CLIENT	MassDOT	STV INCORPORATED			
PROJECT	North Washington St. Bridge	MADE	CHK.	REV.	4015171
SUBJECT	Critical Members Load Analysis	*ARG*			
		8/12/2016			1

Critical Members Load Analysis **Ref.:** -

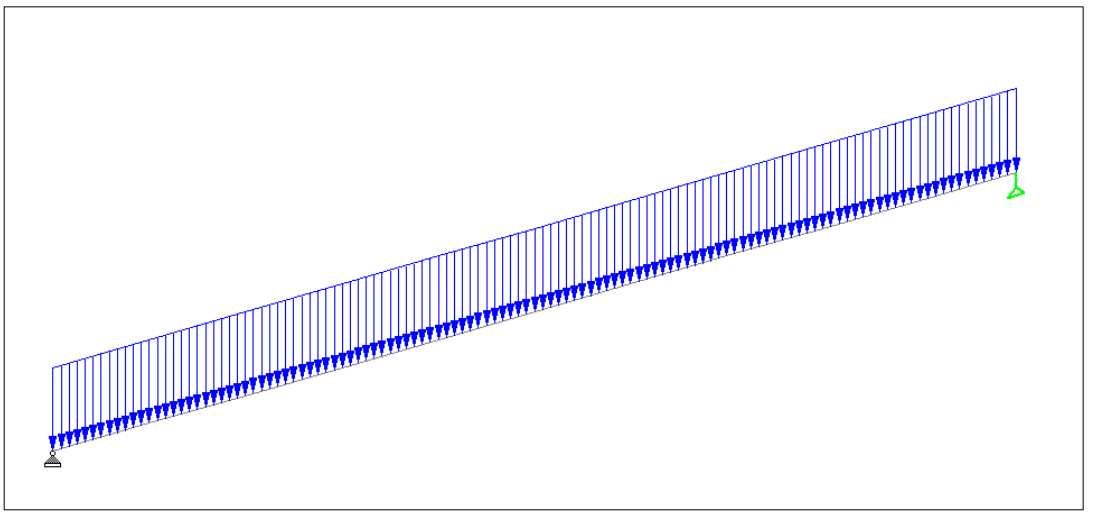
Critical Members: *Reference*

Repair: S-14 *Also applicable to repair S-1*
Member Type: Stringer
Section Type: W18X50 *02/01/16 Inspection Report*
Span Length: 16.417 *ft*

Loading: *CAD Cross-Section Trib. Area*

Item	Thickness in	Width, ft	Length, ft	Tributary Area, ft2	Unit Weight, kcf	Load, klf	Type
Asphalt	4.5	-	16.417	0.7	0.15	0.105	DL
Slab	7	-	16.417	3.09	0.15	0.464	DL
SW	7	-	16.417	0.102	0.49	0.050	DL
					TOTAL =	**0.619**	

