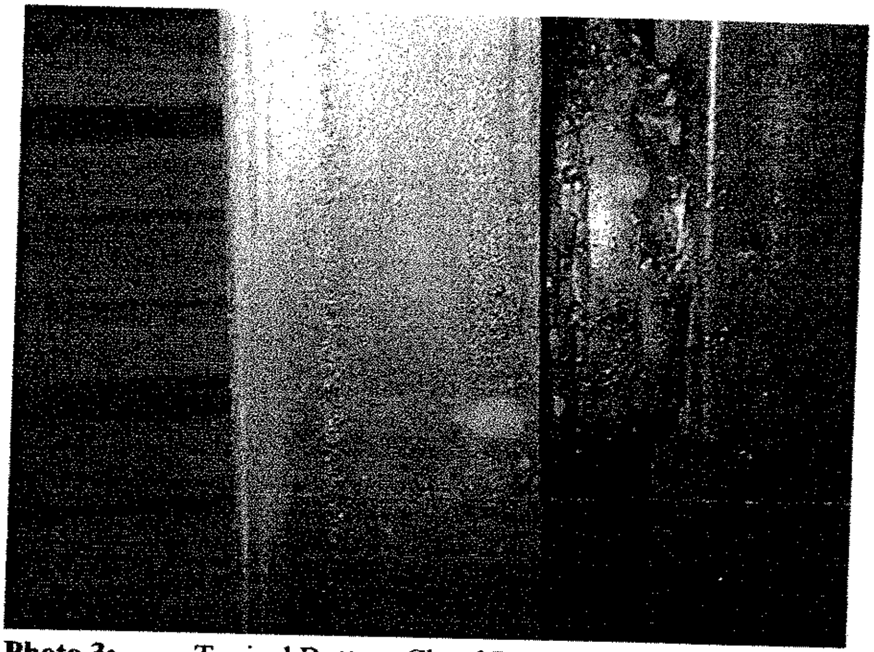


Photo 3: Typical Bottom Chord Panel Point Weld Quality

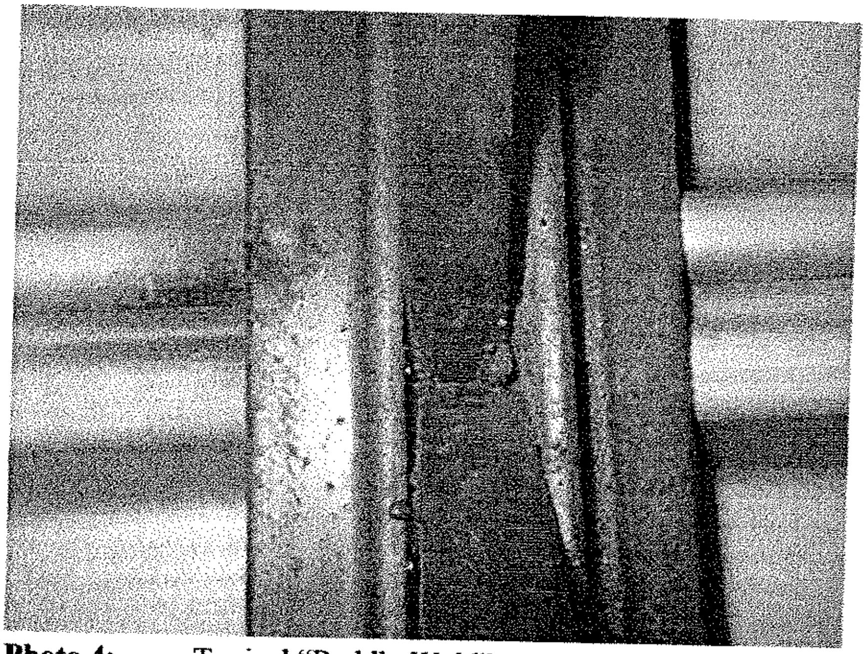


Photo 4: Typical "Puddle Weld" at Non-Continuous Top Chord Panel Point

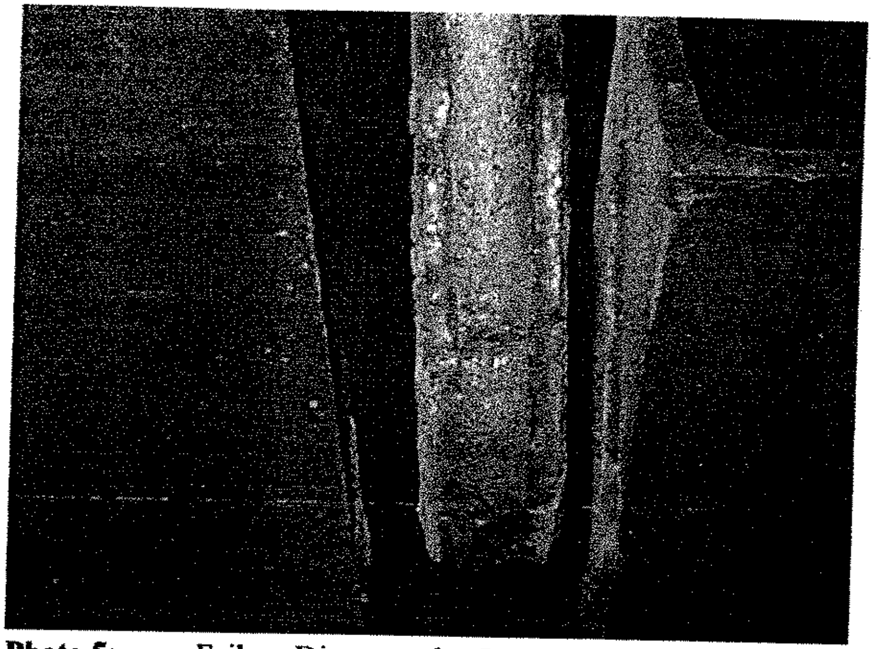


Photo 5: Failure Discovered at Panel Point 2 on Joist 1

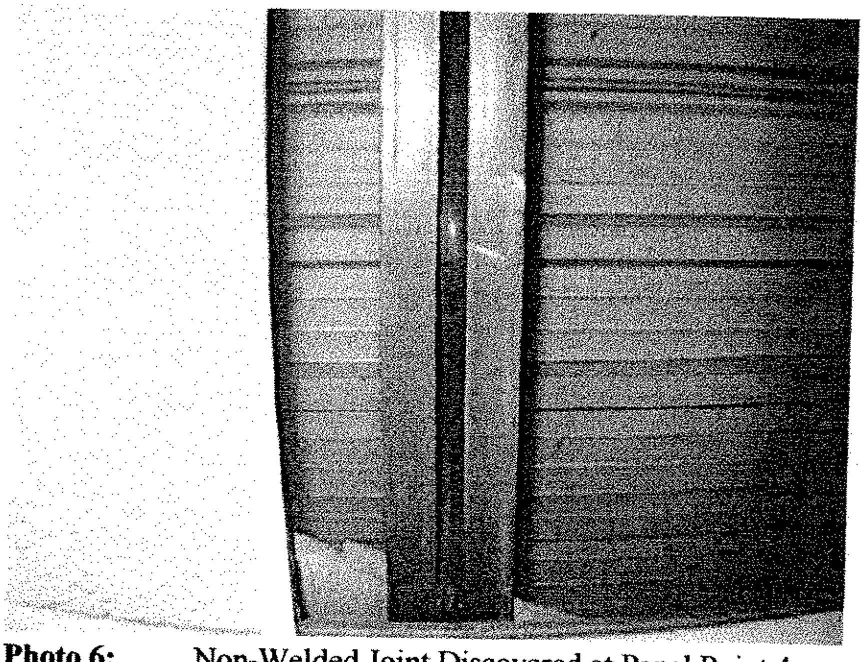
