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September 18, 2026

Powder River, Inc.
 David Baker
 PO Box 50758
 Provo, Utah 84605

RE: Powder River Cattle Guards (MES Job No. 19188.A)
 Various Locations, Utah
 Cattle Guard Structural Calculations

Dear David,

We are writing per your request to provide structural calculations for the cattle guards listed below.

The cattle guards listed below were analyzed for the AASHTO H-15, H-20, HS-20, HS-25, U-54, U-80, and HL-93 loading. The cattle guards were analyzed using the AASHTO LRFD Bridge Design Specifications and are also adequate for the structural requirements in the AISC 360.

The cattle guards are listed below:

Load Requirements	H-15	H-20 HS-20	U-54 HS-25, HL-93	U-80
MAX AXLE LOADING	12 TONS MAX AXLE LOAD	16 TONS MAX AXLE LOAD	25 TONS MAX AXLE LOAD	30 TONS MAX AXLE LOAD
Cattle Guard Model Number	036-15708	036-20708	036-54808	036-80808
	036-15710	036-20710	036-54810	036-80810
	036-15712	036-20712	036-54812	036-80812
	036-15714	036-20714	036-54814	036-80814
	036-15808	036-20808		
	036-15810	036-20810		
	036-15812	036-20812		
	036-15814	036-20814		
	037-15708	037-20708	037-54808	
	037-15710	037-20710	037-54810	
	037-15712	037-20712	037-54812	
	037-15714	037-20714	037-54814	
	037-15808	037-20808		
	037-15810	037-20810		
	037-15812	037-20812		
	037-15814	037-20814		

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CONCLUSIONS:

It was determined that the cattle guards are adequate for their respective design loads in the table above. It was also determined that the cattle guards that are adequate for U-54 loading are also adequate for HS-25 and HL-93 design loads.

LIMITATIONS AND EXCLUSION OF WARRANTY

This report and the professional opinions obtained herein represent our attempt to satisfy the specific request and limited scope with which we were commissioned and asked to perform. It is based on the information we were given or were otherwise able to obtain and what we could physically observe, to which we applied our experience and expertise. New information or findings may naturally alter our assessment. Nothing contained herein should be construed as a guarantee or warranty. If new information becomes available contrary to the information we received, what we assumed, or what we could observe, we reserve the right to amend our findings and recommendations.

We appreciate the opportunity to address these issues and trust that this meets with your needs. Please contact this office with any further questions or for additional clarification.

Sincerely yours,

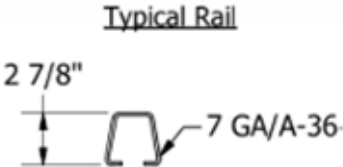
Digitally signed by Anthony B. Schmid
DN: C=US,
E=anthony@mcneileng.com,
O=McNeil Engineering,
OU=Anthony B. Schmid
Date: 2026.09.18
09:57:22-0600

Anthony B. Schmid



Anthony B. Schmid S.E.
Engineer of Record

The following calculations were performed to determine the adequacy of the cattleguards provided by the above listed client. The cattleguards were assumed to have a maximum span of 8'-0". The loading was determined by the AASHTO requirements for H-15, H-20, HS-20, HS-25, and HL-93. The calculations also meet or exceed the AISC 360 requirements.

Load Factors					
D _{dead_factor}	1.25	Per Table 3.4.1-2 AASHTO LRFD			
IM	1.33	Per Table 3.4.1-1 AASHTO LRFD			
LL	1.35	Per AASHTO, loading is Owner Specified Values, therefore LL = 1.35			
F = IM · LL	1.7955				
f _y (rail yield strength)	36,000 psi				
Rail Section Properties (2-7/8" x 7GA/ A-36 rail)					
A	1.650 in ²				
E	29,000,000 psi				
I _x	1.726 in ⁴				
r _x	1.023 in				
y	1.469 in				
S = I _x / y	1.175 in ³				
Z	1.480 in ³				
A _w = (3/16) · 2 · 2.875	1.078 in ²				
Axle Loads					
P _{H-15}	24,000 lbs	Per Axle			
P _{H-20}	32,000 lbs	Per Axle — also use for HS-20			
P _{H-54}	50,000 lbs	Per Axle — also use for HS-25 & HL-93			
P _{H-80}	60,000 lbs	Per Axle			
Calculations — Resistance & Load-Modifier Factors					
φ _f	1.00	Per Section 6.5.4.2			
φ _v	1.00	Per Section 6.5.4.2			
φ _w	0.80	Per Section 6.5.4.2			
φ _c	0.90	Per Section 6.5.4.2			
η _D	1.00				
η _I	0.95				
η _R	1.05				
η _i = η _D · η _R · η _I	0.998	Eq. 1.3.2.1-2 (1.0 used in design)			

The wheel bearing area is 20" x 10". The rails are spaced at 7-1/8" apart max.

