NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

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MATERIALS LABORATORY STUDY REPORT Report No. 08-074

A. ACCIDENT

Place	:	Minneapolis, Minnesota
Date	:	August 1, 2007
Vehicle	:	I35W Highway Bridge 9340
NTSB No.	:	HWY07MH024
Investigator	:	Mark Bagnard

B. TOPICS ADDRESSED

Review of design changes to the bridge before original construction.

C. DETAILS OF THE REVIEW

Documents supplied by the Minnesota Department of Transportation (Mn/DOT) and Jacobs Engineering Group (Jacobs) were examined to better understand the evolution of the types of steels and related construction features to be used in the design of the main trusses of the deck truss portion of the I-35W bridge (Bridge 9340). This report does not address documentation or issues related to the floor trusses of the deck truss or to the approach spans.

At the time of bridge construction, the highway authority in Minnesota was referred to as the Minnesota Department of Highways or at times the Minnesota Highway Department. The highway authority has evolved into the present Minnesota Department of Transportation. Within this report all references to the Minnesota highway authority will be annotated as Mn/DOT. Also involved was the US Department of Commerce, Bureau of Public Roads (BPR), which has evolved into the present Federal Highway Administration.

Documents included design studies, engineering drawings, construction plans, and inter- and intra-agency correspondence and notes. The majority of the documents was provided in electronic format by Mn/DOT and will be referenced herein by the Mn/DOT applied file number. Some documents were paper copies and are referenced by their titles or subject matter.

This report attempts to track the evolution of the specified steels and related design details used in bridge 9340 through the available documentation. The significant factors are summarized below with a full chronology following. Referenced documents are listed at the end of this report.

For ease of reference, the following table shows the four steels cited in the correspondences, with cross references between various specifications and other data. Throughout the documents the four steels were referred to by various names or identifiers. For example, A242 and A441 are both 50 ksi minimum specified yield strength steels and are both indicated on various drawing by the letters AS. In this report, the four steels will be referred to as "A36", "A242," "A441," and "T-1"[1].

Steel Designation Cross Reference						
Report Reference	MHD Number	MHD Name	ASTM Specifications	Minimum Specified Yield Strength	Allowable Stress in Tension	Drawing Markings
A36	3306	Structural Steel	A36	36 KSI	20 ksi	No Marks
A242	3309	Corrosion Resistant High Strength	A242	>3/16" 50 KSI	27 ksi	(AS) ¾" <> 2 ½"
A441	3310	High Strength Mn V	A441	~50 KSI	27 ksi	(AS) <3/4"
T-1	3318	Q&T High Strength	A514	100 KSI	45 ksi	(Q.T.)

The allowable stresses shown in the above table were listed in the S&P design criteria sheets, and on Sheet 2 of the final plans for the bridge.

Summary

The reviewed documents revealed three different stages in the design evolution of the bridge where the materials of individual members were identified. The three documented stages will be referred to as; the initial design, the preliminary design and the final design as follows. 1) In response to an October 1962 agreement between Sverdrup & Parcel and Associates and the State of Minnesota, an initial S&P internal design was developed. The initial design was documented by the unchecked computation sheets dated December 1962 and January 1963. 2). A preliminary design was suggested by the handwritten annotations on the S&P truss span design drawing in March 1963. Some details of the preliminary design were shown to Mn/DOT and BPR during a March 1964 conference. 3) The final design, reflecting changes and suggestions from all parties, was signed by S&P on March 4, 1965 and approved by Mn/DOT on June 18, 1965.

The initial internal S&P design of the main trusses contained about equal numbers of chord and diagonal members to be fabricated from 100 ksi yield, quenched and

[1] T-1 was originally a US Steel trade name for a structural steel meeting ASTM specification A514.

tempered (T-1) steel and 50 ksi yield steel (A441). All of the verticals were A36 steel. No gusset plate materials were specified in the initial design.

The preliminary design was presented to Mn/DOT at a conference in March of 1964. The materials of many members of the deck truss changed between the initial internal S&P design and the preliminary design as presented to Mn/DOT but about half of the chord and diagonal members remained T-1 in the preliminary design. Gusset plate materials were identified for the first time in the preliminary design with slightly more than half of the gussets fabricated from T-1 steel. As an example, the preliminary design identified the gusset plates at nodes U10 and L11 as being made from ½ inch thick, 50 ksi yield (A441) steel plates, and this thickness and material remained in the final design.