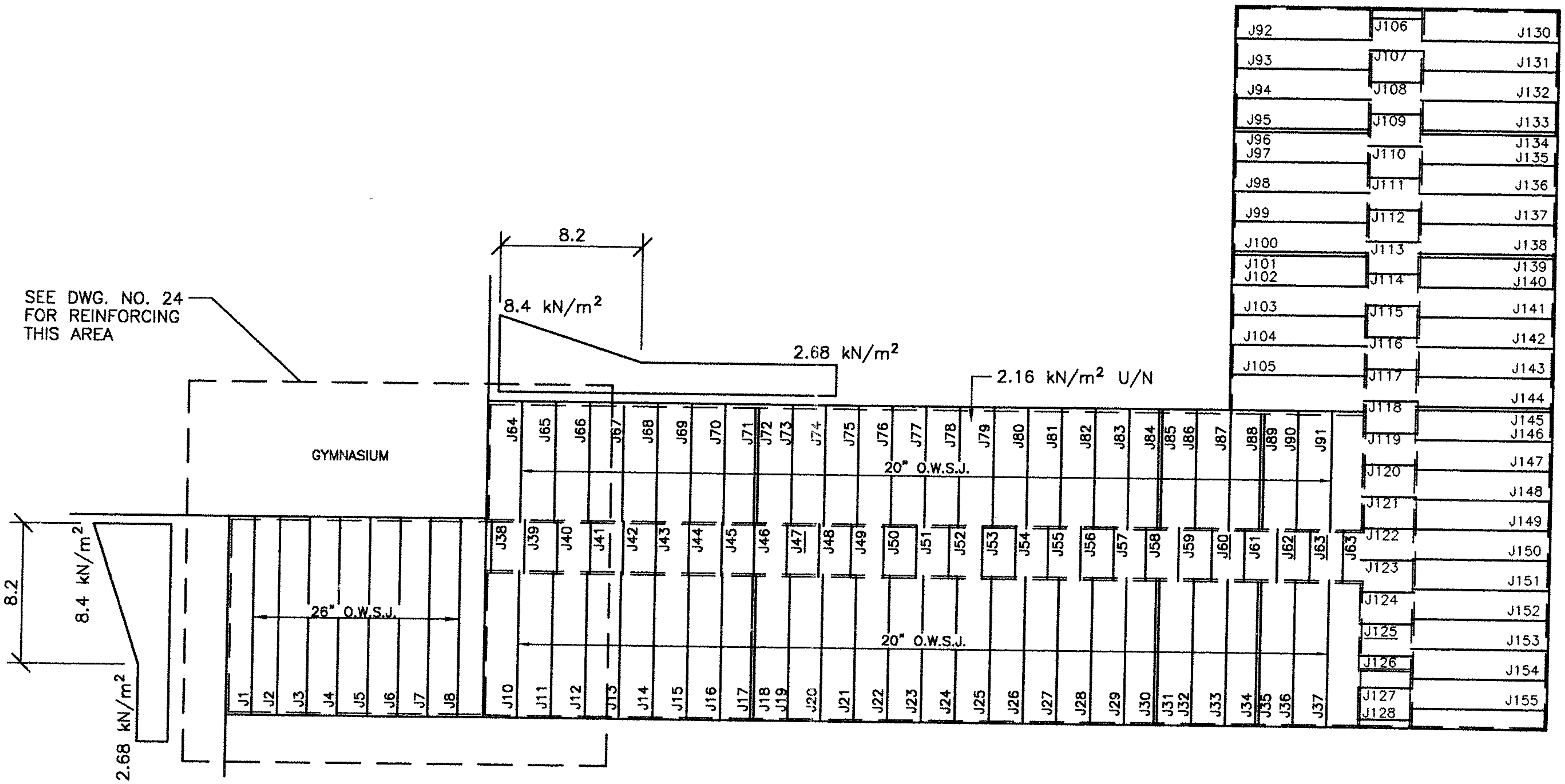


Photo 6: Non-Welded Joint Discovered at Panel Point 4 on Joist J147

APPENDIX VIII

"JACKSON WALSH ELEMENTARY SCHOOL REMEDIATION TENDER DRAWINGS"



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TITLE JACKSON WALSH ELEMENTARY
OPEN WEB STEEL JOIST REMEDIATION
WESTERN BAY
TENDER PACKAGE NO.: 4A-1

