



SECTION 1040

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

1040.1 Scope. These specifications cover guardrail, end terminals, crash cushions, one-strand cable - access restraint, guard cable, end terminals, crash cushions and all appurtenances required for installation.

1040.2 Posts and Blocks. Within any continuous run of guardrail, only one type of post and one type of block shall be used, except as shown in the plans or as approved by the engineer.

1040.2.1 Wood Posts and Blocks. Wood posts and blocks for guardrail and guard 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 ASTM A 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 shall 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 in the standard plans. The blocks shall be a solid, homogeneous product with a uniform texture and shall have no cracking, chipping, flaking, peeling or splintering after fabrication. The blocks shall have no more than five voids larger than 5/8 inch (16 mm) and none larger than 3/4 inch (19 mm) on any cut face. The blocks shall be of new stock unless the contract provides for relocation of existing units or units to be furnished by others. The blocks shall meet all applicable requirements of NCHRP 350 and meet approval by Project Operations.

1040.2.3.1 Approval. Prior to approval and use of the plastic guardrail blocks, the manufacturer shall submit to Project Operations, the manufacturers name, the product brand name or model number, a copy of the NCHRP 350 test results, a copy of the FHWA acceptance letter, a Material Safety Data Sheet, 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 shown on the plans. Guardrail beams shall be galvanized in accordance with the requirements for Type 1 or Type 2. The classes and types of guardrail beams allowed are as follows:

- (a) Class A - 12 Gage - base metal nominal thickness, 0.105 inch (2.67 mm).
- (b) Class B - 10 Gage - base metal nominal thickness, 0.135 inch (3.43 mm).
- (c) Type 1 - Zinc coated, 1.80 ounces per square foot (550 g/m²), minimum single-spot.
- (d) Type 2 - Zinc coated, 3.60 ounces per square foot (1100 g/m²), minimum single-spot.

1040.3.1 Base Metal. The beam elements shall consist of sheet made of open hearth, electric furnace or basic oxygen steel.

1040.3.1.1 The mechanical properties of the base metal for beams shall conform to the following tensile requirements:

- a) Yield Point, minimum, 50,000 psi (345 MPa).
- b) Tensile Strength, minimum, 70,000 psi (483 MPa).
- c) Elongation, 2-inch (50 mm), minimum, 12 percent.

1040.3.1.2 Test specimens for mechanical properties shall be prepared and tested in accordance with ASTM A 924.

1040.3.2 Sheet or Beam Thickness.

1040.3.2.1 The thickness for the finished beam or sheet shall be in accordance with Table I.

TABLE I			
Sheet or Beam Thickness			
Class of Beam	Type of Coating	Thickness, in. (mm)	Tolerance Under Specified Thickness, in. (mm). No limit for over thickness.
A	1	0.108 (2.74)	0.009 (0.23)
	2	0.111 (2.82)	0.009 (0.23)
B	1	0.138 (3.51)	0.010 (0.25)
	2	0.141 (3.58)	0.010 (0.25)

1040.3.2.2 For fabricated beams, thickness measurements will be made on tangent portions of the cross-section.

1040.3.3 Sheet Width. The beam elements shall be formed from sheets having nominal widths of 19 inches (483 mm) for W beams and 29 1/2 inches (749 mm) for thrie beams. A tolerance of minus 1/8 inch (3 mm) from the nominal width will be permissible.

1040.3.4 Galvanized Beams.

1040.3.4.1 The beams may be galvanized before or after fabrication. The zinc used for the coating shall be Prime Western Spelter or better in accordance with AASHTO M 120.

1040.3.4.2 The weight (mass) of coating shall be in accordance with Table II. The weight (mass) of coating is the total quantity of galvanizing on both sides of a sheet or beam, expressed as ounces per square foot (grams per square meter) of sheet.

TABLE II	
Weight (Mass) of Coating	
Type	Check Limit Single-Spot Test oz/ft ² (g/m ²), min.
1	1.80 (550)
2	3.60 (1100)

1040.3.4.3 The sheets or beams shall be of prime finish, that is, free from injurious defects such as blisters, flux and uncoated spots. Uncoated edges resulting from shearing or punching will be acceptable.

1040.3.4.4 The coating shall be smooth, free of beading or sharp projections along the edges, and shall adhere to the surface of the metal.