Both BPR and Mn/DOT had reservations about the large quantities of T-1 steel proposed for use in members for the preliminary design and expressed those reservations as early as September 1963. S&P believed the use of this material would be beneficial and continued recommending its use until directed by Mn/DOT to eliminate T-1 from members of the deck truss at a conference, on March 3-4-5, 1964. At this conference it was decided that 50 ksi steels (A242 and A441) would be used in place of T-1. This change of material required that all members be redesigned or at least resized. The change in material also permitted many of the member geometries to be reconfigured into simple box beams by removing the centerline web, thereby easing fabrication.

The documentation indicated that all truss members were redesigned for 50 ksi steels by the end of March 1964. Interestingly, the dates on documentation pages shows that the majority of the members were apparently revised in October 1963, more than 4 months before T-1 was officially eliminated at the March 1964 conference.

There were multiple correspondences about the types and the specifications for the 50 ksi steels (A441 and A242) to be used. These discussions were mostly about weldability or toughness of the two steels types in thick sections. In the completed bridge, the U10 and L11 gusset plates were not welded and made from 1/2 inch thick 50 ksi steel and therefore not directly affected by the weldability and toughness discussions.

Chronology

October 22, 1962, Initial agreement

On October 22, 1962, the state of Minnesota entered into an agreement[A] for engineering services with Sverdrup & Parcel and Associates (S&P), St Louis, Missouri to produce a preliminary engineering report, checked final design plans and checked design computations for a new interstate bridge, number 9340, crossing the Mississippi River. S&P's responsibilities did not include the checking of shop detail drawings for fabrication.

In regard to the materials of construction, the agreement only stated "The use of steels of various strengths shall be investigated to determine the advisability for use…"

December 1962, January 1963 Preliminary Deck Truss (2 Trusses) Computations

A set of preliminary deck truss design computations[B] with pages[2] dated from 12-19-62 thru 1-21-63 provided the first indication of the materials intended to be used in the construction of the deck truss spans of the bridge. Among other calculations, the computation pages detailed the demand to capacity calculations for members from node 0 through node 14. The capacity calculations included the initial member side plate thicknesses and material strengths. Not including the verticals, 15 chord or diagonal members were specified as using T-1 steel; while 11 were A441 and 4 were specified as A36 steel. The vertical members, referred to as posts and hangers on the computation pages were all listed as A36 steel. These computation pages appear to be part of the basis for the April 1963 Preliminary Report to Mn/DOT but were not presented to Mn/DOT. Only the summary of the material weights was contained in the Preliminary Report.

April 1963, Preliminary Report

Mn/DOT received the preliminary report[C] from S&P on April 12, 1963, less than 6 months after the initial agreement. The report was primarily a narrative without design drawings and recommended a two truss layout for the river spans for "economic reasons". With regard to steel type proposed, the report states that "Welding is planned throughout for the make-up of girders and truss members and, in this connection, high yield strength steel conforming to Minnesota Specification 3318[3] [T-1] will be used extensively." Further, the report proposes that "using high strength steels to the best possible advantage, an all welded structure would require approximately 20% less steel than a rivet structure, with a possible resultant cost saving of more than 10%." S&P's reasoning appears to be that although the high strength steel would cost more ($0.38 per pound for T-1 steel, $0.31 per pound for 50 ksi steel, and $0.28 per pound for 36 ksi steel from the Preliminary Report) the weight savings in the total bridge design would offset the increased price of the high strength steel. The estimated usage of various steel types for the truss section is presented in Table A below. The Preliminary Report does not provide sizes and materials for any members or gusset plates.