PARTIAL ROOF FRAMING PLAN

DWG.NO.	DATE	SCALE
S22	97.05.23	1:250 U/N

K. R. TOBIN
SIGNATURE
DATE

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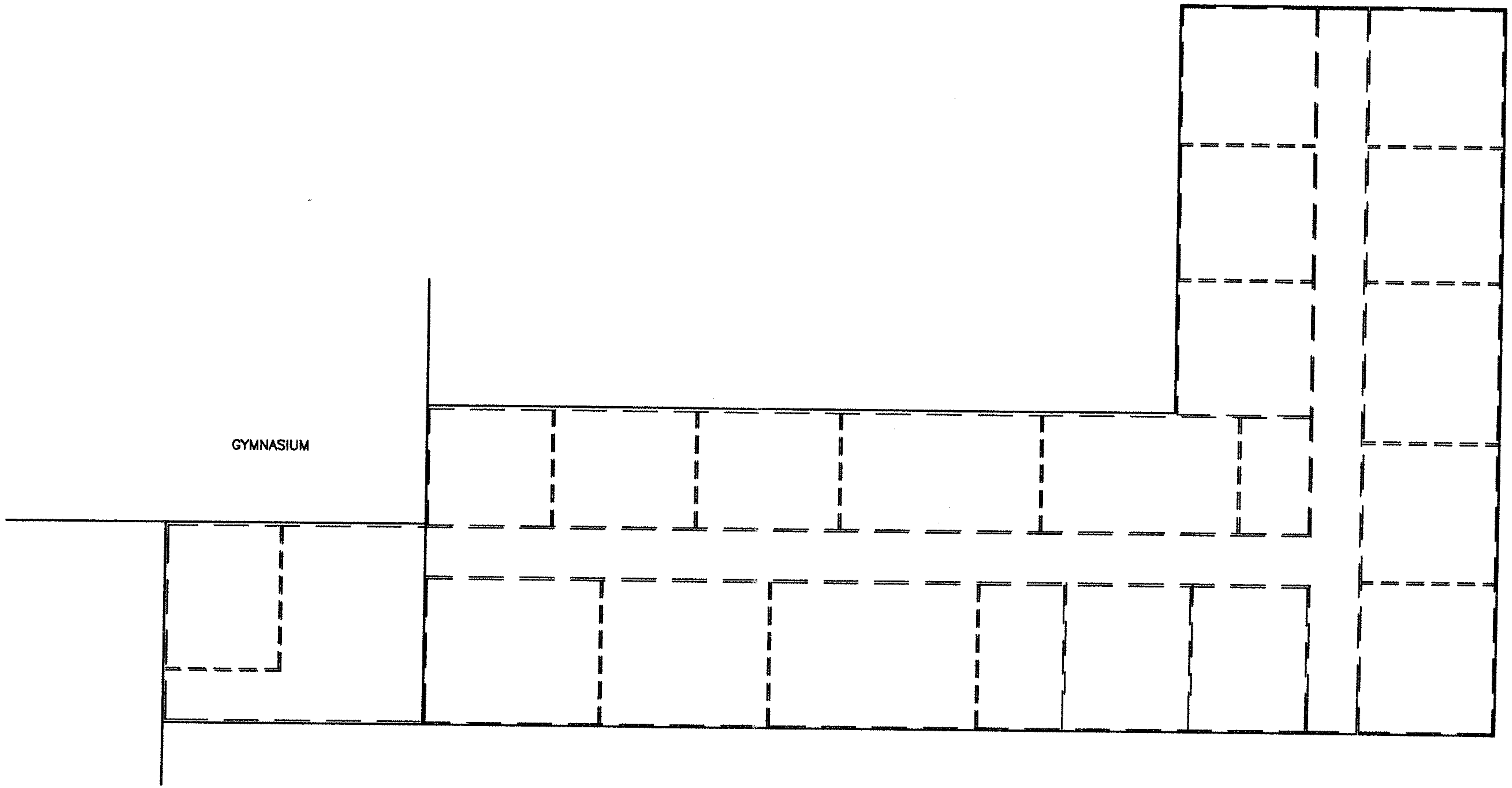

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WESTERN BAY
TENDER PACKAGE NO.: 4A-1

ARCHITECTURAL PLAN

DWG.NO.	DATE	SCALE
S23	97.05.23	1:250

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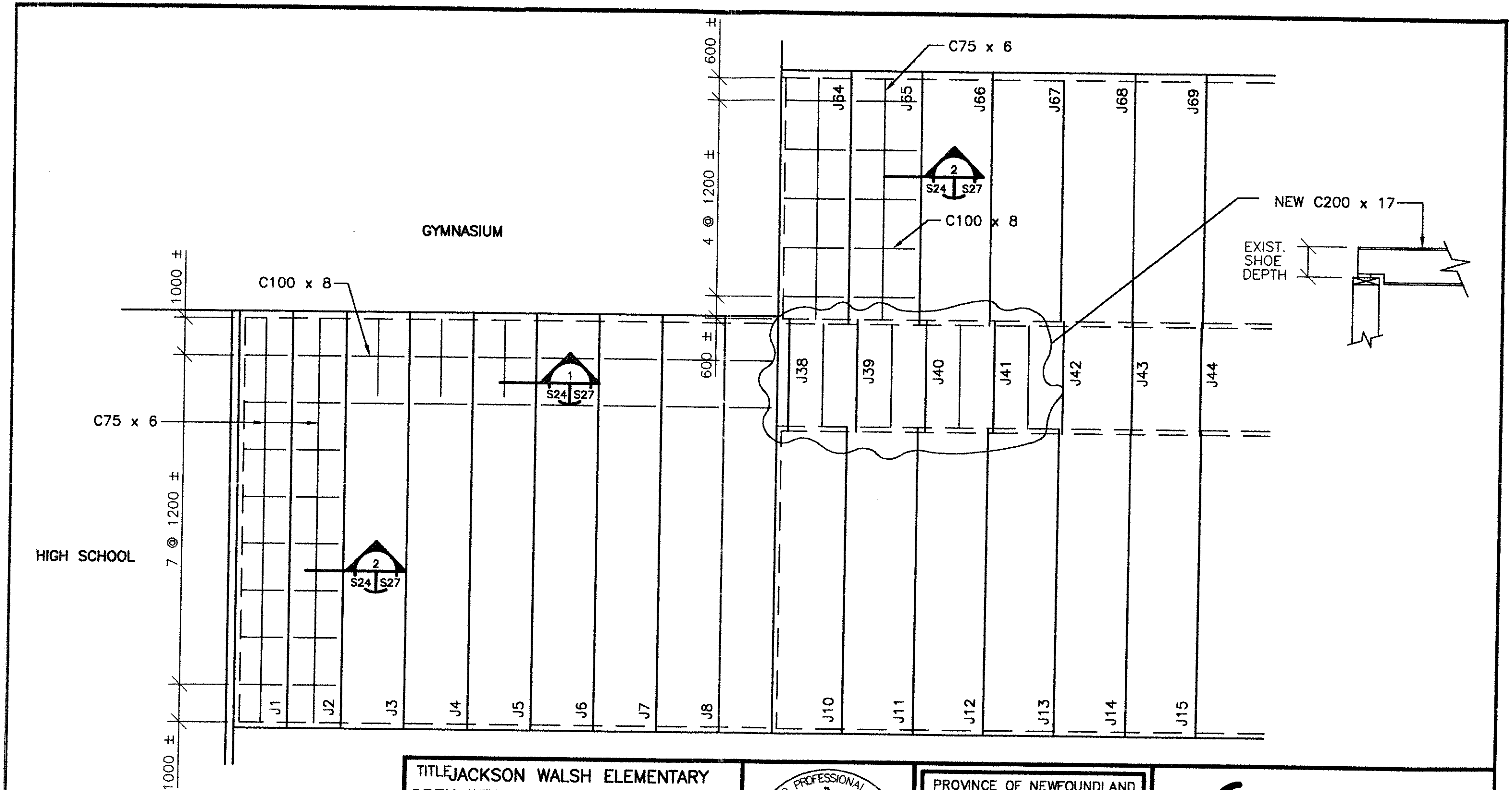

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OPEN WEB STEEL JOIST REMEDIATION
WESTERN BAY
TENDER PACKAGE NO.: 4A-1