Member Loading Demand: *Staad.Pro Models Noted Below*



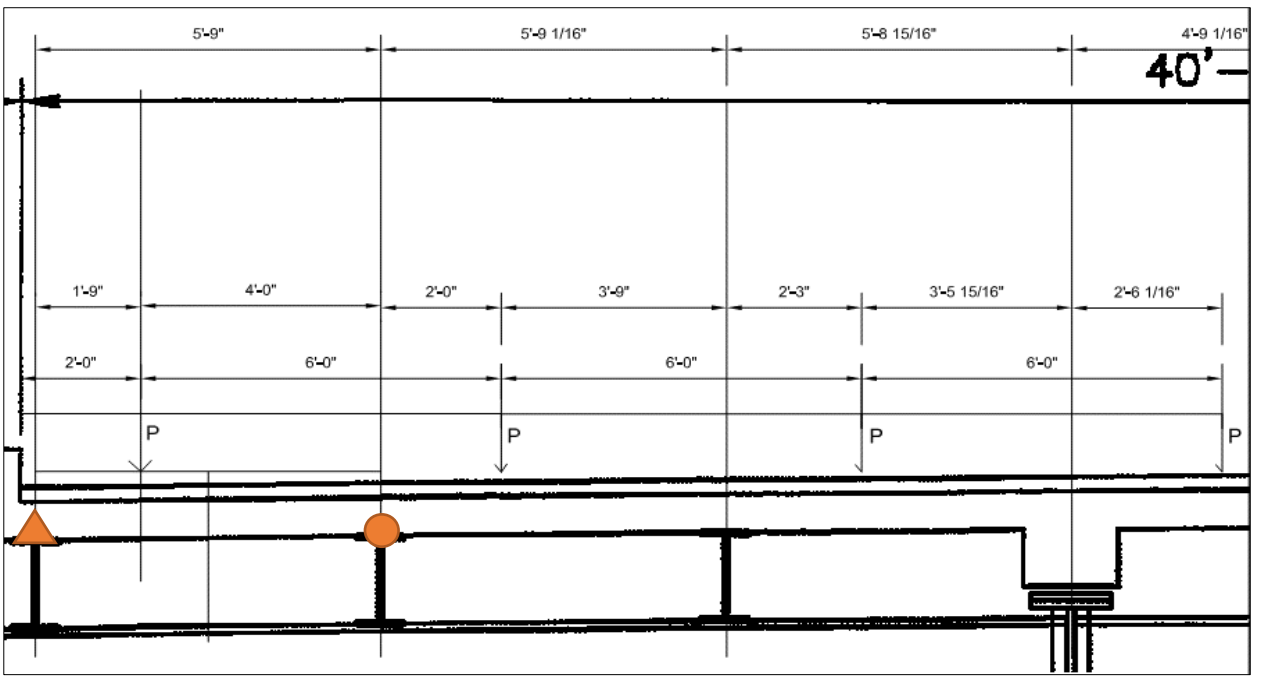
Resulting Loading: *STAAD.Pro Results*

DL	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
Sum	5.08	5.08	0.00	-20.85

See DL-Stringer.std

CLIENT	MassDOT	STV INCORPORATED			
PROJECT	North Washington St. Bridge	MADE	CHK.	REV.	4015171
SUBJECT	Critical Members Load Analysis	*ARG*			
		8/12/2016			2

Live Load Distribution Factor: *First Stringer DF*



Bay 1, Stringer 1 DF = 0.696

With support points on both S1 and S2

Live Load: *(4) ASD Trucks in STAAD.Pro:*

4 different models were developed in order to determine controlling shear and moment on stringer:

Truck	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft	
T3S2	8.23	-14.02	0.00	-35.33	*See T3S2-Stringer.std*
T3	8.74	-9.17	0.00	-32.82	*See T3-Stringer.std*
H20	18.36	-18.32	0.00	-65.64	*See H20-Stringer.std*
HS20	16.59	-15.98	0.00	-65.64	*See HS20-Stringer.std*

Effective Live Load: *Applying DF obtained above and I = 1.33:*

Truck	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
T3S2	7.61	-12.97	0.00	-32.69
T3	8.08	-8.49	0.00	-30.36
H20	16.99	-16.95	0.00	-60.73
HS20	15.35	-14.79	0.00	-60.73

STAAD.Pro Nomenclature:

(-) Tension
(+) Compression

CLIENT	**MassDOT**	**STV INCORPORATED**			
PROJECT	**North Washington St. Bridge**	MADE	CHK.	REV.	**4015171**
SUBJECT	**Critical Members Load Analysis**	***ARG***			
		8/12/2016			3

