

Section 614 Semi-rigid Barrier Systems and End Treatments

614.1 Description

- (1) This section describes providing steel guardrail systems including rail, terminal and transition treatments, other roadside energy absorbing safety devices, and earthwork for barrier systems. This section also describes providing and removing temporary guardrail, adjusting existing guardrail, salvaging materials from existing installations.

614.2 Materials

614.2.1 General

- (1) Furnish materials conforming to the following:

Asphaltic surface	465.2
Non-bituminous joint sealer	502.2
Structural steel and miscellaneous metals.....	506.2
Steel reinforcement.....	505.2
Wood posts and offset blocks.....	507.2
Emulsified asphalt.....	604.2

- (2) Furnish grade A, A-FA, A-S, A-T, A-IS, A-IP, or A-IT concrete conforming to [501](#) as modified in [716](#), except under the Crash Cushions Temporary bid item the contractor may use SHES concrete as specified for SHES concrete repair and replacement in [416.2](#). Provide QMP for class II ancillary concrete as specified in [716](#). If crash cushion manufacturer details specify concrete strength for pads or blocks, provide QMP for class I structure concrete as specified in [715](#). Define class I structure sublots for each crash cushion location, apply the small quantity exceptions specified in [715.1.1.2](#), base acceptance on individual subplot average strength, and adjust pay under [715.5.3](#) as specified for lots with less than 4 sublots.
- (3) Furnish zinc dust/zinc oxide paint conforming to Federal specification TT-P-641.
- (4) Furnish steel nuts conforming to [ASTM A563](#), washers conforming to [ASTM F436](#), grade 1, and bolts conforming to [ASTM A307](#). Ensure that the nuts, washers, and bolts are either hot-dip coated according to AASHTO M232 class C or mechanically coated according to [ASTM B695](#) class 50.
- (5) Furnish zinc coated wire rope and fitting conforming to the plans and galvanized according to [ASTM A741](#).
- (6) Before installation store galvanized components above ground level and away from surface run off. The department may reject material if the zinc coating is physically damaged or oxidized.
- (7) Provide manufacturer's drawings, and installation and maintenance instructions when providing proprietary systems.
- (8) Furnish shop-applied type F reflective sheeting from the department's approved products list.
- (9) Furnish object markers conforming to the type 3 object marking pattern shown in the MUTCD.

614.2.2 Controlled Low-Strength Backfill

- (1) Provide controlled low-strength backfill consisting of a contractor-designed cementitious mixture of fine aggregate, fly ash, cement, water, and optional admixtures. Ensure that the resulting mixture hardens with 24 hours to the degree that it will support foot traffic and conforms to the following:

TEST	METHOD	VALUE
Strength	ASTM D4832	40-80 psi in 28 days

- (2) Submit design mix along with strength test results to the engineer at least 10 business days before placing material.

614.2.3 Steel Rail and Fittings

- (1) Furnish galvanized steel rail conforming to AASHTO M180 class A, type II beam using the single-spot test coating requirements. Furnish steel for retrofit assemblies, anchor post assemblies, plates, anchor plates, post mounting brackets, and other structural steel components conforming to [506.2.2.1](#) and hot-dip galvanized according to [ASTM A123](#).
- (2) For rail requiring bends with a radius less than 150 feet, ensure that the required bends are made in the manufacturer's fabrication shop.
- (3) Furnish steel tubes for breakaway posts conforming to [ASTM A500](#), grade B and hot-dip galvanized according to AASHTO M111.

- (4) Furnish anchor assemblies fabricated as the bridge parapet details show. Over-tap threaded inserts according to [ASTM A563](#) and electro-galvanize the entire assembly according to [ASTM B633](#) after fabrication. Furnish cap screws hot-dip galvanized as the parapet details show.

614.2.4 Energy Absorbing Terminal

- (1) Furnish energy absorbing terminals (EAT's) and EAT marker posts from the department's approved products list. Furnish reflective sheeting panels constructed from sheet aluminum with shop-applied reflective sheeting conforming to the plan details and [637.3.2](#).

