

Rapid Port Enhancement: TSV Causeway Superstructure Concepts

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JLOTS Force Projection from the Sea

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Objective Force Maneuver Support Imperatives

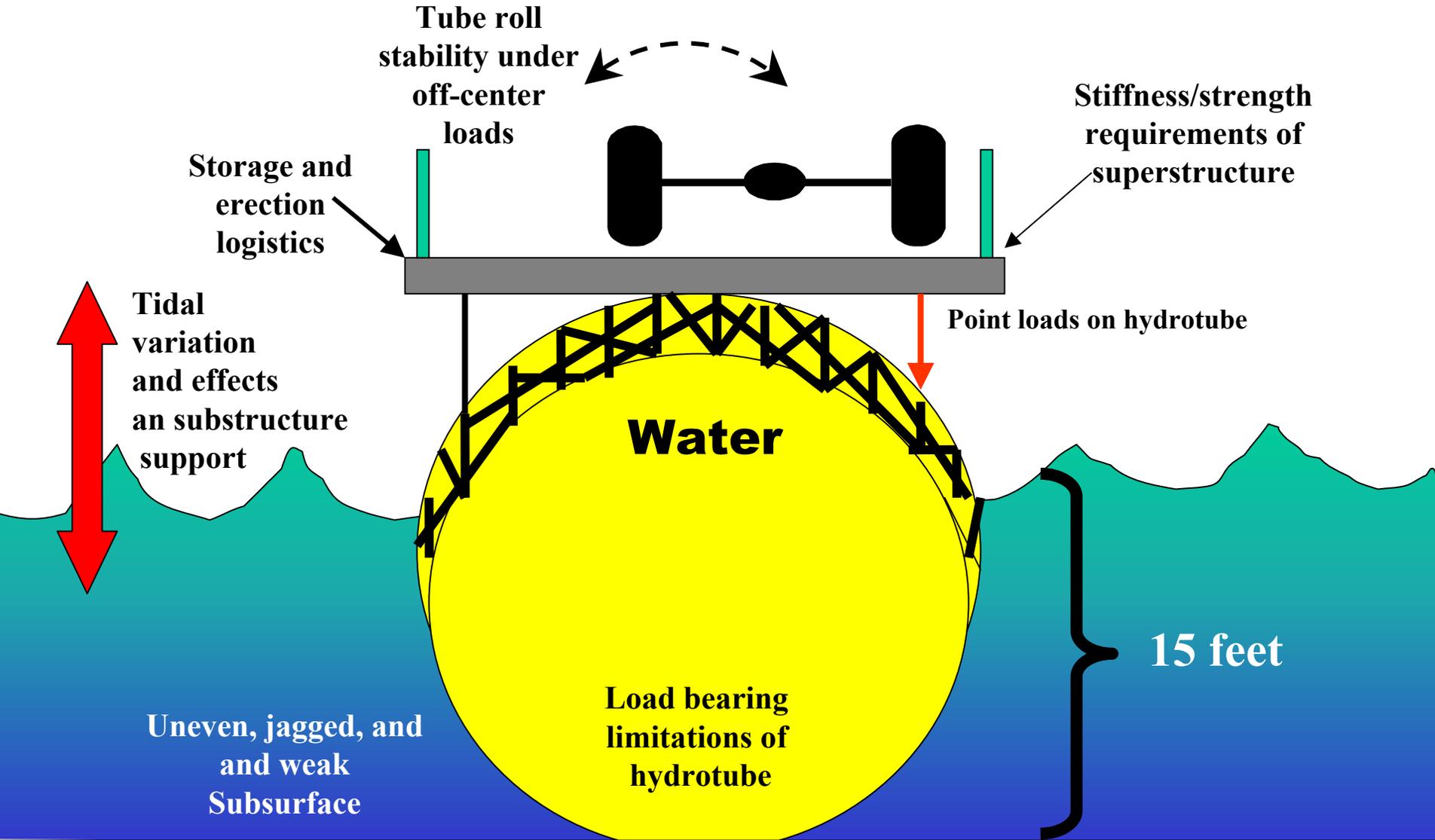
- Understand the Battlespace Environment
- **Enable Theater Access**
- Provide Assured Mobility
- Deny Enemy Freedom of Action
- Enable Force Protection and Security
- Engage and Control Populations
- Neutralize Hazards and Restore the Environment

Development Milestones

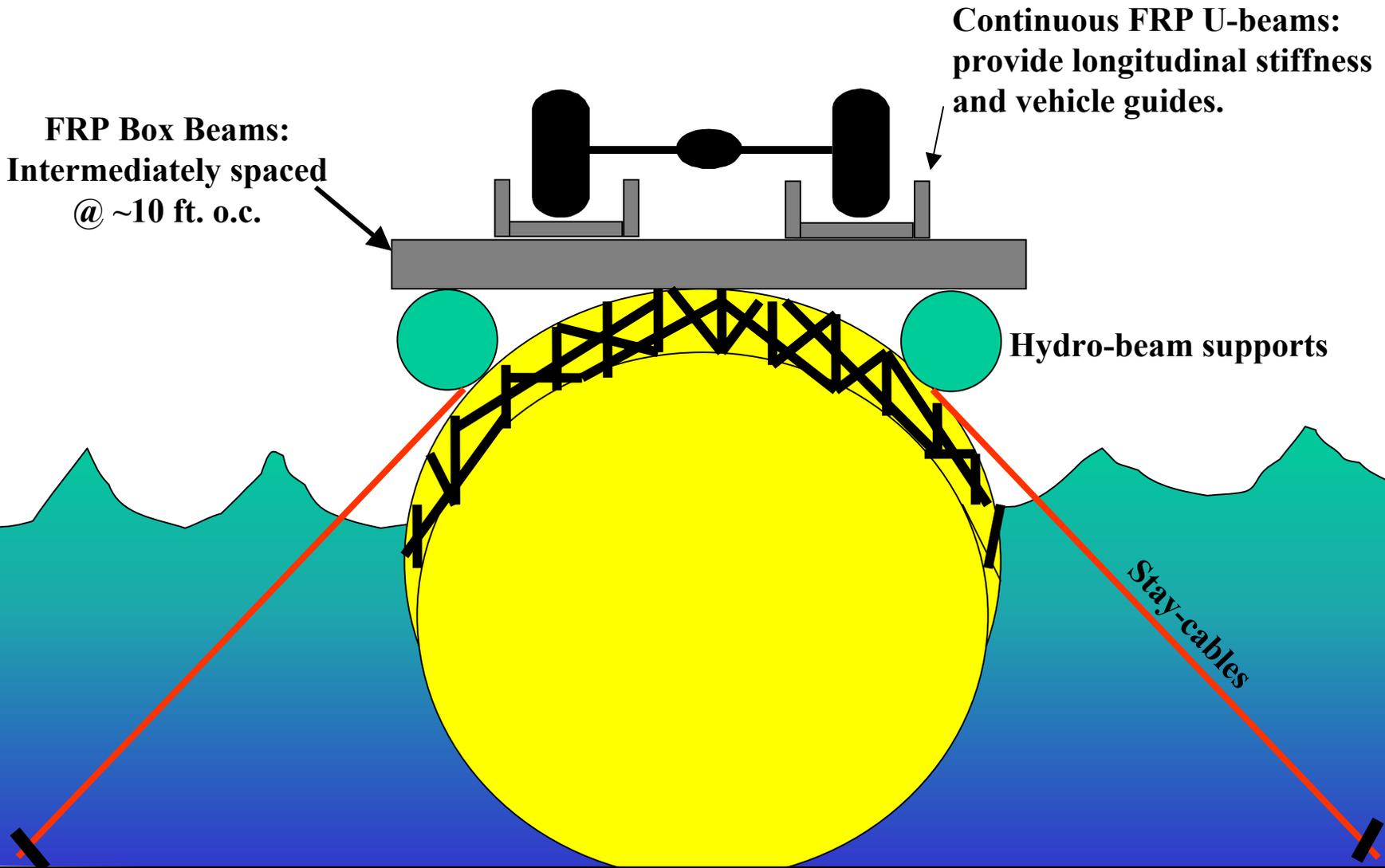
- **Develop initial concepts (FY03)**
- **Develop tools for evaluation and testing (FY03)**
- **Downselect optimal concepts (FY04)**
- **Laboratory testing (FY04)**
- **Scaled field testing (FY05)**
- **“Final” design (FY06)**



