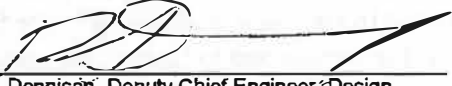


SUPERSEDED BY EB 15-031 EFFECTIVE 9/28/15	MODIFIED BY EI 99-032 EFFECTIVE 5/4/00		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 98-026
Title: BOX BEAM MEDIAN BARRIER END ASSEMBLY TYPE C				
Distribution: ☐ Manufacturers (18) ☒ Main Office (30) ☐ Local Govt. (31) ☒ Regions/Agencies (32) ☐ Surveyors (33) ☒ Consultants (34) ☐ Contractors ()			Approved:  R. Dennison, Deputy Chief Engineer, Design Division Date <u>8/1/98</u>	

ADMINISTRATIVE INFORMATION. This instruction modifies the fourth paragraph of §10.2.5.3 of the *Highway Design Manual*. Its contents eventually will be incorporated into that reference. It takes effect with the letting of 10-22-98. No Engineering Instructions are superseded hereby.

PURPOSES. The purposes of this instruction are to:

- 1 Disapprove the pay items 606.14 M, 606.1450 M, 606.15 M, and 606.1550 M.
- 2 Issue metric standard specifications as follows and their english counterparts:

606.1401 M	Box Beam Median Barrier End Assembly, Type A	each
606.1402 M	Box Beam Median Barrier End Assembly, Type B	each
606.1403 M	Box Beam Median Barrier End Assembly, Type C	each
606.1451 M	Box Beam Median Barrier End Assembly, Type A(Rustic)	each
606.1452 M	Box Beam Median Barrier End Assembly, Type B (Rustic)	each
606.1453 M	Box Beam Median Barrier End Assembly, Type C (Rustic)	each
- 3 Issue a usage and selection policy for these end assemblies.

TRANSMITTED MATERIALS. Standard specifications described above and their english equivalents. They are in "addenda format" and include the specifications transmitted under EI 98-005. Approved Materials Details and a standard sheet showing grading details will be transmitted under separate cover.

BACKGROUND. There have been recent Engineering Instructions which described how, for projects advertised after September 1998, the Federal Highway Administration (FHWA) policy will permit only those safety articles to be installed on the National Highway System (NHS) that have passed, or are judged to be able to pass, *National Cooperative Highway Research Program Report 350 (NCHRP 350)* crash tests. That policy has application to the end assemblies used with box beam median barrier system.

Box beam median barriers are widely used in New York State. There are presently two standard end assemblies for them shown on the standard sheets and used in accordance with the *HDM*. These end assemblies are designated Type A and Type B End Assemblies. They are specified under pay items 606.14 M and 606.15 M for the galvanized finish and under 606.1450 M and 606.1550 M for the rustic versions. Pay items in the U.S. customary unit are also available.

The box beam guide rail itself passed the *NCHRP 350* 100 km/h 25° crash testing with the 2000 kg pickup truck and therefore may be used on all type facilities. On the basis of the successful test of box beam guide rail, the median barrier is also deemed a qualified *NCHRP 350* Test Level III device. Neither of the end assemblies for box beam median barrier, however, has been so qualified with the 2000 kg pickup, thus, their use must be restricted.

Box Beam Median Barrier End Assembly, Type A. The Box Beam Median Barrier End Assembly, Type A is constructed with a concrete anchor. It is presently used for narrow medians.

Box Beam Median Barrier End Assembly, Type B. This end assembly is constructed with a pair of steel posts driven on either side of, and bolted to, the grounded end of the end assembly. It is presently used for wide medians.

Box Beam Median Barrier End Assembly, Type C. This is a new median barrier end terminal. The State of Wyoming and the Texas Transportation Institute have developed an end assembly for box beam guide rail and median barrier. This end assembly is now built and marketed by Syro Steel Company, a subsidiary of Trinity

Industries. At present, this end assembly has been tested to just the NCHRP 230 criteria. Nationally, this unit is known as the WYBET-MB, however, to be consistent with other terminology in New York State, we have decided to call this article the Box Beam Median Barrier End Assembly, Type C.