614.2.5 Posts and Offset Blocks

614.2.5.1 Wood Posts and Offset Blocks

- (1) Furnish sawed posts and offset blocks of one of the following species:
- | | | | | |
|-------------|-----------------|----------------|-----------|------------|
| Douglas fir | Southern pine | Ponderosa pine | Jack pine | White pine |
| Red pine | Western hemlock | Western larch | Hem-fir | Oak |
- (2) Ensure that posts are the size the plans show and conform to the nominal and minimum dimensions tabulated in [507.2.2.3](#). The contractor does not have to surface the posts. Provide posts of the net length the plans show after setting and cut off.
- (3) Use stress graded posts rated at 1200 psi f_b or higher. Determine the stress grade rating for douglas fir, western larch, and southern pine as specified in [507.2.2.4](#).
- (4) For hem-fir, hemlock, red pine, white pine, jack pine, ponderosa pine, and oak conform to the following:

TABLE 614-1 PROPERTIES FOR WOOD POSTS AND BLOCKS

SPECIES		WESTERN HEMLOCK, HEM-FIR, RED PINE, WHITE PINE, JACK PINE, PONDEROSA PINE	OAK			
MAXIMUM SLOPE OF GRAIN		1 in 15		1 in 12		
NOMINAL WIDTH OF FACE		6"	8"	6"	8"	
SHAKES, CHECKS, AND SPLITS	GREEN	1"	1 3/8"	2 3/8"	3 1/8"	
	SEASONED	1 1/2"	2"	2 5/8"	3 1/2"	
MAXIMUM WANE		1"	1 3/8"	1 1/8"	1 5/8"	
MAXIMUM ALLOWABLE KNOTS	NARROW FACE	MIDDLE 1/3 OF LENGTH	1 3/8"	1 5/8"	2 1/8"	2 3/8"
		END ^[1]	2 3/4"	3 1/4"	4 1/4"	4 3/4"
		SUM IN MIDDLE 1/2 OF LENGTH ^[2]	11"	13"	17"	19"
	WIDE FACE	EDGE KNOT N MIDDLE 1/3 OF LENGTH	1 3/8"	1 5/8"		
		EDGE KNOT AT END ^[1]	2 3/4" 7	3 1/4"		
		CENTERLINE	1 3/8"	1 7/8"	2 1/4"	2 7/8"
		SUM IN MIDDLE 1/2 OF LENGTH	5 1/2"	7 1/2"	9"	11 1/2"

^[1] But do not exceed the maximum allowable knot on the centerline of the wide face of the same piece.

^[2] But do not exceed 4 times the maximum allowable knot on the centerline of the wide face of the same piece.

- (5) Pressure treat posts and offset blocks as specified in [507.2.2.6](#). Use one of the oil-soluble preservatives or chromated copper arsenate conforming to [507.2.3](#). Use the same material for offset blocks and posts and treat material used in each continuous installation with the same type of preservative.

614.2.5.2 Steel Posts

- (1) Furnish steel posts conforming to AASHTO M270 Grade 36 and galvanized according to AASTHO M111.

614.2.5.3 Plastic Offset Blocks

- (1) Furnish plastic offset blocks from the department's approved products list.

614.2.6 Sand Barrel Arrays

- (1) Furnish sand barrels from the department's approved products list. Use sand conforming to [501.3.6.3](#) mixed with sodium chloride conforming to AASHTO M143. Apply an object marker to front-most barrel in the array.