Critical Members Load Analysis **Ref.:** -

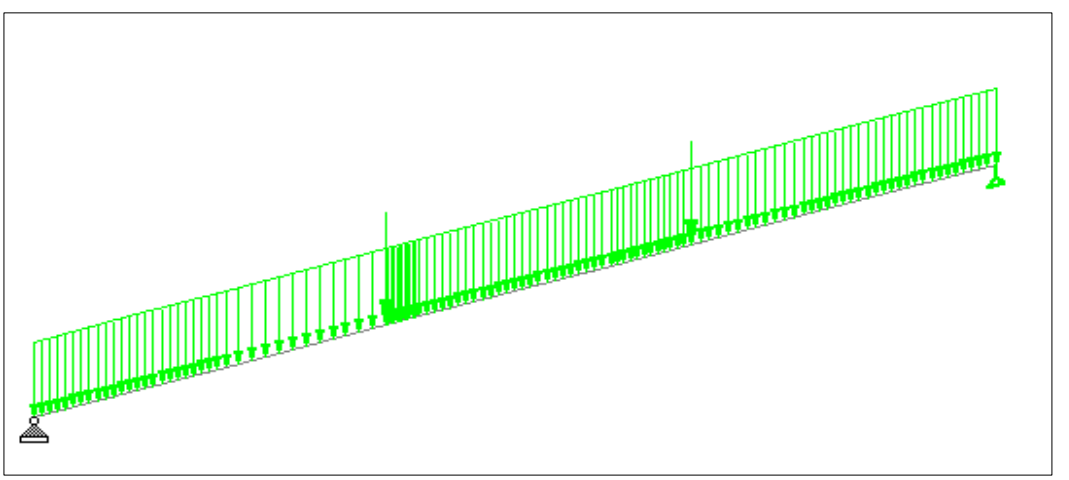
Critical Members: *Reference*

Repair: F-1
Member Type: Floorbeam
Section Type: W24X76 *02/01/16 Inspection Report*
Span Length: 15.000 *ft*

Loading: *Based on CAD Tributary Area*

Item	Tributary Area, ft2	Length, ft	Unit Weight, kcf	Load, klf	Reaction Transf., kip	Load Type	Dist x, ft	
S1	4.82	8.208	0.15	0.723	5.93	Point	5.5	
S1 SW	0.102	8.208	0.49	0.050	0.41	Point	5.5	6.35
S2	4.41	8.208	0.15	0.661	5.42	Point	10.25	
S2 SW	0.102	8.208	0.49	0.050	0.41	Point	10.25	5.84
SW	22.4	15.000	0.490	0.076	1.14	Uniform	-	
			TOTAL =	**1.560**				

Member Loading Demand:



Resulting Loading:

DL	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
Sum	14.42	-14.87	0.00	-63.40

See DL-MidFB.std

Live Load Distribution Factor: *Based on CAD Tributary Area*

To determine a longitudinal distribution factor w/ a STAAD.Pro model, the stringers are represented by supports, and live load reactions are used to determine controlling DF. Largest Reaction per Stringer (support) is thus:

Total Load Applied = 2 trucks w/ 32 kip/axle (P=16 kip) = **4** x 16
= **64** kip

Stringer 1 Reaction = **14.316** kip
Strenger 2 Reaction = **11.79** kip

Stringer 1 DF = **0.22**
Stringer 2 DF = **0.18**

Given reaction due to different live load cases on stringer *(Truck.Stringer.std)* , the DF calculated above is applied to determine live load transferred to FB:

		S1	S2
TRUCK	**Reaction, kip**	**Eff. R, kip**	**Eff. R, kip**
T3S2	12.272	2.745	2.261
T3	8.375	1.873	1.543
H20	16.59	3.711	3.056
HS20	18.358	4.106	3.382

A floorbeam model is set up in STAAD.Pro with the live load reactions determined above. Floorbeam results are catalogued below.

Live Load: *See DL-MidFB.std*

4 different models were developed in order to determine controlling live load shear and moment on stringer. Note that values are increased by 1.33 due to impact.

Truck	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
T3S2	3.26	-3.26	0.00	-17.96
T3	2.23	-2.31	0.00	-12.25
H20	4.41	-4.59	0.00	-24.27
HS20	4.88	-5.08	0.00	-26.86

STAAD.Pro Nomenclature:

(-) Tension
(+) Compression

CLIENT	MassDOT	STV INCORPORATED			
PROJECT	North Washington St. Bridge	MADE	CHK.	REV.	4015171
SUBJECT	Critical Members Load Analysis	*ARG*			
		8/12/2016			5

