



Roadside Safety: High Tension Cable Barrier

Derwood Sheppard, P.E.



FDOT Roadside Safety Updates

- February 26, 2015 - Moratorium on HTCB Lifted:
 - Created Dev. Design Standards Index D450.
 - Created Instructions Dev. for Design Standards, IDDS 450
 - Revised Dev. Specification 540.
- Future Plans:
 - MASH Implementation
 - PPM Chapter 4 Redevelopment (In-Progress)
 - Index 400, Guardrail - Redevelopment (In-Progress)
 - Specification rewrite
 - New IDS
 - Index 410, Concrete Barrier Wall (Fall 2015)
 - Others to Follow...



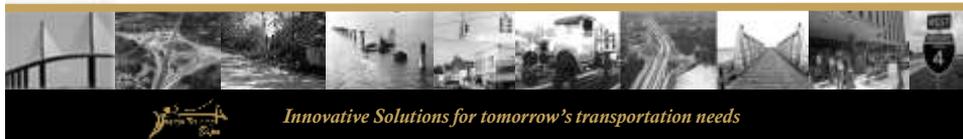
High Tension Cable Barrier (HTCB)



HTCB Overview:

- Primary Function – Reduce **Median Crossover Crashes** or shield continuous longitudinal roadside hazards (e.g. canal hazards).
- Additional Barrier Option to *PPM*, Vol. 1, Chapter 4.
- **Flexible Barrier System** = greater deflections than guardrail (semi-rigid) or concrete barriers (rigid).
- Flexibility allows system to absorb and distribute more impact energy while effectively containing and redirecting vehicles.
- Require **Larger Lateral Offsets/Setbacks** to provide deflection space.
- **Objective** – Reduce Crossover A+K Collisions without Increasing Crash Severity.





HTCB Updates

- Remains a “Developmental” Process
- **New Developmental Design Standard (DDS)** Index 450
- **New Instructions for Dev. Design Standards (IDDS)**
- Revised **Developmental Specification Dev540**
 - ✓ Cable Heights Specified per NCHRP Report 711
 - ✓ Shop Drawing Requirements
 - ✓ Design Criteria
 - End Terminal Foundations
 - Line Post Foundations
 - ✓ Mow Strip
 - ✓ Basis of Payment
- **New Innovative Products List (IPL)**



Developmental Standards & Specifications

!!! * IMPORTANT ** *!!!**

- ✓ “Developmental” Means Standards and Specifications Can Change Throughout the Process.
- ✓ Review Latest Information Posted on the FDOT Website.
- ✓ Always refer to Specification and Standards included in the Contract Documents!



FDOT Developmental Information

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Home About FDOT Contact Us Maps & Data Offices Performance Projects

Office of Design
Office of Design / Design Standards

INDUSTRY REVIEW
Modification Request Origination Form
Current Submittals Under Review
Current Year Submittal History

Effective January 1, 2015

Year	Design Standards eBooklet	Design Standards Revisions	Developmental Design Standards	Contact Information Drainage Intelligent Transportation Systems Roadway Design Structures Design
2015	DSeB	DSR	DDS	



FDOT Developmental Information

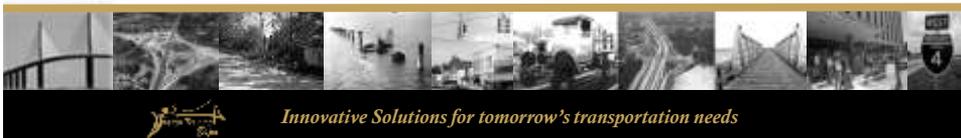
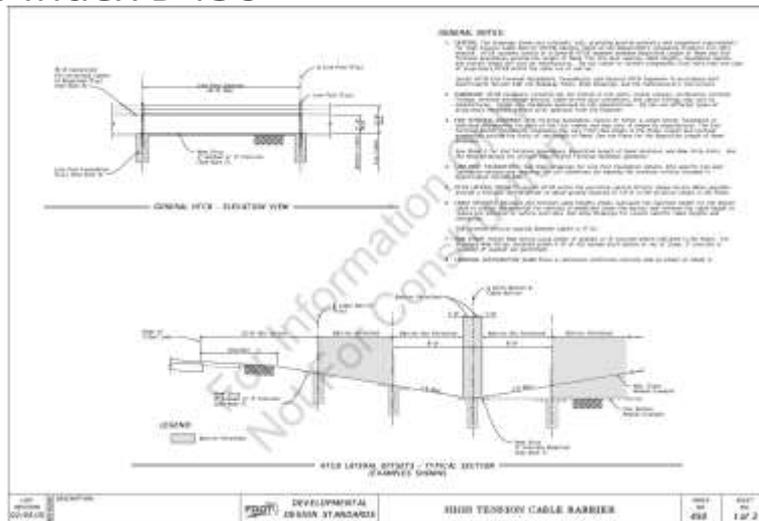
Developmental Design Standards

