April 7, 2017

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Mr. Dennis McCarthy, Director of Public Works
Town of Rye Department of Public Works
10 Central Road
Rye, New Hampshire 03870

RE: Harbor Road Bridge Assessment
NHDOT Bridge No. 135/075
Hoyle, Tanner Project No. 923701

Dear Mr. McCarthy:

Hoyle, Tanner & Associates, Inc. (Hoyle, Tanner) herein submits to the Town of Rye recommendations for repairs to and maintenance for the Harbor Road Bridge evaluation project. In accordance with the agreement between the Town of Rye and Hoyle, Tanner, this is the final report for this project. The repair recommendations and maintenance strategies presented in this report are based, in part, on input received from the Town (Mr. McCarthy) during a progress meeting held on February 2, 2017 as well as alternatives discussed in the initial proposal for this project. This report serves as a continuation of the Preliminary Inspection and Load Rating Report submitted to the Town on August 24, 2016. Consequently, much of the information pertaining to bridge condition is repeated below for completeness. The ultimate selection and level of repair should meet the goals of the Town for the future bridge usage as well as the desired level of capital expenditure. A meeting between the Town and Hoyle, Tanner to discuss the findings and recommendations presented herein is suggested at this time.

## INTRODUCTION

The subject bridge carries Harbor Road over a tidal inlet adjacent to Rye Harbor. For the purposes of this letter, the bridge is assumed to span from east to west and north shall be taken in the direction of the harbor. The bridge is comprised of four - 30' clear span prestressed concrete "light" channel beams supported on cast-in-place mass concrete abutments with steel sheeting facing. The beams are numbered 1 to 4 from North to South. The bridge was not constructed with a concrete overlay; the top flanges of the channel beams alone function as the bridge deck, and the asphalt wearing surface is applied directly to the beam flanges. The crown in the roadway on the bridge is established with a variable thickness asphalt wearing surface that is 2" thick at curb lines and 3" thick at the centerline of the bridge. The bridge is currently load posted "E-2", meaning Certified Vehicles are restricted from crossing the bridge.

## SCOPE OF SERVICES COMPLETED TO DATE

### Initial Field Inspection

A hands-on field inspection of the Harbor Road Bridge was conducted on January 15, 2016 by Aaron Lachance, PE (Project Manager for the project) and Joseph Ripley, PE (Project Engineer). The purpose of the inspection was to evaluate the existing condition of the bridge, approach roadway, and the general project surroundings. Field measurements of the existing structure were taken for use in bridge load rating calculations, and deficiencies to be considered in subsequent repair or maintenance of the bridge were identified. The site visit was performed at low tide to provide maximum access to the steel sheeting of the abutments at the mudline. The inspection team performed a limited visual and physical (hammer sounding) inspection of the existing structure.

Preliminary Load Rating Analysis

A preliminary load rating analysis was conducted for the bridge. Prestressed concrete elements such as the channel beams of this bridge achieve their strength, in part, from embedded steel prestressing strands. Although the Town was able to locate the original construction drawings for the bridge, shop drawings detailing the reinforcing pattern used in the channel beams were not available. Therefore, assumptions based on conventional and practical construction details were made about the number and configuration of prestressing strands in the beams. Load rating calculations were prepared based on these assumptions, and a range of possible results was presented as a function of the number of assumed prestressing strands.

Several maintenance and rehabilitation measures were identified as potential solutions for this structure. Some improvements, however, would increase the dead load of the bridge, and thus decrease the live load capacity. Without a more precise understanding of the structural capacity of the channel beams, it was not recommended that the Town construct any repairs or improvements that would increase the dead load on the channel beams. Therefore, Hoyle, Tanner recommended that additional testing be conducted to determine the number and configuration of the prestressing strands within the webs of the channel beams.

Supplemental Field Investigation

Advanced investigation of the precast concrete channel beams was conducted on October 19, 2016 by S.W. Cole Engineering, Inc. (S.W. Cole), a subconsultant to Hoyle, Tanner. Joseph Ripley, PE from Hoyle, Tanner was onsite to assist in the investigation. Results of the investigation show that each channel beam has a similar pattern of prestressing and reinforcing steel that falls within construction tolerances of reinforcing placement. Two prestressing strands per stem (four strands per beam) were detected in each beam. The top strand in each beam is draped meaning that it is closer to the bottom of the beam at midspan and is at the mid height of the beam at the beam ends. Mild steel reinforcing (used to carry shear forces) was detected in all beams consisting of six bars at one foot spacing at each end of the beam. Additional investigation consisted of obtaining approximate concrete compressive strength using a concrete rebound hammer. This testing indicates that the beams have a compressive strength between 7,000 psi to 8,000 psi. A copy of the investigation findings is attached to this report.

## BRIDGE CONDITION AND OBSERVATIONS

The Harbor Road Bridge is in overall fair condition; the structure is structurally sound but exhibits some deterioration. Hoyle, Tanner's condition assessment and observations are in general agreement with recent NHDOT bridge inspection reports which identify the deck and superstructure as satisfactory and the substructure as fair. Increased inspection scrutiny was warranted at the beam ends and longitudinal joints based on Hoyle, Tanner's experience with similar structures, a cursory overview of the bridge, and a review of the NHDOT Bridge Inspection Report. Concrete deterioration at these locations can lead to a reduction in the overall load carrying capacity of the bridge.

The following specific observations were documented during the field inspection:

Deck – Overall 'Fair' Condition

- The pavement wearing surface exhibits reflective cracking along the longitudinal joints between adjacent beams.
- The ends of the beams at their interface with the bridge abutments comprise the deck joints, and they exhibit advanced deterioration. There are holes in the pavement up to 4" wide and 36" long along the joints, with signs of significant leaking through the joint.
- The bridge and roadway approach rail are substandard by current design standards. The bolted connections between the steel bridge rail posts and the concrete deck soffit exhibit minor corrosion and are not likely adequate to resist loading from a vehicular impact of any significant force.

Prestressed Concrete "Light" Channel Beams – Overall 'Fair' Condition

- Each of the four beams exhibit spalling of the concrete on the undersides of the flanges at the east and west abutments due to moisture introduced from the leaking deck joints.
    - Beams 2 and 3 exhibit delaminated concrete beyond the spalls at the east abutment indicating the beam-end deterioration is continuing along the length of the beam.
- The steel reinforcing of the top flanges that is exposed at various locations from concrete spalling exhibits advanced corrosion with section loss.
- There are several locations along the lengths of the beam stems and flanges where the mild (non-prestressed) reinforcing steel is exposed due to the lack of concrete cover during construction.
- Sporadic spalls were observed in the stems of the beams in the following locations:
    - Beam 2, north stem, from 28" to 55" from the west beam end
    - Beam 2, north stem, at the east beam end
    - Beam 2, south stem, at the west beam end
    - Beam 3, north stem, at the east beam end
    - Beam 4, south stem, at midspan
- The south fascia of Beam 4 exhibits spalling along the entire length of the beam.
- The south stem of Beam 4 exhibits cracking for a length of 61" at midspan.
- The leaking longitudinal beam joints exhibit moderate to major rust staining indicating water migration through, and deterioration of, the joint.