PARTIAL ROOF FRAMING PLAN

DWG.NO.	DATE	SCALE
S24	97.05.23	1:100

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SIGNATURE

DATE

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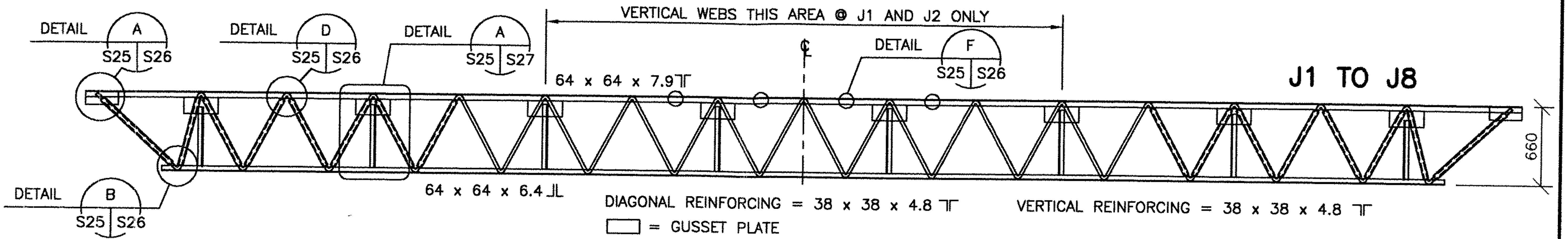
J1 TO J8

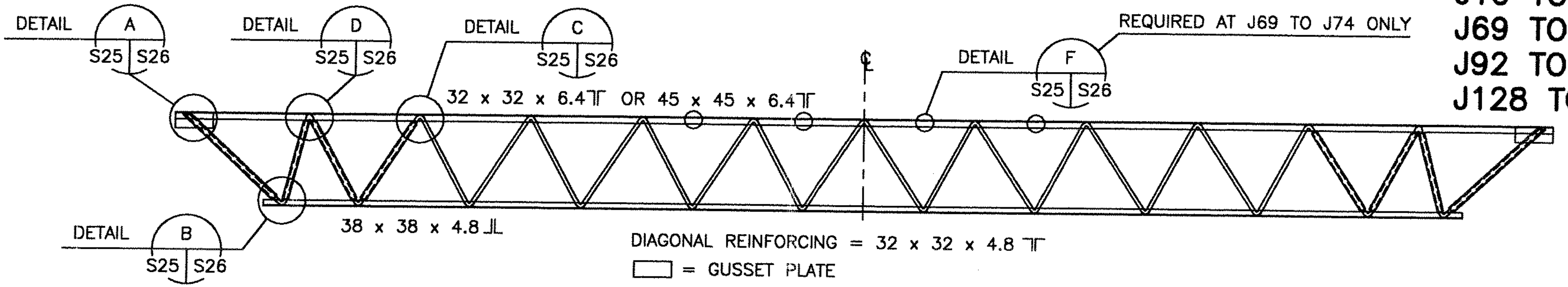


DIAGONAL REINFORCING = 38 x 38 x 4.8 ╥

▭ = GUSSET PLATE

VERTICAL REINFORCING = 38 x 38 x 4.8 ╥

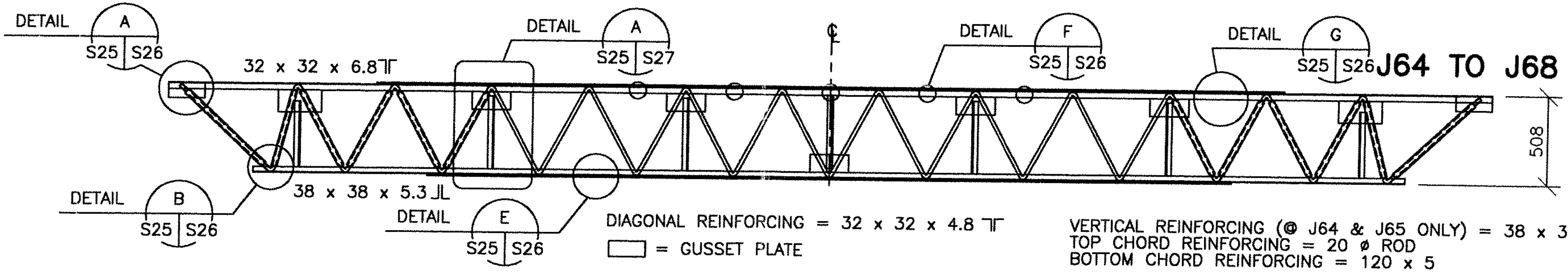
J10 TO J37
J69 TO J91
J92 TO J105
J128 TO J152



DIAGONAL REINFORCING = 32 x 32 x 4.8 ╥

▭ = GUSSET PLATE

J64 TO J68



DIAGONAL REINFORCING = 32 x 32 x 4.8 ╥

▭ = GUSSET PLATE

VERTICAL REINFORCING (@ J64 & J65 ONLY) = 38 x 38 x 4.8 ╥
TOP CHORD REINFORCING = 20 ø ROD
BOTTOM CHORD REINFORCING = 120 x 5

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TITLE JACKSON WALSH ELEMENTARY
OPEN WEB STEEL JOIST REMEDIATION
WESTERN BAY
TENDER PACKAGE NO.: 4A-1

JOIST REMEDIATION DIAGRAMS

DWG.NO.	DATE	SCALE
S25 REV.A	01.09.19	N.T.S.