Major Challenges



Cross-beam/Treadway Concept

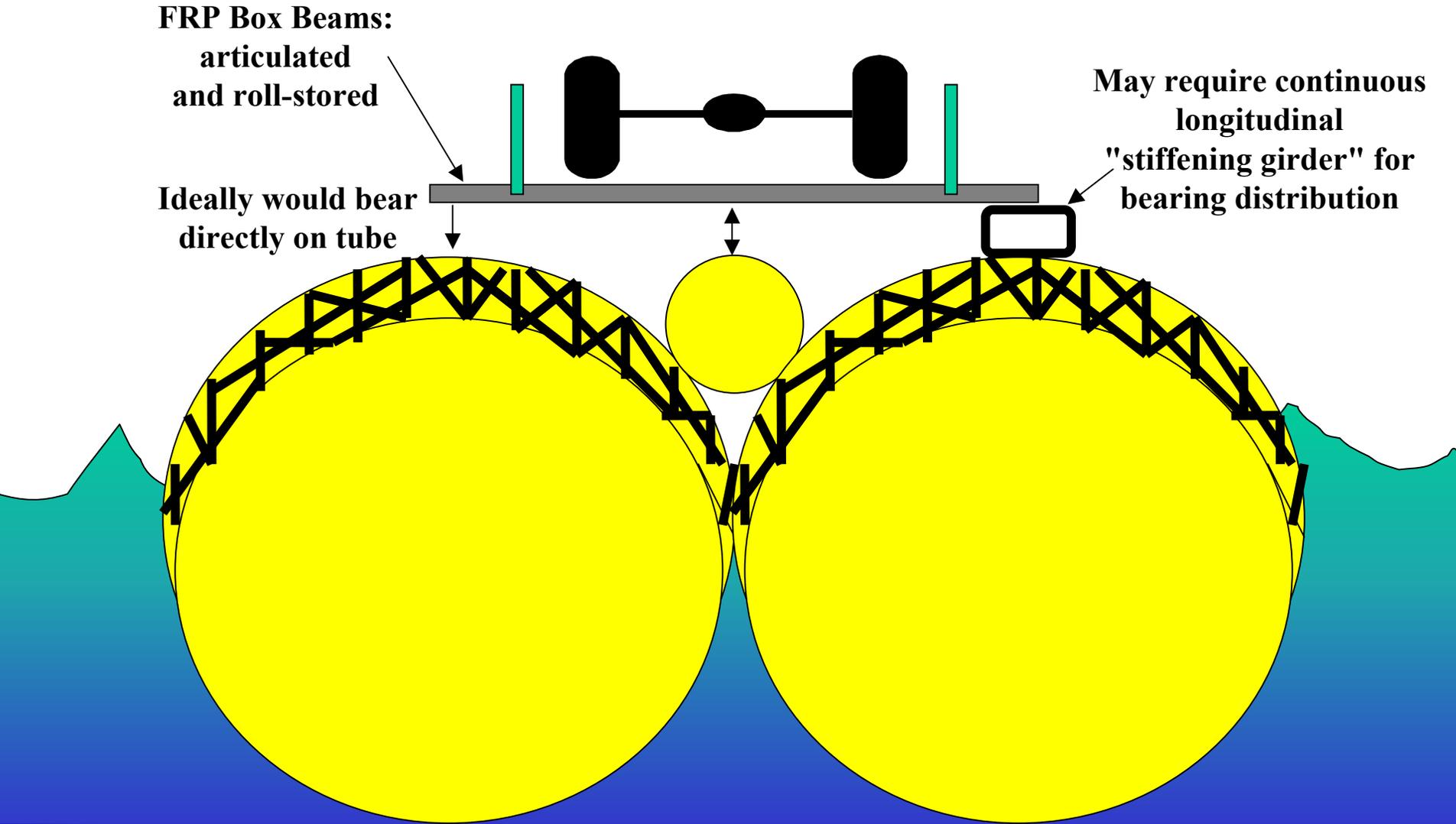


Double-Tube Concept

FRP Box Beams:
articulated
and roll-stored

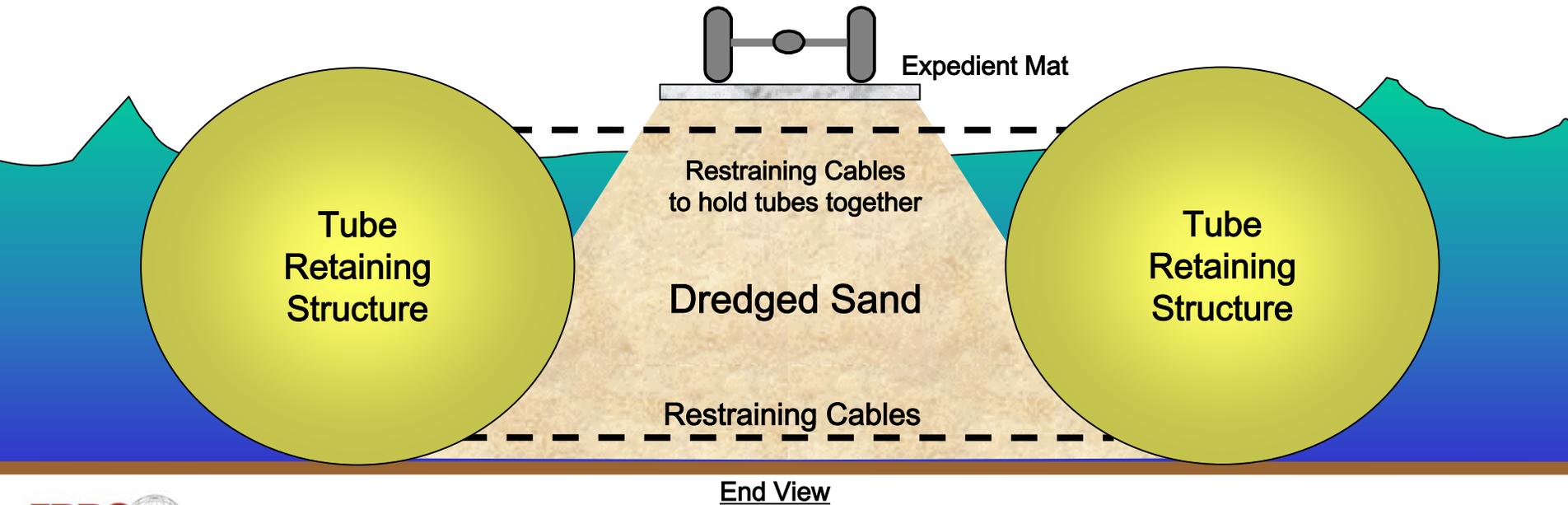
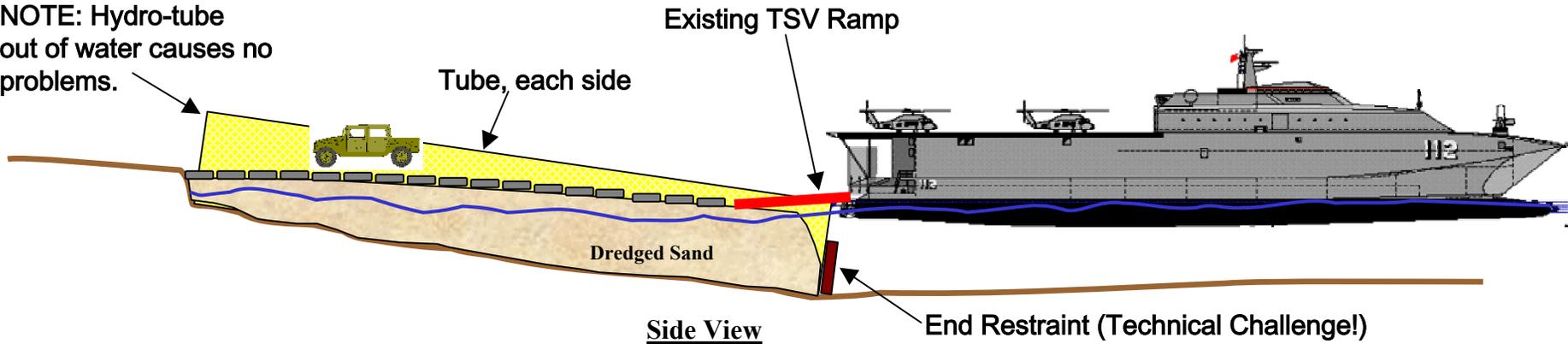
Ideally would bear
directly on tube