Critical Members Load Analysis **Ref.:** -

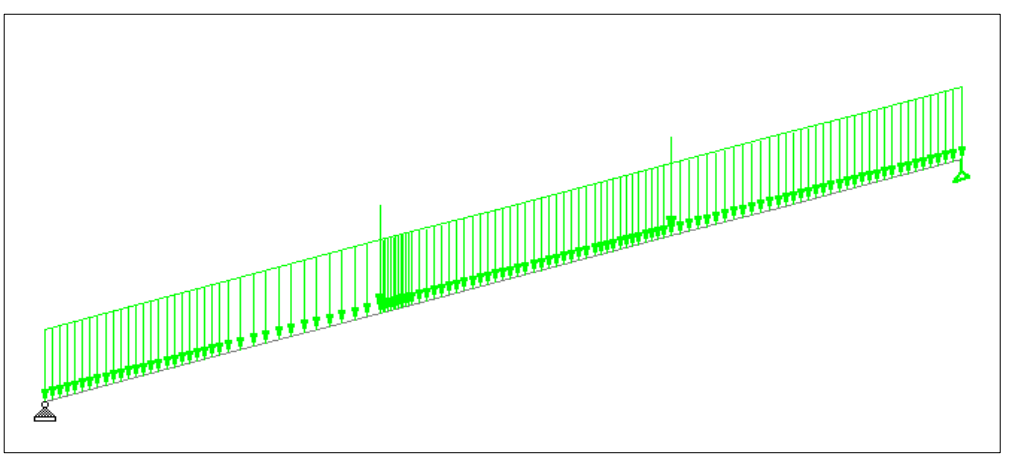
Critical Members: *Reference*

Repair: F-2
Member Type: Floorbeam
Section Type: W24X76
Span Length: 15.000 *ft*

Loading: *Based on CAD Tributary Area*

Item	Tributary Area, ft2	Length, ft	Unit Weight, kcf	Load, klf	Reaction Transf., kip	Load Type	Dist x, ft	
S1	4.82	16.417	0.15	0.723	11.87	Point	5.5	
S1 SW	0.102	16.417	0.49	0.050	0.82	Point	5.5	12.69
S2	4.41	16.417	0.15	0.661	10.85	Point	10.25	
S2 SW	0.102	16.417	0.49	0.050	0.82	Point	10.25	11.67
SW	22.4	15.000	0.490	0.076	1.14	Uniform	-	
			TOTAL =	**1.560**				

Member Loading Demand: *See F2-MidFB.std*



Resulting Loading:

DL	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
Sum	20.28	-21.18	0.00	-94.83

See F2-MidFB.std

Live load is equivalent to both F1 AND F2.

CLIENT	**MassDOT**	**STV INCORPORATED**			
PROJECT	**North Washington St. Bridge**	MADE	CHK.	REV.	**4015171**
SUBJECT	**Critical Members Load Analysis**	***ARG***			
		8/12/2016			6

Live Load Distribution Factor: *See F2-MidFB.std*

To determine a longitudinal distribution factor a STAAD.Pro model, the stringers are represented by supports, and live load reactions are used to determine controlling DF. Largest Reaction per Stringer (support) is thus:

Total Load Applied = 2 trucks w/ 32 kip/axle (P=16 kip) = **4** x 16
= **64** kip

Stringer 1 Reaction = **14.316** kip
Strenger 2 Reaction = **11.79** kip

Stringer 1 DF = **0.22**
Stringer 2 DF = **0.18**

Given reaction due to different live load cases on stringer (Staad.Pro Run 1), the above DF is applied do determine live load transferred to FB:

		S1	S2
TRUCK	**Reaction, kip**	**Eff. R, kip**	**Eff. R, kip**
T3S2	12.272	2.745	2.261
T3	8.375	1.873	1.543
H20	16.59	3.711	3.056
HS20	18.358	4.106	3.382

A floorbeam model is set up in STAAD.Pro with the live load reactions determined above. Floorbeam results are catalogued below.

Live Load: *(4) ASD Trucks in STAAD.Pro:*

4 different models were developed in order to determine controlling shear and moment on stringer. Note that values are also increased by 1.33 due to impact requirements.

