

700 MATERIAL DETAILS

Materials shall conform to the stated requirements and/or the requirements of the referenced specifications including modifications as noted.

Copies of all Supplemental Specifications referenced in this section are on file with the City of Columbus Transportation Division.

730 - TRAFFIC SIGN AND SUPPORT MATERIAL

730.01 Steel Tube and Pipe. ASTM A 53 Grade B or A 501 except that tubing for truss and end frame diagonals shall conform with 730.26.

730.015 U-Channel Posts. Drive Posts shall be fabricated from steel into a characteristic cross section which may be used alone or paired to form a heavier post by being bolted together back to back. The posts shall be of the weight per foot (meter) and length as specified. Posts shall be cut square to a length tolerance of +1 inch (25 mm) and shall be free of ragged or sharp edges and cracks or other imperfections affecting strength or durability. The back of channel sections shall contain raised longitudinal ribs. The channels shall be designed for bolting back to back for use as single post.

All steel drive posts, whether manufactured from rail or billet steel, shall conform to the requirements of ASTM A 499 Grade 60, except as modified below:

Chemical composition by percentage shall be:

Carbon	0.67 - 0.82
Manganese	0.70 - 1.00
Phosphorous, maximum	0.05
Silicon	0.10 - 0.25

Posts shall not exceed a maximum value of 1100 in-lbs/in⁵ (193 kN•m/m⁵) as determined by a Charpy test conducted on a specimen of post at 150° F (66° C) in accordance with ASTM E 23.

The nominal weight of posts before punching or galvanizing shall be as follows:

Post Size Number	Weight Pounds Per Foot (Kg/M)
1	1.12 (1.7)
2	2.00 (3.0)

3	3.00 (4.5)
4	4.00 (6.0)

The weight tolerance shall be -3.5 and +10.0 percent.

All posts shall have 3/8 inch (10 mm) diameter holes on the centerline spaced accurately at 1 inch (25 mm) centers beginning not more than 1 1/8 inch (28 mm) from the top of the post through its entire length. Punching or drilling accuracy shall be sufficient to allow bolting posts together back to back without redrilling holes, using 5/16 inch (8 mm) diameter bolts. Posts shall be either: galvanized in accordance with 711.02, after punching, or painted with a weather resistant, rust inhibited, high quality dark green baked alkyd resin enamel, which shall produce a hard mar resistant coating, free from paint cracks, blisters or other defects. The quality of the paint shall be such that when the finished post is struck a light blow with a sharp tool, the paint shall not crack or chip, and if scratched with a knife, shall not powder. The minimum thickness of the dry enamel film shall be one mil. It shall pass the standard 100 hour salt spray test (20% solution by spray of fog at 70° F (21° C)). Painting shall be the final process after all fabrication and punching has been completed. The paint shall be dry before posts are bundled.

Posts shall meet the requirements of the following load deflection test. Paired posts shall be assembled with 3/8 inch (10 mm) diameter SAE J 429 Grade 8 bolts on 4 inch (102 mm) spacings starting 2 inches (50 mm) from one end. Drilling for bolt assembly shall be as required and the bolts shall be torqued to 150 inch pounds (17 N•m).

The posts shall be loaded as horizontal beams resting on 1 1/2 inch (38 mm) diameter non-restricting supports 6 feet 10 inches (2.1 m) apart. Back to back posts shall be loaded with the axis of the bolts parallel to the direction of the applied bending load. Single U-channel posts shall be loaded with the flanges in tension.

The total bending load shall be divided into two equal loads 3 feet (0.9 m) apart and applied vertically so as to be centered between the supports. The maximum rate of the testing machine cross-head movement shall be 1/2 inch (13 mm) per minute. Deflection shall be measured at the load application points and shall not exceed 0.55 inches (14 mm) under the following total applied loads:

Specimen Configuration	Total Bending Load Pounds (N)
Single No. 1 Post	60 (270)
Single No. 2 Post	400 (1780)
Single No. 3 Post	800 (3560)
Two No. 2 Posts Paired	1,000 (4450)
Two No. 3 Posts Paired	3,000 (13,340)
Single No. 4 Post	1,000 (4,450)

The permanent set after the load has been removed for one minute shall not exceed 0.10 inch (2.5 mm).

730.016 Square Posts. Square posts shall be fabricated from steel conforming to ASTM A 570 or ASTM A 715. The steel shall have a minimum yield strength of 60,000 psi (415 MPa). The cross section of the post shall have 7/16 inch (11 mm) diameter die-cut knock-outs or open holes spaced on 1 inch (25 mm) centers on the centerline of all four sides, in true alignment and opposite to each other.