May require continuous
longitudinal
"stiffening girder"
for bearing distribution



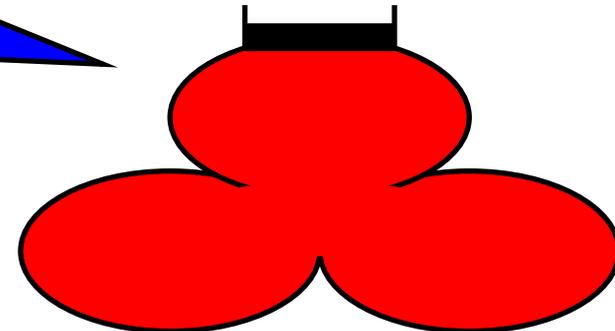
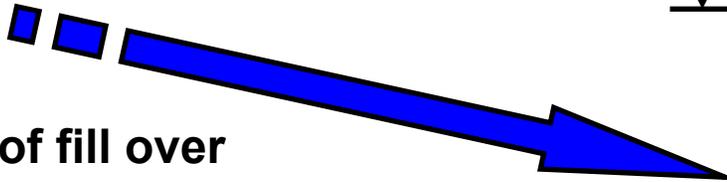
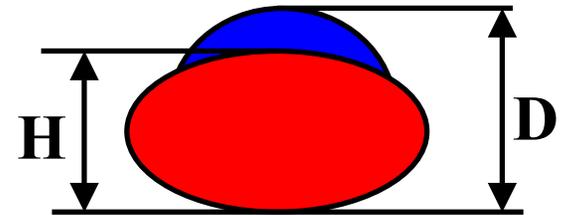
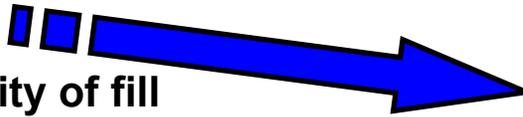
Tube-Confined Backfill

NOTE: Hydro-tube out of water causes no problems.



Geotextile Tubes

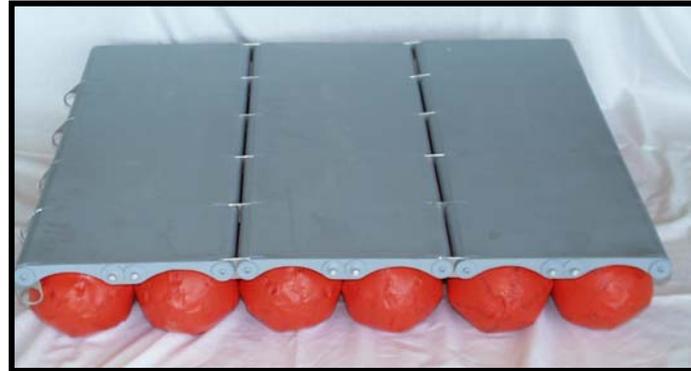
- **Construction Time**
 - 2-4 Days (Tube only)
- **Issues Attaching Superstructure**
- **Site Condition**
 - Sufficient Fill Material
- **Achieving Sufficient Height**
 - $H \cong (5/8)*D$
 - H decreases as quality of fill decreases.
- **Stability**
 - Stacking required to achieve height.
- **Porous fabrics – loss of fill over time**
- **Damage is a given in open environment**



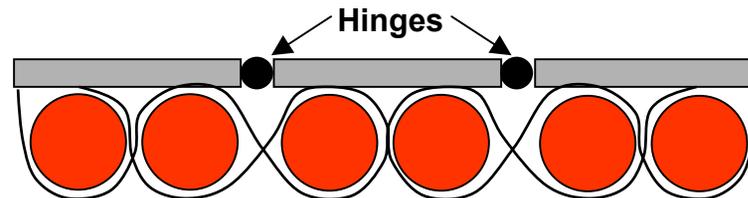
Floating Concept

Section Stiffening Options

Basic Stiffened Section

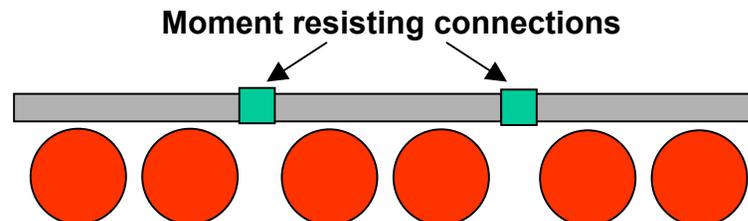


Strap Stiffened Section



Concept:
Woven strapping system forms lower chord of stiffened section. Floats are part of stiffening mechanism.

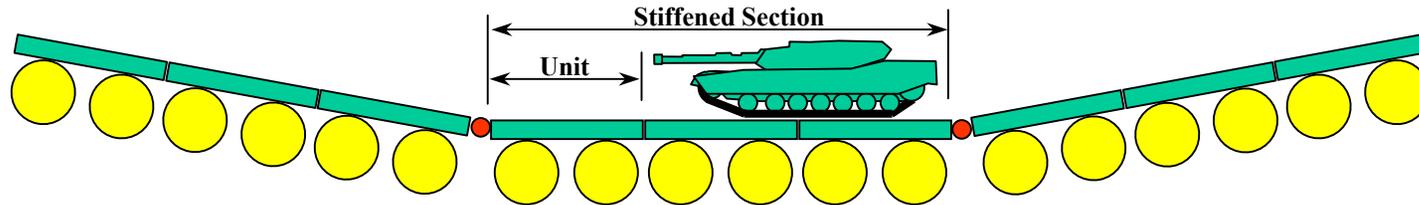
Mechanically Stiffened Section



Concept:
Sections are mechanically stiffened at connections. Floats only provide floatation.

