



SECTION 606

**GUARDRAIL, CRASHWORTHY END TERMINALS, ONE-STRAND ACCESS
RESTRAINT CABLE AND THREE-STRAND GUARD CABLE**

606.1 Description. This work shall consist of furnishing and installing guardrail, crashworthy end terminals, one-strand access restraint cable or three-strand guard cable as shown on the plans or as directed by the engineer.

606.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Concrete	501
Guardrail, End Terminals, Crash Cushions, One-Strand Access Restraint Cable and Three-Strand Guard Cable	1040

606.2.1 Concrete. Concrete shall be placed, finished and cured in accordance with [Sec 703](#).

606.2.2 Cold Weather. During cold weather, the weather limitations of [Sec 502](#) will apply to concrete work.

606.2.3 Aesthetic Guardrail. When specified, aesthetic guardrail shall be in accordance with NCHRP 350, Test Level 3 criteria and shall be of new stock. End terminals and crash cushions for aesthetic guardrail shall be fabricated and installed in accordance with [Sec 606.30.3](#).

606.3 Construction Requirements.

606.3.1 General. Work on guardrail or guard cable removal and replacement when the adjacent travel or auxiliary lane is open to traffic during non-working hours shall adhere to the following requirements:

- (a) The contractor shall provide a schedule of work prior to the beginning of work.
- (b) Remove no more guardrail or guard cable than can be replaced in the same day.
- (c) Schedule guardrail and guard cable installation to ensure guardrail beam or guard cable is properly attached to all installed posts at the end of each work day.
- (d) Ensure end sections or terminals exposed to traffic meet current standards. Guardrail or guard cable shall be maintained to within 3 inches (75 mm) of the nominal barrier height shown on the plans.
- (e) Notify the engineer prior to delivery of the material to the project.

606.3.1.1 If guardrail or three-strand guard cable cannot be replaced the same day as removal, traffic control measures meeting the approval of the engineer shall be provided. The contractor will not be compensated for any additional traffic control items required to perform

this work. In all cases, the contractor shall ensure that the guardrail or guard cable installation is fully anchored before opening the adjacent lane to traffic.

606.3.1.2 The shoulders and slopes shall be in accordance with all standards shown on the plans or shall be as directed by the engineer before the installation of any guardrail, guard cable or end treatments.

606.3.2 Field Repair of Galvanizing. Galvanized material shall be handled in a manner to avoid damage to the surface. No punching, drilling, cutting or welding will be permitted after galvanizing, except as approved by the engineer to provide for lapped beams, or for changes in location of splices necessitated by field clearances. Any galvanized material on which the galvanizing has been damaged will be rejected or may, with the engineer's approval, be repaired in accordance with [Sec 1080](#).

606.3.3 Posts for Guardrail and One-Strand Access Restraint Cable.

606.3.3.1 Posts may be wood or steel. The same material shall be used for all new installations within a single project, except for end treatments. If the project requires an extension of existing guardrail, the new post material for the extension shall match the existing material.

606.3.3.2 Wood posts for end anchors shall be installed as shown on the plans.

606.3.3.3 Posts may be installed by either drilling or driving.

606.3.3.3.1 Posts installed by drilling shall have sufficiently sized holes to permit thorough compaction of backfill material around the posts. The backfill material shall be compacted in layers not exceeding 12 inches (300 mm) high.

606.3.3.3.2 Posts installed by driving may be driven by a power hammer or any other method approved by the engineer. Any mushrooming on the top of the post shall be removed. Damaged zinc coating on galvanized posts shall be field repaired in accordance with [Sec 1081](#). If, in the judgment of the engineer, the exposed portion of a wood post is split or the driving process noticeably worsens the check cracking, the post shall be replaced by the contractor at the contractor's expense.

606.4 Basis of Payment. The accepted quantities of grading and drainage at barrier locations will be paid for at the contract unit price for each of the pay items included in the contract.

SECTION 606.10 GUARDRAIL.

606.10.2.3 Delineators. Delineators shall be placed on all guardrail located 2 feet (600 mm) or less from the edge of the shoulder. Delineators shall be spaced at 50-foot (15 m) intervals.

606.10.2.3.1 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Specification
Delineators	1065

606.10.2.3.2 Construction Requirements.

606.10.2.3.2.1 Delineator reflector colors shall correspond with pavement marking. Delineators shall be sheeted on one side, facing oncoming traffic, unless otherwise specified. Where guardrail divides opposing lanes of travel, the delineators shall have retro-reflective sheeting on both sides corresponding to adjacent pavement markings. Guardrail located on ramps shall have red reflective sheeting placed on the reverse side of the reflector.