The finish on the post shall comply with one of the following methods:

1. Hot-dip galvanized both inside and outside the post in accordance with ASTM A 525 G-90
2. The outside of the post shall have a zinc coating of 0.9 ounces per square foot (244 g/m²) followed by chromate conversion coating and a cross-linked polyurethane acrylic coating. The inside of the post shall have a zinc organic coating.

730.02 Steel Anchor Bolts and Nuts. Anchor bolts shall be steel with an 85,000 psi (586 MPa) (min.) yield strength and shall be galvanized in accordance with 730.27. Galvanizing shall extend at least 2 inches (50 mm) beyond the threads. Ends shall be either bent or have a drilled and tapped steel plated as specified in the plans. Anchor bolts shall be provided with steel leveling nuts and anchor nuts capable of developing the full strength of the anchor bolt.

730.03 Steel Poles and Arms. Poles and arms shall be steel with a 52,000 psi (359 MPa) minimum yield strength and shall be galvanized in accordance with 730.27.

730.04 Base and Arm Plates. Support or pole anchor bases and arm attachment plates shall be steel plated conforming to ASTM A 36 or ASTM A 572 Grade 42. Plates shall be welded to supports, poles or arms both inside and outside with fillet welds equal to the wall thickness, or by AWS prequalified welding joints TC U4a-S or TC U4c-GF. A cast steel base of equivalent strength may be used.

730.05 Handhole Covers. Handhole covers for poles and overhead sign supports shall be 0.109 inch (2.7 mm) (minimum) galvanized steel or 0.125 inch (3 mm) (nominal) aluminum alloy.

730.06 Pole Caps. Pole Caps shall be aluminum, galvanized ferrous metal or zinc die casting.

730.07 Arm Caps. Arm caps shall be steel and cover at least 50 percent of the end area.

730.08 Steel Hardware. Bolts 5/8 inch (16 mm) diameter or larger shall comply with ASTM A 325. Bolts and screws less than 5/8 inch (16 mm) diameter shall comply with SAE J429 Grade 5; nuts of all sizes except anchor nuts and leveling nuts shall comply with SAE J995 Grade 2; flat washers shall comply with SAE J489. U-bolts shall comply with ASTM A 307. All hardware shall be hot dipped galvanized in accordance with ASTM A 153 or mechanically galvanized in accordance with ASTM B 695, Class 50.

730.09 Stainless Steel. Any AISI 300 or 400 series stainless steel may be used.

730.10 Stainless Steel Hardware. ASTM A 320 (AISI 300 series). Bolts, screws, nuts, washers, handhole cover chains and U-bolts shall be passivated commercial grade.

Inspection 11. Inspection shall be done at the project site. Random samples shall be obtained from material delivered to the project site or at other locations designated by the Engineer.

730.11 Aluminum Sheet and Plate. Sheet for extrusheet panels shall be ASTM B 209, 3003-H18 or 5052-H38. Sheet for flat sheet signs, overlay signs and flat copy, as well as plate for sign support structures shall be ASTM B 209, 6061-T6.

730.12 Aluminum Extrusions. Extruded and fabricated extrusheet panels shall be ASTM B 221, 6063-T6. For sign support structures: rolled or cold finished bar, rod and wire shall be ASTM B 211, 6061-T6; extruded bars, rods, shapes and tubes shall be ASTM B 221, 6061-T6.

730.13 Aluminum Tube and Pipe. Seamless pipe and seamless extruded tube shall be ASTM B 241, 6061-T6. Extruded structural pipe and tube shall be ASTM B 429, 6061-T6.

730.14 Aluminum Castings. Sand castings shall be ASTM B 26, 356-T6 or T7. Permanent mold castings shall be ASTM B 108, 356-T6 or T7.

730.15 Aluminum Forgings. ASTM B 247, 6061-T6.

730.16 Aluminum Welding Rods. AWS ER4043.

730.17 Aluminum Hardware. Hardware shall conform to the following:

	ASTM Designation	Condition Alloy	or Temper
Bolts and screws	B 211	2024	T6

	6061	T6	
Studs-welded	B 211	1100	H16
Nuts-hex	B 211	6061	T6
	6262	T9	
Washers-flat	B 209	Clad 2024	T4
	6061	T6	
Lockwashers	B 211	7075	T6
Rivets-solid	B 316	6053	T6
	6061	T6	
Rivets-blind	B 316	2017	F
	2117	F	
	5052	F	

In addition, break-mandrel aluminum blind rivets shall have a stainless steel or aluminum mandrel.

Reflective Sheeting Type F. Type F. reflective sheeting shall comply with Section 718 Type II sheet reflective material of U.S. Department of Transportation "Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects," FP-85. The sheeting shall be on the list of approved manufacturers and brands of reflective sheeting maintained by TEAPD.

