BOARDWALK - MINIMUM BUILDING FOOTPRINT DESIGN

PURPOSE

- Minimum building footprint design to have less disturbance on the wetland area

- Development of an lightweight decking system for the boardwalk

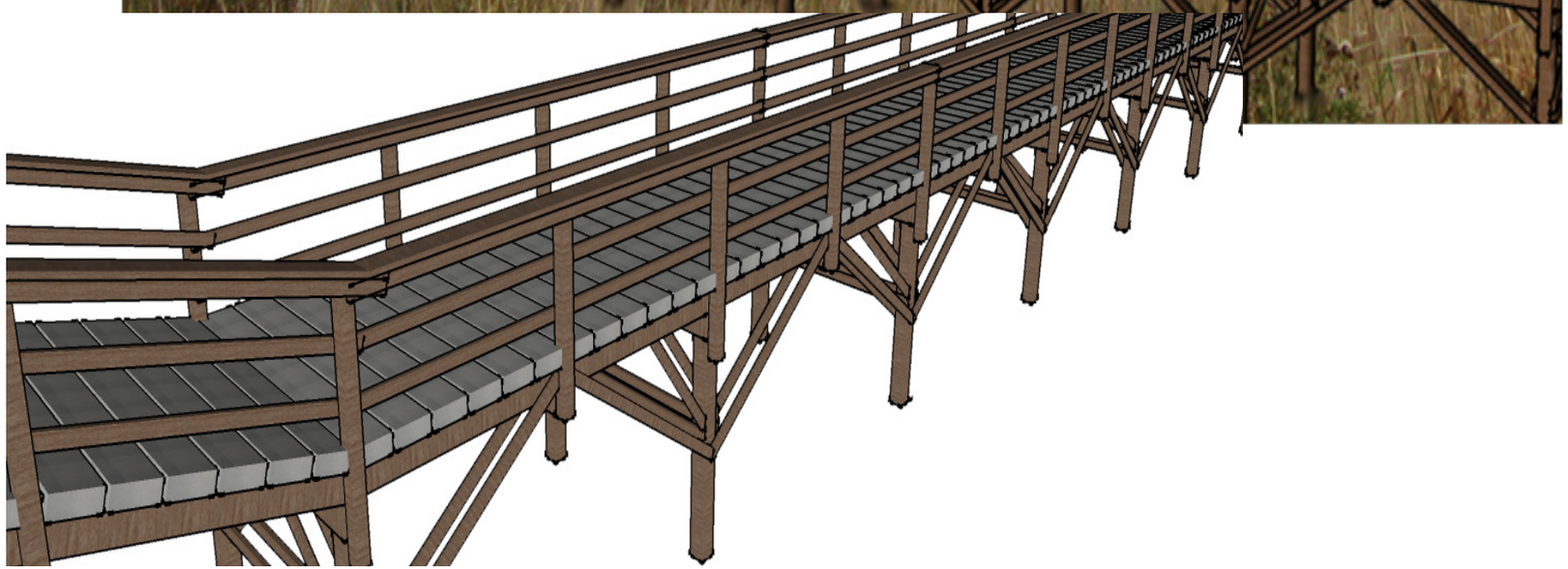
- Development of sustainable and economic horizontal and vertical framing system

DEVELOPMENT OF STRUCTURAL SYSTEM

- Boardwalk decking system

- Horizontal framing system i.e. beam arrangement plan

- Vertical framing system i.e. column arrangement plan



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DECKING SYSTEM

DECKING SYSTEM

The materials considered for the decking system are:

- Recycled concrete
- Lumber (timber) decking
- Wood plastic composite

RECYCLED CONCRETE

Pros

- Use of existing tilt up materials
- Saves landfill space by keeping concrete debris out of landfill
- Reduces pollution by trucking material
- Low maintenance
- Higher durability
- Longer design life

Cons

- Comparatively heavy weight

RECYCLED CONCETE

LUMBER

Pros

- Lightweight
- Energy efficient
- Sustainable

Cons

- Shorter design life
- Requires maintenance
- Requires preservative treatment

LUMBER

WOOD PLASTIC COMPOSITE (WPC)

