

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
HIGH TENSION CABLE BARRIER

GCB:CT

1 of 14

APPR:WKP:RWS:03-14-24
FHWA:APPR:03-18-24

a. Description. This work consists of constructing high tension cable barrier (HTCB) and cable terminals as shown on the plans. Complete this work in accordance with the manufacturer's details and specifications, and this special provision. If the requirements of this special provision conflict with the requirements of the manufacturer's details, comply with the requirements of this special provision.

b. Materials. Provide materials in accordance with the manufacturer's specifications and this special provision. Provide written certification to the Engineer stating that the materials used to construct the high tension cable system and end terminals meet manufacturer's specifications and this special provision.

Provide manufacturer's written certification to the Engineer that all components supplied by the manufacturer meet manufacturer's specifications and this special provision.

1. HTCB systems. Select one of the following systems:

- A. Brifen Cable System, manufactured by Brifen USA, Inc.
- B. CASS, manufactured by Valtir, LLC.
- C. Gibraltar Cable Barrier System, manufactured by Gibraltar Global, LLC.

Provide all cable barriers and end terminals of the same type from the same manufacturer; do not intermix or overlap different cable barrier types or cable barrier systems made by different manufacturers. Provide all line posts of the same type; do not intermix different types of line posts. Ensure that the end terminals are compatible with the cable barrier system installed.

The cable barrier must meet or exceed *National Cooperative Highway Research Program Report 350 (NCHRP 350), Test Level 3 (TL-3)* or *Manual for Assessing Safety Hardware (MASH), Test Level 3 (TL-3)* when installed on a slope with an inclination of 1:4 (1 Vertical on 4 Horizontal) or flatter. The cable barrier must also meet or exceed *NCHRP 350, TL-4* or *MASH, TL-4* when installed on a slope with an inclination of 1:6 (1 Vertical on 6 Horizontal) or flatter. The end terminals must meet or exceed *NCHRP 350, TL-3* or *MASH, TL-3*. The cable barrier and end terminals must have FHWA acceptance. Furnish FHWA acceptance letters, to the Engineer, stating that the cable barrier meets or exceeds *NCHRP 350, TL-3* or *MASH, TL-3* when installed on a 1:4 slope or flatter, the cable barrier meets or exceeds *NCHRP 350, TL-4* or *MASH, TL-4* when installed on a 1:6 slope or flatter, and the end terminals meet or exceed *NCHRP 350, TL-3* or *MASH, TL-3*.

2. Cables. Ensure the cable barrier has a minimum of three cables. Ensure each cable is 3/4-inch (minimum) diameter, 3 x 7 construction, zinc-coated (galvanized) wire rope manufactured in accordance with *AASHTO MP30M/MP30, Type I, Class A* coating. Ensure each cable has a minimum tensile strength of 39,000 pounds. Ensure each cable is factory pre-stretched after manufacture with a tensile load of 50 percent (minimum) of the cable's tensile strength to prevent future strain relaxation of the cable. Do not damage the cable during the pre-stretching process. Ensure each cable has a minimum modulus of elasticity of 11,805,090 pounds per square inch after pre-stretching.

Provide documentation with each cable spool, from the cable manufacturer, to the Engineer, certifying the breaking strength of the cable, the amount of force used to pre-stretch the cable, the modulus of elasticity of the cable after pre-stretching, and the pre-stretching/testing date(s).

3. Posts and Fittings. Ensure all posts are made of steel meeting *ASTM A36/A36M*, or *Nucor Grade SP-80*. Ensure all posts are zinc coated (galvanized) after fabrication to *ASTM A123/A123M*.

Ensure all fittings, including but not limited to turnbuckles and connections, have a minimum diameter of 3/4 inch. Ensure all fittings develop a minimum tensile load (without yielding) of 36,800 pounds. Ensure the manufacturer conducts one tensile load test on each fitting type used in the cable system. Provide documentation to the Engineer from the manufacturer, certifying that all fitting types have been tested and meet the minimum load requirements specified in this special provision. Ensure the documentation also lists the tensile yield strength and test date(s) for each fitting type.

