

STANDARD HANDRAIL TESTING PROCEDURE

KIE has developed a testing procedure for handrail, handrail posts, and handrail post connections for Kiewit operations. The intent is to verify that handrail systems are capable of resisting OSHA loading requirements in combination with wind loading per ASCE, when debris catchment is added to the handrail system. It is not the intent of these procedures to include handrail, handrail posts or associated connections for public service. All engineering assumptions can be found in the attached Appendix. Guardrails shall conform to all OSHA 1926.502 requirements.

HANDRAIL POST LOADING REQUIREMENT											
ELEVATION (FT.)	EXPOSURE TO PUBLIC?	% SOLID DEBRIS CATCHMENT									
		0		25		50		75		100	
		FORCE (LB.)	Y	FORCE (LB.)	Y	FORCE (LB.)	Y	FORCE (LB.)	Y	FORCE (LB.)	Y
40	NO	200	3'-6"	233	3'-3"	347	2'-4"	521	1'-9"	694	1'-9"
	YES	200	3'-6"	243	3'-2"	451	1'-10"	677	1'-9"	903	1'-9"
60	NO	200	3'-6"	236	3'-2"	378	2'-2"	567	1'-9"	756	1'-9"
	YES	200	3'-6"	247	3'-2"	491	1'-9"	737	1'-9"	983	1'-9"
80	NO	200	3'-6"	238	3'-2"	402	2'-0"	603	1'-9"	804	1'-9"
	YES	200	3'-6"	261	3'-0"	522	1'-9"	784	1'-9"	1045	1'-9"
100	NO	200	3'-6"	240	3'-2"	421	1'-11"	632	1'-9"	843	1'-9"
	YES	200	3'-6"	274	2'-10"	548	1'-9"	822	1'-9"	1096	1'-9"

NOTES:

1. DEBRIS CATCHMENT: 0% = NO CATCHMENT INSTALLED, 100% = SOLID PLYWOOD SHEET INSTALLED
2. HANDRAIL WILL NOT BE IN SERVICE WHEN 3 SECOND GUST WIND SPEEDS EXCEED 35 MPH. WORKERS TO MAINTAIN 6' CLEARANCE FROM HANDRAIL.
3. THE OUT OF SERVICE WIND SPEED IS BASED ON A SERVICE LEVEL 3-SECOND GUST OF 80 MPH
4. VALUES ARE FOR A HANDRAIL POST SPACING OF 8'-0" ON CENTER, OR LESS, AND A DEBRIS CATCHMENT HEIGHT OF 42 INCHES
5. FOR TESTING REQUIREMENTS IN SPECIAL WIND REGIONS OR HURRICANE PRONE REGIONS, CONTACT KIE
6. EXPOSURE TO PUBLIC IS DEFINED AS AREAS WHERE THE HANDRAIL SYSTEM WILL AFFECT THE PUBLIC IN THE EVENT OF FAILURE.

Figure 1: Handrail Post Loading Table

TESTING REQUIREMENTS

1. Contact a qualified person to determine if your situation is applicable under the provisions within.
2. Handrail post test loading must be applied directly at the post location (not on the handrail between posts), perpendicular to the handrail away from the work platform. Load should be applied at the distance above the work platform "Y" indicated in the table of Figure 1; see Figures 2 and 3 for loading schematics.
3. When handrail post is attached to another temporary structure (i.e., work platform, deck overhang falsework, etc.), the Engineer of Record (EOR) of the temporary support structure design must be notified of any planned debris catchment installed and this planned testing procedure.
4. Handrail top rails shall be tested with a point load at the center of the span to the handrail post load in Figure 1, or 270 pounds, whichever is lower, for a post spacing of 8'-0" on center; see Figures 2 and 3 for loading schematics.
5. A minimum of three tests shall be performed at similar handrail, handrail post, and handrail post anchorage conditions. Each different condition (i.e., different support structure conditions) shall be tested at three locations, if possible.
 - a. One of the three tests shall be at the end of a work platform.
 - b. Corner handrail posts shall be tested in both directions.
 - c. Testing shall be completed in a controlled manner, with loads recorded and measured with a scale or dynamometer.
 - d. Target load shall be held in a static condition for a minimum of 10 seconds.

STANDARD HANDRAIL TESTING PROCEDURE

- e. Handrail deflection shall be monitored and recorded to ensure top rail height does not drop below 39" above the platform working level during the test (OSHA 1926.502(b)(4)).
- f. Tests shall be completed to verify handrail/handrail post/connection capacity for each different case on a project.
- g. If handrail, handrail posts, or connections fail during a test, the system shall be taken out of service and reconstructed or strengthened appropriately. Per OSHA, failure means a load refusal, breakage, or separation of component parts. A load refusal is the point at which the ultimate strength of a component or object is exceeded.
- h. Testing shall be documented with logs, pictures and/or video and filed per the TSCD document control plan. Photos of the scale or dynamometer shall be included. For situations not covered under the provisions included within, or for any other questions, please contact KIE.