There are four working parts to the Box Beam Median Barrier End Assembly, Type C. The first three are two 152 X 152 mm structural steel tubes and a 178 X 178 mm structural steel tube. The fourth part is an assembly consisting of two fiberglass composite pipe sections¹ separated by a steel spacer block. This assembly is contained and collapsed by the first three parts when the front of the assembled Box Beam Median Barrier End Assembly, Type C is hit. If hit on the side at, or beyond, the third post, Box Beam Median Barrier End Assembly Type Cs redirect. A 510 X 510 mm plate is welded onto the free end of the Nose Assembly to spread the force of the impact over the front of the vehicle and to "catch" the impacting vehicle.

End assemblies are safety articles covered by the above federal and state policies. Unfortunately, there are not yet any end assemblies for box beam systems which have been crash tested to the NCHRP 350 standards, including the Box Beam Median Barrier End Assembly, Type C. Technically, therefore, the introduction of the Box Beam Median Barrier End Assembly Type C would not satisfy the letter of the federal policy after the 1998 date unless the FHWA agrees it would pass NCHRP 350 tests, if tested. Since, however, these articles have demonstrated crashworthiness under NCHRP 230 criteria, and since they are the most crashworthy end terminals available for box beam median barrier, and since they would likely pass the requisite crash testing, if so tested, we believe their use conforms to the intent of the policy.

POLICY. Box Beam Median Barrier End Assembly, Type A and B. There are no plans to test these Box Beam Median Barrier End Assemblies. *Therefore, installations of the Box Beam Median Barrier End Assembly, Type A and B are not to be made as median barrier terminals if they are to be located within the design clear zone at locations where they are subject to end-on, or near end-on, impact. If used to terminate median barrier being used as guide rail for its reduced deflection characteristic, Box Beam Median Barrier End Assemblies, Types A or B are not to be installed within the design clear zone where they would be subject to end on, or near end on, impacts.*

Box Beam Median Barrier End Assembly, Type C This median barrier end assembly is functionally identical to the Box Beam Guide Rail End Assembly Type III, which has been successfully crash tested in accordance with NCHRP 230 with heavy and light passenger cars at sixty miles per hour. It is therefore currently regarded by the FHWA and the Department as a crashworthy end assembly on all highways. It could lose this status if it were to fail NCHRP 350 crash testing. *It is the only one of our end assemblies for box beam median barrier that can be installed within the design clear zone at locations where they are subject to end-on, or near end-on impact.*

OTHER METHODS OF TERMINATING MEDIAN BARRIER. There has been considerable discussion of the various kinds of box beam median barrier end assemblies. These devices are not the only acceptable means of treating the approach ends of median barriers or guide rail. Other acceptable methods of treating these ends includes fitting them with Type A or B End Assemblies and carrying them outside the clear zone; shielding them behind another barrier; burying them in a nearby back slope; constructing a berm and burying them in that; and on one way facilities, protecting them with sand barrel arrays. Details and design information on these treatments are found in Chapter 10 of the *Highway Design Manual* and/or in the *AASHTO Roadside Design Guide*. *These other acceptable methods should be considered before deciding to install the Type C Box Beam Median Barrier End Assembly because many times these methods will be preferable to using an End Assembly Type C.*

APPLICABILITY. The usage policy included in this instruction is applicable to new installations of end terminals, whether on new construction projects, reconstruction projects, or on 3R projects. It also requires replacements of non-conforming end terminals on reconstruction projects. This instruction does not require (i.e., is silent on) replacements of non-conforming end terminals on 3R projects. That matter will be separately addressed.

¹ These pipes are 150 mm diameter. The longer of the two is 3810 mm and the shorter 1830 mm. There is also a 760 mm "air space" that can close up on frontal impact so the maximum "stroke" of these terminals on high speed, frontal impact is 6400 mm. The maximum observed compression in the tests was 4570 mm.

LAYOUT INFORMATION. The following is layout information only. Consult the section of this instruction entitled "Policy" before deciding to use any of the Box Beam End Assemblies at a given location.

Box Beam Median Barrier End Assembly, Types A & B. Layout information for these end assemblies is shown on the standard sheets for box beam median barrier, which is M 606-4.

Box Beam Median Barrier End Assembly, Type C. There are eight posts in the Box Beam Median Barrier End Assembly Type C. Number them from 1 to 8, starting with the post at the free end of the End Assembly as post 1.