K. R. TOBIN
SIGNATURE
DATE

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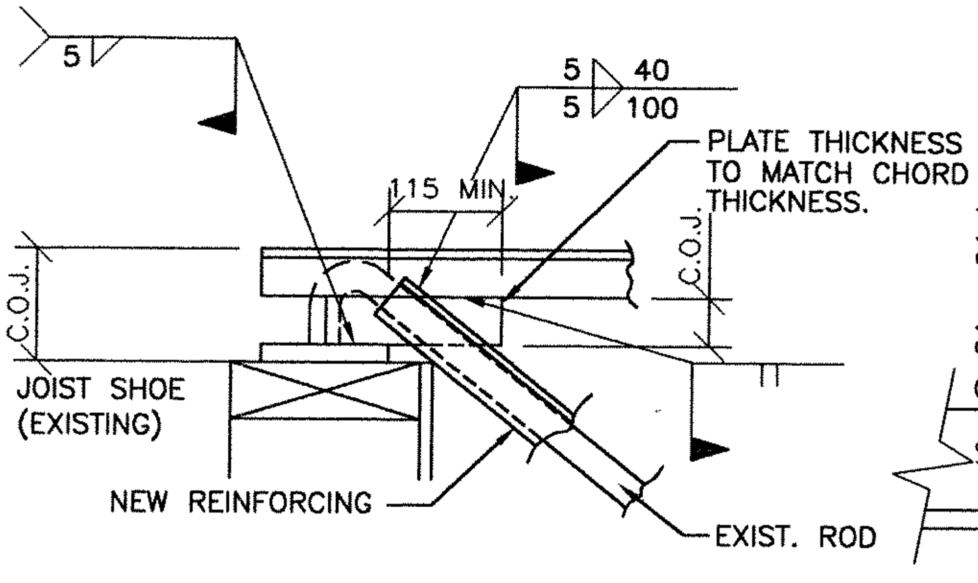
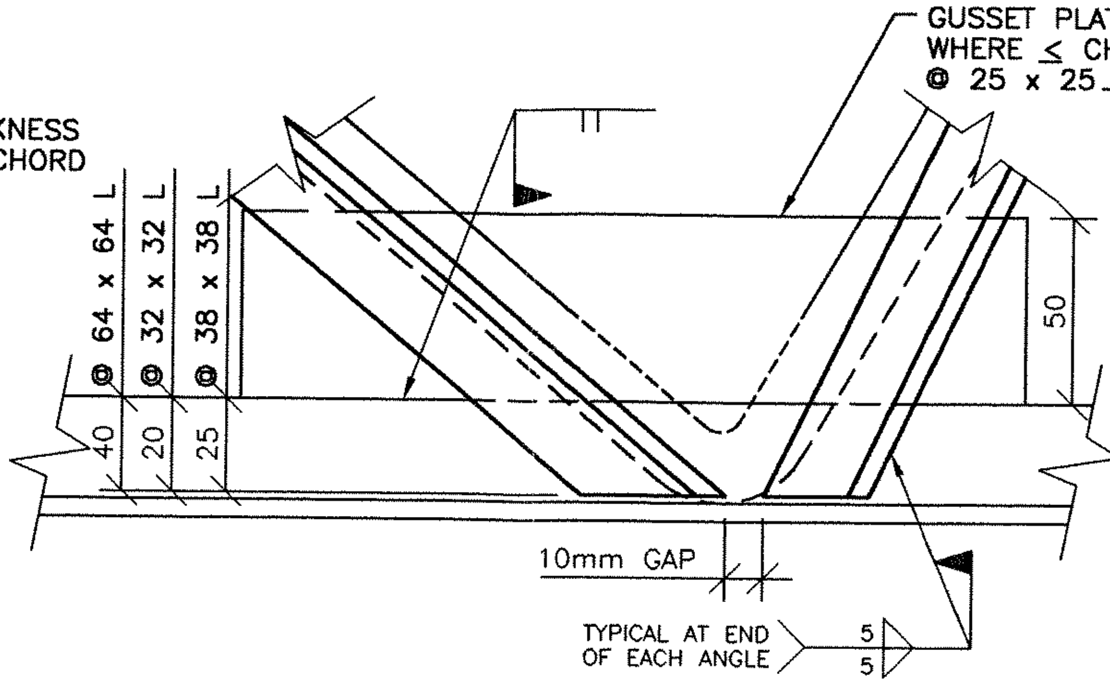
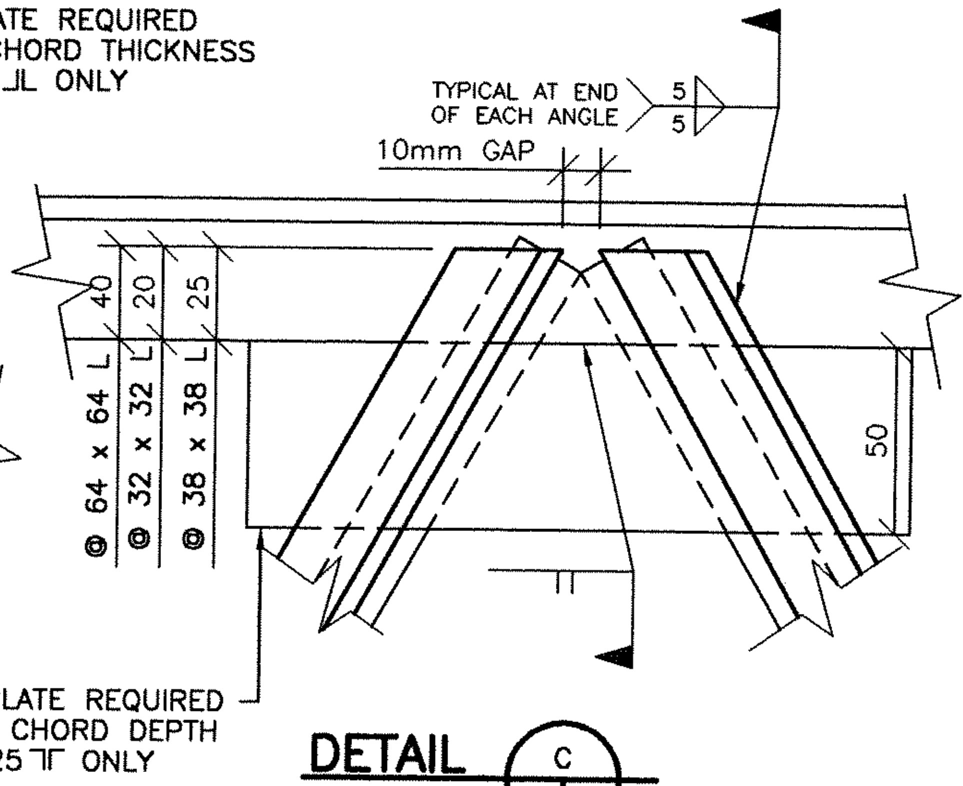