Ensure threaded terminals are right hand or left hand threaded M24 x 3 pitch in accordance with *ANSI B1.13M*. A maximum of one open-type wedge lock terminal or two closed-type wedge lock terminals will be allowed per cable per run (between end anchor foundations). Closed-type wedge lock terminals must utilize a threaded-end socket to secure the wedge by compression. Only one wedge lock terminal type (open-type or closed-type) will be permitted. Ensure all other terminals are of the swaged type. Swaged type terminals may be shop or field swaged.

Ensure the body of the threaded terminal provides a minimum of 5.9 inches wire rope engagement depth. Ensure fully fitted ropes develop a minimum breaking load of 36,800 pounds. Ensure threaded terminals are galvanized, after threading, in accordance with *ASTM A153/A153M*.

Ensure one end of each turnbuckle is threaded right hand and the other end left hand according to *ANSI B1.13M*, M24 x 3 to accept threaded rope terminals. Ensure turnbuckles are of the solid or closed body type with two inspection holes to determine threaded rope terminal penetration. Ensure turnbuckles allow for a minimum of 6 inches of penetration from each end.

Ensure all fittings, including but not limited to turnbuckles and connections, are either zinc coated (galvanized) in accordance with *ASTM A153/A153M* after threading, or are made of stainless steel. Ensure all other components made of ferrous metal, excluding stainless steel components, are zinc coated (galvanized) in accordance with *ASTM A123/A123M* after fabrication.

4. Reflective Sheeting. Ensure Type XI reflective sheeting is attached to all reflectors as specified in subsection 919.03.B of the Standard Specifications for Construction. Ensure reflectors meet manufacturer's specifications. Ensure reflectors match the color of edge line adjacent to approaching traffic. Ensure each reflector has a minimum of 13 square inches of reflective sheeting facing approaching traffic.

5. Concrete/Foundation Materials. Provide Grade 4000 or 4000HP concrete in accordance with section 1004 of the Standard Specifications for Construction for all foundations, except that concrete slump must be modified in accordance with note k or l of Table 1004-1 of the Standard Specifications for Construction.

Provide concrete curing materials in accordance with subsection 903.07 of the Standard Specifications for Construction.

Provide temporary casing material in accordance with subsection 919.10 of the Standard Specifications for Construction unless otherwise shown on the plans.

Provide slurry in accordance with subsection 718.03.E of the Standard Specifications for Construction. Use only polymer type slurries.

6. Steel Reinforcement. Provide epoxy coated steel reinforcement for concrete foundations in accordance with section 905 of the Standard Specifications for Construction

7. Miscellaneous Materials.

A. Ensure excluder caps meet manufacturer's specifications and are made of low-density polyethylene or polypropylene.

B. Use sound earth meeting the requirements specified in section 205 of the Standard Specifications for Construction for grading and earthwork.

C. Use marine-grade anti-seize lubricant for threaded fittings that is acceptable for use on galvanized steel.

D. Ensure sockets for line posts foundations meet manufacturer's specifications. In addition, ensure sockets embedded in concrete foundations are fabricated from 11 gauge (minimum), hot rolled mild steel galvanized to *ASTM A123/A123M*, after fabrication.

c. Manufacturer's Representative. Ensure that prior to cable barrier installation, the cable barrier manufacturing company provides the Engineer with the name, telephone number, electronic mail (e-mail) address, and a resume of a representative from the cable system manufacturing company that has been assigned to this project. The manufacturer's representative must be employed, either directly or under contract, by the cable barrier manufacturer. The manufacturer's representative cannot be employed, either directly or under contract, by the Contractor. The Contractor is prohibited from acting as the manufacturer's representative.