Developmental Design Standards (DDS) are to be released by the appropriate section within the Office of Design to implement new technologies as a tested trial before an as needed or an as available basis. As a DDS is released, a Design Bulletin will be issued to announce its availability. Designers wishing to use a DDS must follow the Developmental Design Standards Usage Process which is posted in the link provided below. Please reviewer's must verify each DDS included in a plan set is permitted for the use by confirming the project's FPD number which is listed with the appropriate DDS below.

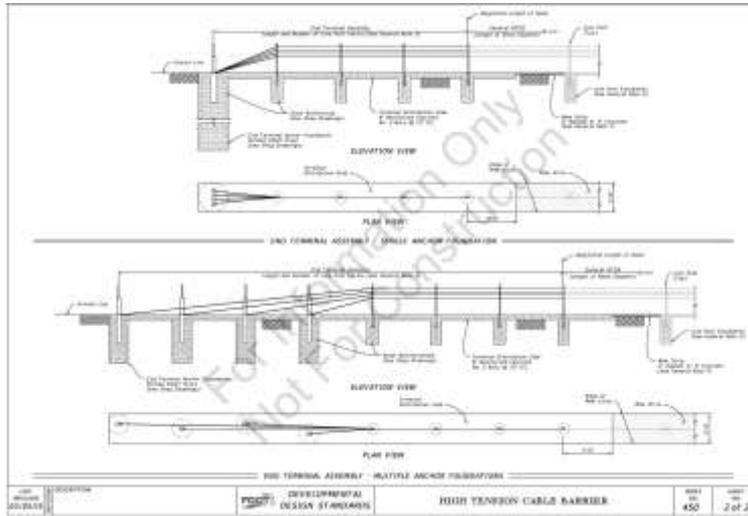
Developmental Design Standards Usage Process for Design-Bid-Build Projects

Developmental Design Standard (PDF)	Title	Member Contact	Design Information		
			Instruments for Developmental Design Sets (DDS) (PDF)	Data Table Cell Library (PDF)	Developmental Specifications (MS-SPeCS)
D450 Certification System	High Tension Cable Barrier (Summary-of-Cable-Barrier.stss) (Permitted Projects FPD No(s))	Derwood Rappaport	DDSS-D450	CDL-D450	Dev-548
D477	Thin Slab Panel Roadway (Concrete Horizontal) (NOTE: Migrated to the Design Standards effective for bidding beginning January 2014. (See Index 477 in the current Design Standards eBook)) (Permitted Projects FPD No(s)) 42396A-1-02-01	Steve Babin	-	-	N/A

DDS Index D450



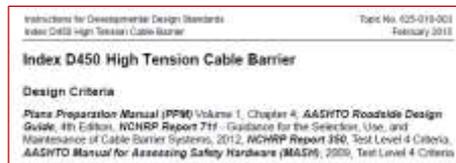
DDS Index D450



Instructions for Developmental Design Standards (IDDS) Index D450

IDDS Includes the following:

- Design Assumptions and Limitations
- Selection & Placement Guidelines
- Plan Content Requirements
- Payment



IDDS Index D450

HTCB Selection & Placement Guidelines

System Selection – Analysis of Following Conditions:

- Median Width – Deflection Space
- Type of Median and Terrain – Flush/Depressed, Slopes, Drainage...
- Traffic Volume, Growth, and % Trucks
- Crash History – Crossover Collisions
- Design Speed
- Access Points
- Median Emergency Crossovers (Openings)
- Alignment and Geometry – Horizontal/Vertical Curves
- Barrier Alternatives
- **Final Approval from DRDE**



IDDS Index D450

HTCB Selection & Placement Guidelines

Slope Considerations – In Order of Preference:

1. Where possible, locate HTCB on relatively flat, unobstructed terrain with a slope of 1:10 or flatter.
2. Locate on shoulders or median cross-slopes up to 1:6.
3. Re-grade or Fill Steeper Slopes. Split-level (bifurcated) concrete median barrier.
4. If regrading or other options are not feasible, placement on slopes up to 1:4 may be considered. Installations on slopes steeper than 1:6 must be **approved by the State Roadway Design Engineer** (TL-3 Design).