730.19 Reflective Sheeting Type G. Type G reflective sheeting shall comply with Section 718 Type III sheet reflective material of U.S. Department of Transportation standard specification FP-85. The sheeting shall be on the list of approved manufacturers and brands of reflective sheeting maintained by the TEAPD.

730.191 Reflective Sheeting Type D. Type D reflective sheeting shall be as manufactured by the 3M Company as "Diamond Grade F (Fluorescent) or approved equal."

730.20 Nonreflective Sheeting. Nonreflective sheeting shall comply with Section 718 of U.S. Department of Transportation standard specification FP-85, with the exception that the sheeting shall not incorporate any optical elements.

730.21 Reflector Units. Reflector units shall consist of transparent units with a smooth front surface and a rear surface sculptured in such a way as to return light from a vehicle's headlights to the driver's eye in conformance with optical performance specifications given herein. The front surface shall contain no projection or identification other than may be required for product identification. The rear surface shall be permanently sealed against dust, water or water vapor by a seal backing of similar material fused around the perimeter. Reflector units assembled with gaskets will not be acceptable.

Reflector units shall have retaining lugs which will deform within elastic limits for insertion into accurately sized holes in embossed sign copy. Retaining lugs shall be

undercut and the reflector unit size shall be such as to permit free movement in the mounting hole to allow for differences in expansion and contraction between the reflector unit and sign copy.

Reflector units shall be fabricated of colorless methylnmethacrylate plastic conforming to Federal Specification L-P-380, Type I, Class 3. Reflector units may be of several sizes to fit differing sign copy.

Reflective intensity values for reflector units shall not be less than those shown in the following table. Reflective intensity values are expressed in candlepower returned at the chosen angle by a reflector per square inch (645 mm²) of reflective surface for each foot-candle (10.76 lux) of illumination at the reflector. For light incidence angles of zero and 20 degrees, the minimum intensity value is given for divergence angles of one-tenth, one-sixth, and one-third of a degree.

Reflective Intensity Values

Divergence angle		0.10	0.17
Incidence angle	0	14	10
	20	5.6	4
			7
			2.8

When required by the Engineer, not less than 50 reflector units, including at least 10 of each size, shall be submitted by the manufacturer for qualification testing purposes. The manufacturer shall certify that units shipped to the project are of the same type and quality as the sample units tested and prequalified.

Reflective Intensity Test. Reflector units will be tested for intensity values shown on the foregoing table. Intensity value measurements at other than zero degree incidence angle will be made with reflector units in a spinning fixture so that intensity variations due to the pattern of the sculptured back surface are averaged. Failure of two or more of the 50 samples to meet minimum intensity values shall require a resampling of 100 reflector units. Failure of 3 or more of the 100 shall be cause for rejection of the reflector units.

Seal Test. A sample of 50 reflector units will be submerged in water at room temperature and subjected for 5 minutes to a vacuum of 5 inches (127 mm) of mercury (gage). After restoring atmospheric pressure, the reflector units will be left submerged for an additional 5 minutes. When examined for water intake, failure of more than one unit shall be cause for rejection of the reflector units.

Heat Resistance Test. A sample of embossed aluminum sign copy containing reflector units will be placed in a horizontal position on a grid or perforated shelf of a circulating air oven so as to receive free circulation of air. The sample will be subjected to a temperature of 175° ± 5° F (79° ± 3° C) for a period of 4 hours. At the conclusion of the test period the sample will be allowed to cool at room temperature and examined for

any change in reflector unit shape or appearance when compared to unexposed reflector units. The reflector units will be removed from the copy and subjected to the seal test of the previous paragraph. Failure of more than one unit shall be cause for rejection of the reflector units.

730.22 Silk Screen Paste. Opaque or transparent colored pastes used in the screen process shall be of the type and quality recommended by the manufacturer of the reflective sheeting. The film when dry shall be smooth, hard, tough, and free from defects such as wrinkling, sagging, checking, or peeling. The ingredients of the paste shall be compatible with the reflective sheeting so that when deposited on the sheeting there shall be proper adhesion with no deterioration. Time shall be provided for silk screen paste solvent vapors to substantially evaporate so that the reflective sheeting surface shall not be damaged.

Opaque screen paste shall be formulated so that it will flow out of the screened area without running, sagging or streaking to form a uniform opaque film on the sign surface which shall be entirely satisfactory as to thickness, shade and hiding power.

Colored transparent paste shall be formulated so that it may be applied by the reverse silk screen process to the surface of reflective sheeting. The transparent film shall present a true color, whether by viewing the sign in daylight or by headlight beams. Colored transparent silk screen paste shall conform to standard interstate color charts of the FHWA as specified for reflective sheeting in accordance with 730.18.

