Index 455-440 Precast Concrete Sheet Pile Wall (CFRP/GFRP & HSSS/GFRP)

Design Criteria

AASHTO LRFD Bridge Design Specifications; ***Fiber Reinforced Polymer Guidelines (FRPG)***; ***ACI 440.1R-06 Guide for the Design and Construction of Structural Concrete Reinforced with FRP Bars***; ***ACI 440.4 Prestressing Concrete Structures with FRP Tendons; FDOT Design Manual (FDM); Structures Design Guidelines (SDG); Structures Detailing Manual (SDM)***

Design Assumptions and Limitations

These piles are typically jetted into place rather than driven like a bearing pile. If shallow rock formations exist within the wall limits, other wall types must be considered.

A cast-in-place reinforced concrete bulkhead cap is required to structurally tie the tops of the concrete sheet piles together.

These piles can be used for cantilevered walls or tied-back walls. Project specific designs and details are required for tie-backs. If the length of piles required for a cantilevered wall exceeds the limits shown on the standard drawings, consider using tie-backs.

These piles are intended for extremely aggressive environments.

The grouted keyway used in combination with plastic filter fabric (the limits of both are defined by dimension "X") are assumed to not be watertight. Thus they contain the soil behind the wall while still allowing groundwater behind the wall to weep through. No other separate weep holes are generally required. The bottom of the "X" dimension is required to be 1'-8" below the mud line.

The tip elevation of piles shall be determined by the Geotechnical Engineer.

STRAND MATERIAL	WALL THICKNESS (in.)	STRAND DIA. (in.)	SECTION MODULUS (in^3)	STRESS* (psi)
CFRP	T=10	0.49 (12.5 mm)	500	730
		0.5 (12.7 mm)		830
		0.6 (15.2 mm)		840
	T=12	0.49 (12.5 mm)	720	730
		0.5 (12.7 mm)		700
		0.6 (15.2 mm)		710
HSSS	T=10	0.5 (12.7 mm)	500	790
		0.6 (15.2 mm)		750
	T=12	0.5 (12.7 mm)	720	780
		0.6 (15.2 mm)		780

* Unit Prestress after losses @ Section B-B (see Sheet 2 for location of Section B-B)

See additional information on the Standard.

Plan Content Requirements

In the Structures or Roadway Plans:

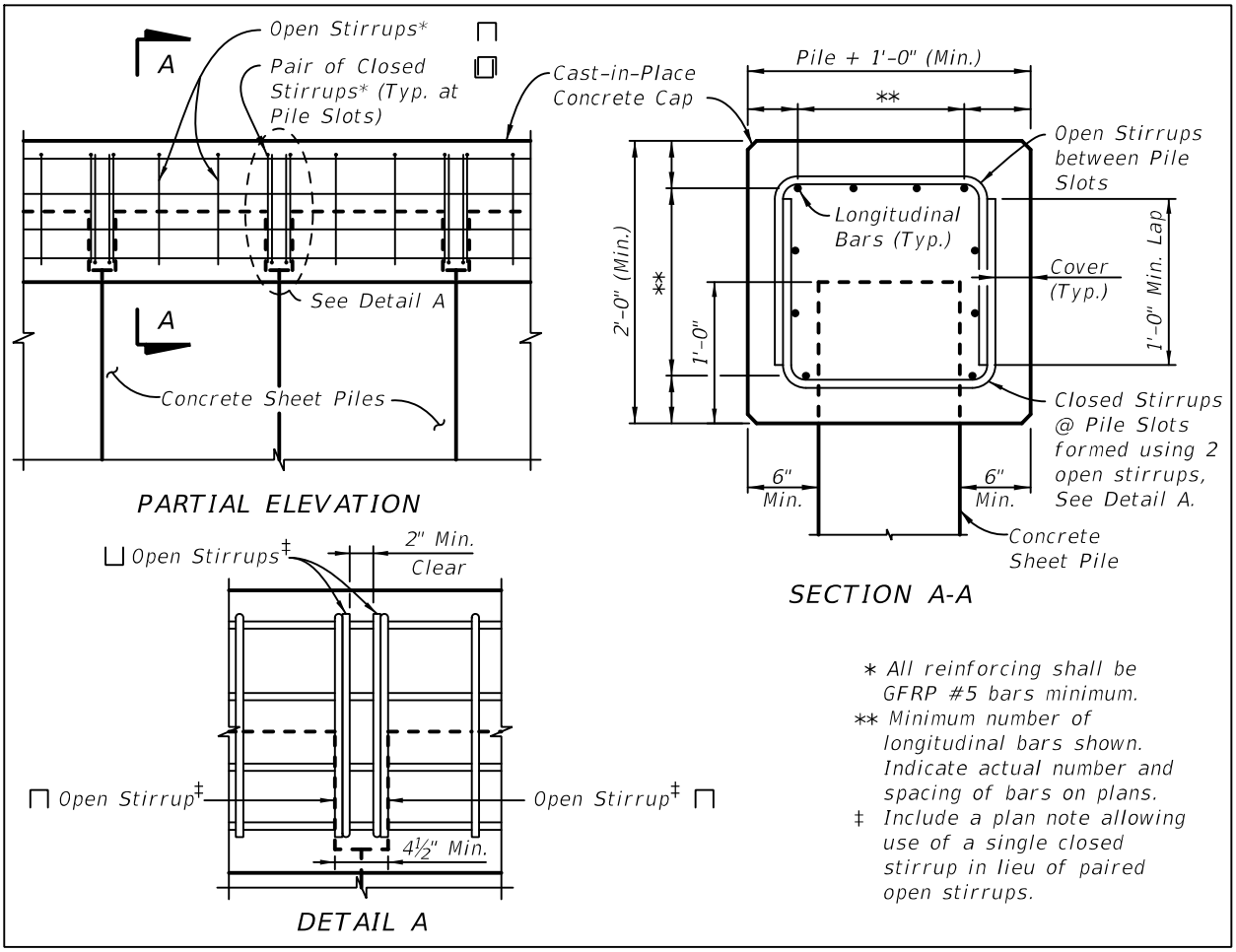
Prepare Wall Control Drawings and related drawings as specified in ***SDM*** Chapter 19 and ***FDM*** 262 and include them in the plans. Use combinations of straight and corner piles to accommodate project specific geometric requirements.

Generally, Type “A” CFRP or HSSS strand prestressed piles are both acceptable in all environments and use is at the option of the Contractor unless project specific needs limit the type to only one prestressing strand material.

Show one Starter Pile location for a given wall. In the Elevation View, show the wall construction sequence proceeding away from the Starter Pile by locating the 11" by 11" corner clip on each Typical Pile on the side farthest away from the Starter Pile. Consider necessary tie-ins with adjacent structures and other boundary restrictions when selecting the Starter Pile location.

Prepare project specific cast-in-place concrete bulkhead cap, tie-back and utility accommodation details and include them in the plans. See Figure 1 for typical cap details. In the Materials Note on the General Notes Sheet, specify the concrete class for the cast-in-place cap in accordance with the retaining wall environment classification. See ***SDG*** 1.4.

Figure 1 Typical Cap Details



Complete the following "Concrete Sheet Pile Wall with Prestressed Soil Anchors Data Table", "Concrete Sheet Pile Wall with Dead Man Anchors Data Table" or "Concrete Sheet Pile Wall, Cantilever Data Table" as applicable and include it on the supplemental sheets. Complete the Notes and add/modify/delete as necessary. See Introduction I.3 for more information regarding use of Data Tables.