Substructure – Overall 'Fair' Condition

- The steel sheeting on the faces of the east and west abutments exhibits advanced section loss with multiple holes at and around the high and low tide water marks.
    - The zone between the high and low tide water marks is covered by barnacles and other marine growth that largely obscure the condition of the sheeting.
- The steel sheeting on the faces of the east and west abutments exhibits significant laminar corrosion above the high tide water mark.
- The exposed abutment concrete visible in the areas of sheeting deterioration appears to be in generally good condition with no significant defects noted.
- The west abutment steel sheeting appears to have been installed around timber cribbing members at/near the mudline. This timber cribbing is deteriorating, leaving an unprotected void in the face of the abutment. The extent of penetration of the timber cribbing into the abutment could not be established.
- The concrete in the east and west abutment backwalls exhibits random spalling and cracking.

**BRIDGE LOAD RATING AND USAGE ANALYSIS**

Information obtained from the supplemental field investigation was used to update the preliminary load rating analysis. A load rating reports a bridge's live load capacity, or the weight of vehicle it can accommodate. The load rating calculations were performed in accordance with the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Highway Bridges, 17th Edition; the NHDOT Bridge Design Manual; and the AASHTO Manual for Bridge Evaluation, Second Edition with 2016 Interim Revisions (AASHTO MBE). The Load Factor Rating Method was used for the analysis. All load rating conclusions are based on the operating rating level. Per the AASHTO MBE, the operating rating level describes the maximum permissible live load to which the structure may be subjected. However, allowing an unlimited number of maximum permissible loads across the bridge may shorten the life of the bridge. The operating level rating was selected because it provides a larger live load capacity than the inventory rating and the number of vehicles that use the bridge is very low.

Load rating calculations indicate that at the operating level the bridge has a recommended load posting level of 15 tons. This is less than the recommended posting of 20 tons reported in the Preliminary Inspection and Load Rating Report for four strands (two strands per beam stem). Additionally, the recommended rating of 15 tons is less than the currently posted "E2" rating. As such, the bridge should be down posted immediately. The difference between the preliminary and actual load rating results for four prestressing strands per beam is due to the difference between the assumed and observed layout of the strands. Based on a review of period channel beam construction, as well as current engineering practice, preliminary rating calculations assumed that the strands would be straight, not draped, and be located at uniform two inch spacing. As discussed above, the actual pattern is draped with an average spacing of 2.5 inches and 4 inches for the first and second strand, respectively.

It is important to note that recommended postings are based on the NHDOT typical posting levels. The actual load carrying capacity of the bridge is dependent on the number and spacing of axles as well as vehicular weight distribution. Based on Hoyle, Tanner's observations as well as discussion with the Town, vehicles with the axle spacing and weights of the AASHTO rating vehicle (HS20-44) do not typically, or in any great quantity, cross the bridge. Therefore, in collaboration with the Town, a list of supplemental vehicles that are likely to cross the bridge was developed for further bridge rating analysis. Specific vehicles analyzed include:

1. Concrete mixer truck
2. Home heating oil delivery truck
3. Septic tank pump truck
4. Tri-Axle dump truck
5. Fire Engine (based on axle configuration and assumed usage, a two axle pumper truck was selected. This vehicle is representative of Rye Fire Department Engine 3 as listed on the Rye Fire Department website.)
6. Ambulance

The AASHTO MBE includes standard load rating trucks that can be used to represent the typical vehicles listed above. As such, vehicles 1-3 were each modeled as the Type 3 Unit which has a total weight of 25 tons, and vehicle 4 was modeled as the SU4 Truck which has a total weight of 27 tons. The axle spacing and loading for a two axle fire engine (pump truck) do not readily conform to a specific AASHTO rating vehicle; therefore, this truck was modeled based on manufacturer specifications with a total weight of 20.25 tons. The ambulance was not rated since the combination of axle configuration and loading produces lesser force effects than other vehicles considered and therefore will not control the rating (i.e. the bridge is not load restricted for ambulances). Results of the usage vehicle load rating calculations are presented below.

Table 1 – Usage Vehicle Load Rating Results:

| Rating Vehicle | Operating Rating Factor | Recommended Max Vehicle Weight (Tons) |
|---|---|---|
| Type 3 Unit | 0.95 | 23 |
| SU4 | 0.82 | 22 |
| 2-Axle Fire Truck | 1.13 | 20 |

As is shown above, the rating factors for the Type 3 Unit and the SU4 Truck are less than 1.0 indicating that these vehicles should be load restricted. Therefore, it is recommended that the Town take active steps to work with abutters to ensure that the weights of vehicles with the axle configurations close to the Type 3 Unit and the SU4 Truck do not exceed these limits. Typical axle configurations and loads for Type 3 Unit and the SU4 Trucks are included in this report, for reference.

## REPAIR RECOMMENDATIONS AND MAINTENANCE STRATEGIES

Hoyle, Tanner understands the importance of the Harbor Road Bridge to the Town. Improvements to the structure are necessary; however, inspection and structure evaluation tasks prepared as part of this project indicate that the bridge can remain serviceable with the proper combination of repair, rehabilitation, and on-going maintenance activity. The life cycle costs represented in repair dollars per year of remaining service life can be substantial for any level of repair or rehabilitation investment. As such, and through discussions with the Town, three levels of potential capital investment have been considered. These include repair, rehabilitation, and superstructure replacement. A description of major work items, conceptual cost estimates, live load carrying implications, traffic control and expected life span is provided for each option below.

### Option 1: Superstructure Repair

This alternative includes the least amount of capital expenditure. It is indented primarily to correct existing deficiencies and to prevent continued deterioration of the bridge superstructure. This option does not include correcting any abutment deficiencies, or improving the substandard bridge rail and approach guardrail.

Major work items for this option include:

1. Removal of existing bridge deck pavement.
2. Hammer sounding of the channel beam flanges to identify areas of concrete delamination.
3. Removal and replacement of deteriorated concrete on top of the beams, as identified above.
4. Removal of existing shear key grout between adjacent beams, re-welding of shear tab connectors and replacement of shear key grout.
5. Installation of new heat welded water proofing membrane on top of beams.
6. Replacement of bearing pads.
7. Installation of new bridge joints.
8. Re-paving the bridge deck.
9. Application of water repellent (silane/siloxane) to the exposed surfaces of the concrete channel beams.

The total concept-level estimated construction cost of this option is approximately $50,000. All costs are presented in 2017 dollars and include a 20% contingency. These superstructure repairs are assumed to provide a service life of approximately 15 years which results in an equivalent uniform annual cost of approximately $3,300 per year of remaining service life. Although these repairs will re-establish connectivity between adjacent channel beams, resulting in improved live load distribution between beams, the recommended posting of 15 tons (based on the NHDOT posting methodology) will not be improved. Engineering services are necessary for the design of the improvements, preparation of plans and specifications, and for bid phase and construction engineering/administration services. An estimate of the approximate cost of these services is $25,000.