Between post 1 and 2, post spacing is 2902 mm; from posts 2 to 5, post spacing is 1829 mm. From post 5 to 6, post spacing is 1676 mm. From post 6 to 8, post spacing is 1829 mm. From post 8 to the center of the splice joining the Box Beam Median Barrier End Assembly, Type C to the run of box beam barrier is 1048 mm. From the front impact plate to the center of post 1 is 295 mm. In addition to the posts mentioned, between post 1 and 2, there is a foundation tube driven into the ground and strutted to the foundation tube of post 1, which is 1905 mm removed from this foundation tube. No post is inserted into this foundation tube. Post 1 is a breakaway wooden posts; all other posts are 75 mm by 8.5 kg/m steel posts of the same kind as used with the box beam median barrier.

The Box Beam Median Barrier End Assembly Type C, telescoping on itself as it does, must be installed without angle or curvature. This is to prevent buckling or binding. It may be installed flared or parallel to the direction of traffic. Flare rates should not exceed 1 on 15. Flare is to be introduced downstream of the Box Beam Median Barrier End Assembly, Type C by flaring back individual lengths of rail. Approximately 1° of flare may be achieved at each box beam median barrier joint.

To reduce nuisance hits and plowing difficulties, the Type C End Assembly should be installed at least 2.5-3 m beyond the traveled way at the approach ends, if possible. On narrow shoulders, the Type C End Assembly and the necessary lengths of median barrier may be flared back from the line of median barrier to attain the recommended offset. Once the line of barrier is established, End Assembly Type Cs may be installed in the line of barrier. At these breaks, the nose assembly shouldn't protrude beyond the established line of median barrier, if possible.

The overall length and payment limits of the Box Beam Median Barrier End Assembly Type C for median barrier is 15.065 m. The downstream 10.0 m of this has redirection capability and may be included within the length-of-need, thereby reducing the paid length of the box beam median barrier.

GRADING REQUIREMENTS. Slopes between the road and the face of the Box Beam Median Barrier End Assembly Type C should be 1:10 or flatter on the approach direction. This slope should be carried underneath the Box Beam Median Barrier End Assembly Type C to a slope break point behind the posts. The location of this slope break point is described below:

Refer to the post numbering description above. At post 8, the slope break point should be 1000 mm (600 minimum) behind the back of the post. Between posts 8 and 4, the distance to the slope break is, or increases to, 1000 mm. From post 4 to post 2, the offset to slope break point continues at 1000 mm. From post 2 to 1, the straight line established from post 4 to 2 is continued to a point opposite the very front nose assembly. At that point, the slope break point transitions back to the normal slope break point over a transition length fifteen times as long as the difference in widths between the offset to the slope break point at the nose assembly of the End Assembly Type C and the normal slope break point established for the median in accordance with Table 10-4 of §10.2.3.5, as needed, to provide adequate anchorage for the posts. The slope on the median side of the slope break point should be the normal median slopes but flatter than 1:3 recommended maximum. This grading will appear on a standard sheet.

ESTIMATED COST. End Assembly Type C is estimated to cost \$2250 parts and another \$1000 for installation and profit for an estimated total of \$3250, not including grading.

CONTACT PERSON. Larry Brown of the Design Quality Assurance Bureau, (518) 457-4093.

BOX BEAM END ASSEMBLY TYPE III BOX BEAM MEDIAN BARRIER END ASSEMBLY, TYPE C

Make the following changes to the Standard Specifications of January 2, 1995:

Page 6-19, Line 35, *add* the words "materials details, manufacturer's directions" after the words "standard sheets".

Page 6-20, between Lines 20 and 21, *add* "710-24 Box Beam End Assembly Type III and Box Beam Median Barrier End Assembly, Type C"

Page 6-20, Line 32, *add* ", 710-24" after "710-22.

Page 6-21, Line 2, *add* "materials details," after "standard sheets".

Page 6-23, Line 4, *add* ", materials details, manufacturer's directions" after "standard sheets".

Page 6-23, Lines 7, 8, 9, 11, 13, 15, and 16, *add* "and foundation tube(s)" after the word "post(s)"

Page 6-31, Line 22, *add* the words ", materials details, manufacturer's directions" after the words "standard sheets"

Line 22, also *add* after this line the following new paragraph

" The payment limits for the Box Beam End Assembly Type III will be the entire length of the unit, which is 14 980 mm, measured from the front of the Nose Assembly to the splice at the far end of the telescoping section. The payment limits for the Box Beam Median Barrier End Assembly, Type C will be the entire length of the unit, which is 15 065 mm, measured from the front of the Nose Assembly to the splice at the far end of the telescoping section."