Rail Capacities							
	$M_{ult} = f_y \cdot Z \cdot \phi_f$	4,440 lb-ft					
	$V_{ult} = \phi_f \cdot 0.6 \cdot f_y \cdot A_w$	23,288 lbs					
By inspection, column buckling of the web at the bearing locations does not govern design.							
Rail Checks (7GA rail, per AASHTO wheel-load / rail-spacing checks)							
w_{eff}	20 in						
	Loading	L	P (plf)	M	Check — M	V	Check — V
	H-15	1.71 ft	12,928	2,702 lb-ft	O.K.	10,799 lbs	O.K.
	H-20	1.54 ft	17,237	3,952 lb-ft	O.K.	14,560 lbs	O.K.
	U-54	1.36 ft	26,933	3,621 lb-ft	O.K.	18,332 lbs	O.K.
	U-80	1.5 ft	32,319	3,514 lb-ft	O.K.	20,344 lbs	O.K.
M and V for each loading are taken from clearcalc calculations provided.							

Beam Analysis (version 63)

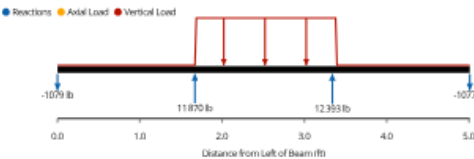
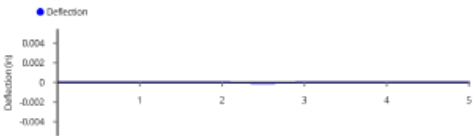
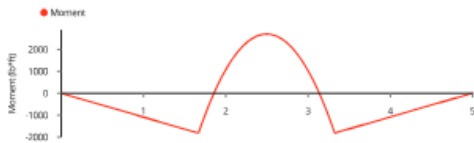
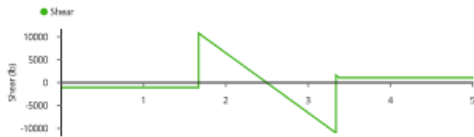
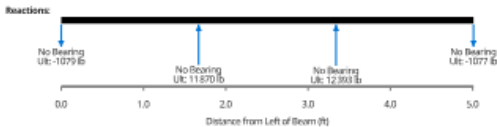
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Client: Powder River	Author: Marshall Clarke	Date: Sep 11, 2026
Project: Powder River Cattle Guards	Job #: 19188.A	
Address:	Subject: H-15 Rail Loading	

Summary

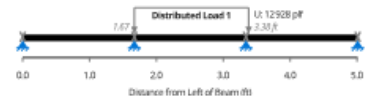
Moment Demand $M^* = 2702 \text{ lb} \cdot \text{ft}$
Shear Demand $V^* = -10\,799 \text{ lb}$
Deflection $\delta = -56.1 \times 10^{-6} \text{ in}$