Since Harbor Road is a dead-end road, maintenance of traffic during construction is an important consideration for any repair or replacement option. A commonly used traffic control method for bridge work is phased construction; this approach constructs sections of the bridge individually while maintaining portions of the bridge not currently under construction open to continuous traffic flow. Based on the narrow width of the existing bridge, some work items such as the removal and replacement of deteriorated concrete on top of the channel beams near the centerline of the bridge cannot be completed while the bridge remains partially open to traffic. As a result, temporary short-duration bridge closures will be required in order to perform certain construction activities. However, measures such as the use of fast setting ultra-high performance concrete (UHPC) can be utilized to limit the duration of necessary closures. For the work items as detailed above, it is likely that the maximum daytime bridge closure could be limited to as little as four hours. It is anticipated that closures will be required for concrete repairs along the centerline of the roadway, barrier membrane installation, and paving. Pedestrian access across the bridge can be maintained throughout the duration of construction. Early and frequent coordination between the Town and users of the bridge will be required to set working parameters and establish contract requirements for the frequency, timing, and duration of allowable bridge closures during construction.

<u>Option 2: Superstructure Rehabilitation</u>

This option includes greater capital expenditure than Option 1. However, it includes several advantages versus the minor superstructure repair option including a longer service life, increased live load capacity, and the ability to correct some of the existing functional deficiencies such as the substandard guardrail. This option does not include correcting any substructure (abutment) deficiencies. Major work items for this option include, in addition to the Option 1 major work items 1 through 9, the following:

1. Addition of a cast-in-place concrete overlay and brush curbs on top of the existing channel beams.
2. Installation of crash tested bridge rail and approach guardrail systems.
3. Superstructure strengthening through the use of an external post tensioning system or adding supplemental galvanized steel H-pile beams to support the channel beam flanges.

The feasibility of using carbon fiber wrap was also investigated as a potential superstructure strengthening system. However, there are several potential limitations associated with the use of this system for this project. A carbon fiber wrap system achieves its strength based on the bond between the concrete channel beams and the carbon fiber. Due to the limited clearance between adjacent beam stems, as well as the previously described areas of cracking along the beam stems, it was determined that the achievable increase in strength for a carbon fiber system could be insufficient to increase the live load posting from 15 tons to equal to or greater than 20 tons.

The total concept-level estimated construction cost of this option is approximately $170,000. All costs are presented in 2017 dollars and include a 20% contingency. These superstructure repairs are assumed to provide a service life of approximately 25 years which results in an equivalent uniform annual cost of approximately $6,800 per year of remaining service life. The increase in service life as compared to Option 1 is primarily achieved through construction of the cast-in-place concrete overlay. However, this overlay will also increase the dead load carried by the channel beams, resulting in a reduction of the allowable live load capacity. As such, some form of supplemental strengthening is necessary with this option (Work Item #3 in the list above). Design of the supplemental strengthening system is beyond the scope of this project, however, it is anticipated that this option will provide a recommended posting equal to or greater than 20 tons. Engineering services are necessary for the design of the improvements, preparation of plans and specifications, and for bid phase and construction engineering/administration services. An estimate of the approximate cost of these services is $60,000.

As explained for the Option 1, the bridge is not wide enough to accommodate phased construction and will require temporary closures. The nature and duration of the temporary closures, as well as the considerations for pedestrian use, are similar to those described for Option 1.

<u>Option 3: Superstructure Replacement</u>

This option includes greater capital expenditure than both Option 1 and Option 2, but offers advantages including having the longest service life of the options, increased live load capacity to eliminate load posting of the bridge, and the ability to correct functional deficiencies such as the substandard guardrail. This option also includes the potential for a slight widening of the travel way over the bridge through construction of a wider replacement superstructure. The allowable increase is limited, however, since this option does not include any substructure work such as abutment widening to accommodate a significantly wider superstructure, or correcting any abutment deficiencies. Further, widening of the approach roadway in the vicinity of the bridge is also constrained by narrow (nonexistent) shoulders and steep roadway embankments; roadway widening will require placement of fill within the tidal buffer zone and below the mean high water elevation.

Major work items for this option include:

1. Complete removal and replacement of the bridge superstructure utilizing precast concrete deck beams with a cast-in-place concrete overlay, heat-welded waterproofing membrane, and new elastomeric bearings.
2. Associated backwall modifications to match the new superstructure depth (as required).
3. Installation of crash tested bridge rail and approach guardrail systems.

The total concept-level estimated construction cost of this option is approximately $250,000. All costs are presented in 2017 dollars and include a 20% contingency. This option is assumed to provide a service life of approximately 35 years which results an equivalent uniform annual cost of approximately $7,100 per year of remaining service life. It is anticipated that the useful service life of this option is limited by the remaining service life of the existing substructure, since a replacement superstructure can be expected to provide a 75+ year service life. The new superstructure will be designed in accordance with current design standards for roadway bridges, including modern design loading, and therefore will not require any load posting upon completion of the work. Engineering services are necessary for the design of the replacement superstructure, preparation of plans and specifications, and for bid phase and construction engineering/administration services. An estimate of the approximate cost of these services is $75,000. The cost of engineering services could increase to, or exceed, approximately $100,000 should the Town select this option and elect to pursue funding through the NHDOT Municipal Bridge Aid Program. More information on funding options, including further details on this program, are provided below.

Unlike Options 1 and 2, the bridge will need to be closed to traffic for an extended duration to accomplish the superstructure replacement work included in Option 3. As such, consideration for the cost of a temporary pedestrian bridge has been included in the conceptual construction cost estimate for this option. The conceptual cost provided above is based on an assumed bridge closure period of 21 calendar days, and assumes construction will be limited to normal working hours of 7 AM to 3 PM. However, it is possible to further accelerate construction activities and reduce the closure period to perhaps as few as 5 days through the use of a combination of Accelerated Bridge Construction (ABC) tactics including maximizing the use of prefabricated elements, utilizing innovative materials and construction methods including UHPC (as previously described), and allowing construction activities to occur outside regular working hours (e.g. night and/or weekend work). It should be noted that significant reductions to the permissible construction duration or bridge closure period will result in increased construction costs. Discussions between the Town, abutters, emergency responders, and other users of the bridge will be required to weigh the interests of the all project stakeholders in relation to factors such as bridge closure duration, construction noise and other associated impacts, construction cost, and public safety.