CONCRETE CFRP/GFRP & HSSS/GFRP SHEET PILE WALL WITH PRESTRESSED SOIL ANCHORS DATA TABLE																					Table Date 11-01-16
CONSTRUCTION INFORMATION																DESIGN PARAMETERS					
WALL LOCATION		WALL NO.	CONCRETE SHEET PILE FABRICATION						ANCHORS					MINIMUM WALL TIP ELEVATION (ft)	TOP OF WALL ELEV. (ft)	SOIL ELEVATION		WATER ELEVATION		FACTORED DESIGN SURCHARGE LOAD (psf)
STATION (begin to end)	OFFSET (ft)		TYPE (See Detail A)	NUMBER REQUIRED	PILE LENGTH L (ft)	PILE THICKNESS T (in)	GROOVE LENGTH X (ft)	CORNER ANGLE Ø (degrees)	MAXIMUM ANCHOR SPACING (ft)	FACTORED ANCHOR LOAD (kips/ft)	SERVICE ANCHOR LOAD (kips/ft)	MINIMUM UNBONDED LENGTH (ft)	INSTALLATION ANGLE BELOW HORIZONTAL (degrees)			* FRONT OF WALL (ft)	BACK OF WALL (ft)	FRONT OF WALL (ft)	BACK OF WALL (ft)	

* Minimum of Design Ground Surface or Design Scour Depth.

NOTES:

1. Work the Data Table with Standard Plans Index 455-440 and Specification Section 451.
2. Factored Anchor Design Load (kips) = Factored Anchor Load (kips/ft) x Anchor Spacing (ft).
3. Environmental Classification is _____.
4. Concrete for cast-in-place retaining wall caps shall be Class _____ (f'c = _____ psi), _____ (with/without) silica fume, metakaolin or ultrafine fly ash.

CONCRETE CFRP/GFRP & HSSS/GFRP SHEET PILE WALL WITH DEAD MAN ANCHORS DATA TABLE																		Table Date 11-01-16
CONSTRUCTION INFORMATION													DESIGN PARAMETERS					
WALL LOCATION		WALL NO.	CONCRETE SHEET PILE FABRICATION						ANCHORS		MINIMUM WALL TIP ELEVATION (ft)	TOP OF WALL ELEV. (ft)	SOIL ELEVATION		WATER ELEVATION		FACTORED DESIGN SURCHARGE LOAD (psf)
STATION (begin to end)	OFFSET (ft)		TYPE (See Detail A)	NUMBER REQUIRED	PILE LENGTH L (ft)	PILE THICKNESS T (in)	GROOVE LENGTH X (ft)	CORNER ANGLE Ø (degrees)	ANCHOR BAR SPACING (ft)	ANCHOR BAR DIAMETER (in)			* FRONT OF WALL (ft)	BACK OF WALL (ft)	FRONT OF WALL (ft)	BACK OF WALL (ft)	

* Minimum of Design Ground Surface or Design Scour Depth.

NOTES:
1. Work the Data Table with Standard Plans Index 455-440.
2. Environmental Classification is _____
3. Concrete for cast-in-place retaining wall caps shall be Class _____ (f'c = _____ psi), _____(with/without) silica fume, metakaolin or ultrafine fly ash.