614.2.7 Crash Cushions

- (1) Furnish permanent and temporary crash cushions from the department's approved products list. Use cushions as wide or wider than the plan back-width. Submit details of the object being shielded and orientation of traffic to the crash cushion manufacturer. The crash cushion manufacturer is responsible for providing design details for each installation that include their crash cushions as well as connections and transitions to the object being shielded. Ensure that the crash cushion manufacturer's design details are signed and sealed by a professional engineer registered in the state of Wisconsin.
- (2) Furnish transitions and connections conforming to the crash cushion manufacturer's design and specifications. Ensure that the transition and connection design includes required modifications to the object being shielded. Submit a copy of the manufacturer's crash cushion, connection, and transition design details to the engineer before installation. Modifications to the object being shielded require the engineer's approval before installation.
- (3) Apply an object marker to the nose of the crash cushion of the color and pattern the MUTCD shows for work zones or permanent installations.

614.2.8 Adhesive Anchors

- (1) Furnish adhesive for concrete anchors conforming to ICC-ES AC308 and capable of resisting the bond strength the plans show. Provide the adhesive manufacturer's installation instructions to the engineer before installing anchors.

614.3 Construction

614.3.1 General

- (1) Paint the ends of cut-off galvanized posts, rail, bolts, cut or drilled surfaces of galvanized components, and areas of damaged zinc coating with 2 coats of zinc dust/zinc oxide paint. Clean and deburr the damaged and adjacent areas thoroughly before applying paint.
- (2) Apply 2 coats of wood preservative to cut surfaces of wood components. Use the same preservative originally used to treat that component or use copper naphthenate solution containing 2 percent or more copper metal conforming to AWWPA P34.
- (3) Anchor barrier systems as the plans show or as manufacturer details show. For anchoring to concrete, clean holes and install according to the adhesive manufacturer's recommendations.

614.3.2 Guardrail

614.3.2.1 Installing Posts

- (1) Set posts at the required plan locations with the front faces in a straight line or, if on a curve, at a uniform distance from the centerline. Ensure that they are installed plumb, to the required depth, and with adequate lateral stability. The contractor may drive posts or set them in excavated post holes. If rock is encountered, install as the plans show.
- (2) If the required plan depth cannot be achieved by driving, set posts in excavated holes. Replace posts damaged during driving. Ensure driving does not damage the shoulders and adjacent slopes.
- (3) If installing posts in excavated post holes, excavate to the plan depth and compact the bottom of the holes to provide a stable foundation. Set posts to firm bearing and backfill with engineer-approved material compacted in layers.
- (4) Cut post tops to the finished elevation the plans show.

614.3.2.2 Installing Rail

- (1) Install rail with lap splices in the direction of traffic. Make all splices, including splices of existing rail to new rail, at posts. Ensure that the number and dimensions of holes and bolts conforms to the plan details for new splices. Place the round head of bolts on the traffic side.
- (2) Cut rails to length by shearing or sawing and drill bolt holes. Do not use cutting torches. After installation, cut off all anchor bolts that project more than one inch from the nut to 1/2 inch from the nut. Deburr the threaded end of cut bolts.

614.3.2.3 Guardrail Terminals and Transitions

- (1) Attach rail ends to cast in place concrete anchorages, energy absorbing terminals (EAT's) or other terminal types, or transition between rail types at structure approaches as the contract requires for each guardrail system installation.

- (2) If concrete anchorages are specified, place concrete without forms filling the entire excavation with concrete to the elevation the plans show. Ensure that steel reinforcement and the rail are secured at their plan locations before placing concrete. Do not apply forces to the rail element embedded in the concrete anchor until after the concrete develops adequate strength to open it to service under [415.3.15](#).
- (3) If anchoring to structures, attach guardrail to the parapets of structures using anchor assemblies cast into the parapets or drill through the parapet whichever the plan details show. Plug anchor assemblies not receiving beam guard using cap screws with anti-seize compound applied to their threads.
- (4) Install EAT's according to the manufacturer's instructions and as the plans show. Attach reflective panels to the EAT head with stainless steel self-tapping screws and install EAT markers as the plans show.