June 5 and 6, 1963 Conference

In a conference with Mn/DOT, S&P, BPR, and the US Army Corps of Engineers, held on June 5 and 6, 1963[D], concerning steels, it was decided that "The consultant will use A36, A441 and T-1 steel. T-1 steel at about 45,000 psi ? (2 ½ inch) and lower at points of fatigue. If 3309 [A242] steel is used stresses should be the same as for A441, AASHO design specification." This set the allowable tensile stress[4] level for T-1 steel at

[2] The computation pages were numbered 1 through 25 but actually contained 31 pages with several sub pages inserted into the number sequence.
[3] Minnesota Specification 3318, Quench and Tempered High Strength Steel, with a minimum 100 ksi yield strength. Sometimes referred to as T-1, Q&T, ASTM A514, or simply high strength steel.
[4] Allowable stress is the maximum computed stress permissible in the design of any component of the bridge. Allowable stresses typically depend on the material used, the force action being resisted and the dimensions and geometry of the component being designed. For simplicity of comparison, in this documentation and those provided by Mn/DOT, the allowable stress permitted to resist direct tensile loads is reported.

45% of minimum specified yield strength, unless governed by fatigue. The AASHO requirements set the allowable tensile stresses for A441 (less than ¾ inch thick) at 27,000 psi or 55% of the minimum specified yield strength.

September 13, 1963 Design Criteria

On September 13, 1963, S&P presented its Design Criteria for Deck Truss Spans[E], defining the allowable tensile stress levels for each type of steel S&P planned to use in the bridge. The allowable tensile stresses (fs) were: 20,000 psi for A36, 27,000 psi for A441 up to ¾ inch thick and A441 modified for thicknesses from ¾ to 2 ½ inches and 45,000 psi for T-1. The use of modified composition A441 for thicker sections was later changed to A242 having the same allowable stress.

It is apparent by the allowable stresses listed that a more conservative approach to the usage of T-1 high strength steels was still applied. While the allowable tensile stress levels in A36 and A441 were set at about 55% of the minimum specified yield stress for these materials, the allowable tensile stress for T-1 steel was limited to 45% of the minimum specified yield stress.

September 26, 1963 Conference

During a September 26, 1963[F] conference between the US Department of Commerce, Bureau of Public Roads (BPR) and Mn/DOT the use of T-1 steel was raised with the stated question “Is it necessary to use T-1 steel?”. Further, in hand written notes from the conference[G] “Where will it (T-1) be used? – Dills[5] does not like using this. Length is too limited.” It was further noted that it would be discussed with LaBonte[6]. From these comments, it was apparent that employees from both BPR and Mn/DOT were apprehensive of the use of T-1 steel.

In addition to the discussions between BPR and Mn/DOT, the conference report (ref F) contained a synopsis of an October 1, 1963 telephone conversation between Mr Mannes[7] and Mr. Swensen[8]. The synopsis indicates that the S&P position in response to the questioning of T-1 was that it was “desirable to use T-1 in some members to allow material thickness and size to be within economical limits.” S&P also noted that “there would be some splicing” of the T-1 steel.

The required splicing of T-1 plate referenced is believed to be to the result of the limited available plate lengths of T-1[9] steel. The production of T-1 steel requires special thermal processing. This additional processing made T-1 steel more expensive than the other steel grades considered and limited the maximum available plate length to the size

[5] Dills refers to a Mn/DOT employee with engineering / metallurgy background.
[6] LaBonte refers to A. E. LaBonte, Bridge Engineer for Mn/DOT.
[7] Mr. A. E. Mannes, Bridge 9340 project engineer for Sverdrup and Parcel.
[8] Mr. P. D. Swensen, employee of Mn/DOT.
[9] “The Making Shaping and Treating of Steel” US Steel, 1970 edition page 749. The Homestead Works facilities are designed to heat treat plates up to 156 inches wide and 514 inches (42.8 feet) long. Other sources cite plate length limits of 15 meters or 40 feet for T-1 steel.

of the thermal processing (heat treating) equipment. A441 and A242 are heat treated in a continuous process with much longer lengths possible.

For example, in the final design, the upper chord members between even numbered nodes and the lower chord members between odd numbered nodes were made from continuous pieces that were at least 72 feet in length. With this design, many of the nodes had a much simplified joint, with the vertical attached to the continuous upper or lower chord. If made from T-1 steel, the upper and lower chord members would have required welded or bolted splices in individual plates to make them continuous through any node. As a result, the fabricator would have had to manage many more individual steel pieces and possibly more complicated node details.