The manufacturer's representative must have thorough knowledge of the cable barrier system being installed and must have prior experience installing the cable system used for this project. The representative's resume must specify the length of time working for the manufacturer, and contain a list detailing the cable barrier projects the representative has worked on over the last 3

years. The Engineer reserves the right to reject a manufacturer's representative if the representative fails to demonstrate thorough knowledge of the cable barrier system being installed, fails to submit proof of prior experience installing the cable system used for this project, or fails to comply with the requirements of this special provision. If the Engineer rejects a manufacturer's representative at any time during construction, the cable system manufacturing company must provide a different manufacturer's representative, meeting the requirements of this special provision, within 2 working days and at no additional cost to the Department.

The manufacturer's representative must respond to any telephone or e-mail inquiries from the Engineer within 2 working days. If requested by the Engineer, the manufacturer's representative must travel to the project site and meet with the Engineer to inspect the cable barrier installation and discuss any issues regarding the cable barrier installation. The manufacturer's representative must travel to the project site and meet with the Engineer no later than 5 working days after the Engineer's request.

No later than 5 days after initial cable tensioning of all cable barrier runs, the manufacturer's representative must travel to the project site, meet with the Engineer, and inspect the entire cable barrier installation. Any deviations from manufacturer's specifications must be reported directly to the Engineer.

d. Consultation and Training. The cable barrier manufacturing company must be available to consult with and train personnel from MDOT and/or any of MDOT's invitees, without additional cost, as requested by MDOT. Consultation and training must encompass the design, installation, operation, and maintenance of the cable barrier system.

The manufacturer must provide training with respect to the design, installation, operation, and maintenance of the cable barrier system. Training and consultation must be held at a location in the State of Michigan deemed acceptable by MDOT. The manufacturer must issue a dated certificate to each individual that has undergone formal training. The manufacturer must comply with all of the training requirements specified in the contract.

Prior to installation of the cable barrier system, provide written certification from the manufacturer, to the Engineer, that the entire workforce to be used for installing the system has received the training and necessary aids to install the system. This workforce training must include installation of the foundations, end terminals, posts, cables, turnbuckles, reflectors, miscellaneous hardware, and tensioning of the cables. The written certification must contain a list of individuals trained and certified by the manufacturer. Provide an updated list of workers trained and certified by the manufacturer no later than 48 hours after personnel changes occur.

e. Plans and Shop Drawings. At least 30 days prior to cable barrier installation, electronically submit a complete set of plans developed by the manufacturer of the high tension cable system selected for the project.

The Department will require up to 30 days for reviewing plans and shop drawings. The Contractor and manufacturer must address any questions, comments, or concerns raised by MDOT personnel. Do not commence cable barrier construction/installation until the plans and shop drawings have been reviewed and approved by the Department.

Incomplete shop drawings will not be accepted or reviewed by the Department. The Contractor will be held responsible for incomplete and/or late plan set submittals. Extension of the completion dates for the project will not be granted due to incomplete and/or late plan set submittals.

Ensure all drawings and calculations are in English units. Ensure the cable system is designed according to manufacturer's recommendations and this special provision. Ensure shop drawings detailing the end terminal foundations are signed and sealed by a Professional Engineer licensed in the State of Michigan.

Include all of the following in the set of plans:

1. Detailed shop drawings of the cable system, design calculations and notes, and any construction specifications.
2. One drawing for each cable run, containing the following items:
 - A. The height of each cable in the system;
 - B. The post length and height of each post with respect to ground level;
 - C. The post spacing along the entire length of each cable run;
 - D. Detailed drawings of all posts and hardware;
 - E. Turnbuckle locations;
 - F. The overall length of the cable run, including the end terminals;
 - G. The cable barrier length, excluding the end terminals;
 - H. The end terminal design, including end terminal length;
 - I. End terminal locations (stations); and
 - J. The foundation dimensions and detailed steel reinforcement layout for all concrete foundations in the cable run.
3. Reflector design.
4. End terminal foundation design(s), signed and sealed by a Professional Engineer licensed in the State of Michigan, showing foundations dimensions and steel reinforcement layout.
5. A report detailing the methodology and geotechnical data (including soil boring logs and soil test results) used to design line post foundations, and end terminal foundations. Ensure geotechnical data used to design foundations, supporting calculations, steel reinforcement calculations, and conclusions/recommendations is included and clearly identified in the report.
6. A table showing the recommended post spacing as a function of roadway curvature.
7. A table or graph, or both, showing impact deflection (under *NCHRP 350*, *TL-3* or *MASH*, *TL-3* conditions) as a function of post spacing.