Complete Bridge Replacement

Detailed investigation of complete bridge replacement alternatives, and the preparation of estimate(s) of probable construction cost for those alternatives, are beyond the scope of work for this project. However, based on Hoyle, Tanner's experience with similar structures, as well as our understanding of the effort and costs associated with engineering design and environmental permitting tasks, it is anticipated that construction of a complete replacement bridge for the Harbor Road crossing will cost approximately $800,000 to $1,000,000. This option is assumed to provide a service life of at least 75 years, resulting in an equivalent uniform annual cost of approximately $10,670 to $13,300 per year of remaining service life. The new bridge will be designed in accordance with current design standards for roadway bridges, including modern design loading, and therefore will not require any load posting upon completion of the work. Engineering services are necessary for the design of the replacement bridge, preparation of plans and specifications, and for bid phase and construction engineering/administration services. An estimate of the approximate cost of these services is $200,000.

Traffic control for this option could include complete closure, off-line construction (i.e. construction of the bridge either directly north or south of the existing bridge), phased construction utilizing the existing roadway alignment (to the greatest extent possible), or some combination of these traffic management scenarios. Complete closure has the greatest impact to users of the bridge, but can be mitigated through the use of accelerated construction techniques as previously discussed. Off-line construction allows traffic to be maintained on the existing bridge during construction, but requires a significant permanent shift of the roadway alignment, and therefore the location of the replacement bridge at the crossing, to facilitate construction activities. Phased construction of a replacement bridge will require three of the four existing beams to be maintained for the existing bridge in the first phase; this will result in a significant shift of the bridge centerline from the existing configuration, similar to what is required for off-line construction.

Table 2 – Repair/Replacement Option Summary

| Option | Construction Cost | Service Life (Years) | Equivalent Uniform Annual Cost | Engineering Costs |
|---|---|---|---|---|
| Option 1: Superstructure Repair | $50,000 | 15 | $3,300 | $25,000 |
| Option 2: Superstructure Rehabilitation | $170,000 | 25 | $6,800 | $60,000 |
| Option 3: Superstructure Replacement | $250,000 | 35 | $7,100 | $75,000 |
| Complete Bridge Replacement | $800,000 to $1,000,000 | 75 | $10,670 to $13,300 | $200,000 |

Bridge Maintenance:

Regardless of the repair, rehabilitation, or replacement option selected, it is important to note that the Town should continue to perform routine maintenance of the Harbor Road Bridge in order to maximize the remaining service life of the structure. Routine maintenance of bridges is considered to be any action taken to keep the structure in good condition by protecting it from inevitable deterioration due to environmental factors, traffic, and deicing chemicals. A routine maintenance plan is presented below summarizing suggested maintenance tasks and the recommended frequency for each.

Table 2 – Suggested Annual Routine Maintenance:

| Maintenance Task | Date Completed | Notes/Identified Issues |
|---|---|---|
| Clean bridge joints and remove debris build up each spring | | |
| Sweep and power wash the bridge deck each spring | | |
| Clean debris from abutment beam seat, particularly from around bearings | | |
| Inspect bridge rail and approach rail for damage/deterioration | | |
| Seal any cracks in the pavement with a flexible asphaltic sealer | | |

Table 3 – Suggested Biennial Routine Maintenance:

| Maintenance Task | Date Completed | Notes/Identified Issues |
|---|---|---|
| Structural and functional inspection of the bridge and approach roadway | | This is completed at no cost to the Town by NHDOT |

Table 4 – Suggested Periodic (~5 Year) Routine Maintenance:

| Maintenance Task | Date Completed | Notes/Identified Issues |
|---|---|---|
| Inspect concrete and repair areas of deterioration | | |
| Seal any cracks in the concrete members | | |
| Re-apply water repellent to concrete members. | | |

Funding Sources:

The New Hampshire Department of Transportation (NHDOT) administers and funds the Municipal Bridge Aid (Bridge Aid) program which reimburses municipalities 80% of the design and construction costs for municipal bridge replacement or rehabilitation projects if certain conditions are met and procedures are followed. It is likely that superstructure replacement (Option 3) or complete bridge replacement would both be eligible for inclusion into the Bridge Aid program. Based on the current and projected budget for Bridge Aid, projects are being programed for funding in or around fiscal year 2026, meaning that the Town would not be eligible to receive construction funding for this project until July 1, 2025. Depending on the Town's preferred repair/rehabilitation option for this project, the Town may want to consider requesting funding for future work while concurrently moving forward with Town-funded repair and minor rehabilitation work, since the options presented in this report are not mutually exclusive. For example, near-term repair work as identified in Option 1 will help to extend the useful service life of the bridge for an additional 15 years while the Town begins the planning process for superstructure replacement (Option 3) or complete bridge replacement though the Bridge Aid program. Due to the existing condition of the bridge, and the 15 ton load posting restriction, a strategy utilizing a combination of the Options presented in this report may be warranted in order to keep the bridge open to traffic while reducing the overall cost of superstructure or complete bridge replacement to the Town.

At this time, we recommend that a meeting between the Town and Hoyle, Tanner be held to review and discuss the project findings, repair recommendations, and to further explain the Town's options for moving forward. It is anticipated that the meeting would consist of a brief presentation to the Selectboard, followed by a collaborative working session.

Please feel free to contact me at (603) 431-2520 extension 23, or at alachance@hoyletanner.com, regarding the Town's availability for a meeting of this nature, or if there are any questions or desire for additional information regarding these findings.

Sincerely,

***Hoyle, Tanner & Associates, Inc.***

Aaron Lachance, P.E.
Senior Structural Engineer / Project Manager

Joseph C. Ripley, P.E.
Project Engineer

Enclosures

# APPENDIX A
# INSPECTION PHOTOGRAPHS

**BRIDGE INSPECTION PHOTOGRAPHS** **HARBOR ROAD BRIDGE**

**PHOTO NO. 1**

**Location:**

West Approach Looking East

**Description:**

Pavement Deterioration in Roadway Approach and Longitudinal Cracking at Beam Joints on Bridge

**PHOTO NO. 2**

**Location:**

Beam 4 South Stem

**Description:**

Longitudinal Cracking in Beam Stem

**INSPECTOR: Joseph C. Ripley, P.E.**
**FEATURE CROSSED: Rye Harbor Tidal Inlet**

**TEAM LEADER: Aaron M. Lachance, P.E.**
**FEATURE CARRIED: Harbor Road**

**BRIDGE INSPECTION PHOTOGRAPHS** **HARBOR ROAD BRIDGE**

**PHOTO NO. 3**

**Location:**

Beam 2 at East Abutment

**Description:**

Typical Top Flange Spall at Deck Joint (CIRCLED)