Truck	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
T3S2	3.26	-3.26	0.00	-17.96
T3	2.23	-2.31	0.00	-12.25
H20	4.41	-4.59	0.00	-24.27
HS20	4.88	-5.08	0.00	-26.86

STAAD.Pro Nomenclature:

(-) Tension
(+) Compression

CLIENT	**MassDOT**	**STV INCORPORATED**			
PROJECT	**North Washington St. Bridge**	MADE	CHK.	REV.	**4015171**
SUBJECT	**Critical Members Load Analysis**	***ARG***			
		8/12/2016			7

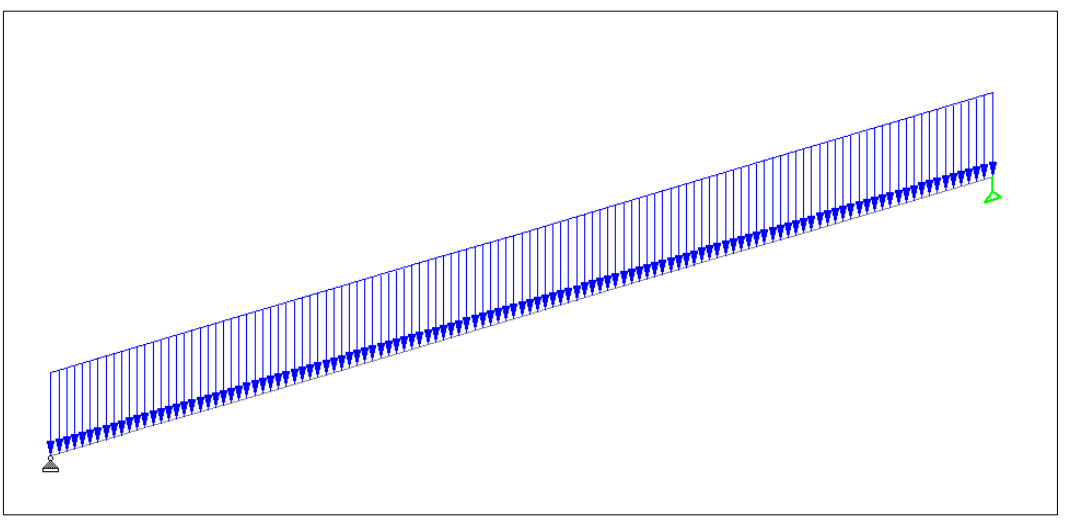
Critical Members: *Reference*

Repair: S-2
Member Type: Stringer
Section Type: W18X50
Span Length: 16.417 *ft*

Loading: *Based on CAD Tributary Area*

Item	Tributary Area, ft2	Length, ft	Unit Weight, kcf	Load, klf	Reaction Transf., kip
S1	4.82	16.417	0.15	0.723	11.87
SW	0.102	16.417	0.490	0.050	0.821
			TOTAL =	**0.773**	

Member Loading Demand: *Staad.Pro Model*



Resulting Loading: *STAAD.Pro Results*

DL	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
Sum	6.35	-6.35	0.00	-26.05

*DL-Stringer.std**

**File run was modified according to the load values noted above.*

Live Load Distribution Factor:

Based on the Floorbeam Staad.Pro model, typical Bay 2 and Bay 3 stringers have a DF:

DF=	0.22

Based on CAD Tributary Area

Previous live load results must account for it, thus:

Live Load: *(4) ASD Trucks in STAAD.Pro:*

4 different models were developed in order to determine controlling shear and moment on stringer:

Truck	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft	
T3S2	8.23	-14.02	0.00	-35.33	*See T3S2-Stringer.std*
T3	8.74	-9.17	0.00	-32.82	*See T3-Stringer.std*
H20	18.36	-18.32	0.00	-65.64	*See H20-Stringer.std*
HS20	16.59	-15.98	0.00	-65.64	*See HS20-Stringer.std*

Effective Live Load: *Applying DF obtained above and I = 1.33:*

Truck	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
T3S2	2.45	-4.17	0.00	-10.51
T3	2.60	-2.73	0.00	-9.76
H20	5.46	-5.45	0.00	-19.53
HS20	4.94	-4.75	0.00	-19.53

STAAD.Pro Nomenclature:

(-) Tension
(+) Compression

CLIENT	**MassDOT**	**STV INCORPORATED**			
PROJECT	**North Washington St. Bridge**	MADE	CHK.	REV.	**4015171**
SUBJECT	**Critical Members Load Analysis**	***ARG***			
		8/12/2016			9