Page 6-33, Line 5, *add* "reflectorization," after the word "backfill"

Page 6-35,

Line 33, *replace* "606.12 M" with "606.1201 M"

Line 34, *replace* "606.13 M" with "606.1202 M"

Line 34, *add* after this line "606.1203 M Box Beam End Assembly Type III Each"

Line 35, *replace* "606.1250 M" with "606.1251 M"

Line 36, *replace* "606.1350 M" with "606.1252 M"

Line 36, *add* after this line "606.1253 M Box Beam End Assembly Type III (Rustic) Each"

Lines 37 through 40, *replace* with the following:

"606.1401 M	Box Beam Median Barrier End Assembly, Type A	Each
606.1402 M	Box Beam Median Barrier End Assembly, Type B	Each
606.1403 M	Box Beam Median Barrier End Assembly, Type C	Each
606.1451 M	Box Beam Median Barrier End Assembly, Type A(Rustic)	Each
606.1452 M	Box Beam Median Barrier End Assembly, Type B(Rustic)	Each
606.1453 M	Box Beam Median Barrier End Assembly, Type C(Rustic)	Each"

Page 7-112, line 20. Delete this line and replace it with the following:

BOX BEAM END ASSEMBLY TYPE III
BOX BEAM MEDIAN BARRIER END ASSEMBLY, TYPE C

**"710-24 Box Beam End Assembly Type III and Box Beam Median Barrier End Assembly,
Type C**

SCOPE. These specifications cover the material and quality requirements for Box Beam End Assembly Type III and Box Beam Median Barrier End Assembly, Type C. When specified, these end assemblies are used to terminate the ends of box beam guide rails and box beam median barriers. Box Beam End Assemblies Type III and Box Beam Median Barrier End Assembly, Type C are fabricated in accordance with these specifications, the manufacturer's instructions, and the approved Materials Details.

MATERIALS REQUIREMENTS. Materials used in the fabrication of the Box Beam End Assemblies Type III and Box Beam Median Barrier End Assembly, Type C shall conform with the following requirements:

Foundation Tubes, Nose Assembly, Outer Tube, Telescoping Section and Intermediate Spacer Block	ASTM A500, Gr. B §710-13
Wood and Timber Posts and Timber Blockouts	ASTM A307
Fasteners, except shear bolts on posts 6, 7, & 8	SAE Grade 0
Shear bolts on posts 6, 7, & 8	Hard Rubber Division II Sect 18.2
Rubber Pad	ASTM A36M
Steel Posts, Shelf Angles, and other metal parts	§719-01
Galvanized Coatings and Repair Methods	

The Cable Assembly shall consist of galvanized steel cable, 6 X 19 mm, with 19 mm threaded rod swaged to both ends.

The composite tube shall be MMFG Extren series 500 pultruded fiberglass structural tubes and shall exhibit the following properties:

1. Tube shall be manufactured using the pultrusion process. Tubing shall be manufactured of glass fiber reinforced resin with a glass resin ratio of 50%. The resin shall be isophthallic polyester. Glass reinforcement shall include the following three varieties:
 - A. Surface mat shall be used on all exterior surfaces.
 - B. Continuous glass strand rovings shall be used internally.
 - C. Continuous strand mats shall be used internally
2. The composite material shall exhibit the following minimum mechanical properties:
 - A. Ultimate Tensile Strength: Ultimate Tensile strength shall be longitudinally 207 000 kPa and transversely 48 300 kPa measured from coupons. Bending strength of the full section shall be 138 000 kPa.
 - B. Ultimate Compressive Strength shall be as given above except Transversely shall be 105 500 kPa.
 - C. Ultimate Shear Strength shall be 31 050 kPa.
 - D. Modulus of Elasticity shall be 17 300 000 kPa
 - E. Barcol Hardness shall be 50.
3. The energy dissipation properties of the alternate fiberglass epoxy composite tube shall be evaluated using static compressive testing. Each test specimen shall be 610 mm long with a 102 mm long tulip shape cut into one end of the test specimen. The test specimen shall be crushed statically at a rate of 50 mm per minute and the total crush length shall be not less than 305 mm. A minimum of three static compressive tests shall be conducted. The results of each test shall meet the following static energy dissipation properties:

First Stage Energy Absorber	
Average Crush Force	80 kN ± 9kN
Maximum Compressive Force	115 kN
Allowable Compressive Force Variation	± 11 kN

BOX BEAM END ASSEMBLY TYPE III
BOX BEAM MEDIAN BARRIER END ASSEMBLY, TYPE C

Second Stage Energy Absorber

Average Crush Force,	182 ±13 kN
Maximum Compressive Force	245 kN
Allowable Compressive Force Variation	± 22.3 kN

The materials and construction requirements of Box Beam End Assemblies, Type III (Rustic) and Box Beam Median Barrier End Assembly, Type C (Rustic) shall be the same as Box Beam End Assemblies, Type III and Box Beam Median Barrier End Assembly, Type C except metal parts shall conform with §710-25 Guide Rail and Median Barrier Systems (Rustic).

BASIS OF ACCEPTANCE. Box Beam End Assembly Type III and Box Beam Median Barrier End Assembly, Type C will be accepted at the site of the work by the Engineer on the basis of the manufacturer's name appearing on the approved list, conformance of the delivered articles with the approved Materials Details, and upon the manufacturer's certificate of compliance with these specifications. The supplier shall provide two copies of the approved Materials Details through the Contractor to the Engineer as part of the evidence of acceptability for the material at least ten days prior to the use of the product.

BOX BEAM END ASSEMBLY TYPE III BOX BEAM MEDIAN BARRIER END ASSEMBLY, TYPE C

Make the following changes to the Standard Specifications of January 2, 1990:

Page 6-14, under "606-1 Description, in the second line, *add* the words "standard sheets, materials details and manufacturer's directions" after the words "these specifications".

Page 6-14, under 606-2 Materials, in the list of materials after "Cable Guide Railing ...710-22" *add* "Box Beam End Assembly Type III and Box Beam Median Barrier End Assembly Type C.....710-26 "

Page 6-16, under 606-3.01 General, in line 2, *add* "materials details," after the word "standard sheets"

also, *replace* the second and third paragraphs of that section with the following:

" Posts and foundation tubes shall be driven unless otherwise specified. The driving shall be accomplished with approved equipment and methods that will leave the posts and foundation tubes in their final position, free of any distortion, burring or other damage. When posts or foundation tubes are driven through asphalt concrete or a bituminous treated material, the Contractor shall take care to prevent damage to the paved or treated areas. Large holes and voids caused by driving the posts or foundation tubes shall be filled and compacted with a bituminous treated material or asphalt concrete similar to that damaged. The small area adjacent to the post or foundation tube disturbed during installation or where gaps exist at the post or foundation tube after pavement repairs shall be sealed with a bituminous material approved by the Engineer. When anchoring devices are required for heavy post blocked-out systems they shall be grouted with §721-03, Epoxy Polysulfide Grout.

As an alternate to driving posts and foundation tubes on unpaved medians and where site conditions are such that driving is not possible, the Contractor shall carefully excavate for all post and foundation tubes. Post holes and holes for post foundation tubes and structures shall be backfilled and backfill material shall be compacted in accordance with §203-3.15, Fill and Backfill at Structures, Culverts, Pipes, Conduits and Direct Burial Cables."

Page 6-22, under §606-4.02, in the third line of this subsection, *add* the words "materials details, manufacturer's directions" after the words "standard sheets"

also *add* the following as a new paragraph

" The payment limits for the Box Beam End Assembly Type III and Box Beam Median Barrier End Assembly Type C will be the entire length of the unit, which is 49'-1.75", measured from the front of the Nose Assembly to the splice at the far end of the telescoping section."

In Addenda No. 1, on page VI-10 under §606-5.02, *add* "reflectorization," after the word "backfill" in the last line of this entry.