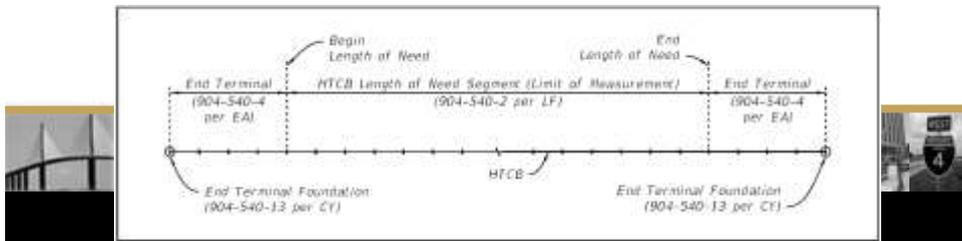


IDDS Index D450

HTCB Selection & Placement Guidelines

Length of Need (LON) Considerations:

- Generally Based on Reducing Median Crossovers
- Minimum Length
 - Preferred – 1,000 feet
 - Absolute – 300 feet
- Maximum – Varies based on Site Constraints (>10,000 ft)
- Median Crossovers (Openings)
- Departure Line in Accordance with Index 400, Guardrail

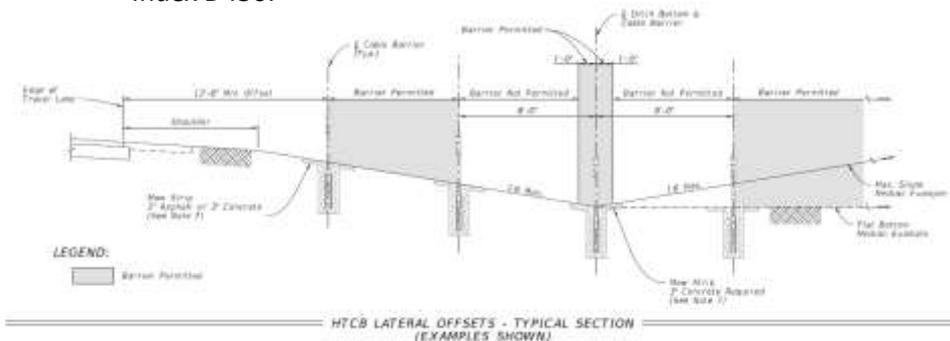


IDDS Index D450

HTCB Selection & Placement Guidelines

Lateral Placement: (NCHRP Report 711)

- As far from traffic as possible
 - Allows for ample Deflection Space
 - Reduces nuisance impacts
- Avoid – Ditch Bottoms, Toe of Slopes, & Drainage Features
- Slopes 1:6 or Flatter follow HTCB Lateral Offset limits shown on Index D450.

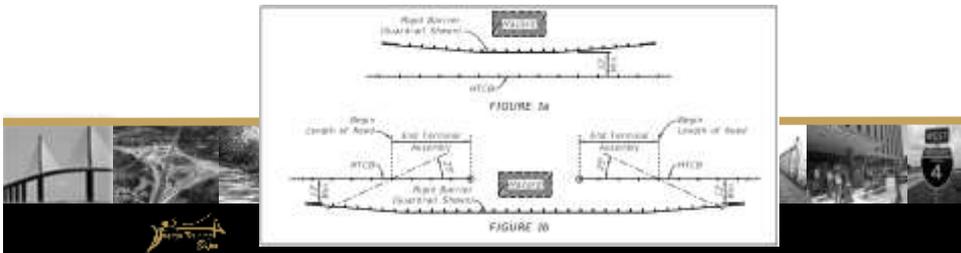


IDDS Index D450

HTCB Selection & Placement Guidelines

Lateral Placement: (CONT.)

- Minimum Offset – 12 ft (Travel Lanes & Other Barriers)
- Not used to shield Aboveground Hazards (i.e. piers, sign structures)
- Non-Symmetric Medians – Locate on Flattest Slope
- Superelevation > 3%
 - Locate no further than 5 ft from Shoulder Breakpoint, or
 - Locate on Opposite Side of Median
- Avoid Drainage Features or Other Utilities.