614.3.2.4 Mow Strips

- (1) Provide mow strips with blockouts for guardrail posts as the plans show. Construct concrete as specified for concrete sidewalk under [602](#). Construct asphalt as specified for asphaltic surface under [465](#). Backfill post blockouts after post installation with controlled low-strength backfill.
- (2) Apply emulsified asphalt to finished aggregate shoulders following the asphalt manufacturer's recommended procedures. Minimize run-off and overspray during application and remove excessive run-off and over spray from adjacent areas immediately after application.

614.3.2.5 Grading, Shaping, and Finishing for Barrier Systems

- (1) Grade, shape, and finish embankment slopes for barrier systems at the locations the plans show. Furnish materials and construct as the plans show and engineer directs conforming to the following:

Common excavation and material disposal	205
Borrow	208
Topsoil	625
Mulching	627
Fertilizer	629
Seeding	630
Construction Staking.....	650

614.3.2.6 Temporary Guardrail

- (1) Provide and maintain temporary guardrail and associated terminals and transitions conforming to the requirements for permanent installations except the contractor may furnish used materials. Replace guardrail components damaged during construction immediately. Remove and dispose of temporary guardrail components when no longer needed.

614.3.3 Sand Barrel Arrays

- (1) Provide sand barrel arrays and foundation at each location the plans show. Have the sand barrel manufacturer design the barrel array layout and determine the sand weights for each individual barrel. Ensure that the manufacturer's design at each plan location conforms to the design speed, shields the required obstruction width, and is appropriate for the traffic direction. Submit a copy of the manufacturer's design details stamped and sealed by a professional engineer registered in the state of Wisconsin to the engineer before installation.
- (2) Fill the barrels with a homogeneous mixture of 3 parts dry sand to one part granular sodium chloride by volume. Do not use pre-packaged sand. Do not place the mixture into the barrels in a wet condition.
- (3) Construct concrete foundation pads as specified for concrete sidewalk under [602](#) conforming to dimensions the sand barrel manufacturer specifies. For permanent installations, paint the foundation pad to indicate the manufacturer, date of installation, and barrel locations and weights.

614.3.4 Crash Cushions

- (1) Provide and maintain permanent crash cushions and transitions at the locations the plans show. Conform to the contract design criteria and to manufacturer's specifications. Certify that the installation was done according to manufacturer's recommendations. Install object markers with reflective sheeting to the crash cushion nose piece before opening to public traffic. Replace parts of crash cushions damaged during construction immediately.
- (2) Provide and maintain temporary crash cushions and transitions conforming to the requirements for permanent installations except the contractor may furnish used materials. Remove and dispose of crash cushions when no longer needed.
- (3) Provide concrete backup blocks and either concrete or asphalt foundation pads conforming to the crash cushion manufacturer's design. Construct concrete components as specified for concrete sidewalk under [602.3](#) and construct asphalt components as specified for asphaltic surface under [465](#).

614.3.5 Adjusting Guardrail

Revise 614.3.5(1) to require backfilling new posts with foundation backfill.

- (1) Adjust existing guardrail to the plan height. The contractor may raise offset blocks up to 3 inches, and only if that is not sufficient to reach the plan elevation, may raise posts an additional 3 inches if the engineer deems that stability is not compromised. Adjustments over 6 inches require placing new posts and backfilling with foundation backfill conforming to [520.2](#).
- (2) Use the existing serviceable guardrail beam, bolts, posts, and offset blocks. Replace existing rail components that are either unserviceable or missing. Straighten existing posts out-of-plumb by 6 inches or more. Straighten existing blocks and reinstall the galvanized nail as the plans show. Replace unstable or deteriorated posts and blocks.

614.3.6 Thrie Beam Structure Approach Retro Fits

- (1) Reinforce existing thrie beam by installing thrie beam retrofit assemblies or posts of the type the bid item indicates and as the plans show. Modify existing work conflicting with retrofitting as the plans show or engineer directs.
- (2) Install posts, drill holes into existing thrie beam, and repair damaged galvanization on thrie beam conforming to [614.3.2](#).