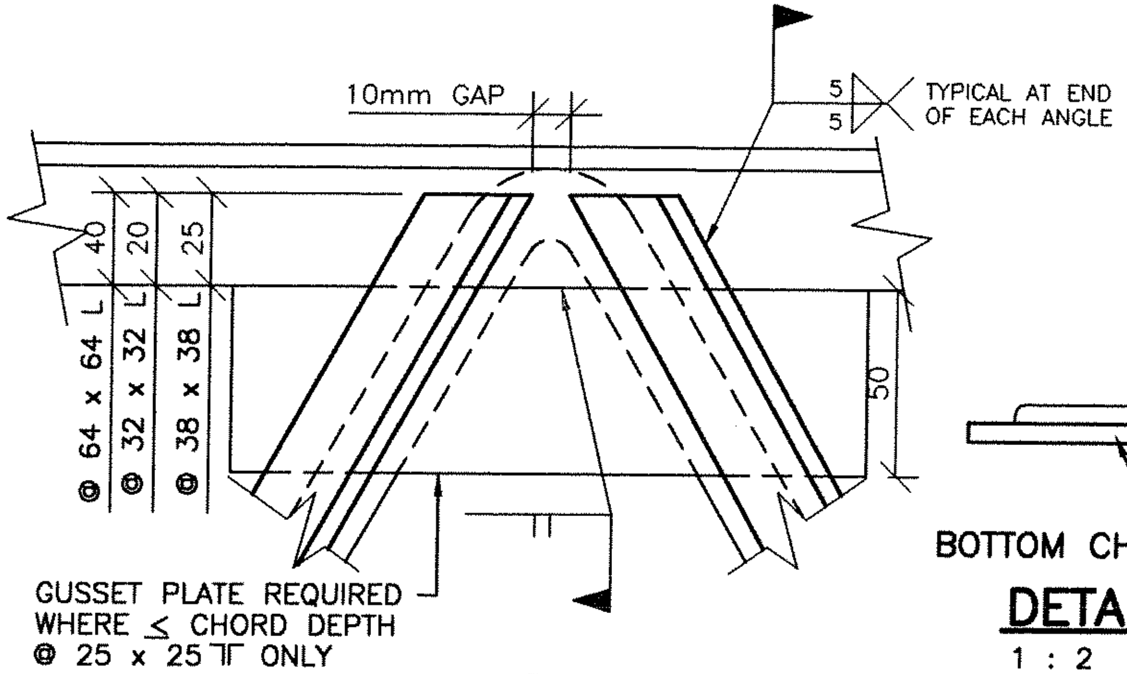
DETAIL A
1 : 5 S25 S26



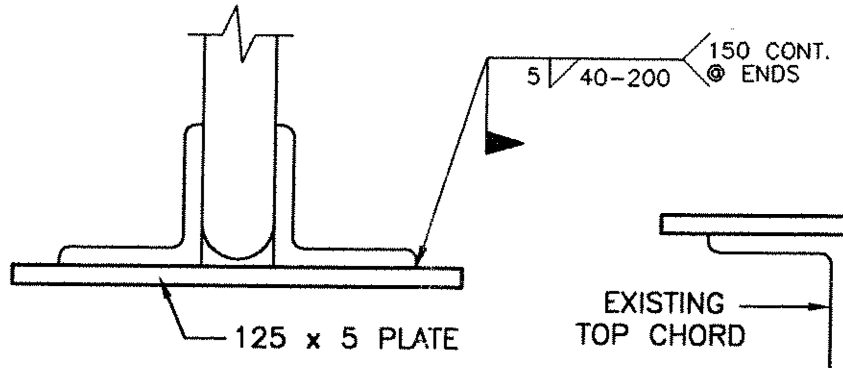
DETAIL B
1 : 2 S25 S26



DETAIL C
1 : 2 S25 S26

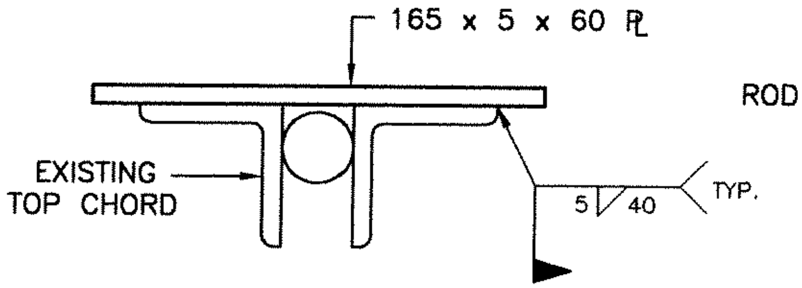


DETAIL D
1 : 2 S25 S26

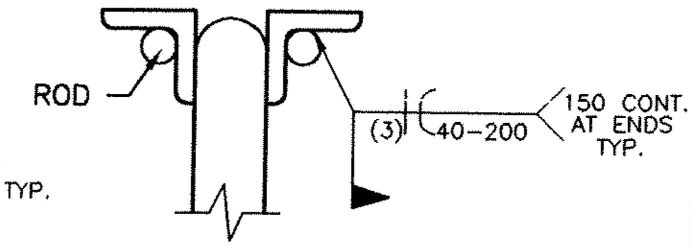


BOTTOM CHORD REINFORCING

DETAIL E
1 : 2 S25 S26



DETAIL F
1 : 2 S25 S26



TOP CHORD REINFORCING

DETAIL G
1 : 2 S25 S26

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TITLE JACKSON WALSH ELEMENTARY
OPEN WEB STEEL JOIST REMEDIATION
WESTERN BAY
TENDER PACKAGE NO.: 4A-1