606.10.2.3.2.2 Delineators will be installed according to manufacturer's recommendations.

606.10.2.3.2.3 Any damaged or missing delineators shall be replaced by the contractor at the contractor's expense.

SECTION 606.50 THREE-STRAND GUARD CABLE.

606.50.1 Description. This work shall consist of furnishing and installing three-strand guard cable, including all hardware, appurtenances and aggregate bedding, as shown on the plans or as directed by the engineer.

606.50.2 Construction Requirements.

606.50.2.1 Line Posts. All posts shall be driven unless otherwise directed by the engineer. Driving shall be accomplished with approved equipment and methods that will leave the posts in the final position, free from any distortion, burring or other damage. All posts shall be aligned to a tolerance of 1/4 inch (6 mm) for plumb and grade line. If rock is encountered when setting line posts, the contractor may set line posts with or without a soil plate. Line posts set with a soil plate shall be installed by digging or boring a hole into the rock to the required depth and of sufficient size for the post to be set with the soil plate attached. Line posts set without the soil plate shall be installed by drilling a hole to the required depth not to exceed 5 inches (125 mm) in diameter. Following placement of the post, the hole shall be backfilled with a cohesive soil or sand in accordance with [Sec 1005.3](#) and thoroughly tamped.

606.50.2.2 Anchor Assemblies. The specified type of anchor assembly shall be constructed at each end of a run of guard cable. If intermediate end anchors are required, the cable assembly shall be overlapped as shown on the plans. The location of all intermediate anchor assemblies shall be determined by the contractor and approved by the engineer. The concrete anchor shall be cast in place with the centerline normal to the line of the guard cable. The top 12 inches (300 mm) of the anchor below finished ground line shall be formed, unless the engineer determines soil conditions permit excavation to be made to the neat lines of the anchor and the anchor cast against the undisturbed vertical soil face. Anchors shall be constructed on firm, stable, undisturbed soil to the minimum dimensions shown on the plans. Anchor bolts and anchor post slip bases shall be firmly held in the proper position supported at the top by a template during concrete placement. Backfill shall be thoroughly compacted with mechanical tampers with care taken to prevent damage to the finished concrete. Backfill shall be brought up level with the finished grade line. The anchor may be cast in place or precast as either one or two units.

606.50.2.3 Cables. Cables shall be attached to the line posts, anchor posts, cable transition brackets and anchor brackets as shown on the plans. Where compensating devices or turnbuckles are required, the cables shall be attached to the end anchor with turnbuckles fully opened. Compensating devices and turnbuckles shall be installed such that no interference with the functions of any other part of the system occurs. Individual cables may be spliced with a device approved by the engineer. Each cable shall be stretched taught by mechanical means to eliminate sag between the posts. The contractor may tighten cable hook bolts after final cable tensioning is complete to allow cable slack to be adequately taken up. Prior to final acceptance, the cables shall be tensioned in accordance with the temperature and spring compression table shown on the plans and all cable hook bolts tightened.

606.50.2.4 Aggregate Bedding. Material for aggregate bedding shall consist of a durable crushed stone, shot rock or broken concrete with approximately 20 percent of the pieces being between 1 inch and 3 inches in diameter but none greater than 3 inches. The remainder of the material shall be such that provides a uniform, angular appearance. Acceptance by the engineer will be made by visual inspection.

606.50.2.5 Delineators. Delineator spacing and reflector colors shall be in accordance with [Sec 606.10](#).

606.50.3 Method of Measurement.

606.50.3.1 Three-Strand Guardrail. Measurement of three-strand guard cable will be made from center of line post to center of line post, totaled to the nearest linear foot (0.5 meter).

606.50.3.2 Anchor Assemblies. Measurement of anchor assemblies will be made per each.

606.50.3.3 Aggregate Bedding . Aggregate bedding material will be measured to the nearest cubic yard (m) of material.

606.50.4 Basis of Payment. The accepted quantities of three-strand guard cable, end anchors, posts, hardware and aggregate bedding will be paid for at the contract unit price for each of the pay items included in the contract. No direct payment will be made for setting posts in rock. No direct payment will be made for guard cable delineators provided on new guard cable. Delineators specified for installation on existing guard cable will be measured and paid for per each.