730.24 Clear Coating. Clear coating shall consist of a colorless transparent plastic fluid coating material for application to the surface of reflective sheeting by the use of roller, spray or by dipping. Clear coating material shall be compatible with and shall extend the useful life of reflective sheeting.

730.25 Plywood. The panels shall be exterior type, B-B, Group 1, 60/60 high density overlay plywood conforming to National Bureau of Standard specifications PS-1. Panel surfaces shall be covered with easily removable protective material.

730.26 Reflector Units for Object Markers. Round prismatic reflectors shall be methylnmethacrylate plastic. They shall have a smooth front surface free from projections or indentations other than for identification of orientation, and shall have a configuration on the rear surface such as to return light in conformance with the brightness specified. The configuration surface shall be sealed against dust, water and water vapor by means of a protective back fused around the perimeter of the reflector and around the central mounting hole where used. The protected back of the round reflector shall be plastic-coated foil or methylnmethacrylate plastic. Reflectors, shall have a net reflective surface area of not less than 7 square inches (4516 mm²).

The reflectors colors shall be yellow, or red as specified, by day and when viewed by reflected light at night.

- (a) **Brightness Test.** A sample of 5 units for each delineator reflector color shall be tested for brightness. The following definitions apply: Entrance Angle shall mean the angle at reflector between axis of light incident on it and the reflector axis; Divergence Angle shall mean the angle at reflector between observer's line of sight and the axis of light incident on reflector; and Brightness shall mean the total candelas returned by a reflector, at the specified divergence angle, per footcandle (10.76 lx) of light incident on the reflector.

The prismatic reflectors shall have the following minimum brightness values:

Entrance Angle Degrees	Divergence Angle Degrees	Brightness	
		Yellow	Red
0	0.10	71	28.6
20	0.10	28	11.3
0	0.33	12	4.8
20	0.33	5	1.9

- (b) **Seal Test.** A sample of 50 reflector units per shipment shall be submerged in water at room temperature and subjected to a vacuum of 5 inches (127 mm) gage for 5 minutes. After restoring atmospheric pressure the units shall be left submerged for an additional 5 minutes. When examined for water intake, failure of more than one unit shall be cause for rejection.
- (c) **Heat Resistance Test.** Three reflectors shall be tested for four hours in a circulating air oven at $150^{\circ} \pm 5^{\circ}$ ($65^{\circ} \pm 1^{\circ} \text{C}$). The test specimens shall be placed in a horizontal position on a grid or perforated shelf permitting free air circulation. At the conclusion of the test the samples shall be removed from the oven and permitted to cool in air to room temperature. The sample after exposure to heat shall show no significant change in shape and general appearance when compared with corresponding unexposed control standards. There shall be no failures.

730.27 Galvanized Steel. Steel shall be galvanized to conform to ASTM A 123 after cutting, bending, and welding. At the discretion of the Engineer, damaged galvanized material shall be replaced, regalvanized or repaired. If a repair is authorized, the method shall be acceptable to the Engineer.

Bolts, nuts, washers and similar threaded fasteners shall be galvanized in accordance with ASTM A 153. These items may be mechanically zinc coated in accordance with ASTM B 695, Class 50. Except for ASTM A 325 Bolts, electro-

galvanizing may also be accepted if the coated item meets the thickness coating requirements above.

All galvanized parts that are to be embedded in fresh concrete except chairs for reinforcing bar support shall be given a chromate treatment in accordance with the American Hot Dip Galvanizers Association, Inc., recommendations. The galvanizer shall furnish a certification for each lot of chromate treated steel.

730.28 Structural Steel. Steel shall be structural steel ASTM A 36, or when specifically called for high-strength low alloy steel ASTM A 572 Grades 42 through 50, or A 588.

Material designated to meet notch toughness requirements shall have a minimum longitudinal Charpy V-notch (CVN) energy absorption value as listed below. Sampling and testing procedures shall be in accordance with ASTM A 673. The (H) frequency of heat testing shall be used, and the test data shall be provided as required by 501.07.

ASTM Designation	Thickness and Connection method	Min CVN Value
A 36	Up to 4 inches (102 mm) mechanically fastened or welded	15 ft. lb (20.3 N•m) @ 40° F (4° C)
A 572, A 588	Up to 4 inches (102 mm) mechanically fastened	15 ft. lb (20.3 N•m) @ 40° F (4° C)
A 572, A 588	Over 2 inches (50 mm) to 4 inches (102 mm) welded	20 ft. lb (27 N•m) @ 40° F (4° C)
A 572, A 588	Up to 2 inches (50 mm) welded	15 ft. lb (20.3 N•m) @ 40° F (4° C)

* If the yield point of the material exceeds 65 ksi, the temperature of the CVN value for acceptability should be reduced by 15° F (-9° C) for each increment, or part of increment, of 10 ksi above 65 ksi.