8. A table showing the recommended cable tension as a function of cable temperature.
9. Detailed drawing of a modified cable post and/or hardware that can accommodate turnbuckles and/or fittings.
10. A signed certification letter from the manufacturer indicating the cable system conforms to this special provision.
11. FHWA acceptance letter indicating the cable barrier meets or exceeds *NCHRP 350, TL-3* or *MASH, TL-3* when installed on a 1:4 slope or flatter.
12. FHWA acceptance letter indicating the cable barrier meets or exceeds *NCHRP 350, TL-4* or *MASH, TL-4* when installed on a 1:6 slope or flatter.
13. FHWA acceptance letter indicating the end terminals meet *NCHRP 350, TL-3* or *MASH, TL-3*.

f. Geotechnical Information. Limited geotechnical information is furnished by the Department on the project plans. Geotechnical information furnished by the Department may be used for design purposes at the manufacturer's discretion. It is expressly understood that the Department will not be responsible for interpretations or conclusions drawn from geotechnical information furnished by the Department by the Contractor, manufacturer, and/or any of their affiliates. Soil data furnished by the Department represent conditions at specific locations. No inference should be made that subsurface conditions are the same at other locations. Additional soil data will not be furnished by the Department.

Contact the manufacturer prior to bidding and determine if additional geotechnical data is required. Obtain and furnish additional geotechnical data (including soil borings and soil testing data) and laboratory tests required for the manufacturer to complete design of end terminal foundations or other components of the cable barrier system. Conduct laboratory tests in accordance with *AASHTO* and *ASTM* Standard Methods of Testing.

g. General HTCB System Design. Design the HTCB system in accordance with the manufacturer's recommendations and specifications, and the following general requirements.

1. Ensure the modified cable post and/or hardware for accommodating turnbuckles and/or fittings meets the manufacturer's specifications and does not undermine the crash worthiness of the cable barrier system.
2. Ensure individual cables terminate at an end terminal foundation. Anchoring individual cables to other cables is prohibited.
3. Ensure end terminal foundation designs satisfy all of the following requirements.
 - A. Ensure the minimum design load for end terminal foundations and cable connections to the foundation are based on the theoretical cumulative cable tension expected at -25 degrees Fahrenheit (F).
 - B. Ensure each end terminal foundation is designed using the P-Y Method (e.g., L-Pile) when checking the theoretical deflection and uses the Broms' Design Methods when checking overturning.

C. Ensure each end terminal foundation is designed using the appropriate geotechnical information furnished by the Department and/or appropriate geotechnical information furnished by the Contractor, as determined by the manufacturer.

D. Use a minimum factor of safety of 2.5 against overturning using the Broms' Design Methods (Refer to Subsection 13.6.1.1 of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals).

E. Ensure end terminal foundation deflection is not greater than 0.5 inch when subjected to the minimum end terminal design load described in this special provision. Use a minimum factor of safety of 1.0 in the foundation deflection analysis.

F. Ensure end terminal foundations are designed to resist uplift and/or downward forces using a minimum factor of safety of 2.0 and the Beta and Alpha Methods as described in *FHWA-IF-99-025 Drilled Shaft: Construction Procedures and Design Methods* (O'Neill and Reese, 1999).

G. Ensure steel reinforcement for end terminal foundations is designed using appropriate AASHTO guidelines.

H. Ensure drilled shaft (cylindrically shaped) concrete foundations are used for all end terminal foundations and post foundations. A rectangular reinforced concrete pile cap may be used to connect two or more cylindrically shaped end terminal foundations. Reinforced concrete pile caps must have a minimum depth of 48 inches.

h. Concrete Foundation Construction. Unless directed otherwise by the Engineer, construct concrete foundations in accordance with the details on the plans, the plan set developed for this project by the manufacturer, section 718 of the Standard Specification for Construction, and this special provision.