**INSPECTOR: Joseph C. Ripley, P.E.**
**FEATURE CROSSED: Rye Harbor Tidal Inlet**

**PHOTO NO. 4**

**Location:**

Beam 2 at East Abutment

**Description:**

Typical Top Flange Spall at Deck Joint

**TEAM LEADER: Aaron M. Lachance, P.E.**
**FEATURE CARRIED: Harbor Road**

**BRIDGE INSPECTION PHOTOGRAPHS** **HARBOR ROAD BRIDGE**

**PHOTO NO. 5**

**Location:**

East Abutment

**Description:**

Typical Steel Sheeting Deterioration

**PHOTO NO. 6**

**Location:**

West Abutment

**Description:**

Deteriorated Timber Cribbing through Abutment

**INSPECTOR: Joseph C. Ripley, P.E.**
**FEATURE CROSSED: Rye Harbor Tidal Inlet**

**TEAM LEADER: Aaron M. Lachance, P.E.**
**FEATURE CARRIED: Harbor Road**

**BRIDGE INSPECTION PHOTOGRAPHS** **HARBOR ROAD BRIDGE**

**PHOTO NO. 7**

**Location:**

West Abutment

**Description:**

Typical Abutment Beam Seat Cracking

**PHOTO NO. 8**

**Location:**

Beam 4

**Description:**

Substandard Bridge Rail and Beam Top Flange Deterioration

**INSPECTOR: Joseph C. Ripley, P.E.**
**FEATURE CROSSED: Rye Harbor Tidal Inlet**

**TEAM LEADER: Aaron M. Lachance, P.E.**
**FEATURE CARRIED: Harbor Road**

# APPENDIX B
# SUPPLEMENTAL FIELD INVESTIGATION

16-0898 C

October 31, 2016

Hoyle Tanner & Associates, Inc.
Attention: Mr. Aaron Lachance, P.E.
150 Dow Street,
Manchester, NH 03101

Subject: Concrete Reinforcing Scanning Services
Harbor Road Bridge
Rye, New Hampshire

Dear Aaron:

As requested, S. W. Cole Engineering, Inc. conducted a site visit on October 19, 2016 to the Harbor Road Bridge located at Rye Harbor in Rye, New Hampshire. The purpose of our visit was to scan the bridge's precast concrete double tee beams to estimate approximate locations of reinforcing bars and pre-stressing strands.

Access from beneath the bridge was accomplished at low tide using an extension ladder. A Proceq Profoscope was used to measure the reinforcing pattern within the underside of the double tee beams. The beams were found to have reinforcing strands spanning along the bottom 2 inches of the each web. A piece of reinforcing steel was found at mid-span, approximately 7 inches up from the bottom of each web. This reinforcing steel was found to be positioned in a "draped" manner, with the reinforcing piece increasing in elevation towards the end of each span. In addition be being located by the Profoscope, a section of the mid-height reinforcing steel was visible along an interior beam where the concrete had spalled.

Vertical reinforcing stirrups were located at the ends of the outside beams. Five stirrups were located at each end and were spaced at approximate 12 inch increments.

The deck flange of the beams were found to be reinforced with 6"x6" welded wire fabric (WWF). The outline of the WWF was visible at the concrete's underside surface through reflective shrinkage cracks and shadowing.

In addition to performing reinforcing scanning, a James Instruments Rebound Hammer was used to generally test the strength of the pre-cast concrete. Several areas were checked with results indicating a strength of between 7,000 to 8,000 psi. Tests performed at the top of the cast in-place abutments provided results between 4,500 to 5,500 psi.

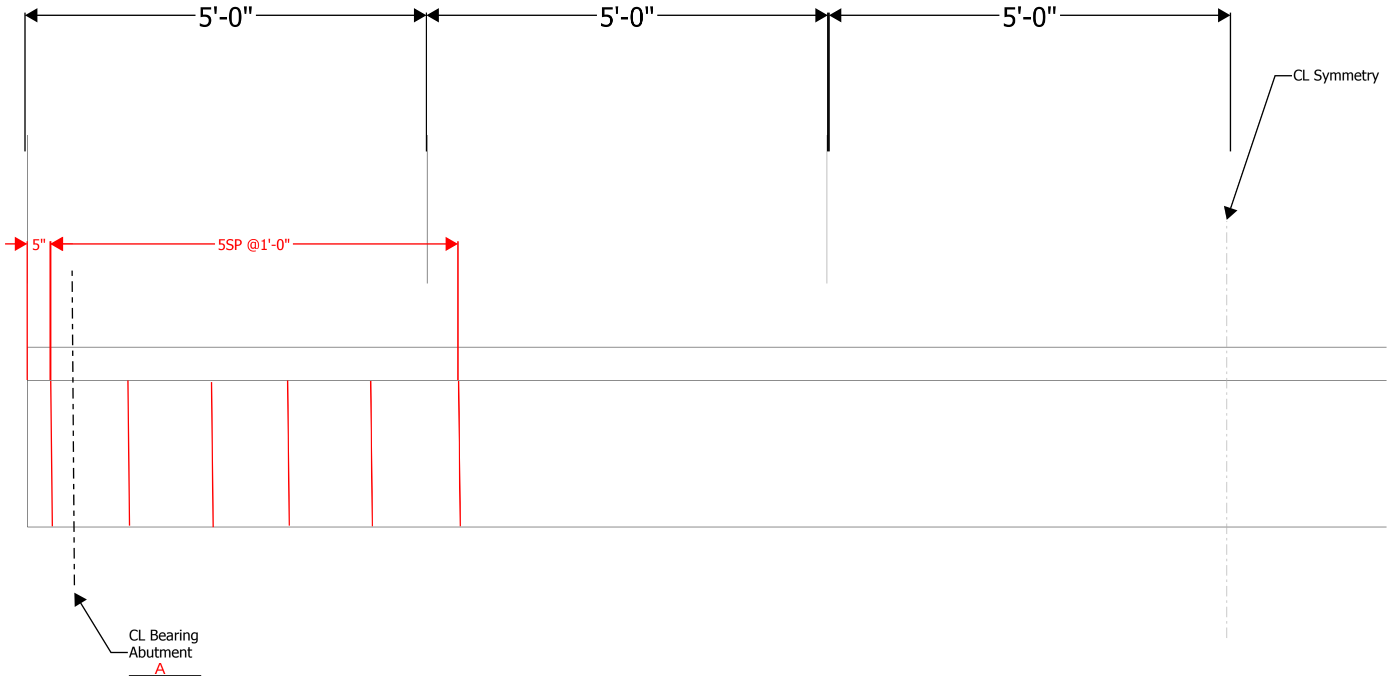
Approximate reinforcing patterns were marked on sections of the concrete's surface to illustrate our findings. Our findings were provided to Hoyle Tanner & Associates representative Joseph Ripley while on site.

We trust this report meets your needs. If you have any questions or if we can be of further assistance to you, please call.