Pros

- Low maintenance
- Higher durability and longer design life
- Aesthetic
- Recycled material
- Higher resistance to moisture to and decay
- Resistance to termites

Cons

- Thermal expansion
- Higher initial cost
- Lower stiffness than timber and thus have higher deflection

Material Properties

Material	Unit Weight	Modulus of Rupture	Modulus of Elasticity
	pcf	Psi	psi
Recycled Concrete	135-145	500-600	$2.5x10^6 – 3.5x10^6$
Lumber	30	6000	$1.1x10^6$-$1.8x10^6$
Wood Plastic	56	7000	$7.2x10^5$

Required Thickness for Boardwalk Deck

Material	Thickness (inch)		SW (lb/ft)	
	6 ft Span	3 ft Span	6 ft Span	3 ft Span
Recycled Concrete	3.75	2.5	46.9	31.25
Lumber	2.5	1.5	6.25	3.75
Wood Plastic	4 (Hollow Box Section)	1.25	8.8	5.83

WPC - HOLLOW BOX SECTION

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FRAMING DESIGN - OPTION 1

HORIZONTAL FRAMING PLAN

- Determining the most efficient structural system

- Optimizing the beam cross-section to reduce the self weight of the boardwalk.

- Only engineered timber has been considered for the beam design.

VERTICAL/ COLUMN FRAMING PLAN

- Minimum disturbance to the wetland area

- Optimizing the pin pile capacity

OPTION 1:

This is a conventional type of framing system with beam supported by columns on each side.

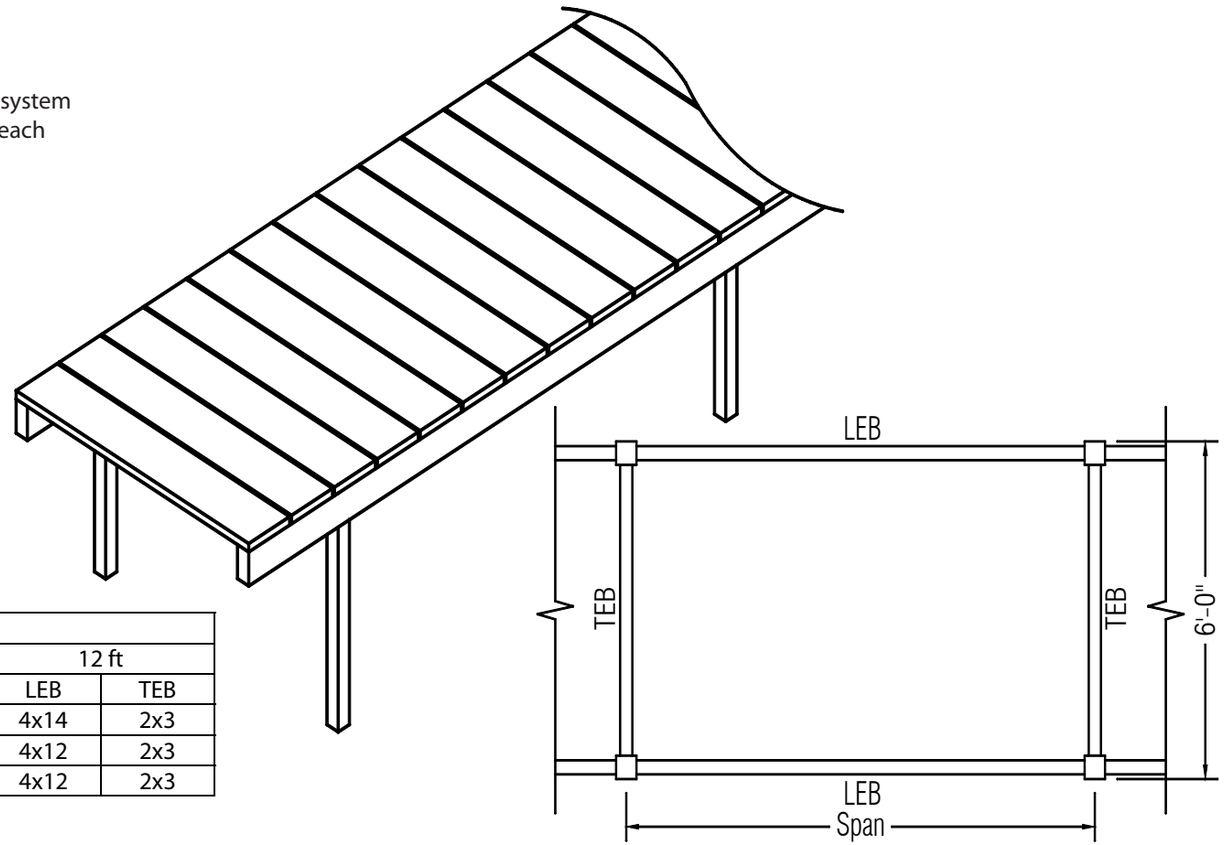
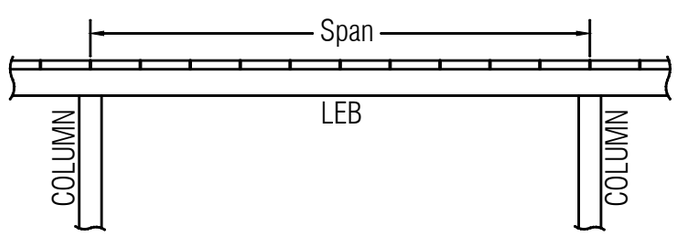