1040.3.4.5 The test specimen size and method of tests for determining the weight (mass) of coating shall be in accordance with AASHTO T 65. At the option of the engineer, material may be accepted on the basis of magnetic gauge determinations made in accordance with ASTM E 376.

1040.3.5 Connections and Splices. All beam connections or splices shall be formed with oval shoulder button-headed bolts to minimize projections on the traffic face of guardrail. Bolts and nuts shall be in accordance with ASTM A 307, and shall be galvanized in accordance AASHTO M 232, or may be mechanically galvanized in accordance with AASHTO M 232, Class C.

1040.3.6 Back-up Plates. Back-up plates shall consist of one-foot (305 mm) sections of beams and shall be of the same class and type specified for the full length beams.

1040.3.7 End Sections. End sections, buffer ends, end shoes and terminal connectors shall be formed of material of a class and type the same as or superior to that used for the beam to which they are attached.

1040.3.8 Fabrication. The beams, end sections, buffer ends, end shoes and terminal connectors shall be shaped and punched as shown on the plans. They shall be 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.

1040.3.9 Marking.

1040.3.9.1 Each beam element shall be identified by the following:

- (a) Name or Brand of Manufacturer.
- (b) Identification Symbols or Code for Heat Number and Coating Lot.
- (c) AASHTO Specification Number.
- (d) Class and Type.

1040.3.9.2 If approved by the engineer, the AASHTO specification number may be omitted, and other designations for Class and Type may be used.

1040.3.9.3 Markings shall not be placed at such location that they will be obscured after erection, or in a manner that the brand will be conspicuous to any traffic. Markings placed on the traffic face of the beam shall be placed in the valley of the center corrugation and shall be die imprinted with letters and numerals not exceeding one-half inch (13 mm) high.

1040.3.9.4 Marking material shall be such as to resist obliteration during storage, transportation and erection.

1040.3.9.5 Markings for end sections, buffer ends, end shoes and back-up plates may be on durable tags securely attached to each section or to each bundle. Markings shall include name or brand of manufacturer, Class and Type. Heat numbers and coating designations are not required.

1040.3.10 Basis of Acceptance.

1040.3.10.1 All material shall be subject to inspection and sampling at the fabricating plant or warehouse, or after delivery to the site of construction. The contractor or supplier shall provide equipment and personnel required to obtain samples as directed by the engineer.

1040.3.10.2 Acceptance by Sampling. The engineer may take one piece of guardrail beam, a back-up plate, an end section, a buffer end and an end shoe from each 200 pieces in a lot, or from each lot if less than 200 pieces are included therein, for determination of compliance with specification requirements. If one piece fails to meet requirements, two other pieces shall be tested. If either of these pieces fails to conform to the requirements of this specification, the lot of material represented by these samples will be rejected. A lot shall be considered that quantity of material, offered for inspection at one time, which bears the same heat and coating identification.

1040.3.10.3 Acceptance by Brand Registration and Guarantee.

1040.3.10.3.1 By mutual agreement between the fabricator and engineer, acceptance may be based upon a Brand Registration and Guarantee filed with Project Operations by the fabricator. For acceptance of a brand, the fabricator shall furnish a Brand Registration and Guarantee meeting the approval of the engineer and showing the brand name or designation, the manner in which the brand name or designation will appear on the fabricated beams, the typical mechanical properties, chemical composition if specified, the class and type of guardrail, and other specified properties. The fabricator shall also guarantee that as long as material is furnished under that brand and designation, the material will conform fully to the requirements of the specifications and shall be replaced without cost to the Commission when found not in conformity with any of the specified requirements. The Brand Registration and Guarantee shall be sworn to for the fabricator by a person having legal authority to bind the company. Upon approval of a Brand Registration and Guarantee, that brand will be accepted without further certification. If, in subsequent actual field use, there is evidence of misbranding, as determined by random sampling and detection of inadequate tensile strength, yield strength, elongation, improper chemical composition, inadequate or improper coating, deficient thickness or improper fabrication, the material will be rejected and approval for further use withdrawn until subsequently reapproved. Samples for tests of any material offered for use may be taken at any time deemed desirable by the engineer.