Analysis Considerations

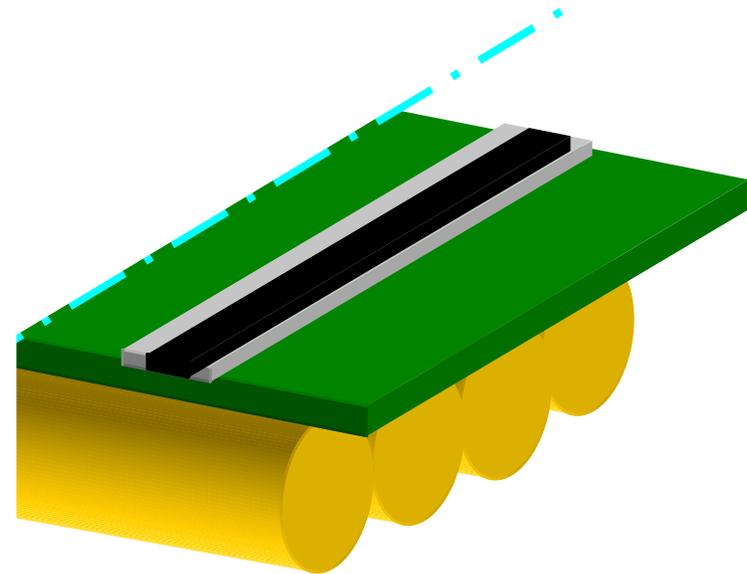
For Mechanically Stiffened Sections



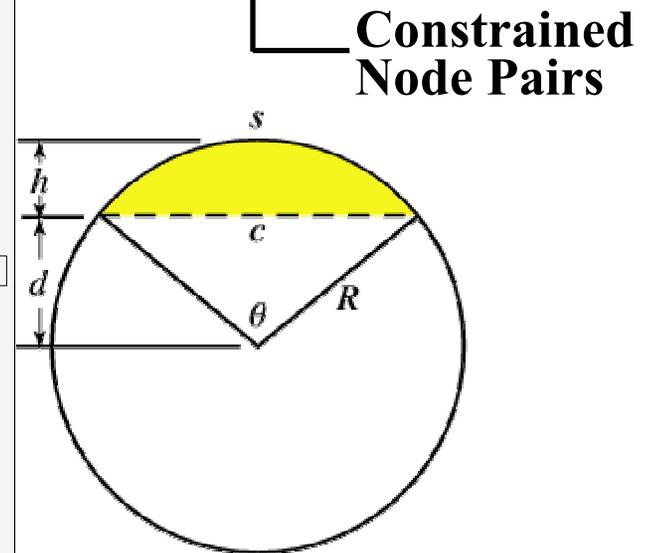
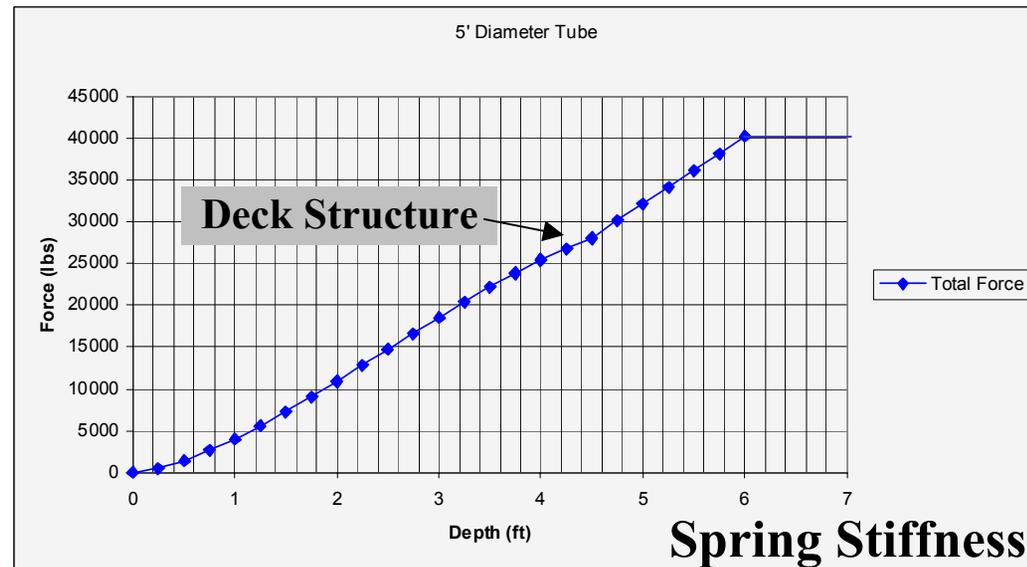
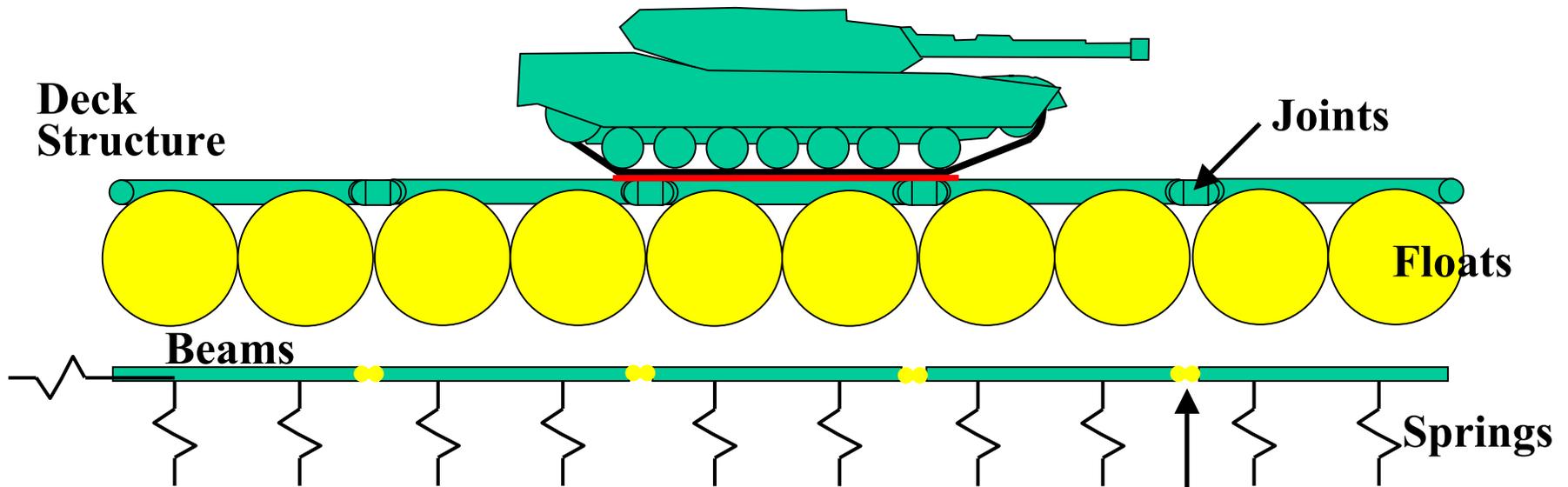
- **Global Stability**
 - Stiffened Section Length
 - Unit Length
- **Floatation**
 - Number and Size of Floats per Unit
 - Attaching to superstructure
- **Beam Strength**
 - Cross-Section
 - Material
- **Hydrodynamics**
 - Wave Loadings