The conference also raised questions about the acceptable allowable stress levels for the chosen 50 ksi steel, A441 plate, in thicknesses over ¾ inch, and a note from the conference included the statement that A441 would be modified to achieve acceptable properties in these thicker sizes. Other hand-written notes (ref G) indicated that A441 would not be modified: "Will A441 be modified? for yield of 50,000 for thickness > ¾ No (Dills)". In the documented telephone conversation (ref F), it was decided that Mn/DOT "will permit fs=27,000 for A-441 in thickness ¾ [inch] and less and for MHD 3309[10] [A242] in thickness up to and including 2 ½". This compromise led to the use of two types of 50 ksi steel, A441 for thicknesses ¾ inch and under, and A242 for thicknesses greater than ¾ inch.

December 1963, U12 Detail

On December 4, 1963, Mn/DOT requested drawings from S&P showing a typical joint layout[H]. Mn/DOT received a detail drawing of node U12[I] on December 13, 1963.

Up to this point in time, the drawings and documents available to Mn/DOT had not detailed any node design features or indicated any material selections for specific locations. Review of the U12 detail drawing shows extensive use of T-1 steel not only in two of the five members (U12/U14 and U12/L13) connected at the node but also in the ½ inch thick gusset plates, the joint splice plates and the lightly loaded lateral attachment plates and angles.

In the final plans, node U12 gusset plates were made from 1 inch thick 50 ksi steel (A242) and had a slightly different overall size and shape compared to the detailed drawing of node U12 provided in December, 1963. Had the final U12 gusset thickness been simply scaled up based on the allowable stresses for the substituted material, the U12 gussets would have only needed to be 0.83 inch thick[11] to maintain the same net section tensile capacity.

Other design features presented on the December 13, 1963, drawing were horizontal centerline webs in both upper chord members and sealing bulkheads near the ends of each member. The member thicknesses were not listed on the drawing, and

[10] MHD 3309 specification for Corrosion Resistant High Strength Steel (50 ksi yield strength).
[11] T-1 allowable (45ksi) divided by A441 allowable (27ksi) multiplied by original plate thickness (1/2 inch).

scaling from the drawing was unreliable and therefore could not be compared to the final plans.

In a February 14, 1964 letter[J] to Mn/DOT about the U12 joint details, BPR said "The proposed truss joint detail at U12 appears to be satisfactory, except for the unbalanced rivet pattern and resulting eccentric connection of the truss diagonals is considered undesirable and unnecessary. It is recommended that the gusset plates be enlarged to facilitate a balanced connection."

The reference appears to be directed at the asymmetric geometries and rivet patterns at the upper ends of the diagonals, L11/U12 and U12/L13. In the December 1963 drawing of node U12, the upper corners of both diagonals were chamfered heavily while the lower corners remained square or nearly square. In the final design, the corners of all of the diagonals on the bridge were chamfered symmetrically.

March 3, 4 and 5, 1964 Conference

During a series of meetings held March 3, 4 and 5, 1964 between Mn/DOT, BPR and S&P, several important decisions were made. During the meetings preliminary details for the truss superstructure were shown. A memorandum for the record from Mr. Mannes[K] (S&P) was most succinct in the decisions forthcoming from the meeting. The most significant decision was that "T-1 steel will not be used in the truss members."

The elimination of 100 ksi yield T-1 steel from the truss members would necessitate a complete redesign of all members due to the decreased allowable stress levels for the substitute materials (from 45 ksi to 27 ksi). At a minimum all tension members would need to be about 67% thicker to accommodate the lower allowable stress levels. Further computations would also be necessary to accommodate the increase in dead load resulting from the thicker members.

The reduction in the use of T-1 material would allow for some reductions in weight when the centerline webs of most members were eliminated, as pointed out in the S&P reference and in a BPR letter to Mn/DOT[L]. Elimination of the centerline web would also simplify the construction of many members resulting in simple box section members with external welds.