SECTION 1040

GUARDRAIL, END TERMINALS, ONE-STRAND ACCESS RESTRAINT CABLE AND THREE-STRAND GUARD CABLE MATERIAL

1040.1 Scope. This specification covers guardrail, end terminals, one-strand access restraint cable, three-strand guard cable, and all appurtenances required for installation.

1040.2 Posts and Blocks. The same type of posts and blocks shall be used in a given run, except as shown on the plans or as approved by the engineer.

1040.2.1 Wood Posts and Blocks. Wood posts and blocks for guardrail and one-strand access restraint cable shall be in accordance with [Sec 1050](#).

1040.2.2 Steel Posts, Plates and Rails. Steel posts, anchor plates, bearing plates, soil plates, plate washers and channel rail shall be structural steel in accordance with AASHTO M 270, Grade 36, shall be of the dimensions and weights (masses) shown on the plans and shall be galvanized in accordance with AASHTO M 111. Bolts, nuts and washers shall be in accordance with the dimensions shown on the plans and shall be galvanized in accordance with AASHTO M 232, or may be mechanically galvanized. If mechanically galvanized, the coating thickness, adherence and quality requirements shall be in accordance with AASHTO M 232, Class C. Any dimensional defects and structural discontinuities will be cause for rejection. The material to be welded shall be preheated in accordance with good welding practice, and welds shall be full-section and sound throughout. All welds shall be mechanically cleaned before galvanizing. No punching, drilling, cutting or welding will be permitted after galvanizing.

1040.2.3 Plastic Blocks. Plastic guardrail blocks shall meet the dimensional requirements shown on the plans. The blocks shall be a homogeneous product with a uniform texture, and shall have no cracking, chipping, flaking, peeling or splintering after fabrication. The blocks will not be considered homogeneous if there are more than five voids larger than 5/8 inch (16 mm) or any voids larger than 3/4 inch (19 mm) on any cut face. The blocks shall be of new stock, shall meet all applicable requirements of NCHRP 350, and shall meet the approval of Construction and Materials.

1040.2.3.1 Approval. Prior to approval and use of the plastic guardrail blocks, the manufacturer shall submit to Construction and Materials, the manufacturer's name, the product brand name or model number, a copy of the NCHRP 350 test results, a copy of the FHWA acceptance letter, an MSDS and a sample block.

1040.2.3.2 Acceptance. Acceptance of the material will be based on the manufacturer's certification and upon the results of such tests as may be performed by the engineer.

1040.3 Steel Beam Guardrail. Guardrail beams shall be of the class and type shown on the plans. Guardrail beams shall be in accordance with AASHTO M 180, Type 1 or Type 2, except as noted herein. Type 1 material shall be galvanized by the continuous method.

1040.3.1 Test Specimens. Test specimens for mechanical properties shall be prepared and tested in accordance with ASTM A 653.

1040.3.2 End Sections. End sections and terminal connectors shall be of a class and type the same as or superior to that used for the beam to which the end sections and terminal connectors are attached. The physical properties shall be in accordance with AASHTO M 180.

1040.3.3 Fabrication. The beams, end sections and terminal connectors shall be shaped and punched as shown on the plans and ready for assembly when delivered. Only drilling or cutting necessary for special connections and for sampling will be permitted in the field. Warped or deformed beams will be rejected. Beams to be erected on a radius of 150 feet (46 m) or less shall be shop curved to the approximate curvature of the installation.

1040.3.4 Markings.

1040.3.4.1 Beams. Beam markings shall be in accordance with AASHTO M 180, except the AASHTO specification number may be omitted if another designation for Class and Type is used.

1040.3.4.2 Transition Sections and Terminal Connectors. Transition sections and terminal connectors shall be marked in accordance with [Sec 1040.3.4.1](#), except as follows. Durable tags securely attached to each section or connector may be used. If the transition section or terminal connector is Class B, the Class indicator will not be required. If the transition section or terminal connector is Type 2, the Type indicator will not be required. Heat numbers and coating designations will not be required.

1040.3.4.3 End Sections. No markings or tags will be required for end sections.

1040.3.4.4 Posts. Posts shall be marked such that the marking is exposed after installation, in such a manner as to indicate the manufacturer.

1040.3.5 Brand Registration and Guarantee. The manufacturer shall submit a brand registration and guarantee, and current test results indicating compliance with this specification prior to delivery of any material. Once the brand registration and guarantee is approved, the manufacturer's name will be added to the qualified list of guardrail fabricators. For Type I coated material, the brand registration and guarantee shall certify the material as being produced by the continuous galvanizing method.