Embed a sleeve/socket in the concrete of each line post foundation to hold the post. Place steel reinforcement in each line post foundation in accordance with the plans, the plans developed by the manufacturer for this project, and this special provision.

Place steel reinforcement in each end terminal foundation in accordance with the plan set developed by the manufacturer for this project and this special provision.

Ensure that the bottoms of all concrete foundations, including but not limited to line post foundations and end terminal foundations, are a minimum of 48 inches below ground level. Ensure that the tops of all concrete foundations are at ground level. The minimum diameter for all foundations is 15 inches. The top of all concrete foundations must have a smooth finish.

Conduct concrete quality control and quality assurance in accordance with the contract, or as directed by the Engineer.

1. **Qualifications of Drilled Shaft Contractor.** The Contractor constructing cable terminal foundations must have installed drilled shafts with diameters up to 4 feet and depths in excess of 30 feet within a period of 3 years or less prior to the bid date for this project. The Contractor must demonstrate to the Engineer that the Contractor's supervisor and drillers performing the work have completed at least three projects of similar scope, drilled shaft diameters and

depths, and subsurface conditions to this project. The Contractor's supervisor must have at least 3 years of acceptable experience in installing similar types of drilled shafts.

2. Drilled Shaft Installation Plan. In addition to the requirements of subsection 718.03.A of the Standard Specifications for Construction, the drilled shaft installation plan must include the methods proposed to prevent drilled shaft excavation spoils from entering the waters of the state or stormwater drainage systems, when the work is within the influence of same.

3. Subsurface Data. Review the available geotechnical information for this project. Notify the Engineer in writing within 48 hours of determining that the actual subsurface conditions differ substantially from those reported on the boring logs. It is expressly understood that the Department will not be responsible for interpretations or conclusions drawn by the Contractor from geotechnical information provided by the Department.

4. Casing. Determine the need for casing the shaft excavation and if casing is required, use shaft excavation casing temporarily, and remove casing in accordance with this special provision. The use of permanent shaft excavation casing is prohibited.

5. Protection of Existing Structures, Utilities, Culverts, and Drain Pipes. Control operations to prevent damage to existing structures, utilities, culverts, and drain pipes. Preventative measures include, but are not limited to, selecting construction methods and procedures that will prevent caving of the shaft excavation, monitoring and controlling the vibrations from construction activities (such as installation of casing and drilling of the shaft), and monitoring and controlling the depth of excavation. Repair any damage to existing structures, utilities, culverts, or drain pipes, to the satisfaction of the Engineer at no additional cost to the Department, including engineering analysis and redesign, and without any extension of the completion dates for the project.

6. Construction Tolerances. The manufacturer of the cable system selected for this project must prepare a complete list of construction tolerances, including but not limited to cable height, post spacing, and horizontal alignment, for the cable system selected for this project. Submit the list of construction tolerances to the Engineer for review and approval. Obtain the Engineer's approval of all construction tolerances prior to beginning cable barrier construction/installation.

Manufacturer's tolerances must comply with the following minimum construction tolerances:

A. Ensure at the drilled shaft actual bottom elevation, the out-of plumb is no greater than one percent of the drilled shaft length as measured from the actual center of the shaft at the shaft design top elevation.

B. Ensure after cable barrier installation, the out-of-plumb of all cable barrier line posts is no greater than one percent in all directions. The use of plastic shims for leveling line posts is prohibited.

C. Ensure after all the shaft concrete is placed, the top of the reinforcing steel cage for end terminal foundations and line post foundations is no more than 1 inch above or below plan position.

D. The top elevation of all concrete foundations must have a tolerance of 0 to 1 inch above top of shaft elevation. Ensure the top of all concrete foundations is not below

ground level.

Drilled shaft excavations and completed foundations not constructed and installed within the required tolerances will be considered unacceptable. Correct all unacceptable shaft excavations and completed foundations to the satisfaction of the Engineer. Furnish labor, equipment, and materials necessary to complete corrections for out of tolerance drilled shafts and posts, including engineering analysis and redesign, at no additional cost to the Department, and without an extension of the completion dates for the project.