IDDS Index D450

HTCB Selection & Placement Guidelines

Vertical Curve Placement:

- Cable forces can damage or pull-out Line Posts.
- Considerations:
 - End Terminal Anchors:
 - Points of Minimum and Maximum Curvature
 - Location of Sudden Vertical Curvature
 - Reduce Post Spacing
 - Re-grading to remove sharp curves

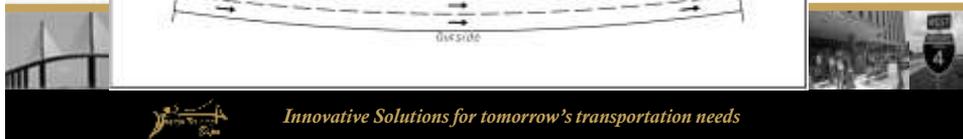
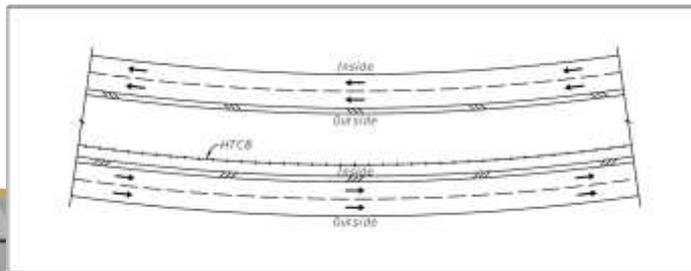


IDDS Index D450

HTCB Selection & Placement Guidelines

Horizontal Curve Placement:

- Affects Performance.
 - Impacts on Convex side produce higher deflections.
 - Tight radius can create post damage (bending).
- Considerations:
 - Locate closer to Convex side of traffic.
 - Decrease line post spacing for radius < 1,300 ft.



IDDS Index D450

HTCB Selection & Placement Guidelines

Line Post Spacing:

- Proprietary Systems are Limited to Max. 8 ft deflection
 - Based on Crash Testing
 - End Anchor/Line Post Spacing greatly impact deflection
- Spacing affects dynamic deflection & containment effectiveness.
- Maximum Spacing:
 - Outside of Clear Zone.....16 ft
 - Within Clear Zone.....10 ft
 - Slopes Steeper than 1:6....10 ft
- Tighter Spacing used when deflection limits are of specific concern

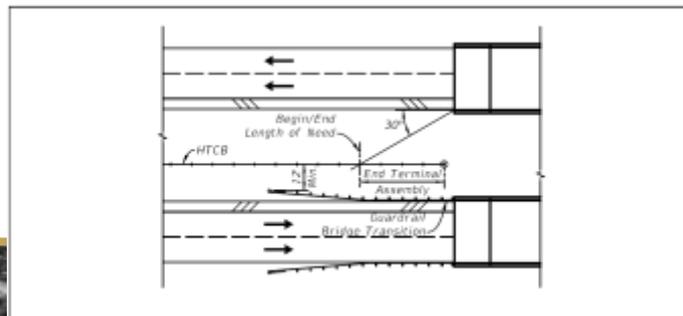


IDDS Index D450

HTCB Selection & Placement Guidelines

End Terminal Placement & Protection:

- Variable Length End Treatments
 - Limits on IPL may be needed for LON.
- When Possible, Protect End Treatments with adjacent Barriers
 - End Treatments are Crashworthy, BUT
 - "Gating" (i.e. Loss of Tension when hit).



Innovative Solutions for tomorrow's transportation needs

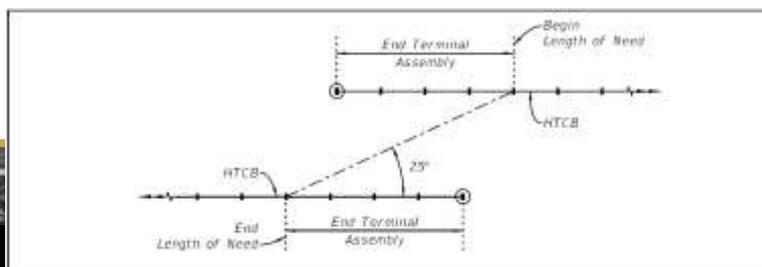


IDDS Index D450

HTCB Selection & Placement Guidelines

Barrier (End Terminal) Overlap – Protection of End Terminals:

- Switching Side of Median
 - Gradual Transitions from One Side to the Other is permitted
 - **Do Not Taper** HTCB towards the Direction of Traffic
- System Limitations
- Terrain Constraints (i.e. Vertical Curves)
- Maximum Length Restrictions

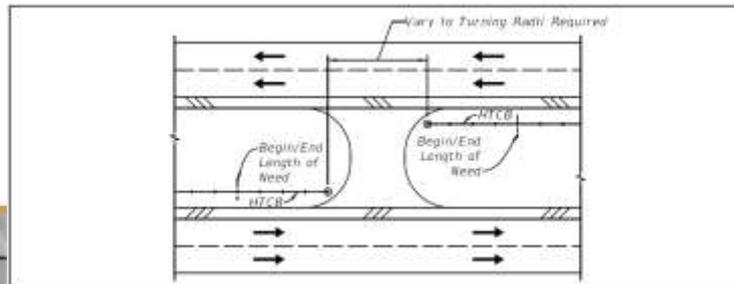


IDDS Index D450

HTCB Selection & Placement Guidelines

Median Crossover:

- Permanent Median Crossovers (Openings)
 - *PPM*, Vol. 1, Chapter 2, Section 2.14.4
 - Wide Median – Overlap
 - Narrow Median – Terminate End Treatments
- Consider when determining Overall System Length (i.e. **1 mile Max.**)



Innovative Solutions for tomorrow's transportation needs



IDDS Index D450

HTCB Selection & Placement Guidelines

Mow Strip:

- Prevent Vegetation Growth
- 3-inch Concrete
 - Required for Installation within 1 ft of Ditch Bottom or Toe of Slope.
 - Consider for Saturated or Low Strength soil conditions.
 - Reduce Gouging of Vehicles (under-rides)
- 2-inch Misc. Asphalt
 - Min. requirement for all other locations.
- Terminal Distribution Slab
 - 6-inch Reinforced Concrete
 - Different Purpose than Mow Strip



Innovative Solutions for tomorrow's transportation needs

IDDS Index D450

HTCB Selection & Placement Guidelines

Soil & Groundwater Conditions:

- SHGW Depth \geq 1 ft (Below Grade)
- Line Post Foundation Design:
 - Saturated or Unsaturated
 - Classification = Cohesionless (Fine Sand)
 - Friction Angle = 30 Degrees
 - Moist Unit Weight = 112 lbs./cu. ft.
 - Effective Unit Weight = 50 lbs./cu. ft.
- End Terminal Foundations – Design Data Tables
- Evaluate in accordance with *Soils and Foundations Handbook*, Section 3.2.2.10
- Foundations Designed by Specialty Engineer



IDDS Index D450

Plan Content Requirements

DDS Index D450:

- Include Developmental Design Standards Index D450 in Plan Set
- Special Details section of Roadway Plans
- *PPM*, Vol. 2, Section 3.8

Typical Sections:

- Indicate lateral offset on the Roadway Typical Sections

Roadway Plan Views:

- Length of Need (LON)
 - Station and Offset
 - HTCB Run No.
 - Space Limitations (i.e. End Treatment Length), if any.
- Line Post Spacing (if specific spacing required)
- Mow Strip (if specific type required)



IDDS Index D450

Plan Content Requirements

Special Details:

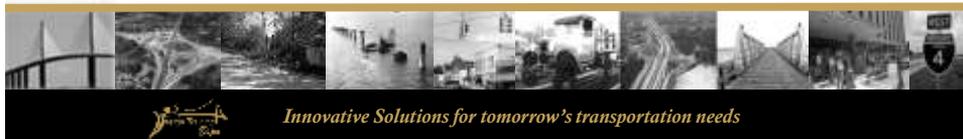
- Overlaps
- Median Crossovers

Geotechnical:

- Report of Core Boring Sheets (End Anchorages)

Design Data Tables:

- Geotechnical Information:
 - End Terminal Foundations
 - Line Post Foundations
- Summary of HTCB Locations and Foundations
- Locations/Limits of Special Designs



IDDS Index D450

Plan Content Requirements – Design Data Tables

Florida Department of TRANSPORTATION

Office of Design

Developmental Design Standards

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START HERE → Developmental Design Standards Usage Process for Design-Bid-Build Projects ← END HERE

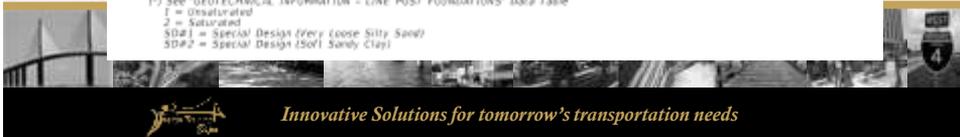
Developmental Design Standard (DDS)	Title	Standard Contract	Design Information		
			Instructions for Developmental Design Sets (DDS) (PDF)	Data Table Call Library (DDS)	Developmental Specifications (DDS-Specs)
D450 Certification Statement	High Tension Cable Barriers (Summary-of-Cable-Barrier-steps) Permitted Projects FPD No(s)	Denwood Highway	DDS-D450	CEL-D450	
D477	Thin Beam Panel Retards (Concrete Handrail) (NOTE: Migrated to the Design Standards section for Interchange Engineering January 2014. See index 477 in the current Design Standards (Booklet)) Permitted Projects FPD No(s) 427064.1-427070	State Road			N/A