1040.3.6 Acceptance. Acceptance will be by brand registration and guarantee, and any sampling deemed necessary by the engineer. The contractor or supplier shall provide equipment and personnel required to obtain samples as directed by the engineer.

1040.4 Crashworthy End Terminals.

1040.4.1 Material. Only new material shall be used in the fabrication of end terminals. The major items of the installations shall be the best standard products of a manufacturer regularly engaged in the production of that type of end terminal and shall be of the manufacturer's latest approved design. After installation, the end terminal shall redirect traffic face side vehicle impacts within the prescribed performance crash test criteria ranges.

1040.4.2 Manufacture's Approval. Prior to approval and use of a end terminal, the manufacturer shall submit to MoDOT the manufacturer's name, the product brand name or model number, a copy of the NCHRP 350 test results, a copy of the FHWA acceptance letter, and shop drawings.

1040.4.3 Acceptance. Acceptance of the material will be based on the manufacturer's certification and upon satisfactory field performance.

1040.4.4 Contractor's Certification. Prior to installation, the contractor shall furnish to the engineer a manufacturer's certification that the units furnished are identical in material and design to approved units.

1040.5 End Anchors and Bridge Anchors.

1040.5.1 Steel Tube and Tube Block. Steel tubes for end anchors shall consist of structural steel tubing in accordance with ASTM A 500, Grade B, or ASTM A 501 and shall be galvanized in accordance with AASHTO M 111. Structural steel tubing blocks for guardrail shall consist of steel tubing in accordance with ASTM A 500, Grade B, and shall be galvanized in accordance with AASHTO M 111.

1040.5.2 Cable. Cable shall be 3/4 inch (19 mm) in diameter, Type II, Class A in accordance with AASHTO M 30.

1040.5.3 Transition Cap Rail. The transition cap rail shall be in accordance with AASHTO M 270, Grade 36.

1040.5.4 Thrie Beam Rail and Transition Section. The thrie beam rail and transition section shall be galvanized in accordance with AASHTO M 180, Type 2.

1040.5.5 Approval. The cable assembly and anchor plate will be subject to approval by the engineer and shall have a minimum breaking strength of 20 tons (178 kN).

1040.5.6 Markings. Thrie beam rail and transition sections shall be marked in accordance with [Sec 1040.3.4](#).

1040.6 Cable and Fittings.

1040.6.1 One-Strand Access Restraint Cable.

1040.6.1.1 Cable. Cable shall be zinc-coated steel wire strand; 1/2-inch (12.7 mm) diameter; seven wire strand; Common, Siemens-Martin or High Strength grade; Class A coating; and shall be in accordance with ASTM A 475.

1040.6.1.2 Hardware. Eyebolts, turnbuckles and clips for cable connections and end anchors shall be steel forgings in accordance with AASHTO M 102 or pearlitic malleable iron in accordance with ASTM A 220. All miscellaneous parts, comprising of cable connections, fasteners and end anchors, shall be galvanized in accordance with AASHTO M 232.

1040.6.2 Three-Strand Guard Cable.

1040.6.2.1 Cable and Connecting Hardware. The cable and connecting hardware shall be in accordance with AASHTO M 30 and AASHTO M 269. The wire rope shall be Type 1, 3/4-inch (19 mm) diameter, 3 by 7 construction with a Class A coating. The rope, with connecting hardware, shall develop the breaking strength of a 25,000-pound (111 kN) single cable. Connecting hardware shall be galvanized in accordance with AASHTO M 232 or may be mechanically galvanized. If mechanically galvanized, the coating, thickness, adherence and quality requirements shall be in accordance with AASHTO M 232, Class C. Cast Steel components shall be in accordance with AASHTO M 103, Grade 70-40, Class 1. Malleable iron castings shall be in accordance with ASTM A 47. Compensating devices shall have a spring constant of 0.46 psi (80 kN/m), plus or minus 0.06 pound per inch (10 kN/m), and permit 6 inches (150 mm) of travel, plus or minus one inch (25 mm). All threaded parts on compensating cable end assemblies shall be in accordance with ASTM F 568, Class 4.6,

3/4-10 threads. Socket baskets shall be designed for use with the cable anchor wedge as shown on the plans. Guard cable anchor brackets shall be manufactured from an AASHTO M 270, Grade 250 steel plate, and zinc-coated in accordance with AASHTO M 111. Dimensional tolerances not shown on the plans shall be consistent with the proper functioning of the part, including the part's appearance and accepted manufacturing process.