Table 1: Beam X-Section with beam on four edges of the boardwalk

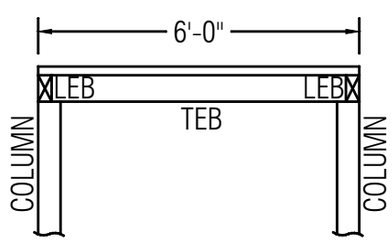
Deck Type	Longitudinal Span							
	6 ft		8 ft		10 ft		12 ft	
	LEB	TEB	LEB	TEB	LEB	TEB	LEB	TEB
Recycled Concrete	2x12	2x3	3x12	2x3	4x12	2x3	4x14	2x3
Lumber	2x8	2x3	2x12	2x3	4x10	2x3	4x12	2x3
Wood Plastic	2x10	2x3	4x8	2x3	4x10	2x3	4x12	2x3

Table 2: Required pile capacity at each column for option 1

Deck Type	Service load at each column (lb)			
	6 ft	8 ft	10 ft	12 ft
Recycled Concrete	1075	1435	1805	2170
Lumber	705	940	1190	1430
Wood Plastic	730	975	1225	1480



Longitudinal Elevetion



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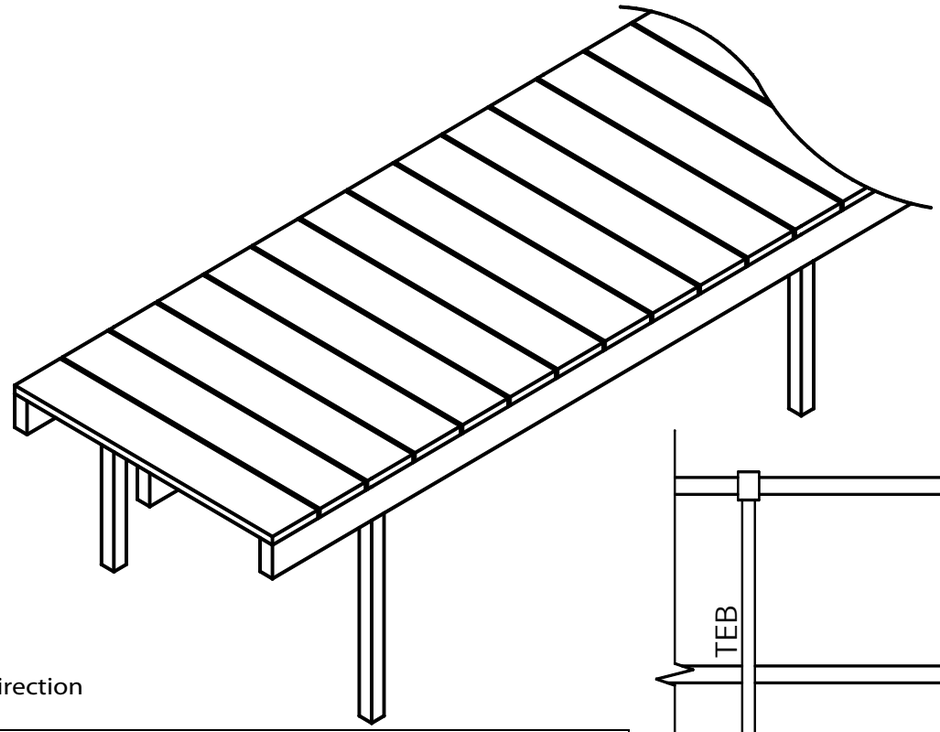
FRMNING DESIGN - OPTION 2