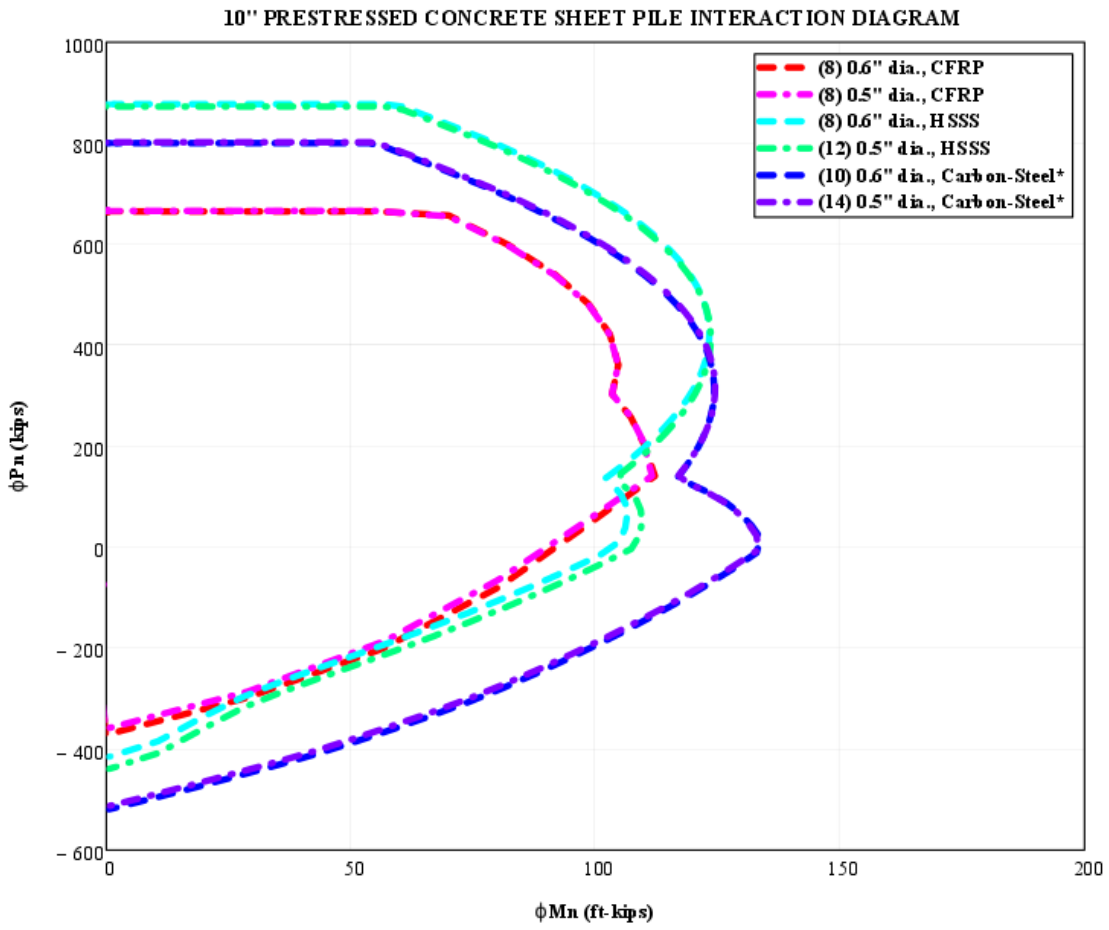
CONCRETE CFRP/GFRP & HSSS/GFRP SHEET PILE WALL, CANTILEVER DATA TABLE																Table Date 11-01-16
CONSTRUCTION INFORMATION											DESIGN PARAMETERS					
WALL LOCATION		WALL NO.	TYPE (See Detail A)	NUMBER REQUIRED	PILE LENGTH L (ft)	PILE THICKNESS T (in)	GROOVE LENGTH X (ft)	CORNER ANGLE Ø (degrees)	MINIMUM WALL TIP ELEVATION (ft)	WALL TOP ELEV. (ft)	SOIL ELEVATION		WATER ELEVATION		DESIGN LIVE LOAD (psf)
STATION (begin to end)	OFFSET (ft)										FRONT OF WALL (ft)	BACK OF WALL (ft)	FRONT OF WALL (ft)	BACK OF WALL (ft)	

NOTES:
1. Work the Data Table with Standard Plans Index 455-440.
2. Environmental Classification is _____.
3. Concrete for cast-in-place retaining wall cap shall be Class _____ (f'c = _____ psi). _____ (with/without) silica fume, metakaolin or ultrafine fly ash.