Key Properties

Length of Beam $L = 5.01 \text{ ft}$

Simple Loads



Comments

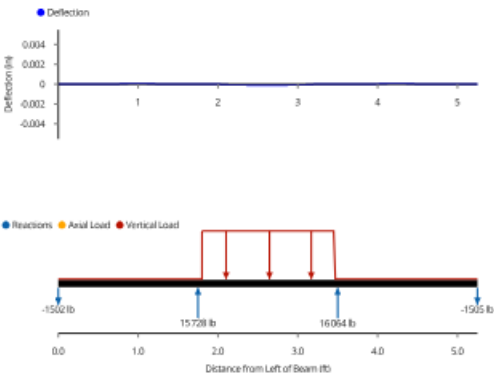
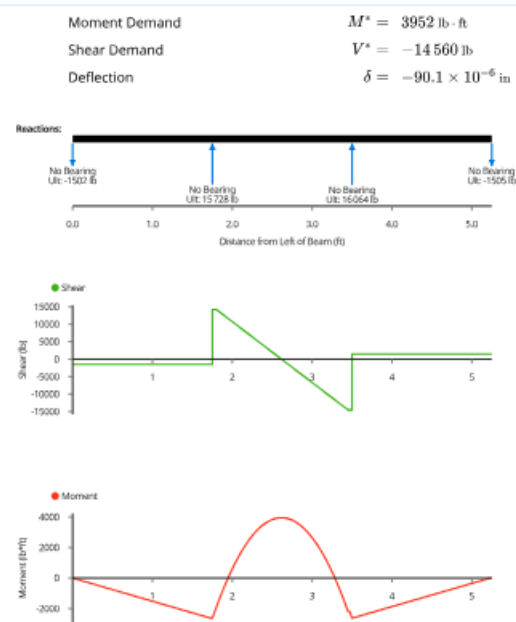
Beam Analysis (version 63)

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Client: Powder River	Author: Marshall Clarke	Date: Sep 11, 2026
Project: Powder River Cattle Guards	Job #: 19188.A	
Address:	Subject: H-20 Rail Loading	

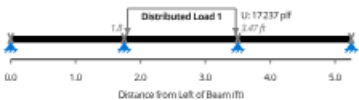
Summary



Key Properties

Length of Beam $L = 5.25 \text{ ft}$

Simple Loads



Comments

Beam Analysis (version 63)

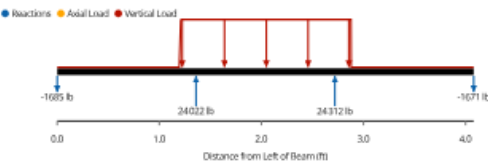
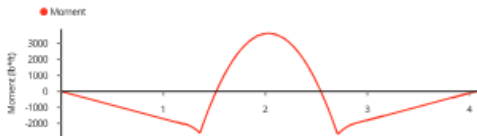
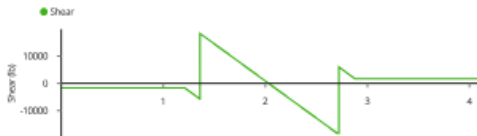
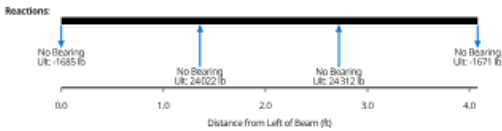
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Client: Powder River	Author: Marshall Clarke	Date: Sep 11, 2026
Project: Powder River Cattle Guards	Job #: 19188.A	
Address:	Subject: U-54 Rail Loading	

Summary

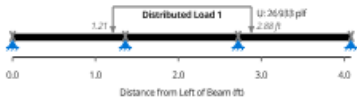
Moment Demand $M^* = 3621 \text{ lb} \cdot \text{ft}$
Shear Demand $V^* = -18\,332 \text{ lb}$
Deflection $\delta = -49.3 \times 10^{-6} \text{ in}$



Key Properties

Length of Beam $L = 4.08 \text{ ft}$

Simple Loads



Comments

Beam Analysis (version 63)

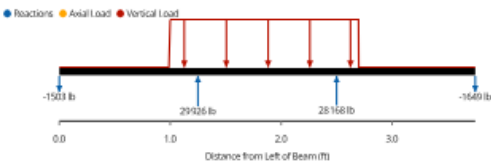
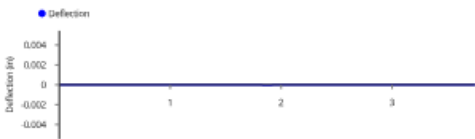
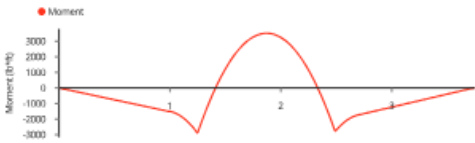
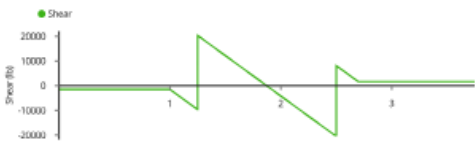
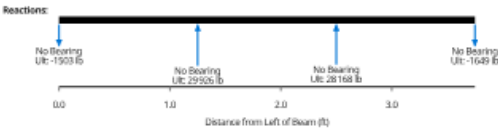
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Client: Powder River	Author: Marshall Clarke	Date: Sep 11, 2026
Project: Powder River Cattle Guards	Job #: 19188.A	
Address:	Subject: U-80 Rail Loading	