Critical Members: *Reference*

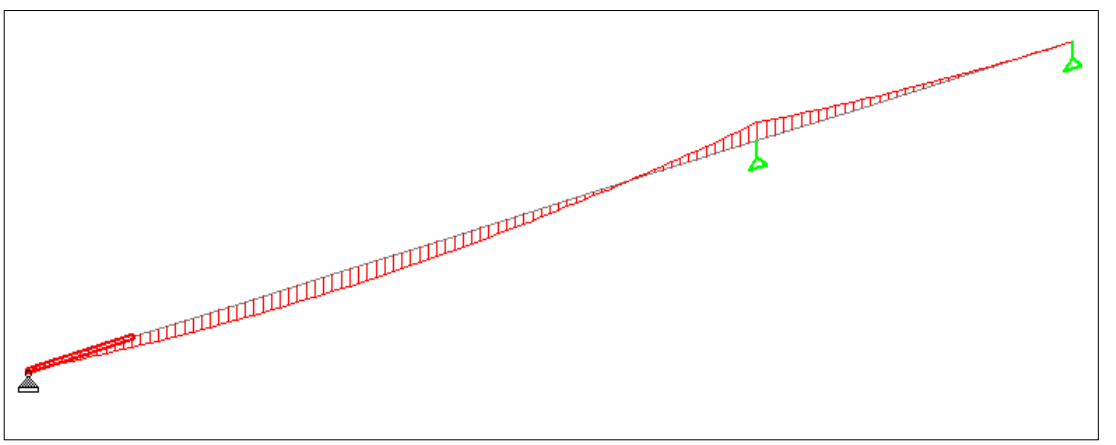
Repair: S-15
Member Type: Stringer
Section Type: W18X50
Span Length: 23.500 *ft*

Loading: *Based on CAD Tributary Area*

Item	Tributary Area, ft2	Length, ft	Unit Weight, kcf	Load, klf	Reaction Transf., kip	
S1*	78.52	0.958	0.15	0.48	-	*Uniform*
SW**	0.102	23.500	0.490	0.05	0.294	*Point @ End*
END BEAM	0.102	6.667	0.490	0.05	0.17	*Point @ End*
S1 SW	0.102	23.500	0.490	0.05	-	*Uniform*
			TOTAL =	**0.530**		

**S1 length = HMA + Slab thickness . Area = trapezoidal area obtained in CAD.*
***Sister Str. Load is split in between both end floorbeam supports onto both S1 & S2 stringers.*

Member Loading Demand: *Staad.Pro Model*



Moment Diagram w/ FB6 as an additional support.

Resulting Loading: *STAAD.Pro Results*

DL	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
Sum	3.68	-5.12	12.74	-12.04

See DL-Stringer2.std

Stringer S-15 support (FB6 and FB7) reactions are catalogued for floorbeam rating purposes.

	DL	LL-T3S2	LL-T3	LL-HS20	LL-H20
FB6	8.802	16.693	15.239	17.728	17.728
FB7	0.542	-3.089	1.65	-2.855	-2.855

Live Load Distribution Factor:

Based on the typical Bay 1 stringers DF:

DF=	0.70

Live Load: *See DL-Stringer2.std*

4 different models were developed in order to determine controlling shear and moment on stringer:

Truck	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
T3S2	12.57	-15.00	21.87	-20.80
T3	13.09	-10.17	16.92	-24.93
H20	16.40	-16.77	20.21	-22.17
HS20	17.74	-19.09	35.64	-49.24

Effective Live Load: *Applying DF obtained above and I = 1.33:*

Truck	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
T3S2	11.63	-13.87	20.23	-19.24
T3	12.11	-9.41	15.65	-23.06
H20	15.17	-15.51	18.70	-20.51
HS20	16.41	-17.66	32.98	-45.56

STAAD.Pro Nomenclature:

(-) Tension
(+) Compression

CLIENT	MassDOT	STV INCORPORATED			
PROJECT	North Washington St. Bridge	MADE	CHK.	REV.	4015171
SUBJECT	Critical Members Load Analysis	*ARG*			
		8/12/2016			11