Analytical Approximations

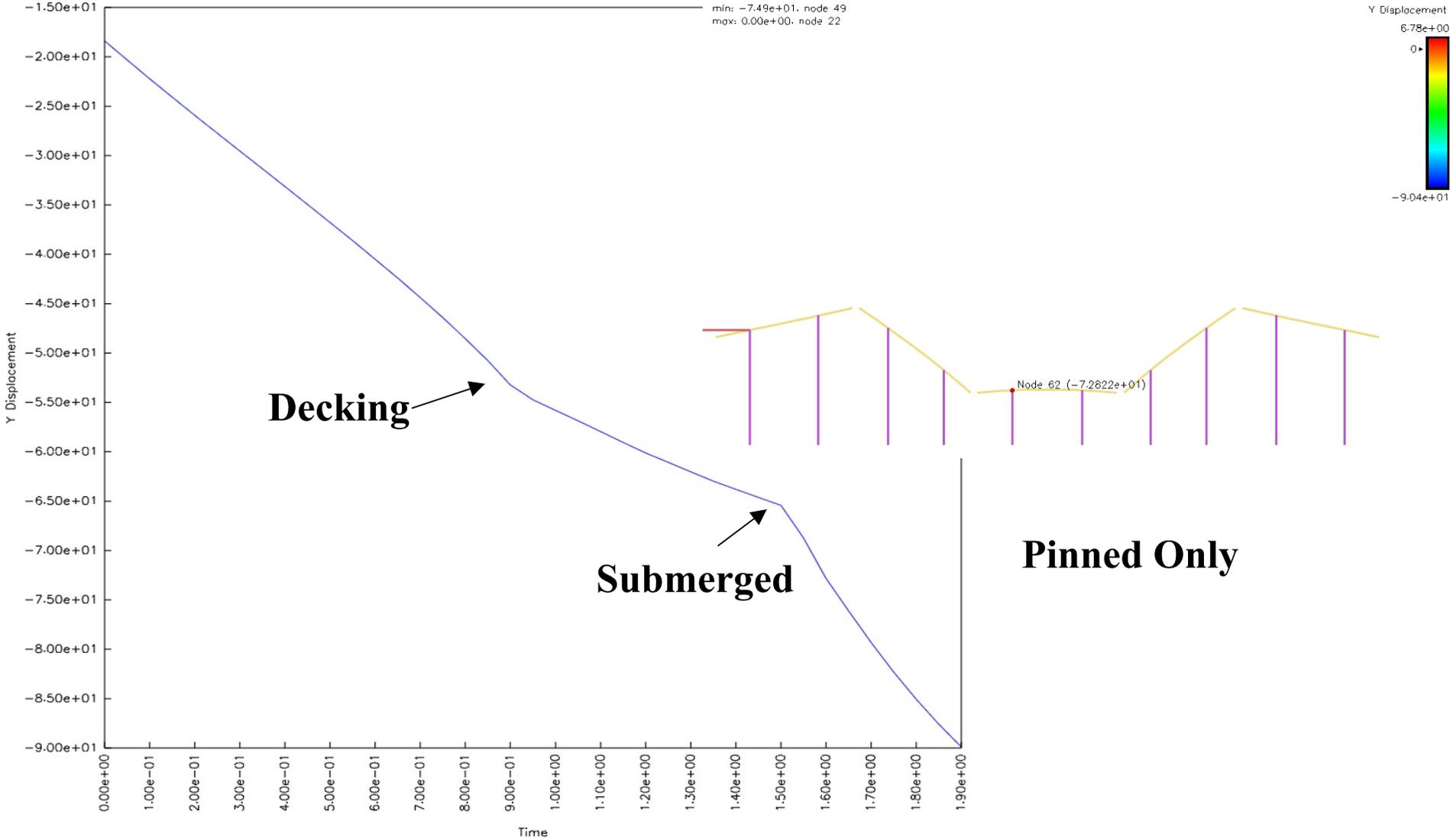
- **Model represents single track-line or wheel-line**
- **Use $\frac{1}{2}$ of Live Load, Dead Load, and Flotation Support**
- **Ramp load is not included at this time.**
- **Shore support is not included at this time.**
- **30% Overload**



Analytical Approximations (Continued)

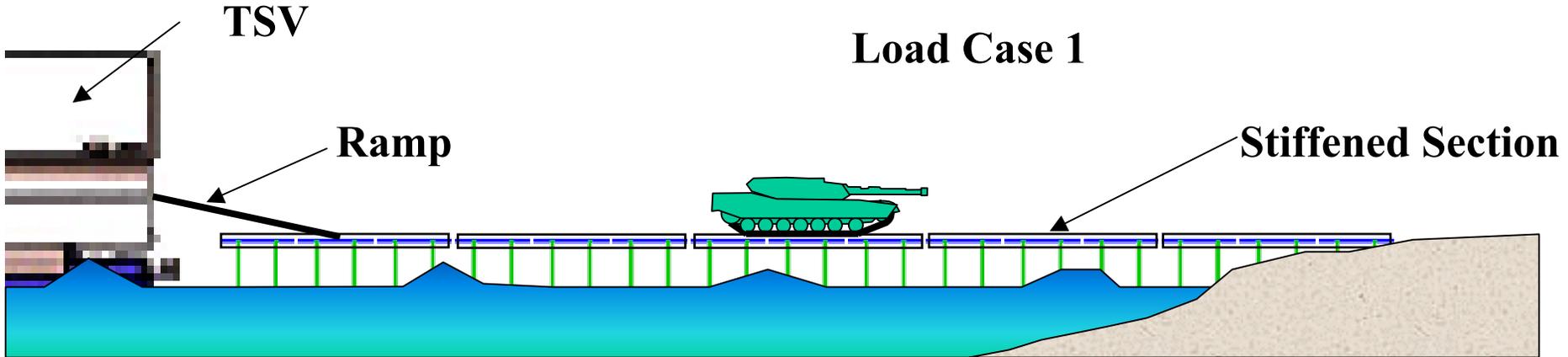


Analysis Results, 10 Ft, Preliminary



Node 62

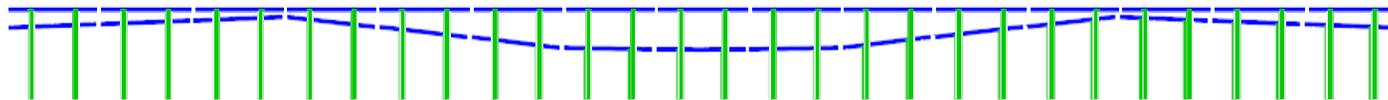
150 ft. Causeway, 30 ft. Stiffened Sections