Summary

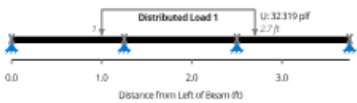
Moment Demand $M^* = 3514 \text{ lb} \cdot \text{ft}$
Shear Demand $V^* = 20344 \text{ lb}$
Deflection $\delta = -39.7 \times 10^{-6} \text{ in}$



Key Properties

Length of Beam $L = 3.75 \text{ ft}$

Simple Loads



Comments

Channel Section Properties						
Property	Main Span: H-15	Main Span: H-20	Main Span: U-54	Main Span: U-80		
Member	C8X11.5	C8X11.5	C10X15.3	C10X15.3		
F _y	36,000 psi	36,000 psi	36,000 psi	36,000 psi		
d	8.00 in	8.00 in	10.00 in	10.00 in		
t _w	0.22 in	0.22 in	0.24 in	0.24 in		
S	8.14 in ³	8.14 in ³	13.50 in ³	13.50 in ³		
Z	9.63 in ³	9.63 in ³	15.90 in ³	15.90 in ³		
I	32.5 in ⁴	32.5 in ⁴	67.3 in ⁴	67.3 in ⁴		
r	3.11 in	3.11 in	3.88 in	3.88 in		
E	29,000,000 psi	29,000,000 psi	29,000,000 psi	29,000,000 psi		
A _w = d · t _w	1.760 in ²	1.760 in ²	2.400 in ²	2.400 in ²		
M _n = φ _t · F _y · Z	28,890 lb-ft	28,890 lb-ft	47,700 lb-ft	47,700 lb-ft		
V _n = φ _v · 0.6 · F _y · A _w	38,016 lbs	38,016 lbs	51,840 lbs	51,840 lbs		

H-15 (uses C8x11.5 channel)						
Wheel load was distributed by using table 3.23.1 for distribution of wheel loads in Longitudinal beams for Steel Grid deck based on spacing.						
$P = (P_{H-15} / 2 \cdot F) \cdot S / 4.5$	8,187 lbs					
L	7.5 ft	8-ft minus 3-in bearing on each end				
S	1.71 ft	Spacing				
$M_{ult} = P_{H-15} \cdot L / 4$	15,352 lb-ft	O.K.	vs. Mn, C8X11.5			
$V_{ult} = P_{H-15} / 2$	4,094 lbs	O.K.	vs. Vn, C8X11.5			
$\Delta_{max} = P \cdot (L \cdot 12)^3 / (48 \cdot E \cdot L \cdot F)$	0.073 in		I from C8X11.5			
H-20 (uses C8x11.5 channel)						
Wheel load was distributed by using table 3.23.1 for distribution of wheel loads in Longitudinal beams for Steel Grid deck based on spacing.						
$P = (P_{H-20} / 2 \cdot F) \cdot S / 4.5$	9,831 lbs					
L	7.5 ft	8-ft minus 3-in bearing on each end				
S	1.54 ft	Spacing				
$M_{ult} = P_{H-20} \cdot L / 4$	18,434 lb-ft	O.K.	vs. Mn, C8X11.5			
$V_{ult} = P_{H-20} / 2$	4,916 lbs	O.K.	vs. Vn, C8X11.5			
$\Delta_{max} = P \cdot (L \cdot 12)^3 / (48 \cdot E \cdot L \cdot F)$	0.088 in		I from C8X11.5			
U-54 (uses C10x15.3 Channel)						
Wheel load was distributed by using table 3.23.1 for distribution of wheel loads in Longitudinal beams for Steel Grid deck based on spacing.						
$P = (P_{U-54} / 2 \cdot F) \cdot S / 4.5$	13,566 lbs					
L	7.5 ft	8-ft minus 3-in bearing on each end				
S	1.36 ft	Spacing				
$M_{ult} = P_{U-54} \cdot L / 4$	25,436 lb-ft	O.K.	vs. Mn, C10X15.3			
$V_{ult} = P_{U-54} / 2$	6,783 lbs	O.K.	vs. Vn, C10X15.3			
$\Delta_{max} = P \cdot (L \cdot 12)^3 / (48 \cdot E \cdot L \cdot F)$	0.059 in		I from C10X15.3			
U-80 (uses C10x15.3 Channel)						
Wheel load was distributed by using table 3.23.1 for distribution of wheel loads in Longitudinal beams for Steel Grid deck based on spacing.						
$P = (P_{U-80} / 2 \cdot F) \cdot S / 4.5$	17,955 lbs					
L	7.5 ft	8-ft minus 3-in bearing on each end				
S	1.5 ft	Spacing				
$M_{ult} = P_{U-80} \cdot L / 4$	33,666 lb-ft	O.K.	vs. Mn, C10X15.3			
$V_{ult} = P_{U-80} / 2$	8,978 lbs	O.K.	vs. Vn, C10X15.3			
$\Delta_{max} = P \cdot (L \cdot 12)^3 / (48 \cdot E \cdot L \cdot F)$	0.078 in		I from C10X15.3			