The preliminary report estimated the weight of the steel in the truss spans of the bridge at 5,430,000 pounds (with extensive use of T-1 steel). The final weight of the steel in the truss spans, as listed in billing documents[M], was 6,689,199 pounds, an increase of 1,259,199 pounds or 23%. Table A below provides a breakdown of the steel weight per type of steel for the initial design from the Preliminary Report and for the final design, as provided in the Allied billing document. As shown, T-1 was not completely eliminated in the truss but the total T-1 weight decreased radically and as a result the use of 50 ksi steels increased substantially. Using cost data from the preliminary report, the overall cost of the steel also increased but by only 16%.

Table A Steel Usage						
Steel Type	MHD Spec No.	Price per Pound*	Quantity (lbs) Preliminary Report 4-1963	Cost	Quantity (lbs) Allied Billing	Cost
				$	6/21/1967	$
A36	3306	0.28	3,410,000	954,800	4,392,616	1,229,932
A441 (50ksi)	3309	0.31	660,000	204,600	1,576,023	488,567
A242 (50ksi)	3310	0.31	0	0	659,831	204,548
T-1 High Yield	3318	0.38	1,360,000	516,800	60,729	23,077
		Totals	5,430,000	1,676,200	6,689,199	1,946,124
* From S&P Preliminary Report				% Change	23	16

Other conference decisions included (1) the ends of the diagonals (previously presented in the U12 detail) would be cut for symmetry, and (2) the arrangement of perforations in the member cover plates was settled by the decision to use solid top cover plates on the upper chord and all other cover plates to be perforated. Figure 1 shows the final design of node U12 (in red) overlaid onto the preliminary design (in black) to illustrate the changes in geometry. Note that the gusset plates at this node changed from ½ inch thick T-1 steel in the December 1963 version to 1 inch thick AS steel (A242) in the final design.

The March 3-4-5, 1964 conference notes and the December 1963 U12 detail drawing implied that T-1 steel was to be widely used in members throughout the truss. One of the documents discussed at the conference was an S&P truss span design document[N] containing drawings and computations. A drawing in the document was hand annotated, apparently during or after the March 3-4-5, 1964 conference, with member materials[12] of the preliminary design. The drawing legend identified the materials used at each member as A36, A441 or T-1. From the added annotations, it was apparent that T-1 steel was originally intended to be used in 25 of the 57 identified truss members in the preliminary design. The materials of eight chord and diagonal members listed in the annotated drawing and computation sheets were different from those identified in the preliminary deck truss design computations (ref B). No T-1 steel truss members were specified in the final design plans[O].

The legend in the S&P truss design document (ref N) was followed by the hand written note “Revised, see sections in comps. T-1 eliminated.” The computations (comps) in the document contained geometric parameters[13] and loads for each member. The computations cited the materials used in the final design plans for all members.

[12] Vertical member materials were not denoted.
[13] Geometric parameters included cross sectional areas and moments of inertia.

Calculations with the member materials specified of the preliminary design were not present in the document.

Individual checked computation sheets from the truss design document were dated with a month and year. Dates ranged from September 1963 to March 1964. There did not seem to be a pattern in the computation dates, with calculations for members in which the material changed dated as early as October 1963 and calculations for members without material changes dated as late as March 1964. Either S&P anticipated the elimination of T-1 steel or the substitute material computations were made by erasure of the old data without a page date change. Interviews with former S&P engineers indicated that changes were sometimes accomplished by erasure of old data without an accompanying date change on the affected computation sheet.

November 1963-January 1964 S&P Computation Sheets

A set of unchecked[14] computation sheets dated from November 1963 through January 29, 1964 also contained information on proposed member materials and further information on some gusset materials used in the preliminary design of the deck truss[P]. The set of computation sheets were numbered from 1 to 25 but sheets 3, 7, 8 and 21 were missing. Several of the sheets were marked “VOID”. The computation sheets showed calculations to determine the number of rivets for each member of the truss. Additional calculations used the load carried across the chord splices (the upper or lower chord) to determine the thickness of the gusset plates. These calculations only considered forces carried by the upper and lower chord members and neglected any forces associated with the diagonal and vertical members. Gusset plate materials were simply listed. The allowable stresses associated with the gusset plate materials used in these calculations were the same as those listed in the S&P design criteria sheet (ref E). For node U10, the gusset plate material was listed as “A.S.” and for node L11 the material was listed as “A441”.