7. Excavation. Maintain the stability of the excavation sidewalls and extend the shaft excavation to a stratum accepted by the Engineer. Extend drilled shaft tip elevations when the Engineer determines the bearing stratum encountered during excavation is unsuitable or differs from that anticipated in the design of the drilled shaft. Provide the Engineer access to auger cuttings of the bearing material for additional analysis. Fill over-excavation of shafts, and unauthorized shaft excavations extended below required depths or elevations, with concrete when constructing concrete foundations, at no additional cost to the Department.

Do not leave an uncased drilled shaft excavation open overnight. If, when constructing concrete foundations, an uncased drilled shaft cannot be completed in one day, backfill the excavation with flowable fill.

Dispose of excavated materials removed from shaft excavations, and not used for slope grading, in accordance with subsection 205.03.P of the Standard Specifications for Construction. Keep excavated materials away from each open shaft excavation. Remove excavated materials immediately after completing the shaft excavation, or as directed by the Engineer. Direct surface water away from shaft excavations. Ensure that excavated material does not enter the waters of the state or stormwater drainage systems.

8. Obstructions. Remove surface and subsurface obstructions encountered in the length of excavation at concrete foundation locations. Such obstructions may include materials such as old concrete foundations or abandoned utilities, or natural materials such as boulders. In the event that the excavation cannot be advanced using conventional augers fitted with soil or rock teeth, drilling buckets and/or under reaming tools, use special procedures or tools including, but not limited to, chisels, boulder breakers, core barrels, air tools, hand excavation, and enlarging the hole diameter. Unless otherwise specified in the contract, removal of such obstructions will be paid for as extra work provided that special procedures or tools are utilized. To be considered for payment for obstruction removal, submit written notification to the Engineer no later than 24 hours after encountering obstructions and allow the Engineer to inspect the excavation and verify that special procedures or tools are required prior to undertaking the removal.

9. Excavation Inspections. Ensure excavation inspection is in accordance with subsection 718.03.F.1 of the Standard Specifications for Construction, with the following addition: after shaft excavation, and provided that a tremie pour is not required, provide access and allow time for the Engineer to inspect the shaft. Provide suitable lighting if needed.

10. Steel Reinforcement. Place steel reinforcement in concrete foundations as specified on the plans and shop drawings developed for the project. Construct and place reinforcing steel cage in accordance with subsection 706.03.E of the Standard Specifications for Construction and the following:

A. Completely assemble a reinforcing cage, consisting of longitudinal bars, stiffener bars, centralizers and tie reinforcement or spiral reinforcement prior to placement in the shaft excavation. Tie together steel reinforcement cages for all cable barrier foundations. Do not use welded steel reinforcement cages.

B. Place the steel reinforcement as a unit immediately after the shaft excavation is inspected and accepted, and prior to concrete placement.

C. Use non-corrosive spacers on the exterior of the reinforcing cage, near the bottom of the cage and at sufficient intervals to ensure concentric spacing of the cage for its entire length within the shaft excavation. Ensure the spacers are of adequate dimensions to provide a minimum 3 inches annular space between the outside of the reinforcing cage and the perimeter of the excavated shaft.

D. Maintain the bottom of the cage the proper distance above the shaft base using approved concrete bottom supports, or by other methods approved by the Engineer.

E. Tie and support the reinforcing steel in the shaft during concrete placement and temporary casing removal such that the reinforcing steel will remain within the allowable tolerances.

F. Check the elevation of the top of the steel cage before and after the concrete is placed. If the reinforcing steel cage is not maintained within the specified tolerances, make corrections to the satisfaction of the Engineer. Modify the steel cage support in a manner satisfactory to the Engineer prior to constructing additional shafts.

G. Use epoxy coated steel reinforcement for all cable barrier foundations, including line post foundations.

11. Concrete Placement. Complete concrete placement for concrete foundations in accordance with the applicable portions of section 706 and subsection 718.03.H of the Standard Specifications for Construction, and as modified herein.