The framing plan consists of four beams at edges and one longitudinal beam at the center of the transverse direction. The advantage of this framing system is:

- Less thickness for the deck

- Decreasing the transverse span will reduce the deflection of deck



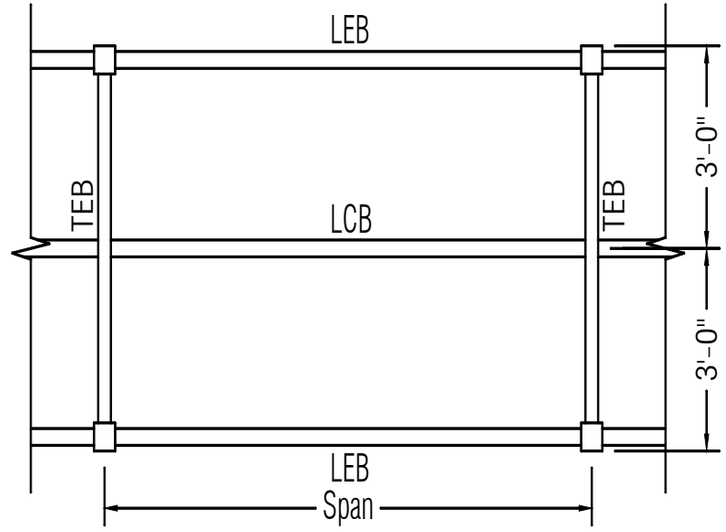
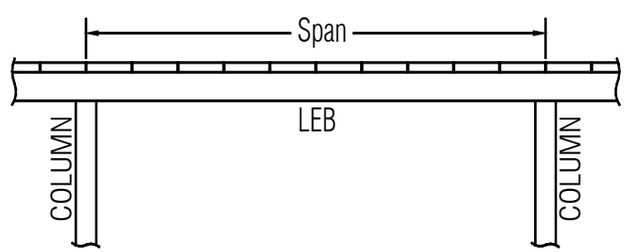


Table 3: Beam X-Section with center beam in the longitudinal direction

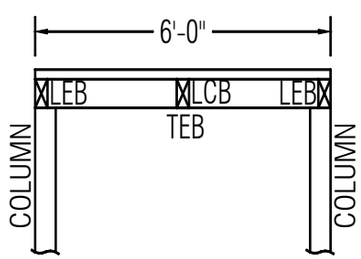
Deck Type	Longitudinal Span											
	6 ft			8 ft			10 ft			12 ft		
	LCB	LEB	TEB	LCB	LEB	TEB	LCB	LEB	TEB	LCB	LEB	TEB
Recycled Concrete	3x8	2x8	2x12	3x10	2x10	4x10	4x12	2x12	4x12	6x10	4x10	6x10
Lumber	2x8	1x8	2x12	4x8	2x8	4x10	4x10	2x10	3x12	4x12	2x12	4x12
Wood Plastic	2x8	1x8	2x12	4x8	2x8	3x12	4x10	2x10	3x12	4x12	2x12	4x12