JOIST REMEDIATION DETAILS

DWG.NO.	DATE	SCALE
S26 REV.A	01.09.19	AS NOTED

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SIGNATURE
DATE

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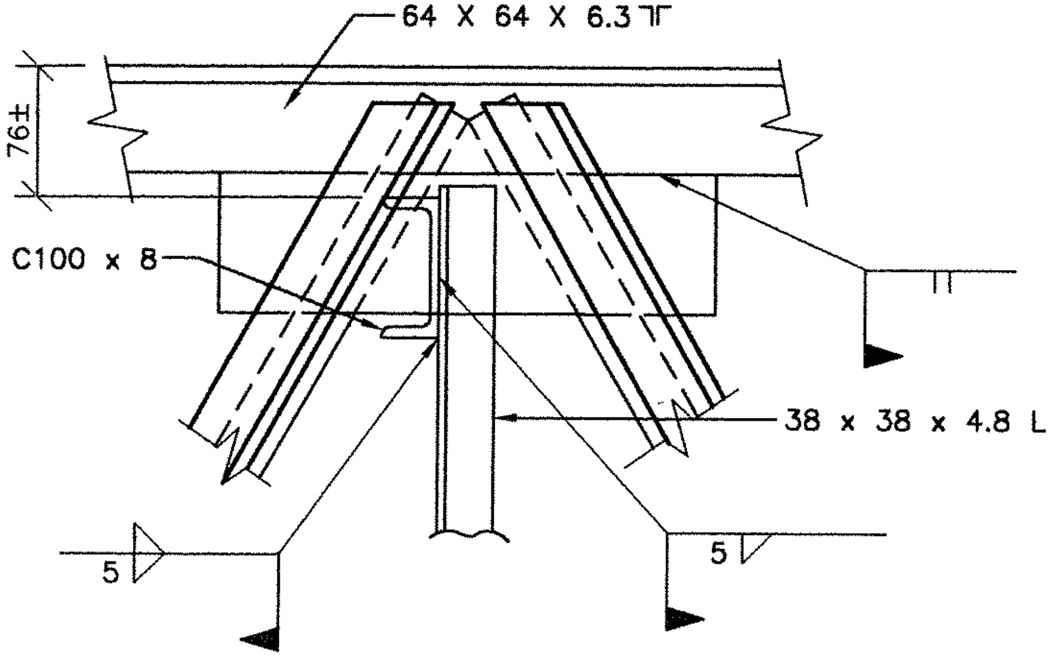
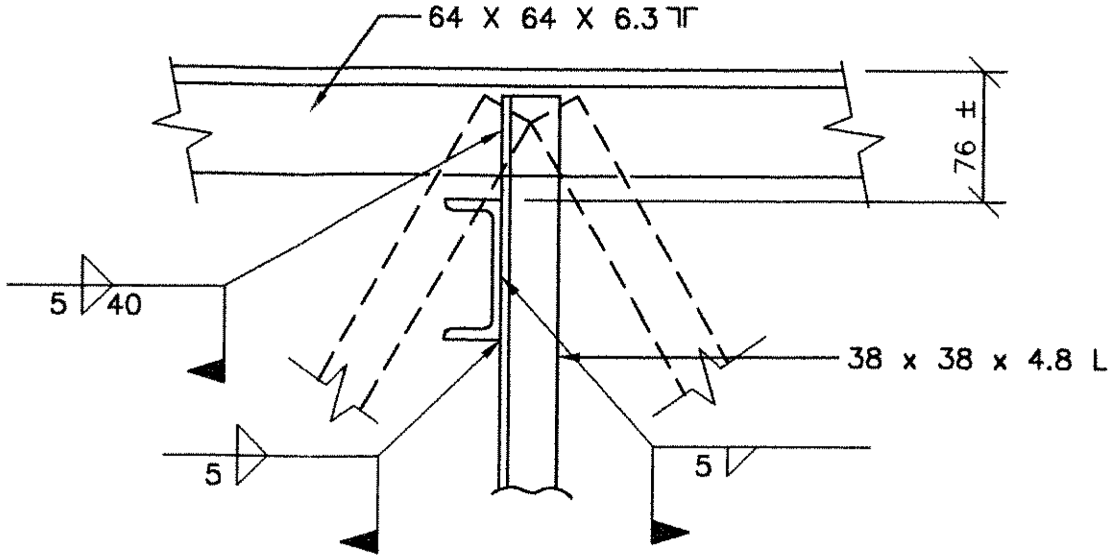
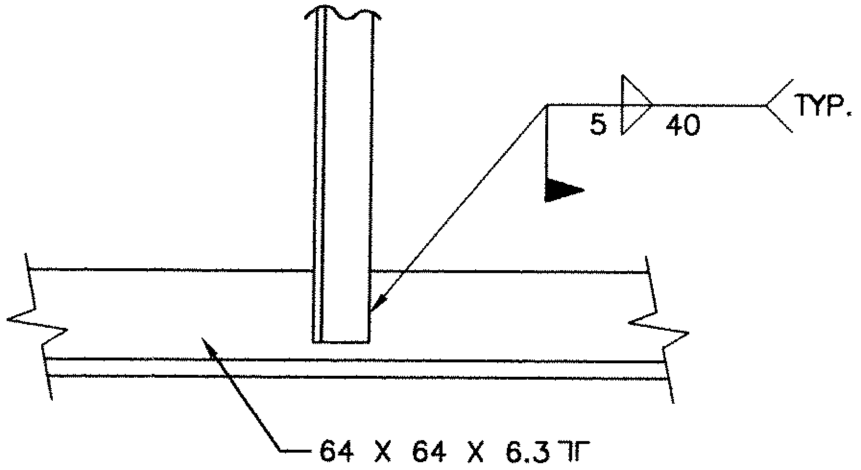
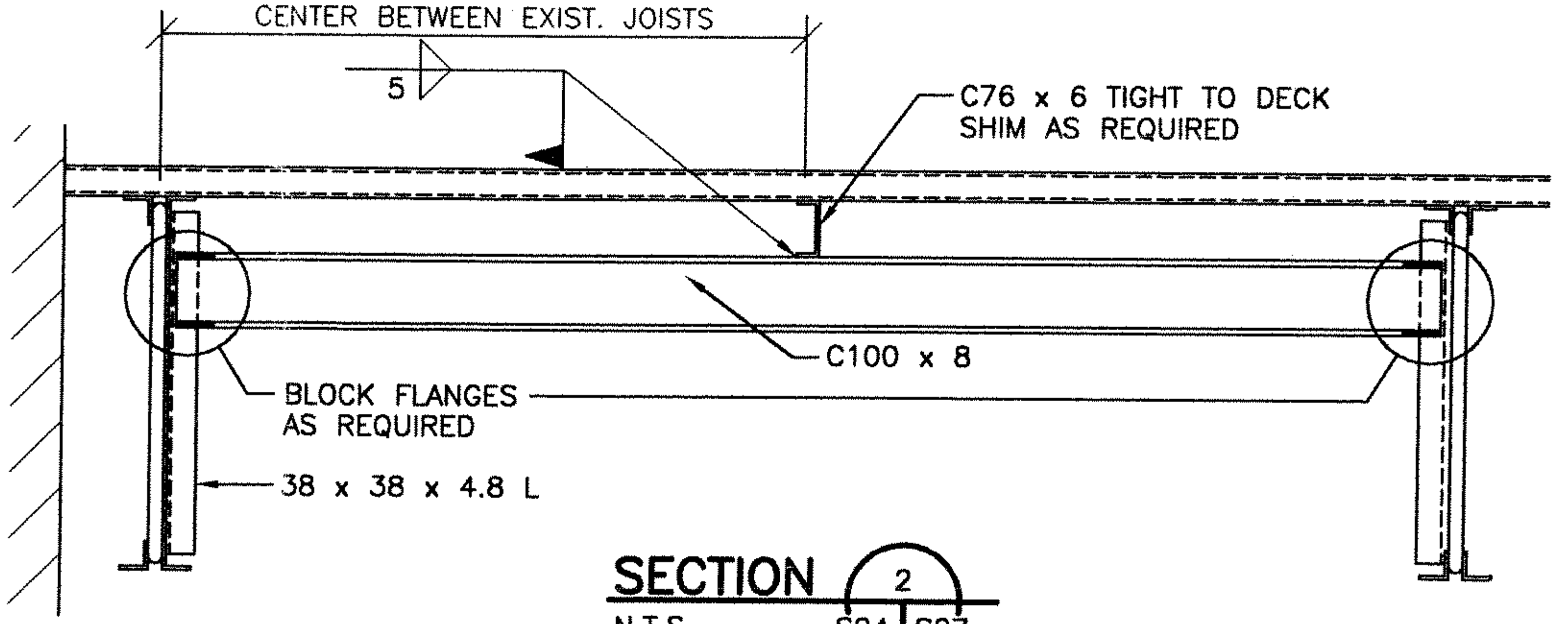




SECTION 1
N.T.S. S24 S27



DETAIL A
N.T.S. S25 S27



SECTION 2
N.T.S. S24 S27

"THESE DESIGN DOCUMENTS ARE PREPARED SOLELY FOR THE USE BY THE PARTY WITH WHOM FGA CONSULTING ENGINEERS LTD. (FGA) HAS ENTERED INTO A CONTRACT & THERE ARE NO REPRESENTATIONS OF ANY KIND MADE BY FGA TO ANY PARTY WITH WHOM FGA HAS NOT ENTERED INTO A CONTRACT.