min: $-5.27e+01$, node 67
max: $0.00e+00$, node 22

Y Displacement

$0.00e+00$



$-5.27e+01$

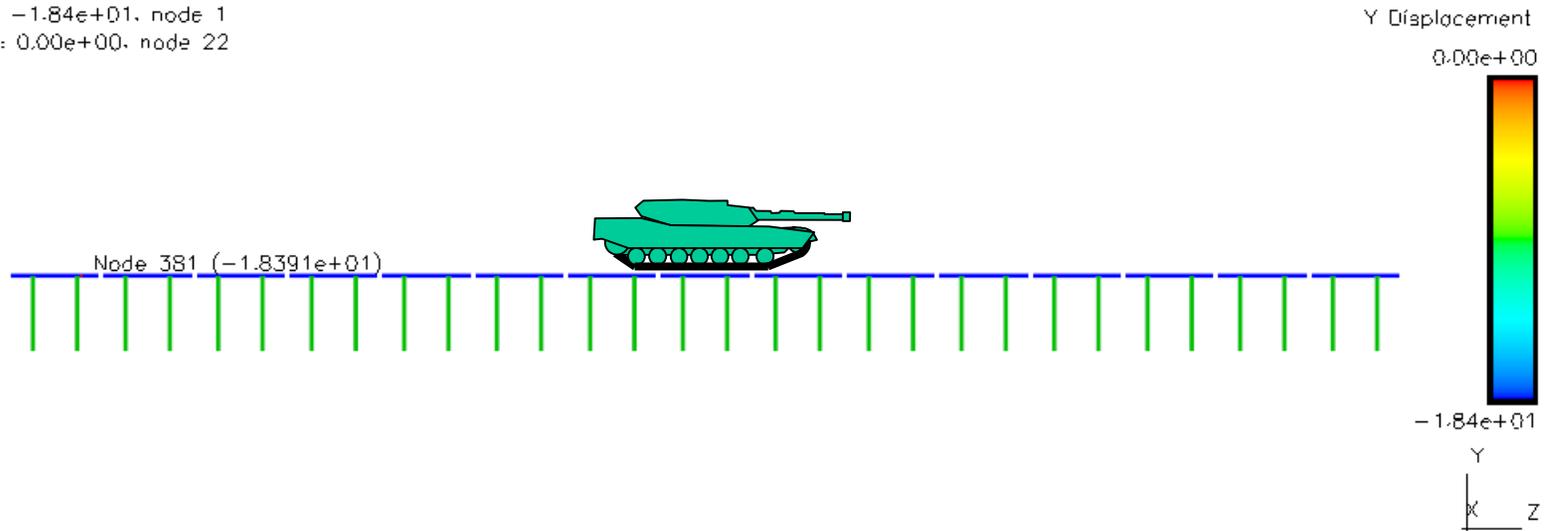


Self-v Total Loading

1 150' Length, 15 Sections @ 10', 30
t = $2.00000e+00$

150 Ft Causeway

min: $-1.84e+01$, node 1
 max: $0.00e+00$, node 22



1 150' Length, 15 Sections @ 10', 50
 t = 0.000000e+00

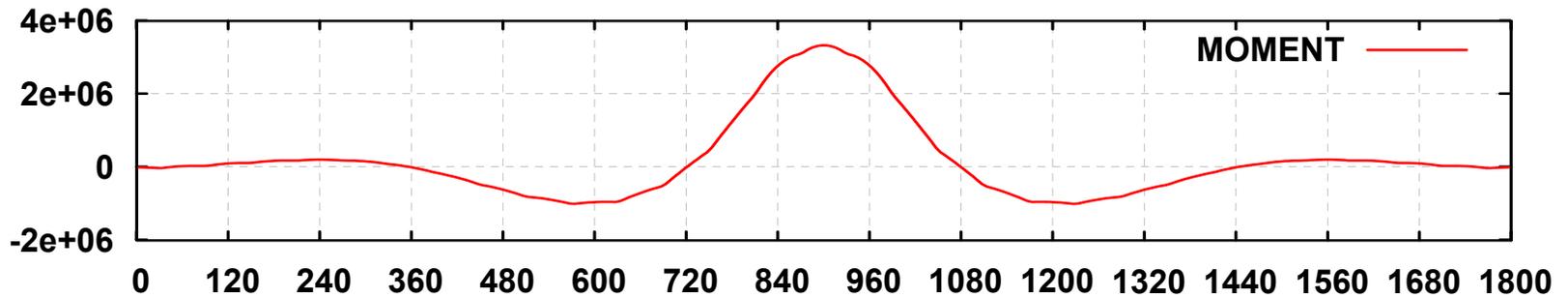
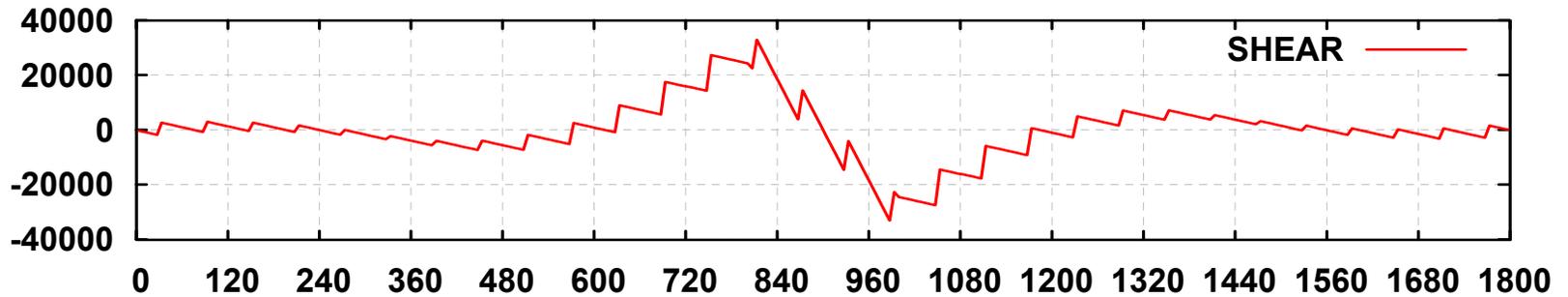
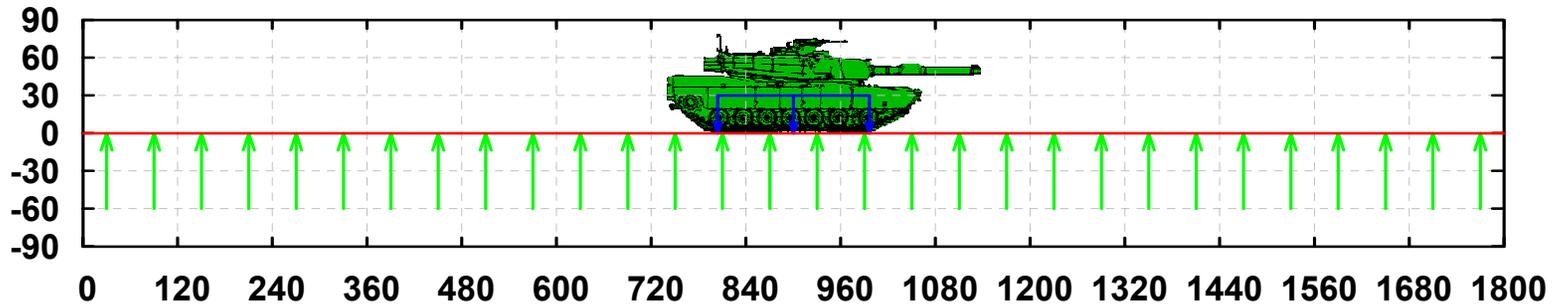
Section Length (Feet)	10	20	30	50	150
Displacement (inches)	UNK	UNK	52.7	45.5	43.0
Moment (in-lb)			3E6	6E6	6E6