IDDS Index D450

Plan Content Requirements

SUMMARY OF HTCBL LOCATIONS AND FOUNDATIONS								
GEO TECHNICAL INFORMATION - END TERMINAL FOUNDATIONS								
Soil Description	Begin of Run				End of Run			
	Loose Fine Sand	Dense Silty Fine Sand		Design Groundwater Depth (ft)	Dense Fine Sand	Loose Clayey Sand	Soft Sandy Clay	Design Groundwater Depth (ft)
Depth Below Existing Ground Line (ft.)	HTCB Run No. 1	0.0 - 33.0	30.0 - 25.0		33.0	0.0 - 30.0		20.0 - 40.0
	HTCB Run No. 2	0.0 - 35.0	25.0 - 25.0		35.0	0.0 - 3.0	3.0 - 35.0	≥ 35.0
	HTCB Run No. 3	0.0 - 35.0			5.0		0.0 - 25.0	25.0 - 40.0
	HTCB Run No. 4							
Total Unit Weight (pcf)	100	115		—	115	112	118	—
Effective Unit Weight (pcf)	48	53		—	53	50	50	—
Cohesion (pcf)	0	0		—	0	0	600	—
Internal Friction Angle (deg)	29	31		—	33	29	0	—

(*) See "GEO TECHNICAL INFORMATION - LINE POST FOUNDATIONS" Data Table
 J = Unsaturated
 J = Saturated
 SD#1 = Special Design (Very Loose Silty Sand)
 SD#2 = Special Design (Soft Sandy Clay)



IDDS Index D450

Payment

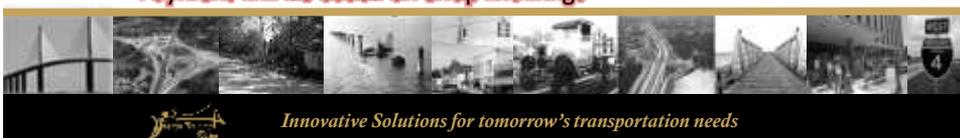
Basis of Payment (**New Pay Item #'s**):

Item number	Item description	Unit Measure
904-540-13	HTCBL Length of Need Segment	LF
904-540-14	End Terminal	EA
904-540-15*	End Terminal Foundation (Misc. Drilled Shaft)	CY
904-540-16	Concrete Mow Strip	LF
339-1	Miscellaneous Asphalt Pavement	TN

(* Note: For End Terminal Foundations include 4 CY per End Terminal as the quantity shown in the Plans.

End Terminal Foundation – per cubic yard

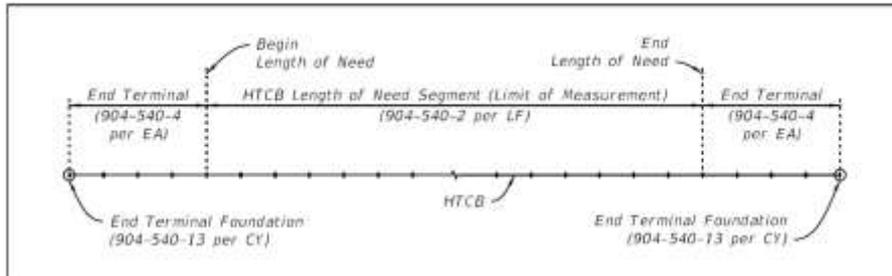
- Quantity in Plans for **Bid Purposes Only**
- **Payment will be based on Shop Drawings**



IDDS Index D450

Payment

Method of Measurement:



HTCB Length of Need Segment – per lineal foot

- Includes General HTCB segments only.
- **End Terminals are separate.**



IDDS Index D450

Plan Content Requirements – Summary Table

Florida Department of TRANSPORTATION

Office of Design

Developmental Design Standards

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START HERE → Developmental Design Standards Usage Process for Design-Bid-Build Projects ← END HERE

Developmental Design Standard	Title	Standard Contract	Design Information		
			Instructions for Developmental Design Sets (DDS)	Data Table Call Library	Developmental Specifications
(PDF)			(PDF)	(PDF)	(MS-Word)
D488	High Tension Cable Barrier	TRM/FIC/RAA/800			
Construction Specification	Summary-of-Cable-Barrier-stall Preliminary Projects FPD: None	None Issued	DDS-D488	CDL-D488	Dev-S488
D477	Two Beam Panel Retards (Concrete Handrail) [NOTE] Migrated to the Design Standards section for Interchange beginning January 2014. See Index 477 in the current Design Standards (eBooklet) Preliminary Projects FPD: None 4/20/14 1. 4/20/14	None Issued			N/A