The member materials listed in the computations match those indicated in the annotated S&P truss design document (ref N) and further identify the materials of several vertical members not previously identified. Additionally, the gusset plates for upper and lower nodes 0 through 14 were identified for material and / or thickness. Significant in the listings was that both nodes U10 and L11 gussets (½ inch A441 steel), had not changed from the preliminary design to the final design. In comparison, node U12 was identified as ½ inch T-1 in these computations and in the U12 detail (ref I) but was changed to 1 inch thick A441 steel for the final design.

March 1964 to March 1965

There were no apparent changes in material or material specification between the March 1964 conference and the final design plans signed by S&P on March 4, 1965, except to adopt the Mn/DOT specification numbering system for the final plans. The final

[14] Each computation sheet contained an entry block (BY) for the author of the computations and a separate block (CHKD) to indicate that the sheet had been checked.

plans use the Mn/DOT specification numbering system with A36 now listed as MHD 3306, A242 as MHD 3309, A441 as MHD 3310 and T-1 as MHD 3318.

Material Change Summary

The reviewed documents revealed three different stages in the evolution of the design where the materials of the deck truss members were identified. An initial S&P internal design was documented by the unchecked computation sheets (ref B) dated December 1962 and January 1963. An interim preliminary design was suggested by the handwritten annotations on the S&P truss span design drawing in March 1963 (ref N). The final design, reflecting changes and suggestions from all parties, was dated March 1965 (ref O).

Figure 2 shows elevations of the deck truss with the steel type of the members and gusset plates color coded to reflect the material specified for that component during each of the three stages of design. The upper view, labeled as the initial design, shows the member materials as listed in the preliminary deck truss design computation pages (ref B). The middle drawing shows the member materials and five-member-node gusset plate materials as indicated in the preliminary design documents (the truss span design document (ref N) and the computations set (ref P)). The lower view has the materials specified in the final plans (ref O). The members that changed material from the prior design iteration are highlighted in yellow in each drawing of figure 2. The gusset plates that changed material from the prior design iteration are circled.

The material of all 84 members in each truss was identified (assuming symmetry) in the initial design. The material of 62 members in each truss was identified in the preliminary design. From the initial design to the preliminary design, the material identified for 12 members changed. From the preliminary design to the final design, the material identified for 35 members changed.

The gusset plate material proposed for 13 nodes was identified in the preliminary design documentation. In the final design, the material proposed for the gusset plates at 8 of these 13 nodes had changed.