614.3.7 Anchor Post Assemblies

- (1) Before drilling into concrete, adjust beam guard post locations to avoid placement conflicts. do not relocate post more than 1 foot from the plan location without the engineer's written approval. Set anchor post assemblies with the front faces in a straight line or, if on a curve, at a uniform distance from the centerline.

614.3.8 Replacing Material

- (1) Remove and replace unserviceable posts, blocks, rail, and rail hardware at locations within existing guardrail systems where the contract or engineer designates. Take care to avoid damage to adjacent materials remaining in place.

614.3.9 Salvaging Material

- (1) Dismantle and remove the rail, guardrail end treatment, or other component the salvaged bid item indicates from the locations the contract designates. Minimize damage to reusable materials. Do not cut material that would be otherwise reusable. Replace contractor-damaged materials that are to remain in place. Remove and dispose of all wooden component parts and unwanted or damaged materials. Restore the site.
- (2) Sort by component part and load reusable materials onto separate pallets for each component part. The contractor may place hardware and smaller parts in clearly labeled crates or plastic buckets. Stockpile reusable material in engineer-approved locations on the project.
- (3) The contractor may use salvaged materials for temporary installations under the contract.

614.4 Measurement

- (1) The department will measure the EACH bid items under this section as each individual unit acceptably completed except as follows:
 - The department will measure Steel Thrie Beam Structure Approach Retrofit as each individual assembly or retrofit post.
 - The department will measure Sand Barrel Arrays as each individual sand barrel array, including foundation, measured individually for each required plan location.
 - The department will measure Salvaged Sand Barrels as each individual barrel.
 - The department will measure Replacing Guardrail Posts and Blocks as each individual post/block unit whether the post, block, or both are replaced.
 - The department will measure Barrier System Grading Shaping Finishing as each individual plan location acceptably completed.
 - The department will measure Anchor Post Assemblies as each individual post.
- (2) The department will measure bid items under this section with LF as the unit of measure by the linear foot acceptably completed, measured along the face of the rail element except; the department will measure Steel Plate Beam Median Guard along the centerline of the completed installation.
- (3) The department will measure the mow strip bid items by the square yard acceptably completed, measured without reduction for the area of the post blockouts.

614.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
614.0010	Barrier System Grading Shaping Finishing	EACH
614.0115 - 0149	Anchorage for Steel Plate Beam Guard (type)	EACH
614.0150	Anchor Assemblies for Steel Plate Beam Guard	EACH
614.0200	Steel Thrie Beam Structure Approach	LF
614.0210 - 0219	Steel Thrie Beam Structure Approach Retrofit (type)	EACH
614.0220	Steel Thrie Beam Bullnose Terminal	EACH
614.0230	Steel Thrie Beam	LF
614.0250	Steel Thrie Beam Structure Approach Temporary	LF
614.0300 - 0339	Steel Plate Beam Guard (class)	LF
614.0340	Steel Plate Beam Guard Over Low-Fill Culverts Class A	LF
614.0345	Steel Plate Beam Guard Short Radius	LF
614.0355	Steel Plate Beam Median Guard	LF
614.0360	Steel Plate Beam Guard Temporary	LF
614.0370	Steel Plate Beam Guard Energy Absorbing Terminal	EACH
614.0380	Steel Plate Beam Guard Energy Absorbing Terminal Temporary	EACH
614.0390	Steel Plate Beam Guard Short Radius Terminal	EACH
614.0395 - 0399	Guardrail Mow Strip (material)	SY
614.0400	Adjusting Steel Plate Beam Guard	LF
614.0500 - 0599	Guardrail Stiffened (type)	LF
614.0700	Sand Barrel Arrays	EACH
614.0800	Crash Cushions Permanent	EACH
614.0805	Crash Cushions Permanent Low Maintenance	EACH
614.0905	Crash Cushions Temporary	EACH
614.0920	Salvaged Rail	LF
614.0925	Salvaged Guardrail End Treatments	EACH
614.0930 - 0939	Salvaged (component)	EACH
614.0950	Replacing Guardrail Posts and Blocks	EACH
614.0951	Replacing Guardrail Rail and Hardware	LF
614.1000	MGS Guardrail Temporary	LF
614.1100	MGS Guardrail Temporary Thrie Beam Transition	LF
614.1200	MGS Guardrail Temporary Terminal EAT	EACH
614.2300	MGS Guardrail 3	LF
614.2310	MGS Guardrail 3 HS	LF
614.2320	MGS Guardrail 3 QS	LF
614.2330	MGS Guardrail 3 K	LF
614.2340	MGS Guardrail 3 L	LF
614.2500	MGS Thrie Beam Transition	LF
614.2610	MGS Guardrail Terminal EAT	EACH
614.2620	MGS Guardrail Terminal Type 2	EACH
614.8010 - 8019	Anchor Post Assemblies (type)	EACH