Ensure that concrete is delivered to the site from the batch plant in a continuous manner to help avoid interruption of placement. Place concrete, either by free-fall or through a tremie or concrete pump, the same day the shaft is excavated.

Place concrete by free-fall methods only in dry excavations where free water accumulation of 3 inches or less can be maintained immediately prior to concrete placement. Direct concrete placed by free-fall methods in the center of the shaft to avoid contact with the reinforcing steel cage, shaft sidewalls and temporary casing. Drop chutes may be used to direct concrete in a vertical stream down the shaft.

Consolidate the concrete in all cable barrier foundations, including line post foundations, with vibrators in accordance with the requirements of subsection 706.03.H.1 of the Standard Specifications for Construction.

12. Temporary Casing. Coordinate temporary casing withdrawal carefully with concrete placement. When temporary casing is being withdrawn, maintain a sufficient head of concrete above the bottom of the casing to prevent reduction in the shaft diameter due to earth and/or hydrostatic pressure on the fresh concrete, and to prevent extraneous material from mixing

with fresh concrete. Check the concrete level in the temporary casing prior to, and after casing withdrawal to confirm that separation of the shaft concrete has not occurred.

13. Protection of Concrete. Protect fresh concrete from flowing water and damage from mechanical equipment and nearby construction vibrations. Do not generate vibrations from pounding of sheet piling, pile driving, or casing installation within a radius of 25 feet until the concrete has attained 75 percent of its specified minimum strength. Protect concrete from strength reduction caused by frost or freezing actions.

Comply with the curing requirements of subsection 810.03.J.8 of the Standard Specifications for Construction for all cable barrier foundations, including line post foundations.

i. HTCB Construction/Installation. Furnish and install the HTCB system in accordance with the following:

1. General. Furnish and install an approved HTCB and end terminals at the location(s) specified on the plans. Install all cable barriers and end terminals in accordance with the plans, this special provision, and the shop drawings developed by the manufacturer for this project.

2. Posts. Base post spacing on manufacturer's specifications depending on the roadway curvature shown on the plans while satisfying the following condition: Ensure the post spacing does not exceed 10 feet, 6 inches, unless otherwise specified on the plans developed by the Department or directed by the Engineer;

Install a modified cable post and/or hardware, in accordance with the plans developed by the manufacturer for this project and this special provision, at all locations where a standard cable post cannot be properly installed and attached to the cables due to the presence of a turnbuckle or fitting.

Install excluder caps on all posts placed in sockets to prevent debris from entering the socket.

3. Reflectors. Attach reflectors to line posts in accordance with the manufacturer's specifications and this special provision. Install reflectors on both sides of the line post, unless otherwise specified on the plans developed by the Department. Space reflectors at the following intervals:

A. 48 feet (maximum) on tangent sections and curves with a radius of 1,150 feet or greater.

B. 24 feet (maximum) on curves with a radius less than 1,150 feet.

4. Slope Grading. Grade around all concrete foundations, as necessary, to remove any ridges, dips, holes, or voids around the foundations and match the surrounding slopes. Graded areas must have a slope of 1:4 or flatter. Graded areas must meet Class A slope tolerances in accordance with subsection 205.03.N of the Standard Specifications for Construction.

5. Fittings. Ensure that wedge-lock type fittings have a minimum of one wire crimped over the base of the wedge to hold it firmly in place. The crimped section of wire over the base of the wedge must have a minimum length of 3/16 inch. Lubricate all threaded fittings

with marine-grade anti-seize lubricant prior to assembly and installation.

6. **Cable Tensioning.** Do not tension cables until the concrete in the cable barrier foundations has reached a minimum compressive strength of 3,000 pounds per square inch.

Upon complete assembly of the cable barrier, set each cable to the initial tension specified by the manufacturer. Measure the temperature of each cable prior to tensioning and use this temperature to determine the required tension. Perform final cable tensioning in each cable a minimum of 2 weeks after initial cable tensioning and, if necessary, adjust the tension to the proper setting. Submit written certification to the Engineer indicating the date of initial cable tensioning, date of final cable tensioning, the ambient temperature and cable temperature on each of these dates, and the tension in each cable on each of these dates.