Tandem Loading					
This is the maximum wheel load that can be placed at any given point along either the channel. Some loading may change depending on the spacing of the channels. The					
a	4 ft	Spacing between axels			
P_tandem	12,500 lbs				
H-15 (uses C8x11.5 channel)					
Wheel load was distributed by using table 3.23.1 for distribution of wheel loads in Longitudinal beams for Steel Grid deck based on					
$P = (P_{\text{tandem}} \cdot F) \cdot S / 4.5$	8,529 lbs				
L	7.5 ft	8-ft minus 3-in bearing on each end			
S	1.71 ft	Spacing			
$M_{\text{ult}} = P_{\text{tandem}} / 2 \cdot L \cdot (L - a/2)^2$	17,199 lb-ft	O.K.	vs. Mn, C8X11.5		
$V_{\text{ult}} = P_{\text{tandem}} \cdot (2 - a/L)$	12,509 lbs	O.K.	vs. Vn, C8X11.5		
H-20 (uses C8x11.5 channel)					
Wheel load was distributed by using table 3.23.1 for distribution of wheel loads in Longitudinal beams for Steel Grid deck based on					
$P = (P_{\text{tandem}} \cdot F) \cdot S / 4.5$	7,681 lbs				
L	7.5 ft	8-ft minus 3-in bearing on each end			
S	1.54 ft	Spacing			
$M_{\text{ult}} = P_{\text{tandem}} / 2 \cdot L \cdot (L - a/2)^2$	15,490 lb-ft	O.K.	vs. Mn, C8X11.5		
$V_{\text{ult}} = P_{\text{tandem}} \cdot (2 - a/L)$	11,265 lbs	O.K.	vs. Vn, C8X11.5		
U-54 (uses C10x15.3 Channel)					
Wheel load was distributed by using table 3.23.1 for distribution of wheel loads in Longitudinal beams for Steel Grid deck based on					
$P = (P_{\text{tandem}} \cdot F) \cdot S / 4.5$	6783 ft				
L	7.5 ft	8-ft minus 3-in bearing on each end			
S	1.36 ft	Spacing			
$M_{\text{ult}} = P_{\text{tandem}} / 2 \cdot L \cdot (L - a/2)^2$	13,679 lb-ft	O.K.	vs. Mn, C10X15.3		
$V_{\text{ult}} = P_{\text{tandem}} \cdot (2 - a/L)$	9,948 lbs	O.K.	vs. Vn, C10X15.3		
U-80 (uses C10x15.3 Channel)					
Wheel load was distributed by using table 3.23.1 for distribution of wheel loads in Longitudinal beams for Steel Grid deck based on					
$P = (P_{\text{tandem}} \cdot F) \cdot S / 4.5$	7,681 lbs				
L	7.5 ft	8-ft minus 3-in bearing on each end			
S	1.54 ft	Spacing			
$M_{\text{ult}} = P_{\text{tandem}} / 2 \cdot L \cdot (L - a/2)^2$	15,490 lb-ft	O.K.	vs. Mn, C10X15.3		
$V_{\text{ult}} = P_{\text{tandem}} \cdot (2 - a/L)$	11,265 lbs	O.K.	vs. Vn, C10X15.3		