1040.6.2.2 Cable Brackets. Steel used in the fabrication of the bracket shall be in accordance with ASTM A 36. The bracket shall be galvanized after fabrication in accordance with AASHTO M 111. All fittings, including splices, shall be designed to use the wedge detail, and shall be of such section as to develop the full strength of the 3/4-inch (8 mm), 25,000-pound (111 kN) round cable. Designs for a combination or single-unit compensating device and turnbuckle assembly shall be submitted for approval. Compensating devices shall have a spring rate of 0.46 ± 0.03 pound per inch (80 ± 10 kN/m), and shall permit 6 inches \pm one inch (150 ± 25 mm) of travel. All parts, except cable wedge, shall be hot-dip zinc coated in accordance with AASHTO M 232 or AASHTO M 298.

1040.6.2.3 Hook Bolts, Hex Bolts, Nuts and Washers. Hook bolts, hex bolts and washers shall be in accordance with ASTM A 307. Cable hook nuts shall be 5/16-18 threads and in accordance with ASTM A 563. Hook bolts, as installed, shall develop an ultimate pull open strength of 450 to 1000 pounds (2.0 to 4.5 kN) applied in a direction normal to the axis of the post. Hooked anchor studs shall be in accordance with AASHTO M 314, except the threads and nominal diameter shall be 3/4-10 and in accordance with ASTM F 568, Class 4.6. All items shall be galvanized in accordance with AASHTO M 232 or may be mechanically galvanized in accordance with AASHTO M 232, Class C.

1040.7 Certification. The contractor shall furnish the manufacturer's certification for all material governed by this specification. Specifically, each certification shall indicate compliance with the requirements of each applicable section and as set forth in Table I.

1040.8 Repair of Galvanizing. Galvanized material shall be handled in a manner to avoid damage to the surface. No field punching, drilling, cutting or welding will be permitted after galvanizing. Any galvanized material on which the spelter coating has been damaged will be rejected or may be repaired in accordance with [Sec 1081](#), with approval from the engineer.

Item	Galvanizing Standard	Steel Grade	Other
Wood Post and Blocks	-	-	a
Steel Posts, Plates and Brackets	AASHTO M 111	AASHTO M 270, Grade 36	b
Plastic Blocks	-	-	g
Guardrail Beam	Sec 1040.3	Sec 1040.3	b, c
Bolts, Nuts and Washers	AASHTO M 232	ASTM A 307	
End Terminals Systems	-	-	f
End Anchors			
- Tubes	AASHTO M 111	ASTM A 500/ASTM A 501	b
- Transition Cap Rail	AASHTO M 111	AASHTO M 270, Grade 36	b
One-Strand Access Restraint Cable			
- Cable	AASHTO M 30	AASHTO M 30	b
- Hardware	AASHTO M 232	AASHTO M 102/ ASTM A 220	b

Three Strand Guard Cable			
- Cable	AASHTO M30	AASHTO M 30 & AASHTO M 269	b
- Hardware	AASHTO M 232	AASHTO M 102/ ASTM A 220	d d
- Cast Steel Components	AASHTO M 232	AASHTO M 103	d
- Malleable Iron Castings	AASHTO M 232	ASTM A 47	e
- Anchor Brackets	AASHTO M 111	AASHTO M 270	
- Cable Brackets	AASHTO M 111	AASHTO M 270, Grade 36	d
- Hook and Hex Bolts	AASHTO M 232	ASTM A 307	
- Hook Nuts	AASHTO M 232	ASTM A 563	
- Hooked Anchor Studs	AASHTO M 232	AASHTO M 314	

(a) Certification shall state that the material is in accordance with [Sec 1050](#) and shall include a listing of the material supplied and a certified test report as detailed in Section 7.2 of AWP, Standard M2, attesting to complete compliance with this specification.

(b) Certification shall include, or have attached, specific results of laboratory tests for physical and chemical properties from samples representative of the material.

(c) Shall have Brand Registration and Guarantee on file, including certification indicating the coating is either Type 1 by Continuous Galvanizing Method or Type 2.

(d) All threaded parts of compensating cable end assemblies and hooked anchor studs shall be in accordance with ASTM F 568.

(e) All fittings for cable bracket, except the cable wedge, shall be in accordance with AASHTO M 232 or AASHTO M 298.

(f) Certification shall state the name of the manufacturer and that the units furnished are identical in material and design as those tested for performance in accordance with [Sec 606.30](#).

(g) Certification shall state that the materials furnished are identical in chemistry, mechanical properties and geometry as those that passed the NCHRP 350 crash test, and as those that were approved by the Missouri Department of Transportation.