Upon complete assembly of the cable barrier, ensure that all threaded terminals, except one terminal per cable per run, penetrate a minimum of 3 inches and a maximum of 4 inches into the turnbuckle measured from the ends of the turnbuckle. Ensure that all threaded terminals, including terminals not required to meet the 3 inch minimum and 4 inch maximum penetration requirements, penetrate the turnbuckle past the inspection holes located on the turnbuckle. Ensure that the terminal threads are visible through the inspection holes located on the turnbuckle.

Upon completion of the construction/installation of the HTCB, both the Contractor and the manufacturer's representative must provide written certifications to the Engineer indicating that the high tension cable system and end terminals were installed in accordance with the plans, manufacturer's specifications and guidelines, and this special provision.

j. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

Pay Item	Pay Unit
Cable Barrier, High Tension	Foot
Cable Barrier Terminal, High Tension.....	Each

1. **Cable Barrier, High Tension.** The plan quantity for **Cable Barrier, High Tension** is based on the overall dimension between the final concrete foundations in each run of cable barrier. Actual final payment will be based on the field measurements deducting the terminal system per the manufacturer's approved shop drawings. For bidding and ordering purposes, it is the Contractor's responsibility to make necessary adjustments by deducting the length of the terminal endings from the plan length.

Cable Barrier, High Tension includes the following:

- A. Selecting a HTCB system that meets the requirements of this special provision;
- B. Constructing the cable barrier in accordance with the plans, the plan set developed by the manufacturer for this project, and this special provision;
- C. Obtaining and furnishing soil properties (including soil borings and laboratory testing), as specified by the manufacturer;

- D. Furnishing and installing reflectors, as specified in this special provision;
- E. Constructing line post foundations, as specified on the plans developed by the manufacturer for this project and this special provision;
- F. Conducting concrete quality control and quality assurance;
- G. Providing a trained work force and a manufacturer's representative on-site during installation and during consultation/training requested by MDOT;
- H. Preparing and submitting plans and/or requested information to MDOT;
- I. Grading around cable barrier foundations;
- J. Removal and disposal of excavated materials;
- K. Furnishing, installing, and removing shaft excavation casings;
- L. Providing training/consultation by the manufacturer as requested by MDOT; and
- M. Providing a manufacturer's representative on-call throughout the duration of the project, on-site as requested by the Engineer and as specified in this special provision, and during consultation/training requested by MDOT.

2. Cable Barrier Terminal, High Tension includes the following:

- A. Constructing a NCHRP 350, TL-3 or MASH, TL-3 compliant high tension cable terminal compatible with the cable system installed;
- B. Constructing end terminal in accordance with the plans, the plans developed by the manufacturer for this project, and this special provision;
- C. Constructing all end terminal foundations and post foundations, as specified on the plans developed by the manufacturer for this project and this special provision;
- D. Conducting concrete quality control and quality assurance;
- E. Obtaining and furnishing soil properties (including soil borings and laboratory testing), as specified by the manufacturer;
- F. Preparing and submitting plans and requested information to MDOT pertaining to the end terminals;
- G. Certification of the manufacturer's end terminal foundation design(s) by a Professional Engineer licensed in the State of Michigan;
- H. Grading around cable terminal foundations;
- I. Removal and disposal of excavated materials; and
- J. Furnishing, installing, and removing shaft excavation casings.

3. Payment Schedule. Payment will be made after final cable tensioning is completed, unless otherwise authorized by the Engineer.

4. Bid Preparation. Bidders are required to consult with cable barrier manufacturers and geotechnical consultants prior to bidding and estimate foundation dimensions and steel reinforcement quantities based on the foundation design requirements of this special provision and appropriate soil data furnished on the project plans. Unit prices should be based on conservative foundation designs that meet or exceed the requirements of this special provision. Additional payment will not be provided for constructing cable barrier foundations with dimensions and/or depths different from those used by the bidder for bidding and estimating purposes.