1040.3.10.3.2 The manufacturer or fabricator shall make such tests and measurements as necessary to ensure that the material produced complies with all specification requirements. These tests and measurements shall be so identified by the identification symbols or code used on the beam that the manufacturer can produce specific reports showing these test results.

Copies of reports of these tests shall be kept on file and shall be submitted to the engineer upon request.

1040.3.10.3.3 The brand shall be removed or obliterated by the manufacturer or fabricator on all material where control tests, as outlined herein, do not show conformance to this specification.

1040.4 End Terminals and Crash Cushions

1040.4.1 Approval. Approval of end terminal and crash cushion units may be requested by submitting proof of equivalent crash test results as described in [Sec 606.30](#), shop drawings, certification, and any additional required information to the engineer. Approval shall be received prior to the fabrication and installation of any units.

1040.5 End 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 Approval. Cable assembly and anchor plate shall be subject to approval by the engineer and shall have a minimum breaking strength of 20 tons (178 kN).

1040.6 Cable and Fittings.

1040.6.1 One-Strand Cable - Access Restraint.

1040.6.1.1 Cable. Cable shall be zinc coated steel wire strand; 1/2 inch (12.7 mm) in diameter; seven wire strand; Common, Siemens-Martin or High Strength grade; Class A coating; and 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 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 x 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 pounds per inch (80 kN/m), plus or minus 0.06 pounds per inch (10 kN/m) and permit 6 inches (150 mm) of travel, plus or minus 1 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. Cable guardrail 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 its 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 M111. 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 pounds per inch (80 kN), plus or minus 0.03 pounds per inch (10 kN/m), and permit 6 inches (150 mm) of travel, plus or minus 1 inch (25 mm). 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 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 manufacturer's certification for all material governed by this specification. Specifically, the certifications shall indicate compliance with the requirements of each applicable section and as set forth in the following table.

Table III			
Certification Requirements			
Item	Galvanizing Standard	Steel Grade	Other
Wood Post and Blocks	-	-	1
Posts, Plates and Brackets	AASHTO M111	ASTM A 36	2
Plastic Blocks	-	-	7
Guardrail Beam	Sec 1040.3	Sec 1040.3	2, 3
Bolts, Nuts and Washers	AASHTO M 232	ASTM A 307	
End Terminals and Crash Cushions Units	-	-	6
End Anchors - Tubes	AASHTO M 111	ASTM A 500/ASTM A 501	
One-Strand Cable - Access Restraint			
- Cable	AASHTO M 30	AASHTO M 30	2
- Hardware	AASHTO M 232	AASHTO M 102/ASTM A 220	2
Three Strand Guard Cable - Cable		AASHTO M 30 & AASHTO M 269	2
- Hardware	AASHTO M 232	AASHTO M 102/ASTM A 220	4
- Cast Steel Components	AASHTO M 232		4
- Malleable Iron Castings	AASHTO M 232	AASHTO M 103	4
- Anchor Brackets	AASHTO M 111	ASTM A 47	
- Cable Brackets	AASHTO M 111	AASHTO M 270	5
- Hook and Hex Bolts	AASHTO M 232	ASTM A 36	
- Hook Nuts	AASHTO M 232	ASTM A 307	
- Hooked Anchor Studs	AASHTO M 232	ASTM A 563 AASHTO M 314	4

1. Certification shall state that the material is in accordance with [Sec 1050](#) and shall include a listing of the materials supplied, and shall have a certified test report as detailed in Section 7.2 of AWP Standard M2 attesting to complete compliance with this specification.
2. Certification shall include, or have attached, specific results of laboratory tests for physical and chemical properties from samples representative of the material.
3. Certification will not be required if the manufacturer complies with [Sec 1040.3.10.3](#).
4. All threaded parts of compensating cable end assemblies and hooked anchor studs shall be in accordance with ASTM F 568.
5. All fittings for cable bracket, except the cable wedge, shall be in accordance with AASHTO M 232 or AASHTO M 298.
6. Certification shall state the name of the manufacturer and that the units furnished are identical in materials and design as those tested for performance in accordance with [Sec 606.30](#).
7. 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.

1040.8 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. Any galvanized material on which the spelter coating has been damaged will be rejected or may, with the engineer's approval, be repaired by the zinc alloy stick method in accordance with [Sec 712](#).