Table 4: Required pile capacity at each column for option 2

Deck Type	Service load at each column (lb)			
	6 ft	8 ft	10 ft	12 ft
Recycled Concrete	940	1265	1590	1935
Lumber	690	930	1165	1420
Wood Plastic	710	955	1195	1455



Longitudinal Elevetion



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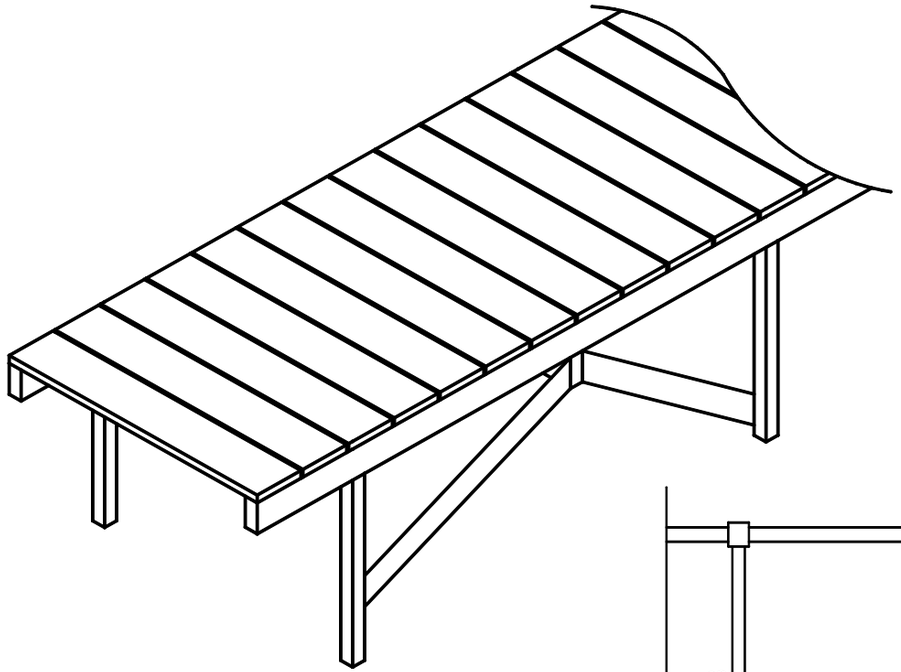
FRMNING DESIGN - OPTION 3

The option 1 described earlier has been modified with cross-bracing connecting the column. The additional advantages it provides are:

- Lowered beam sizes
- Increased column spacing
- Less disturbance on wetland area



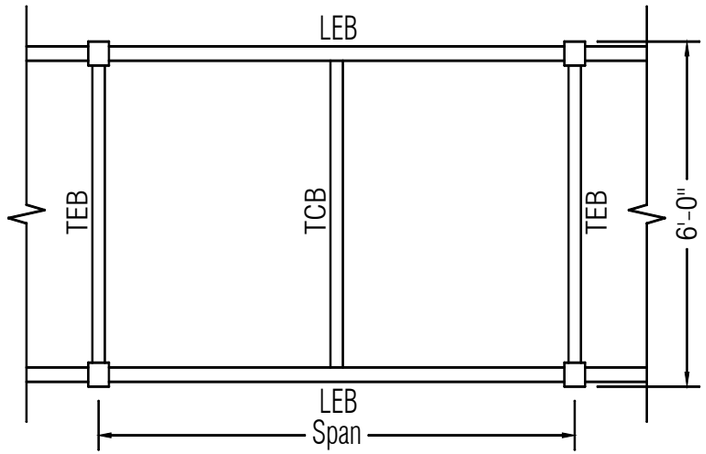
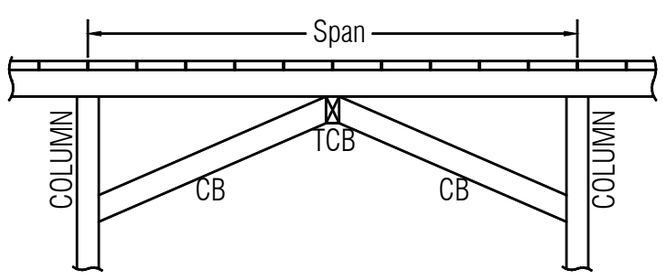