Critical Members Load Analysis **Ref.:** -

Critical Members: *Reference*

Repair: F-3
Member Type: Floorbeam
Section Type: W24X76
Span Length: 22.500 *ft*

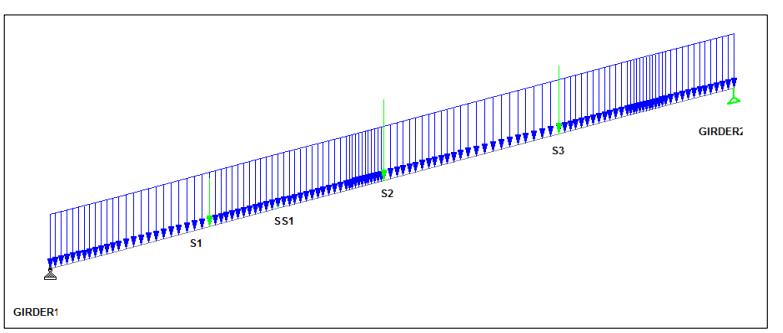
02/01/16 Inspection Report

Loading: *Based on CAD Tributary Area*

Item	Tributary Area, ft2	Thickness/ Length, ft	Unit Weight, kcf	Load, klf	Reaction Transf., kip	Load Type	Dist x, ft	
S1	*(As calculated on S-15)*				8.80	Point	5.25	
SS1*	0.102	23.500	0.49	0.050	0.83	Point	8.5	
S2	136.29	0.958	0.15	0.834	13.85	Point	11	
S2 SW	0.102	23.500	0.490	0.050	0.83	Point	11	14.68
S3	114.020	0.958	0.15	0.697	11.58	Point	16.75	
S3 SW	0.102	23.500	0.49	0.050	0.83	Point	16.75	12.41
FB SW	0.156	-	0.490	0.076	-	Uniform	-	
			TOTAL =	**0.076**				

**Sister Stringer assumed identical member to other stringers. All stringers selfweight are calculated based on reaction at FB6. Stringer load transfer reactions are calculated using STAAD.Pro.*

Member Loading Demand:



Resulting Loading:

DL	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
Sum	18.79	-19.64	0.00	-149.45

See F3-MidFB.std

Live Load Distribution Factor: *See F3-MidFB.std*

To determine a longitudinal distribution factor a STAAD.Pro model, the stringers are represented by supports, and live load reactions are used to determine controlling DF. Largest Reaction per Stringer (support) is thus:

Total Load Applied = 2 trucks w/ 32 kip/axle (P=16 kip) = **4** x 16
= **64** kip

Member	Reaction	DF
S1	13.45	0.21
SS1	1.92	0.03
S2	14.05	0.22
S3	17.01	0.27

Assuming reaction due to different live load cases on stringer S-5 (*DL-Stringer2.std*) is the same to all other stringers the above DF is applied do determine live load transf.:

		S1	SS1	S2	S3
TRUCK	**Reaction, kip**	**Eff. R, kip**	**Eff. R, kip**	**Eff. R, kip**	**Eff. R, kip**
T3S2	16.693	3.508	0.502	3.665	4.437
T3	15.239	3.203	0.458	3.345	4.050
H20	17.728	3.726	0.533	3.892	4.712
HS20	17.728	3.726	0.533	3.892	4.712

A floorbeam model is set up in STAAD.Pro with the live load reactions determined above. Floorbeam results are catalogued below.

Live Load: *See F3-MidFB.std*

4 different models were developed in order to determine controlling shear and moment on stringer. Note that values are also increased by 1.33 due to impact requirements.