Developmental Specification Dev540

INCIDENTAL CONSTRUCTION			
High Tension Cable Barrier Systems. Furnish and install high tension cable barrier systems in accordance with the requirements of the Contract Documents and the manufacturer's recommendations.	Deneod Sheppard	Dev540**	
Retaining Wall Systems. Use when Segmental Block MSE Walls (SBW) are allowed.	Larry Jones	Dev548** Project List	N/A
Geosynthetic Reinforced Soil Abutments and Walls. Construct geosynthetic reinforced soil abutments and walls (GRS) in accordance with this Section and in conformance with the lines, grades, design, and dimensions shown in the Contract Documents or established by the Engineer.	Larry Jones	Dev549** Project List	IDDS D6025
Temporary Geosynthetic Reinforced Soil Walls. Construct temporary geosynthetic reinforced soil walls (GRS) in accordance with this Section and in conformance with the lines, grades, design, and dimensions shown in the Contract Documents or established by the Engineer.	Larry Jones	Dev549TW**	N/A
Fencing. Use on jobs when Developmental Design Standard Index No. D-804 is called for in the Plans.	Gavin McDaniel	Dev550	IDDS-D804
TRAFFIC CONTROL DEVICES			
Road Weather Information System (RWIS)	Alan El-Urtal	Dev588**	N/A
<small>Specification: Standard Development Initiative These specifications apply to projects issued for bidding by State Departments, with the intent to increase the number of potential bidders on FDOT projects. NOTE: Developmental Spec 8000A, 9000A and 9000B must be used with this specification.</small>	No Weight	Dev5003 Project List	N/A

Developmental Specification Dev540

System Requirements

- FHWA Eligibility Letter
 - NCHRP 350 Test Level 4 (TL-4)
 - MASH (None at this time)
- 4-Cable



- ✓ Top Cable Min. Height = 33"
- ✓ Bottom Cable Max. Height = 21"



Developmental Specification Dev540

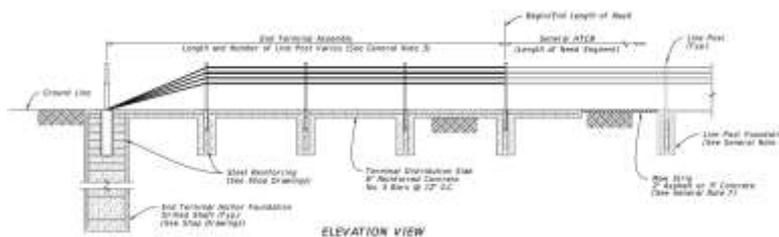
- End Terminals
 - Must be include in FHWA Eligibility Letter
 - Hardware same as in Crash Test
- End Terminal Foundations
 - **ALL** - Miscellaneous Structure Drilled Shaft
 - Same Requirements as Mast Arms, High Mast Lights, Etc...
 - **ALL** - Project Specific Designed



Developmental Specification Dev540

End Terminal Foundations – Design Criteria

- Design Loads – **Thermal Loading**
 - Theoretical Cumulative Cable Tension @ Zero Degrees Fahrenheit
- Lateral Deflection
 - **1-inch Maximum Deflection**

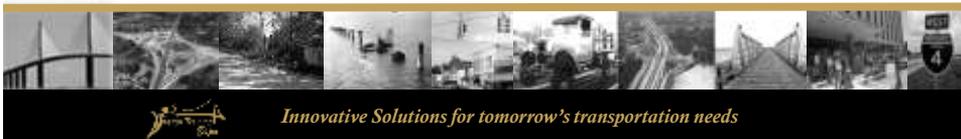


Developmental Specification Dev540

Shop Drawings and Calculations Submittals

Shop Drawings:

1. General notes and construction specifications
2. Height of each cable in the system
3. Post length and height of each post with respect to the ground level
4. Post Spacing along entire length of system
5. Detailed drawings of all posts and hardware
6. Turnbuckle and/or splice locations
7. Overall length of the cable barrier segment, including end terminals
8. Cable barrier length, excluding end terminals
9. End terminal design, including length and location (station/offset)
10. Foundation dimensions and detailed steel reinforcement layout for all concrete foundations, including end terminal anchors, end terminal transition line posts, and standard line posts
11. Location and design of Barrier Delineators, including line post and end terminal



Developmental Specification Dev540

Shop Drawings and Calculations Submittals

Design Calculations:

1. The manufacturer's product brochure, construction specifications, installation manual, and maintenance manual
2. Contact information and qualifications/resume for manufacturer's technical representative
3. Design tables including cable tension as a function of cable temperature
4. The NCHRP-350 or MASH FHWA eligibility letter for the proposed cable barrier system and end terminals
5. Blank sample of the proposed Cable Tension Log
6. The end terminal foundation design(s) prepared by the Contractor's Specialty Engineer
7. The line post foundation design(s) prepared by the Contractor's Specialty Engineer (required when geotechnical soil conditions do not meet standard criteria).