Sincerely,

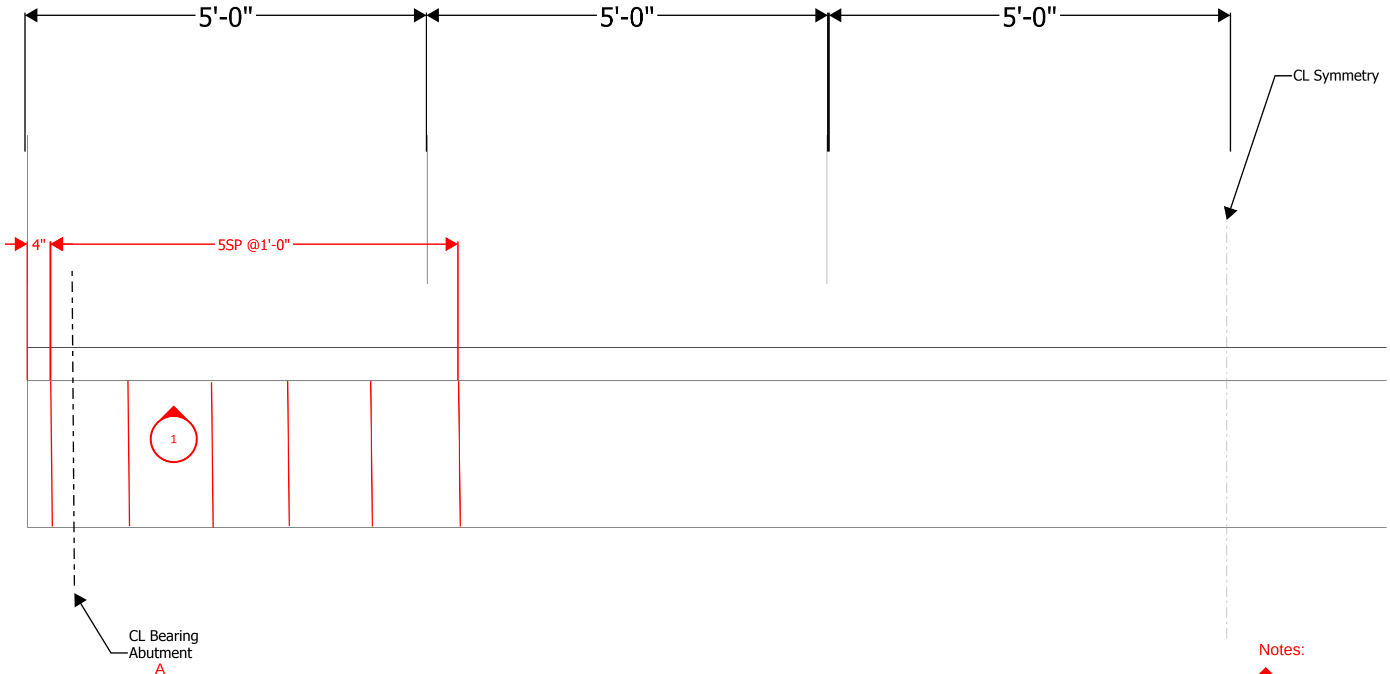
**S. W. Cole Engineering, Inc.**

Scott L. Harmon
Construction Services Manager




Beam 1 North Web

South Elevation Looking North

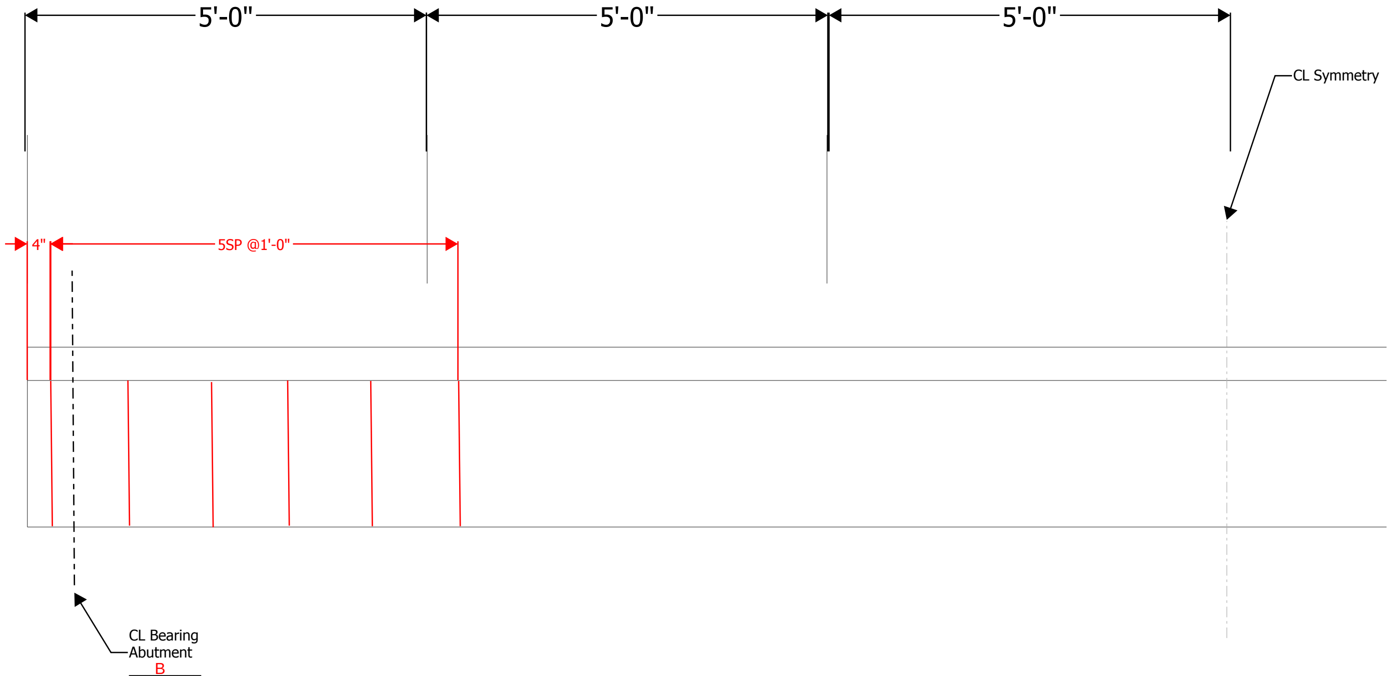



Notes:

1 Rebound Hammer Test Location.
f'c = 7,000 - 8,000 psi

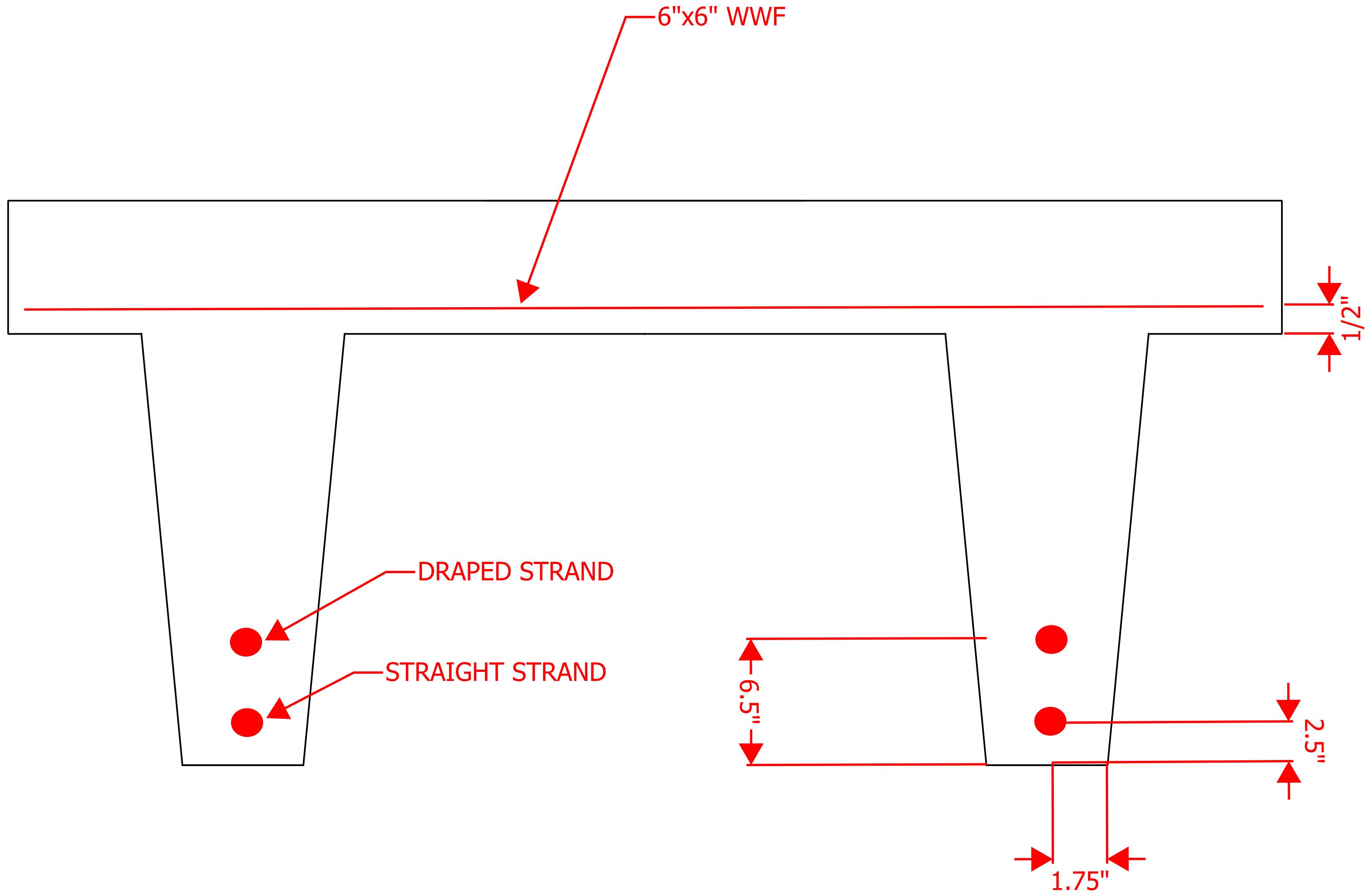
# Beam 4 South Web

South Elevation Looking North



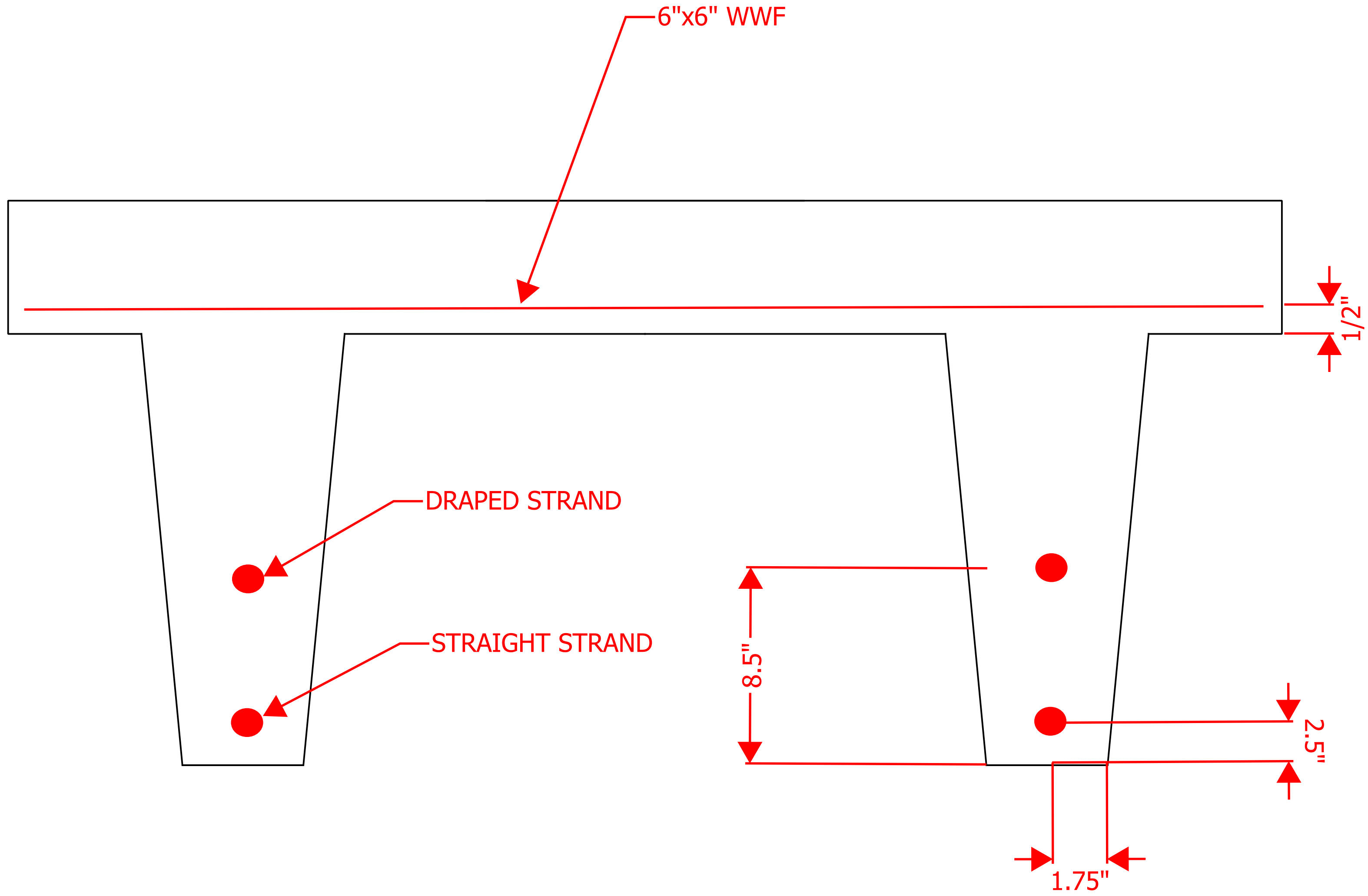

Beam 4 South Web

North Elevation Looking South




BEAM 1-4

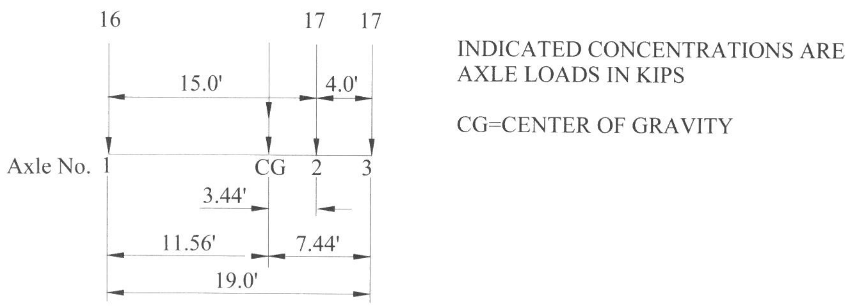
AT MIDSPAN



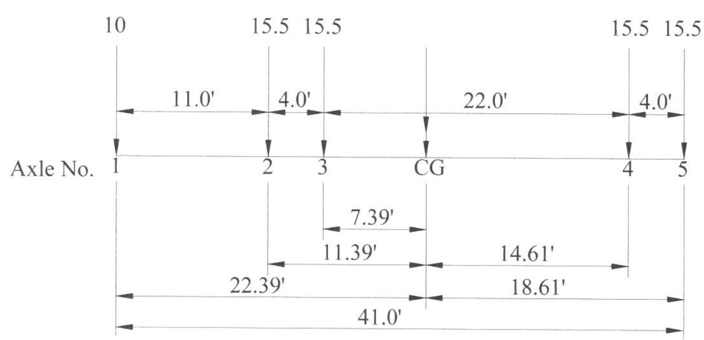

BEAM 1-4

AT 1/4 POINT