Truck	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
T3S2	7.86	-8.18	0.00	-60.02
T3	7.17	-7.46	0.00	-54.79
H20	8.35	-8.68	0.00	-63.75
HS20	8.35	-8.68	0.00	-63.75

STAAD.Pro Nomenclature:

(-) Tension
(+) Compression

CLIENT	MassDOT	STV INCORPORATED			
PROJECT	North Washington St. Bridge	MADE	CHK.	REV.	4015171
SUBJECT	Critical Members Load Analysis	*ARG*			
		8/12/2016			13

Critical Members Load Analysis **Ref.:** -

Critical Members: *Reference*

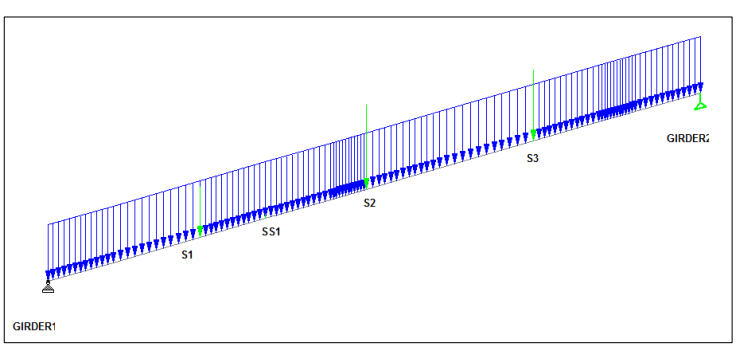
Repair: F-4
Member Type: Floorbeam
Section Type: W30X108 *Dwgs S.27C/27*
Span Length: 23.526 *ft*

Loading: *Based on CAD Tributary Area*

Item	Tributary Area, ft2	Thickness/ Length, ft	Unit Weight, kcf	Load, klf	Reaction Transf., kip	Load Type	Dist x, ft	
S1	*(As calculated on S-15)*				0.54	Point	5.5	
SS1*	0.156	23.500	0.49	0.076	0.83	Point	8.5	
S2	136.29	0.958	0.15	0.834	13.85	Point	11.5	
S2 SW	0.156	23.500	0.490	0.076	0.83	Point	11.5	14.68
S3	114.020	0.958	0.15	0.697	11.58	Point	17.5	
S3 SW	0.156	23.500	0.49	0.076	0.83	Point	17.5	12.41
FB SW	-	23.526	0.490	0.108	-	Uniform	-	
			TOTAL =	**0.108**				

**Sister Stringer assumed identical member to other stringers. All stringers selfweight are calculated based on reaction at FB6 (Values are typically larger). Stringer load transfer reactions are calculated using STAAD.Pro.*

Member Loading Demand:



Resulting Loading:

DL	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
Sum	12.90	-18.10	0.00	-135.48

See F4-MidFB.std

Live Load Distribution Factor: *See F4-MidFB.std*

To determine a longitudinal distribution factor a STAAD.Pro model, the stringers are represented by supports, and live load reactions are used to determine controlling DF. Largest Reaction per Stringer (support) is thus:

Total Load Applied = 2 trucks w/ 32 kip/axle (P=16 kip) = **4** x 16
= **64** kip

Member	Reaction	DF
S1	14.46	0.23
SS1	1.17	0.02
S2	15.56	0.24
S3	16.79	0.26

Assuming reaction due to different live load cases on stringer S-5 (*DL-Stringer2.std*) is the same to all other stringers the above DF is applied do determine live load transf.:

		S1	SS1	S2	S3
TRUCK	**Reaction, kip**	**Eff. R, kip**	**Eff. R, kip**	**Eff. R, kip**	**Eff. R, kip**
T3S2	-3.089	-0.698	-0.056	-0.751	-0.810
T3	1.65	0.373	0.030	0.401	0.433
H20	-2.855	-0.645	-0.052	-0.694	-0.749
HS20	-2.855	-0.645	-0.052	-0.694	-0.749

A floorbeam model is set up in STAAD.Pro with the live load reactions determined above. Floorbeam results are catalogued below.

Live Load: *See F4-MidFB.std*

4 different models were developed in order to determine controlling shear and moment on stringer. Note that values are also increased by 1.33 due to impact requirements.

Truck	V+ , kip	V- , kip	M+ , k.ft	M- , k.ft
T3S2	1.53	-1.54	11.98	0.00
T3	0.83	-0.82	0.00	6.40
H20	1.42	-1.42	11.07	0.00
HS20	1.42	-1.42	11.07	0.00

STAAD.Pro Nomenclature:

(-) Tension
(+) Compression