Joe Epperson
Senior Metallurgist

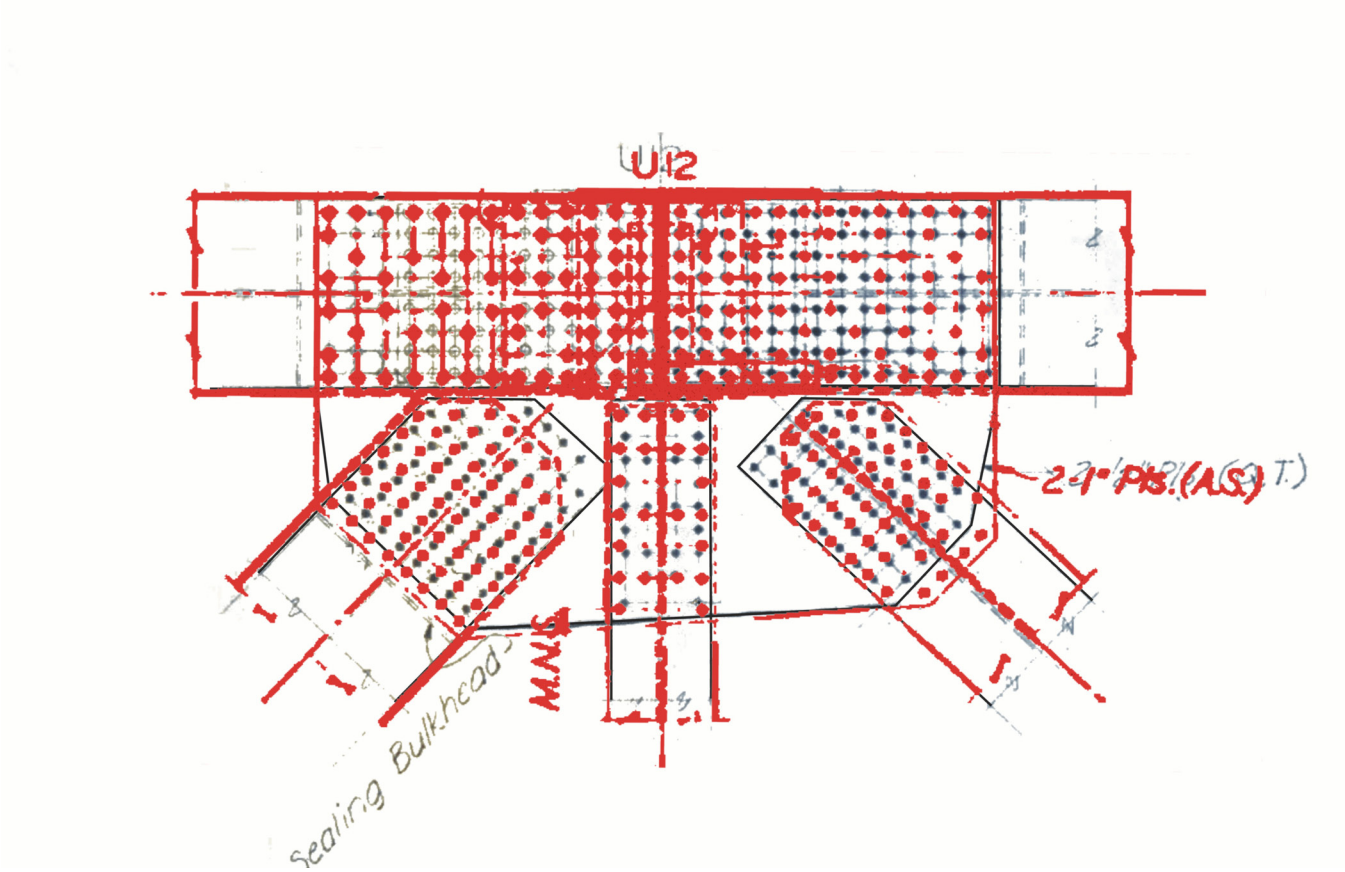

Figure 1. Comparison of preliminary U12 node design in black to final design in red.