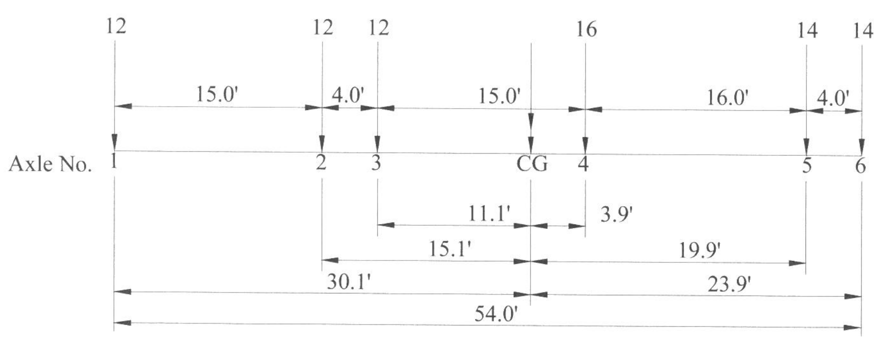
# APPENDIX C
# LOAD RATING VEHICLES




**TYPE 3 UNIT** WEIGHT = 50 KIPS (25 TONS)




**TYPE 3S2 UNIT** WEIGHT = 72 KIPS (36 TONS)




**TYPE 3-3 UNIT** WEIGHT = 80 KIPS (40 TONS)

**Figure 6B.7.2-1—Typical Legal Loads Used for Posting**

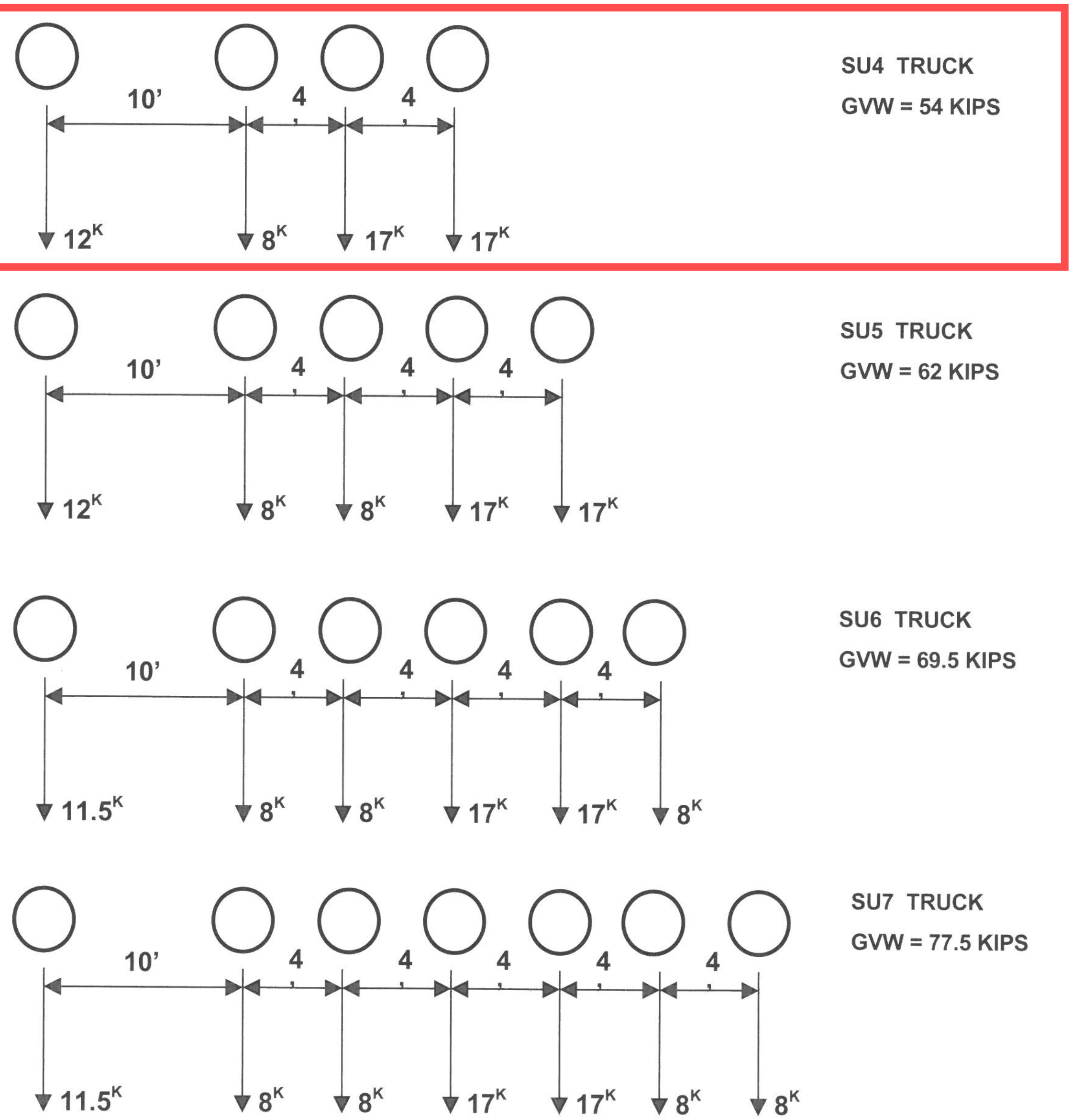



**Figure 6B.7.2-2—Bridge Posting Loads for Single Unit Trucks that Meet Formula B**