Payment

Item number	Item Description	Unit Measure
400-2-8	Concrete Class II, Bulkhead	CY
400-3-8	Concrete Class III, Bulkhead	CY
400-4-8	Concrete Class IV, Bulkhead	CY
415-10-AA	Fiber Reinforced Polymer Bar (for Bulkhead)	LF
451-70-AA	Prestressed Soil Anchor	EA
455-14-AA	Concrete Sheet Piling	LF
455-87	Anchor Bar, Steel	EA

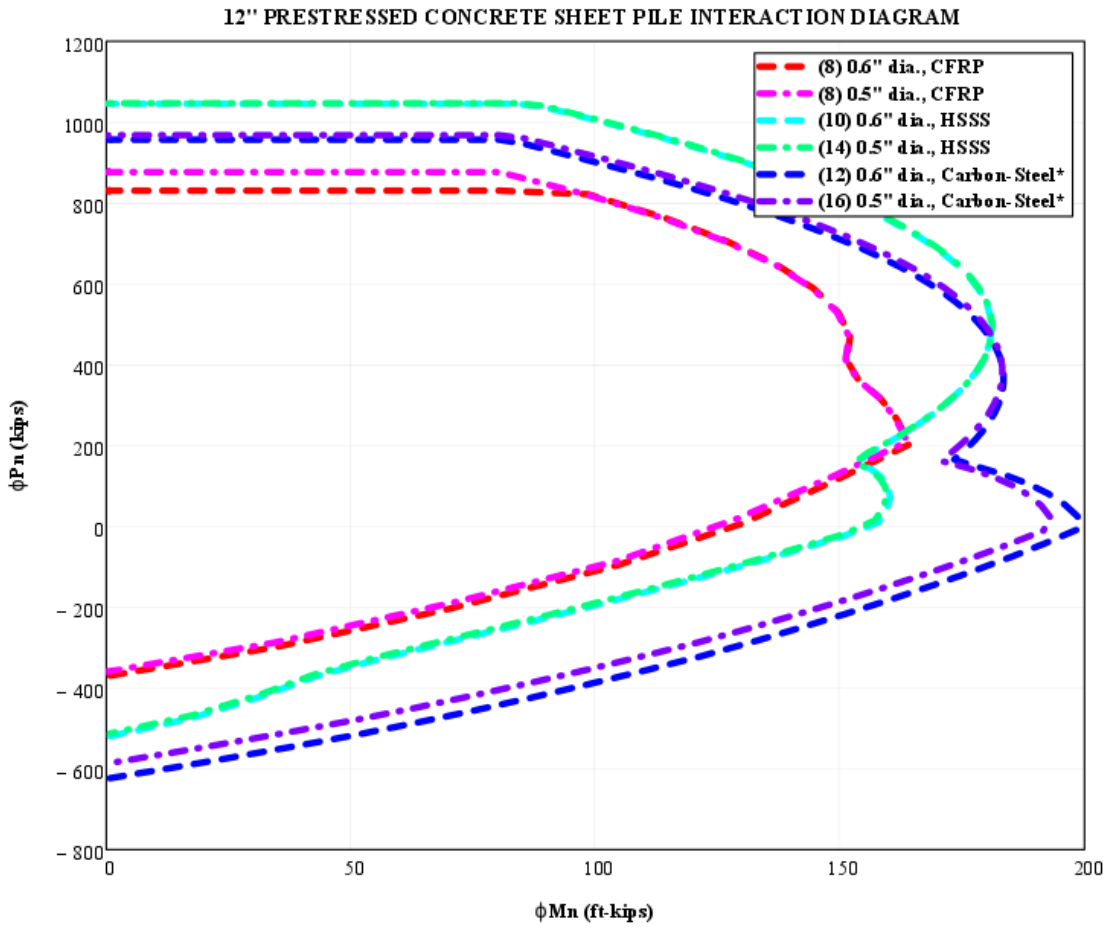
Design Aids



Design Assumptions:

- Concrete compressive strength $f'_c = 6$ ksi.
- Modulus of elasticity of prestressing strands, $E_p = 22{,}480$ ksi (0.6" CFRP), 23,500 ksi (HSSS) & 28,500 ksi (Carbon-Steel).
- Resistance factors ϕ based on ACI 440.4R for CFRP strands (0.65 compression-controlled, 0.85 tension-controlled); and AASHTO LRFD 5.5.4.2.1 for HSSS & Carbon-Steel strands (0.75 compression-controlled, 1.0 tension-controlled).

* The M-N Curve for Carbon-Steel, based on Index 455-400, is shown for information purposes only.



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