Developmental Specification Dev540

Manufacturer's Representative

- Onsite Milestones
 1. Cable Barrier and Foundation Layout
 2. Installation of End Terminal Cable Anchorage
 3. Installation of Post Sleeves
 4. Setting of Initial Line Post
 5. Installation of Post Hardware
 6. Cable Attachment and Tensioning
- **Installation Training**

Manufacture must certify that Construction Personnel have received adequate training for installation and tensioning of system.



Developmental Specification Dev540

Cable Installation and Tensioning

- Cable Height Tolerance $\pm 1''$
- Location of Hardware
 - As Crash Tested (FHWA Eligibility Letter)
 - Otherwise, **DO NOT interfere with Line Post**
- Initial Tensioning
- Final Tensioning
 - **14 to 21 days** after Initial Tensioning
 - Re-tensioning when **< 90%**



Innovative Products List (IPL)

Florida Department of TRANSPORTATION

Program Management / Product Evaluation

Karas Systems
Product Evaluation Administrator
Phone: (850) 414-4303
Fax: (850) 414-4189

Approved Product List (APL)	The Approved Product List identifies the products that have been approved for use by the Florida Department of Transportation for use on State and Federal Highways. The products are listed by the Specification, Structure or Design Value reference that identifies the product usage or material requirements. Where applicable, cross references are provided to that usage and material requirements are easily identified.
New Product Submitted Process Flow Chart	This flowchart illustrates the process followed when introducing products to the Department for consideration when no FDOT Specification or Standard exist.
New Product Application	This application is to be used when submitting products to the Department for consideration when no FDOT Specification or Standard exist.
Approved Product Submitted Process Flow Chart	This flowchart illustrates the process followed when a product is submitted for evaluation against an existing FDOT Specification or Standard.
Product Evaluation Application	This application is to be used when submitting a Product for evaluation against an existing FDOT Specification or Standard.
APL Submitted Process Sample Packing Slip	This slip provides information on the process used when submitting a product for evaluation against an existing FDOT Specification or Standard. The product must meet all the requirements without exception in order to be listed on the APL. The Sample Packing Slip documents it to be used when submitting a Sample to the State Materials Office for product testing.
APL Request/Review and Other Product Evaluation Links	This will take you to the Request/Review Schedule and Other, which is a good reference to identify the evaluation schedule and the criteria used to accept existing products on the APL. This will also take you to the Transportation Product Evaluation Procedure and the Request/Review Transportation Product Approval Product List (APL).
Innovative Product List (IPL)	This list provides information on innovative products being evaluated to the Department.

Innovative Products List (IPL)

Product list may be viewed on the Developmental Specifications or Developmental Design Standards web page.

Developmental Specification	Developmental Design Standard	Description	Revised	Product List
Dev016		Installation of Post-installed Anchor Systems and Details for Structural Applications in Concrete Elements. This specification includes the use of Undercut Anchor Systems. Hide View with Data?	Gene McDaniels	
Dev032		Post-Installed Anchor Systems and Details for Structural Applications in Concrete Elements. This specification includes the materials for the use of Undercut Anchor Systems. Hide View with Data?	Gene McDaniels	
Dev025		Retractable Car Wash Screen for use on roadways with a posted speed limit of 40 mph or less.	Rick Ramo	
Dev428		Threaty Deck Early Rise 200 Buoyant Flow Control Device allows for a constant discharge of water out of a storm water management facility.	Rick Ramo	
Dev548	1003.0499	High Tension Cable Barrier System	Devoid Sheppard	Tirey - CAS-1L Cable Safety System, FDOT Report Hulse - 100.CAB.F Barrier Systems, FDOT Report Biden - 25/100 Wire Rope Fence, FDOT Report Obraster - Gibraltar Systems, FDOT Report
Dev548		Retaining Wall Systems - used when Segmental Block MSE Walls (SBW) are allowed.	Larry Jones	
Dev548	1003.0621	Geosynthetic Reinforced Soil Abutments and Walls	Larry Jones	





Questions?