Table 5: Beam X-Section with cross beam

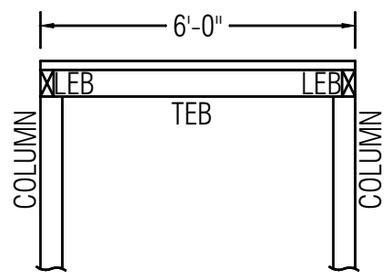
Deck Type	Longitudinal Span								
	8 ft			10 ft			12 ft		
	LEB	CB	TEB/ TCB	LEB	CB	TEB/ TCB	LEB	CB	TEB/ TCB
Recycled Concrete	2x8	2x3	2x3	2x10	2x4	2x3	3x8	2x4	2x4
Lumber	2x6	2x3	2x3	2x8	2x3	2x3	2x8	2x4	2x3
Wood Plastic	2x6	2x3	2x3	2x8	2x3	2x3	3x6	2x4	2x3

Table 6: Required pile capacity at each column for option 3

Deck Type	Service load at each column (lb)		
	8 ft	10 ft	12 ft
Recycled Concrete	1430	1790	2155
Lumber	940	1175	1410
Wood Plastic	970	1210	1455



Longitudinal Elevetion



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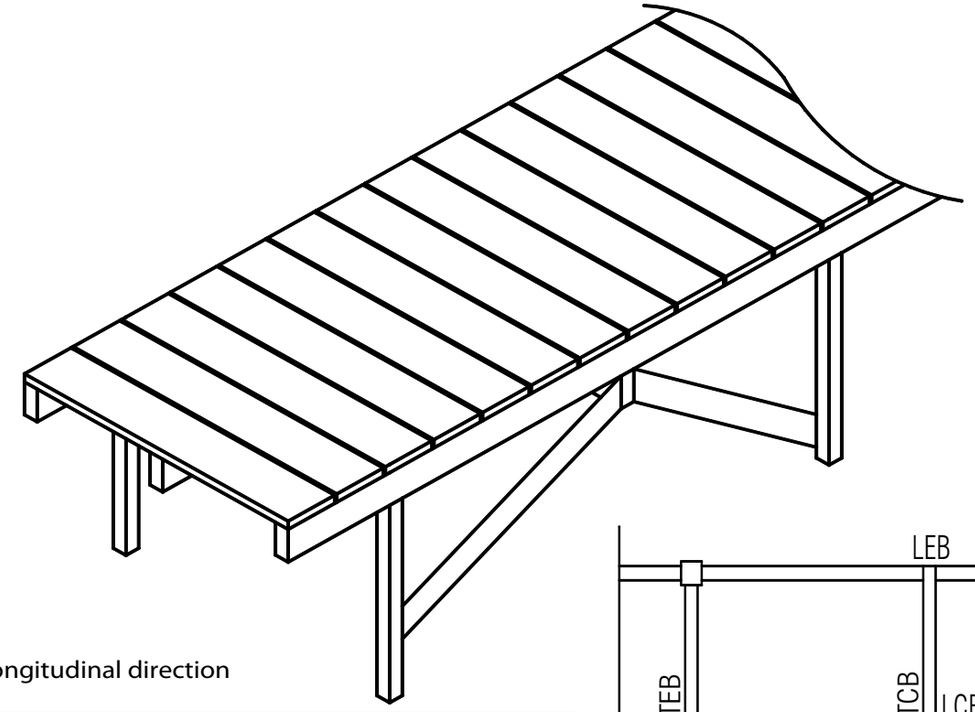
FRMNING DESIGN - OPTION 4

Option 4: Again option 2 has been modified here with cross bracing included.