70 Ton M1 Tank

Shear and Moment Summary

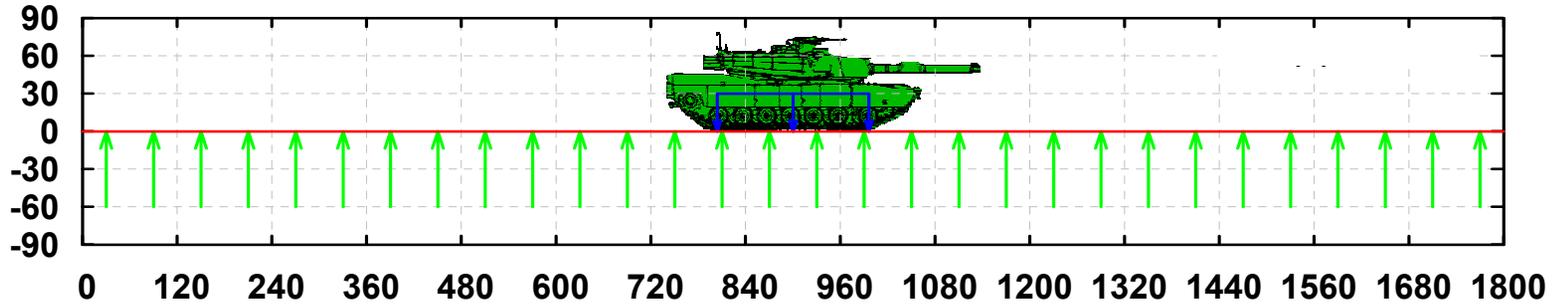
Length			Load				Displacement			Forces					
Total (ft)	Section (ft)	Unit (ft)	Type	Case	Start (ft)	Stop (ft)	Total (in)	Beam (in)	L/D	Moment (in-lbs)		Shear (lbs)		Spring Compression (lbs)	
										+	-	+	-	Max	Min
150	50	10	T70.30	1	67	83	45.50	10.90	55	9.6E5	6.1E6	3.8E4	3.8E4	1.2E4	2.1E3
				2	42	58	74.8	68.7 ^R	--	3.0e6	1.4E6	2.7E4	2.4E4	2.0E4	0.0E0
				3	34	50	64.1	56.7 ^R	--	3.2E6	2.3E6	3.6E4	2.5E4	1.7E4	1.2E3
				4	17	33	50.9	20.6 ^R	--	4.2E6	5.0E6	3.6E4	2.8E4	1.3E4	3.0E3
				5	0	16	104 ¹	--	--	--	--	--	--	--	--
	30	10	T70.30	1	67	83	52.7	2.4	150	1.0E6	3.3E6	3.3E4	3.3E4	1.4E4	1.5E3
				2	22	38	109 ²	--	--	--	--	--	--	2.0E4	0.0E0
				3	14	30	76.3	-- ^R	--	1.9E6	1.9E6	3.1E4	1.3E4	2.0E4	2.4E2
				4	7	23	93.5	54.4 ^R	--	2.2E6	1.9E6	2.6E4	3.0E4	2.0E4	2.3E3
				5	0	16	105 ³	--	--	--	--	--	--	2.0E4	1.4E3