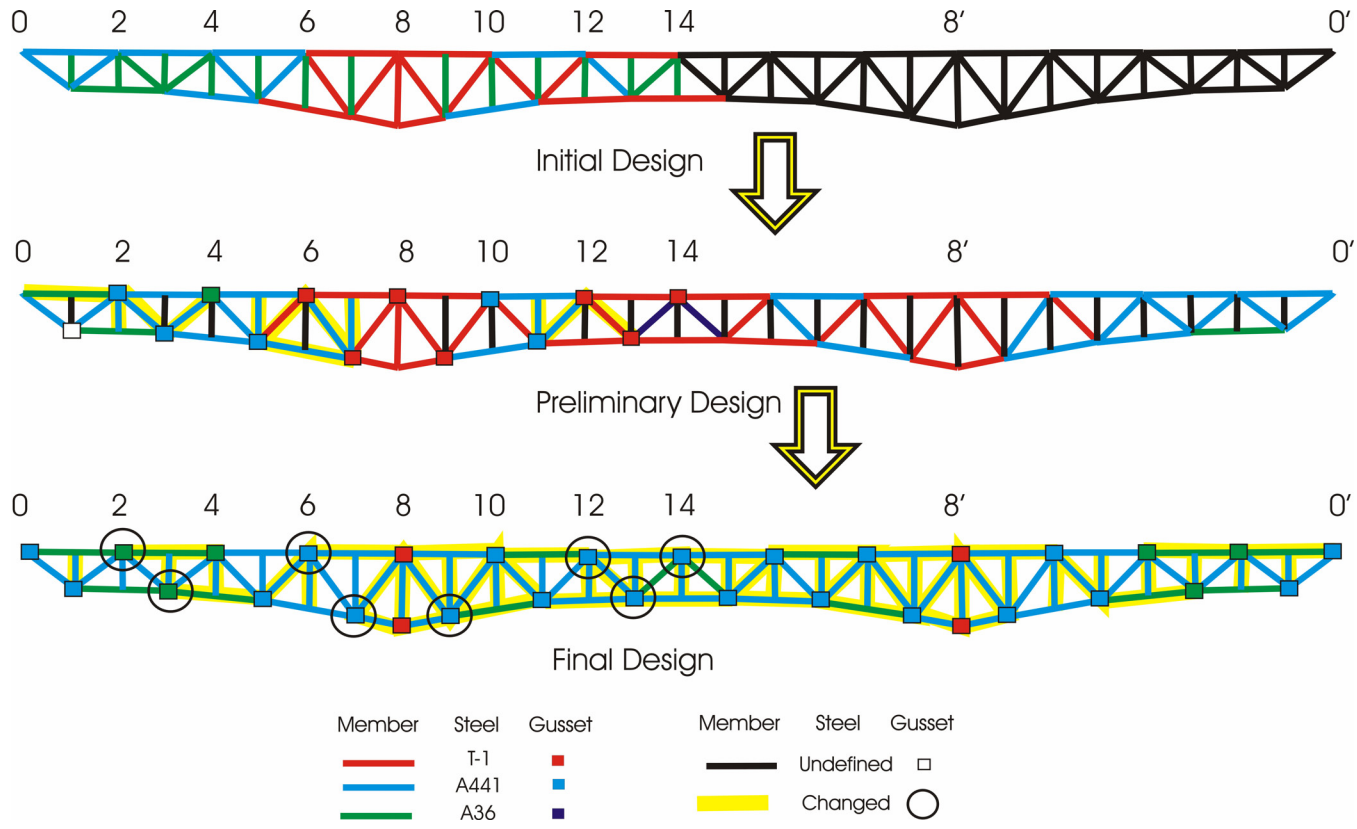

Figure 2-Illustration comparing the bridge members known materials from an initial design (top), through a preliminary design (middle) to the final design (bottom). Changed members from previous design are highlighted in yellow. Changed gussets are circled.

References

[A] Document 581443, Signed agreement between S&P and State of Minnesota, signed October 22, 1962.

[B] Set of unchecked S&P Preliminary Deck Truss Computation (2 truss) sheets by RJA dated December 7, 1962 thru January 21, 1963. 31 pages total.

[C] Document 579696, S&P Preliminary Engineering Report Bridge No. 9340, Project I 35W-3-(47)112, April 1963

[D] Document 581351, Conference Report by Mn/DOT, June 5 and 6, 1963.

[E] Document 581252, S&P Design Criteria for Deck Truss Spans, undated, received by Mn/DOT September 13,1963.

[F] Document 580201, Conference Report by Mn/DOT, Sept 26, 1963, regarding S&P Sept 13, 1963 Design Criteria and Cross Section. S&P response included.

[G] Document 580009, Hand written notes dated 9-26-63, unknown author.

[H] Document 579756, Mn/DOT Letter to S&P, dated December 4, 1963.

[I] Document 579771, S&P undated drawing, Joint U12 Detail, received by Mn/DOT on December 13, 1963.

[J] Document 579753, BPR letter to Mn/DOT, dated February 14, 1964

[K] Document 579738, S&P Memorandum for the Record, Conference in St. Paul March 4 and 5, 1964 on Minnesota Bridge 9340. Dated March 11, 1964

[L] Document 580174, BPR letter to Mn/DOT with attachment concerning the March, 1964 conference, dated April 20,1964

[M] Document 579959 Mn/DOT Letter to Allied Structural Steel Co, dated June 21, 1967

[N] Document 579693, S&P Truss Span Design Calculations and Drawings, dated September, October and November 1963 and March 1964. Drawing Sheet 5 with handwritten annotations of member materials.

[O] Document 580332, Final design plans Bridge 9340, signed by S&P March 4, 1965 approved by Mn/DOT June 18, 1965.

[P] Set of unchecked S&P computation sheets by CRJ dated from November 1963 through January 29, 1964.