TITLE JACKSON WALSH ELEMENTARY
OPEN WEB STEEL JOIST REMEDIATION
WESTERN BAY
TENDER PACKAGE NO.: 4A-1

JOIST REMEDIATION DETAILS

DWG.NO. S27
DATE 97.05.23
SCALE AS NOTED

REGISTERED PROFESSIONAL ENGINEER
K. R. TOBIN
SIGNATURE
DATE
PROVINCE OF NEWFOUNDLAND

PROVINCE OF NEWFOUNDLAND
PERMIT HOLDER
CLASS "A"
This Permit Allows
FGA CONSULTING ENGINEERS LTD.
To practice Professional Engineering in Newfoundland and Labrador.
Permit No. as issued by APEGN M0113 which is valid for the year 1997

fga Consulting Engineers Limited

2 Hunt's Lane, St. John's, Nfld. A1B 2L3
Tel: (709) 753-2100 / Fax: (709) 753-7011

APPENDIX IX

“REMEDIATION COST REPORT”

SCHOOLS COST REPORT:

Tender	School	Completed Contract Value (unless noted)
1A/1	H.G. Fillier All Grade - Englee	$90,182.08
	Harriot Curtis Collegiate – St. Anthony	$40,727.84
	St. Anthony Elementary	$160,002.23
	Total	**$290,912.15**
1B/1	Elwood Elementary – Deer Lake	N/A
	Rocky Harbour Elementary	$106,365.18
	Total	**$106,365.18**
1B/2	Beothic Collegiate – Baie Verte	$41,447.31
	Ricketts Elementary – Seal Cove	N/A
	Deckwood Elementary – Woodstock	N/A
	Hillside Elementary – LaScie	N/A
	Total	**$41,447.31**
1B/3	Valley Vista Senior Citiz	$221,415.91
	Total	**$221,415.91**
2A/1	G.C. Rowe – Corner Brook	$414,811.21
	Charisma – Springdale	$77,094.04
	Total	**$491,905.25**
2A/3	Lourdes Elementary – Lourdes	$85,913.13
	Lady of Mercy – St. Georges	$54,484.25
	L.S. Eddy Academy – Stephenville	$116,969.62
	Total	**$257,367.00**

Tender	School	**Completed Contract Value** (unless noted)
2A/4	St. Annes – Codroy	$3,641.45
	Belanger Academy – Codroy	N/A
	St. Stephen's Elementary – Stephenville	$110,952.65
	Total	**$114,594.10**
3A/1	Lake Melville – North West River	$201,641.34
	Peacock Elementary – Happy Valley	$236,199.22
	Total	**$437,840.56**
3A/2	Labrador College – Goose Bay	$276,385.28
	Labrador College Dormi – Goose Bay	$15,977.12
	Student Dorm (5004) – N – NW River	$58,224.05
	Total	**$350,586.45**
3A/3	Henry Gordon Academy – Cartwright	$111,678.87
	Total	**$111,678.87**
3B/1	Helen Tuck Elementary – Bishop's Falls	$100,234.40
	GFA Primary	$114,509.12
	Avoca Collegiate – Badger	N/A
	Notre Dame Academy	$20,127.00
	Total	**$234,870.52**
3B/2	Point Leamington & Leading Tickles	$140,508.00
	St. Joesph's All Grade – Harbor Breton	$34,867.38
	Total	**$175,375.38**

Tender	School	Completed Contract Value (unless noted)
4A/1	Tricon – Bay de Verde	$63,051.76
	Jackson Walsh – Western Bay	$70,474.04
	Holy Trinity – Heart's Content	$33,634.50
	Perlwin Winterton & Woodland-Dildo	$101,137.06
	Coley's Point Primary – Coley's Point	$18,961.13
	Woodland Elementary	$24,971.46
	Total	**$312,229.95**
5A/1	Bishop White All Grade – Port Rexton	$177,338.68
	Holy Cross – Eastport	$102,520.24
	Gander Academy – Gander	$242,291.31
	Total	**$522,150.23**
5A/2	North Haven Manor	$52,146.14
	Total	**$52,146.14**
5A/3	Lewisport High – Lewisporte	$183,507.65
	Twillingate Elementary – Twillingate	$58,067.65
	Newville – New World Island	$65,051.65
	Coaker Academy – Virgin Arm	$44,891.67
	Total	**$351,518.62**
5A/4	Swift Current All Grade – Swift Current	$72,525.61
	Total	**$72,525.61**
5A/5	Inter-Island Academy – Summerford	$58,176.22
	Total	**$58,176.22**

Tender	School	Completed Contract Value (unless noted)
6A/1	St. Theresa's – St. John's	$120,600.51
	St. Francis – Logy Bay	$35,718.37
	Holy Cross Elementary –Holyrood	$13,420.55
	Fatima All Grade – St. Brides	$24,448.34
	Whitbourne School – Whitbourne	$2,930.48
	Total	**$197,118.25**
7A/1	Beaconsfield Elementary – St. John's	$604,568.55
& 3031	Roncolli – St. John's	$13,537.08
	Holy Cross Elementary – St. John's	$121,654.52
	Ecole St. Gerard – St. John's	$53,272.91
	Total	**$793,033.06**
9877	Davis Elementary – Carbonear	$18,458.50
	Total	**$18,458.50**
3014	Gander Campus – Gander	$12,456.00
	Total	**$12,456.00**
3117(A)	Avoca Collegiate – Badger	$96,491.30
	Deckwood Elementary – Woodstock	$38,392.30
	Total	**$134,883.60**
3117(B)	Jen Haven Memorial Sc – Nain	$258,478.24
	Total	**$258,478.24**
3119	Peenamin McKenzie – Sheshatshit	$88,699.80
	Total	**$88,699.80**

Tender	School	Completed Contract Value (unless noted)
3120	Ricketts Elementary – Seal Cove	$51,997.20
	Total	**$51,997.20**
3021	Persalvic Elementary Sc – Victoria	$179,271.67
	Total	**$179,271.67**
40023	St. Thomas Aquinas El –Port au Port East	$61,146.32
	Total	**$61,146.32**
4-00	Deer Lake Clinic – Deer Lake	$44,749.19
	Total	**$44,749.19**

GOVERNMENT BUILDINGS:

<table>
<tr><th>Tender</th><th>Building</th><th>Contract Value</th></tr>
<tr><td>**1B/3**</td><td>Valley Vista Senior Citizens Home – Springdale</td><td></td></tr>
<tr><td></td><td>**Total**</td><td></td></tr>
<tr><td colspan="3">*** $185,000.00 is the consultants estimate for remediation and engineering. To date approximately $9,000.00 in remediation costs have been incurred to complete a 12 joist pilot project.**</td></tr>
<tr><td>**3A/2**</td><td>Northwest River Student Dorm</td><td>--</td></tr>
<tr><td></td><td>Labrador College & Dorm – Happy Valley</td><td>--</td></tr>
<tr><td></td><td>**Total**</td><td>**310,000.00***</td></tr>
<tr><td colspan="3">* Consultant's maximum estimate of final contract cost.</td></tr>
<tr><td>**5A/1A**</td><td>Central College – Gander</td><td>N/A</td></tr>
<tr><td></td><td>**Total**</td><td>**N/A**</td></tr>
<tr><td colspan="3">Central College had been included with 5A/1 Tender for three schools – Bishop White, Holy Cross (Eastport) and Gander but has since been removed.</td></tr>
<tr><td>**5A/2**</td><td>North Haven Manor - Lewisporte</td><td></td></tr>
<tr><td></td><td>**Total**</td><td>**297,550.00***</td></tr>
<tr><td colspan="3">***The consultant provided the following estimate:**
Emergency repairs $ 24,750.00
Phase III remediation 272,800.00
TOTAL $ 297,550.00</td></tr>
<tr><td colspan="2">**TOTAL VALUE – GOVT. BUILDINGS**</td><td>**607,550.00***</td></tr>
<tr><td colspan="3">* $607,550.00 does not include any cost for Tender 1B/3.</td></tr>
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