- Less disturbance to wetland area with increased column spacing
- Reduced beam sizes thus eventually decreasing the self weight



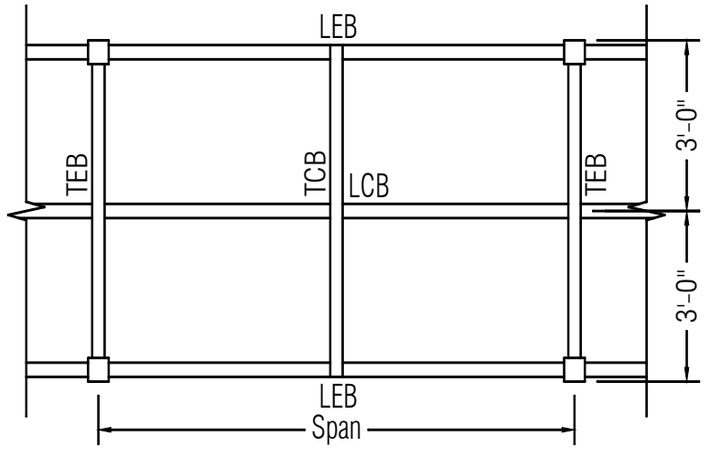
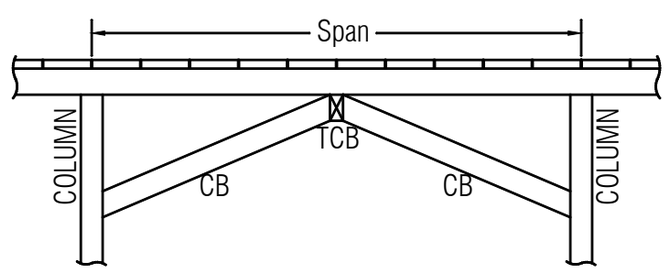


Table 7: Beam X-Section with cross bracing and center beam in the longitudinal direction

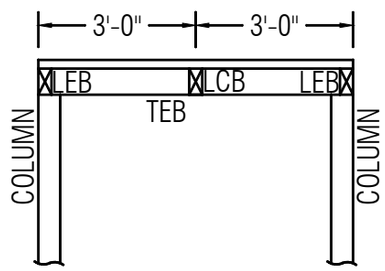
Deck Type	Longitudinal Span											
	8 ft				10 ft				12 ft			
	LCB	LEB	CB	TEB/ TCB	LCB	LEB	CB	TEB/ TCB	LCB	LEB	CB	TEB/ TCB
Recycled Concrete	2x6	1x6	2x3	2x12	3x6	2x6	2x3	2x12	4x6	3x6	2x4	3x12
Lumber	3x4	2x4	2x3	2x10	4x4	2x4	2x3	2x10	3x6	2x6	2x3	2x12
Wood Plastic	3x4	2x4	2x3	2x10	4x4	2x4	2x3	2x12	3x6	2x6	2x3	2x12

Table 8: Required pile capacity at each column for option 4

Deck Type	Service load at each column (lb)		
	8 ft	10 ft	12 ft
Recycled Concrete	1250	1565	1900
Lumber	920	1145	1380
Wood Plastic	945	1180	1415