In Addenda No. 1, on page VI-11, in the list of pay items, add:

606.1403	Box Beam Guide Railing End Assembly Type III.....	Each
606.1453	Box Beam Guide Railing End Assembly Type III(Rustic).....	Each
606.17	Box Beam Median Barrier End Assembly Type C.....	Each
606.1750	Box Beam Median Barrier End Assembly Type C(Rustic).....	Each

Page 7-90, *change* §710-26 Through §710-29 Vacant" to "§710-27 Through §710-29 Vacant" and *add*:

**BOX BEAM END ASSEMBLY TYPE III
BOX BEAM MEDIAN BARRIER END ASSEMBLY, TYPE C**

**"710-26 BOX BEAM END ASSEMBLY TYPE III and BOX BEAM MEDIAN BARRIER END
ASSEMBLY TYPE C**

SCOPE. These specifications cover the material and quality requirements for Box Beam End Assembly Type III and Box Beam Median Barrier End Assembly Type C. When specified, these end assemblies are used to terminate the ends of box beam guide rails and box beam median barriers. Box Beam End Assemblies Type III and Box Beam Median Barrier End Assemblies Type C are fabricated in accordance with these specifications, the manufacturer's instructions, and the approved Materials Details.

MATERIALS REQUIREMENTS. Materials used in the fabrication of the Box Beam End Assemblies Type III and Box Beam Median Barrier End Assemblies Type C shall conform with the following requirements:

Foundation Tubes, Nose Assembly, Outer Tube, Telescoping Section and Intermediate Spacer Block	ASTM A500, Gr. B
Wood and Timber Post Posts and Timber Blockouts	§710-13
Fasteners, except shear bolts on posts 6, 7, & 8	ASTM A307
Shear bolts on posts 6, 7, & 8	SAE Grade 0
Rubber Pad	Hard Rubber Division II Sect 18.2
Steel Posts, Shelf Angles, and other metal parts	ASTM A36
Galvanized Coatings and Repair Methods	§719-01

The Cable Assembly shall consist of 3/4" galvanized steel cable with 3/4 inch threaded rod swaged to both ends.

The composite tube shall be MMFG Extren series 500 pulltruded fiberglass structural tubes and shall exhibit the following properties:

1. Tube shall be manufactured using the pulltrusion process. Tubing shall be manufactured of glass fiber reinforced resin with a glass resin ratio of 50%. The resin shall be isophthallic polyester. Glass reinforcement shall include the following three varieties:
 - A. Surface mat shall be used on all exterior surfaces.
 - B. Continuous glass strand rovings shall be used internally.
 - C. Continuous strand mats shall be used internally.
2. The composite material shall exhibit the following minimum mechanical properties:
 - A. Ultimate Tensile Strength: Ultimate Tensile strength shall be longitudinally 30,000 psi and transversely 7,000 psi measured from coupons. Bending strength of the full section shall be 20,000 psi.
 - B. Ultimate Compressive Strength shall be as given above except transversely shall be 15,000 psi.
 - C. Ultimate Shear Strength shall be 4,500 psi.
 - D. Modulus of Elasticity shall be 2,500,000 psi
 - E. Barcol Hardness shall be 50.
3. The energy dissipation properties of the alternate fiberglass epoxy composite tube shall be evaluated using static compressive testing. Each test specimen shall be 24 inches long with a 4 inch long tulip shape cut into one end of the test specimen. The test specimen shall be crushed statically at a rate of 2 inches per minute and the total crush length shall be not less than 12 inches. A minimum of three static compressive tests shall be conducted. The results of each test shall meet the following static energy dissipation properties:

First Stage Energy Absorber

Average Crush Force	18±2 kips
Maximum Compressive Force	26 kips
Allowable Compressive Force Variation	±2.5 kips

**BOX BEAM END ASSEMBLY TYPE III
BOX BEAM MEDIAN BARRIER END ASSEMBLY, TYPE C**

Second Stage Energy Absorber	
Average Crush Force,	41 ±3 kips
Maximum Compressive Force	55 kips
Allowable Compressive Force Variation	±5 kips

The materials and construction requirements of Box Beam End Assemblies, Type III (Rustic) and Box Beam Median Barrier Type C (Rustic) shall be the same as Box Beam End Assemblies, Type III and Box Beam Median Barrier Type C , respectively, except metal parts shall conform with §710-25 Guide Rail and Median Barrier Systems (Rustic).

BASIS OF ACCEPTANCE. Box Beam End Assembly Type III and Box Beam Median Barrier End Assembly Type C will be accepted at the site of the work by the Engineer on the basis of their manufacturer's name appearing on the approved list, conformance of the delivered articles with the approved Materials Details, and upon the manufacturer's certificate of compliance with these specifications.