- (2) Payment for the Anchorages for Steel Plate Beam Guard bid items is full compensation for providing concrete anchorages, including concrete and reinforcement; and for excavating, backfilling, and disposing of excess material.
- (3) Payment for Anchor Assemblies for Steel Plate Beam Guard is full compensation for providing anchors in parapet walls.
- (4) Payment for the Steel Thrie Beam, Steel Plate Beam Guard, Guardrail Stiffened, MGS Guardrail, and various transition bid items is full compensation for providing rail, posts and offset blocks, terminal connectors, fittings, and hardware; for repairing damaged zinc coatings; for setting and driving posts; and for excavating, backfilling, and disposing of surplus material.
- (5) Payment for the Steel Thrie Beam Structure Approach Retrofit bid items is full compensation for providing retrofit assemblies or posts; for required modifications to existing work; and for drilling and repairing damaged galvanized coated thrie beam.

- (6) Payment for the terminal bid items is full compensation for providing terminals required under the selected system; for EAT reflective sheeting panels and marker posts; for setting and driving posts; and for excavating, backfilling, and disposing of surplus material.
- (7) Payment for the Guardrail Mow Strip bid items is full compensation for providing the paved strip adjacent to the guardrail installation; for concrete, asphaltic surface material, or emulsified asphalt; and for controlled low-strength backfill including mix design and testing.
- (8) Payment for Adjusting Steel Plate Beam Guard is full compensation for adjusting existing guardrail including backfilling. The department will pay separately for replacing unserviceable posts, blocks, rail, and rail hardware under the replacing guardrail bid items.
- (9) Payment for Sand Barrel Arrays is full compensation for providing manufacturer design details for each sand barrel array; for the foundation pad; and for providing each system at the plan location including barrels, sand, and sodium chloride.
- (10) Payment for the Crash Cushions bid items is full compensation for providing crash cushions; for the foundation pads, transitions, and backup blocks.
- (11) In addition to the work elements enumerated for the various permanent bid items, payment for the temporary bid items also includes removing and disposing of materials when no longer needed.
- (12) Payment for the salvaged bid items is full compensation for dismantling and stockpiling reusable rail, guardrail end treatments, or system elements; for replacing contractor-damaged material remaining in place; for removing and disposing of wooden components and unwanted or damaged materials; and for restoring the site.
- (13) Payment for Replacing Guardrail Posts and Blocks is full compensation for replacing posts and blocks; and for excavating, backfilling, and disposing of surplus material.
- (14) Payment for Replacing Guardrail Rail and Hardware is full compensation for replacing rail and associated hardware.
- (15) Payment for Barrier System Grading Shaping Finishing is full compensation for providing embankment at each barrier system plan location including required construction staking, excavation, borrow, topsoil, mulch, fertilizer, and seeding when the barrier system is outside the contract grading limits. If the work specified in [614.3.2.5](#) falls within the contract grading limits, the department will pay separately for that work under the construction staking, excavation, borrow, topsoil, mulch, fertilizer, and seeding bid items.
- (16) Payment for the Anchor Post Assemblies bid items is full compensation for providing anchor post assemblies.