Longitudinal Elevetion



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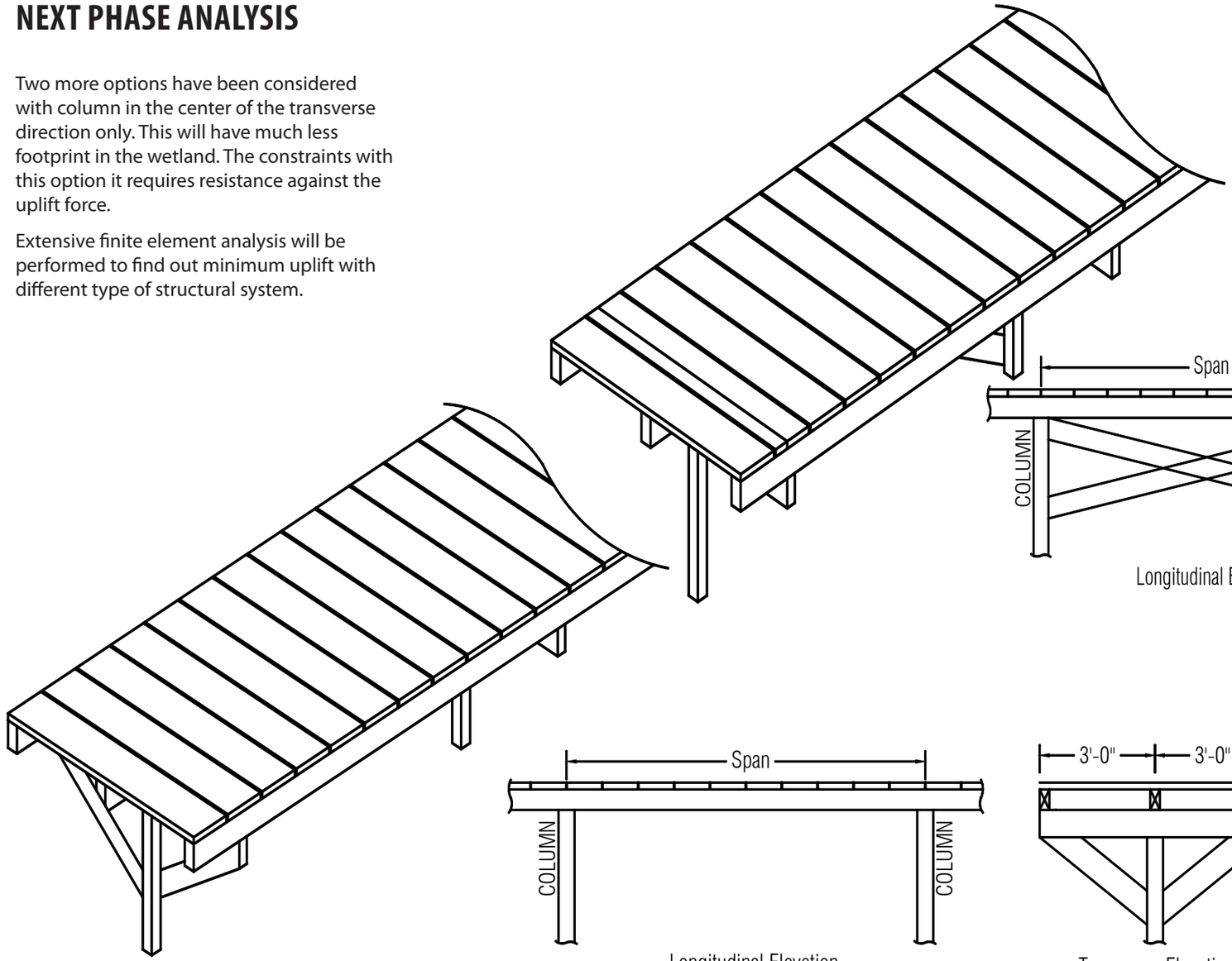
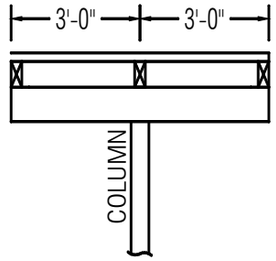
NEXT PHASE ANALYSIS

Two more options have been considered with column in the center of the transverse direction only. This will have much less footprint in the wetland. The constraints with this option it requires resistance against the uplift force.

Extensive finite element analysis will be performed to find out minimum uplift with different type of structural system.



Longitudinal Elevetion



Transverse Elevetion

Longitudinal Elevetion

Transverse Elevetion

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