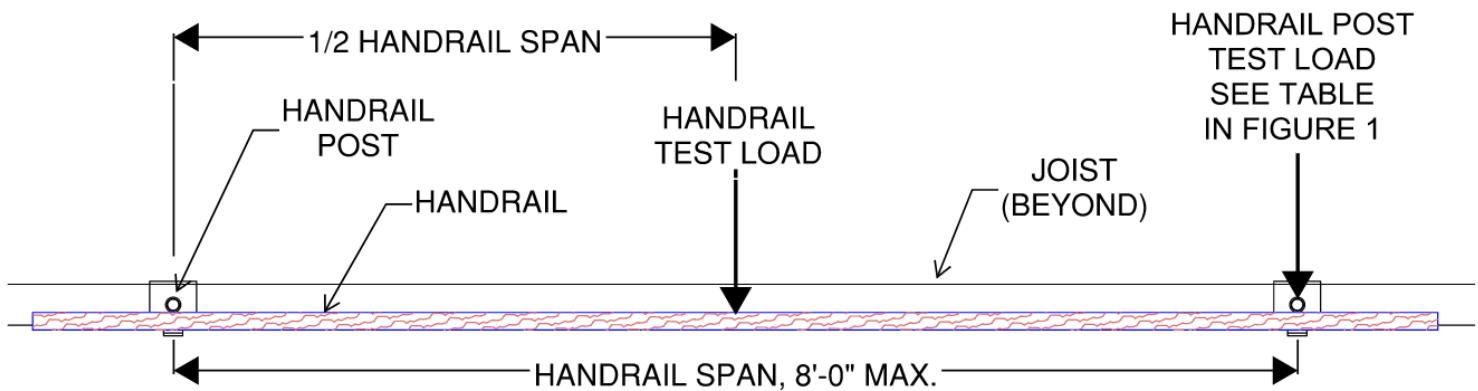


Figure 2: Plan - Loading Schematic
NOTE: Debris Catchment and Plywood Deck Not Shown

STANDARD HANDRAIL TESTING PROCEDURE

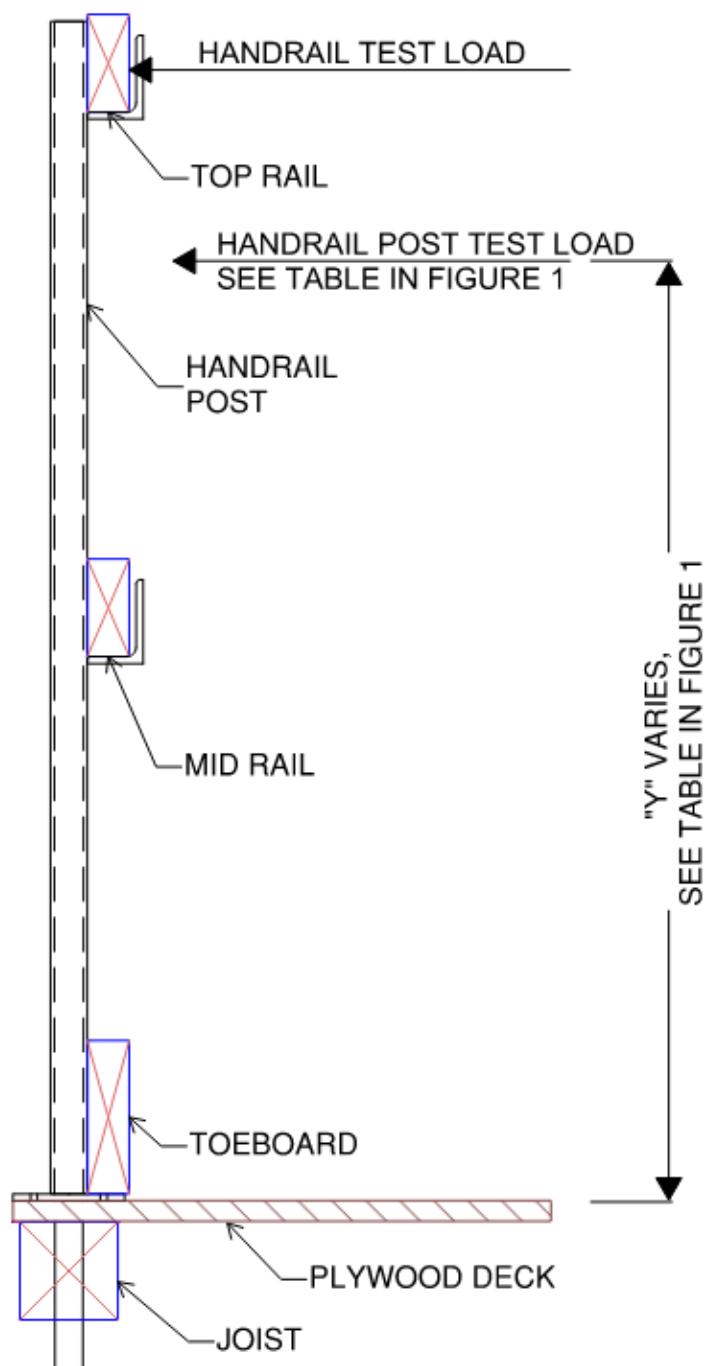


Figure 3: Section - Loading Schematic
NOTE: Debris catchment not shown

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Appendix:

- OSHA handrail loading requirement = 200 lb. minimum applied at the top rail
 - Reference OSHA section 1926.502(b)(3)
- Wind pressures were calculated based upon the following code:
 - ASCE7-16: Minimum Design Loads and Associate Criteria for Buildings and Other Structures
 - Out-of-service winds speed of 115 mph 3-second gust is reduced to 80 mph per ASCE 37-14 for a maximum construction duration of 5 years
 - Risk category II classification
 - Surface Roughness C – open terrain with scattered obstructions that have heights generally less than 30'. This category includes flat, open country, and grasslands
 - NOTE: This classification yields higher wind pressures than urban/suburban areas, but lower wind pressures than flat, unobstructed areas and water surfaces.
 - Exposure Category C
 - Force coefficient = 2.0
 - Gust factor = 0.85 (rigid)
- Debris catchment height = 42" max.
- Handrail post spacing = 8'-0" O.C. max.
- Load factor
 - OSHA loads = 1.0
 - Wind loads = 1.0 (handrail not exposed to public), 1.3 (handrail exposed to public)