Shear and Moment Diagram, 30 ft. Section

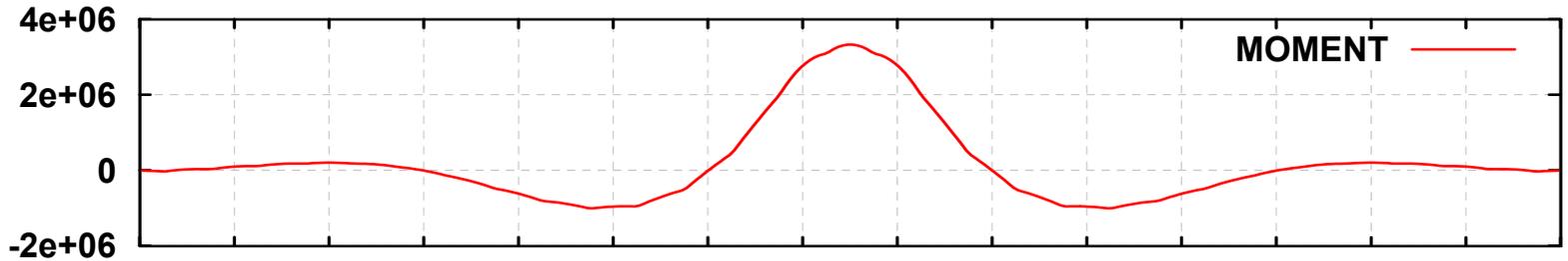


Comparison of Section Lengths

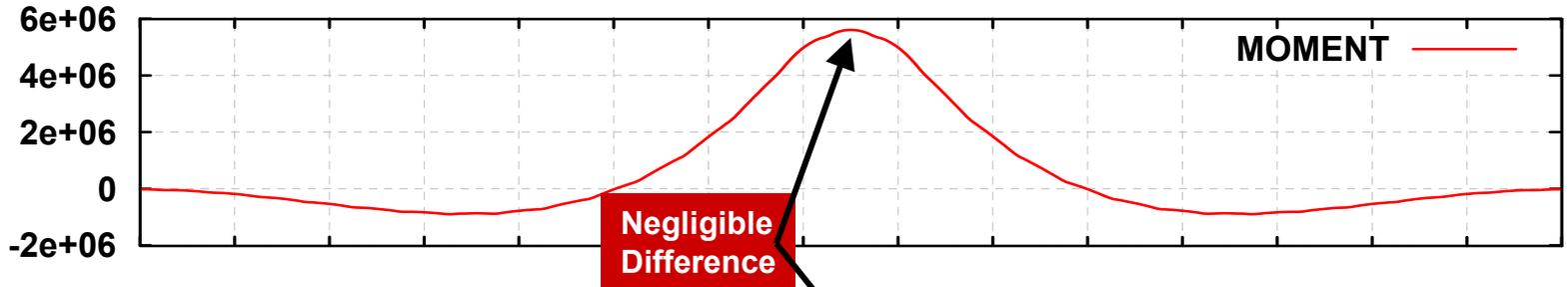
Model



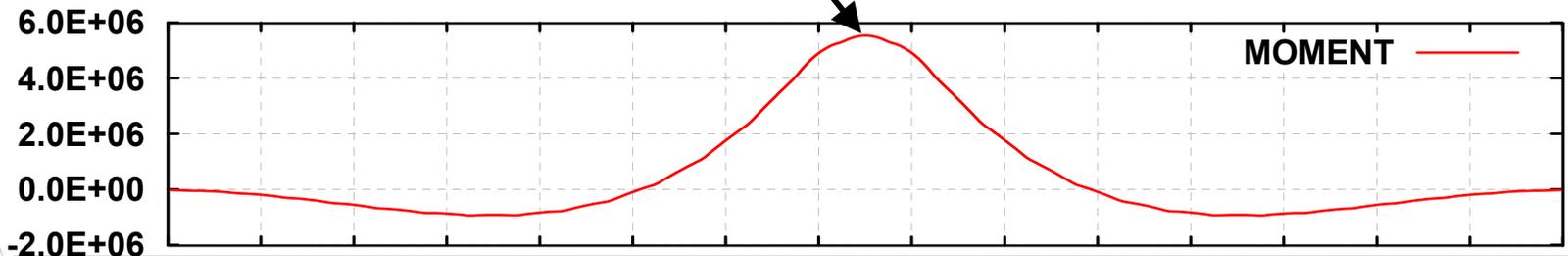
30 ft. Section



50 ft. Section



150 ft. Section

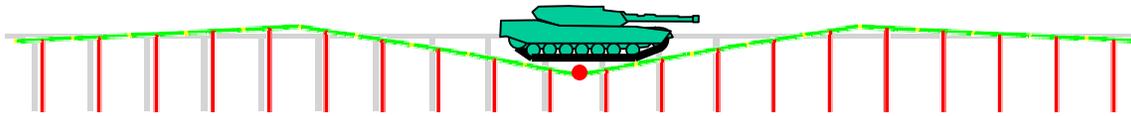


8 Ft Diameter Floats

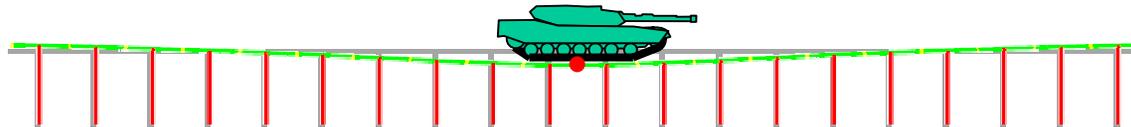
Gravity Load, 22.2 inch displacement



40 Ft Stiffened Sections: 86.5 inches



160 Ft Stiffened Section: 49.8 inches



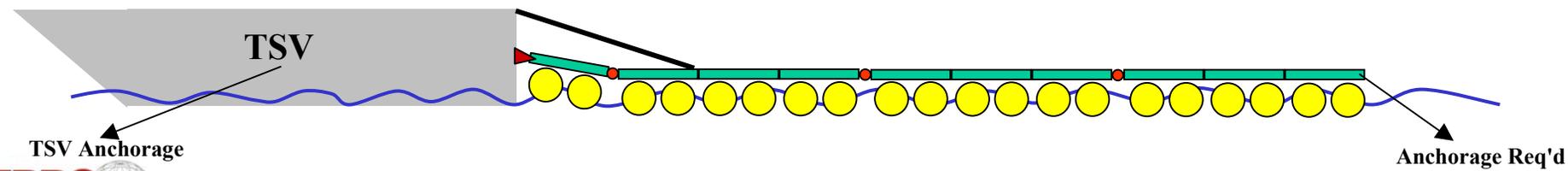
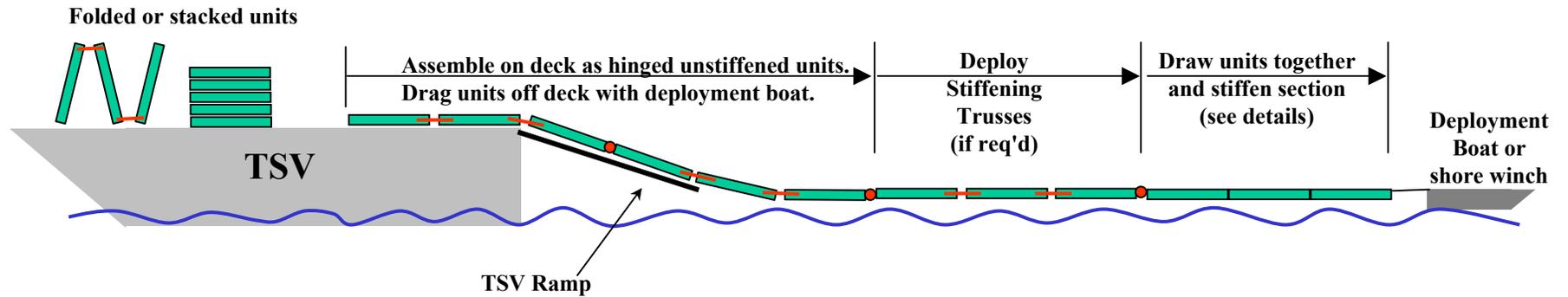
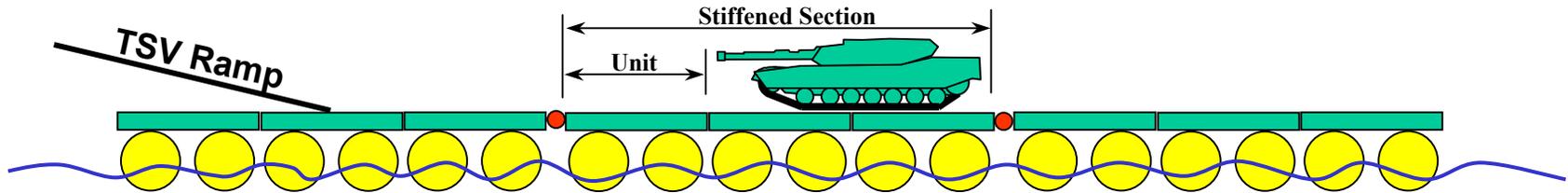
Future Analytical Plans

For Mechanically Stiffened Sections

- **Wave loadings**
 - Partially Complete
- **Preliminary strength design for main girders**
 - Update FE model values and check design
- **Small scale experiments to verify analytical assumptions**
- **Update model to 3D for lateral stability analysis.**
 - Add beam element models for main girders and floor beams.
- **Detailed 3D structural modeling for design of causeway sections**
 - Stringers
 - Skin plates

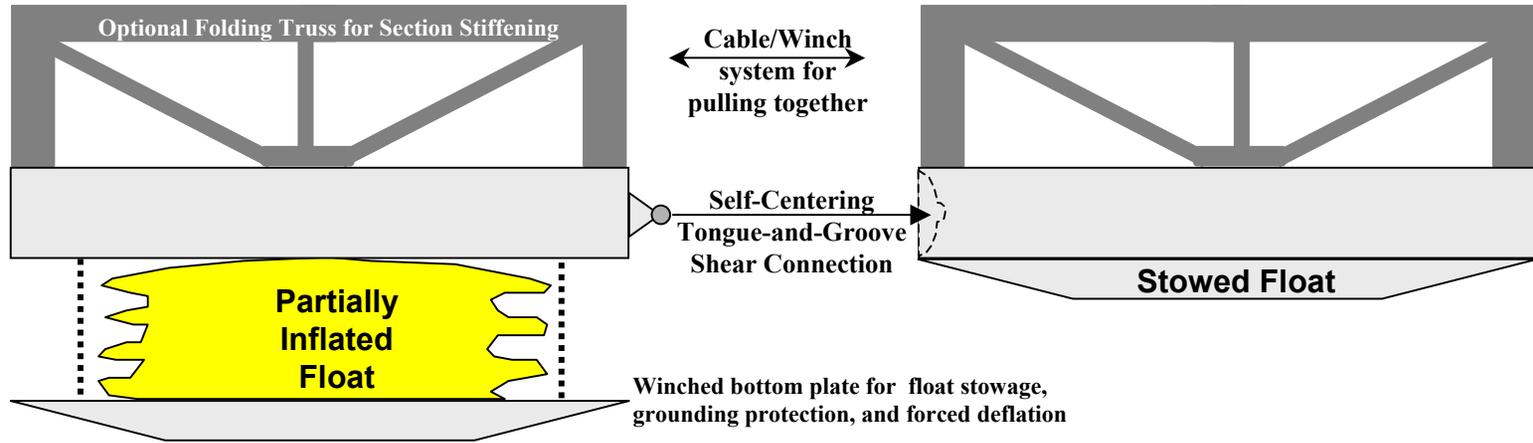


Deployment Concept



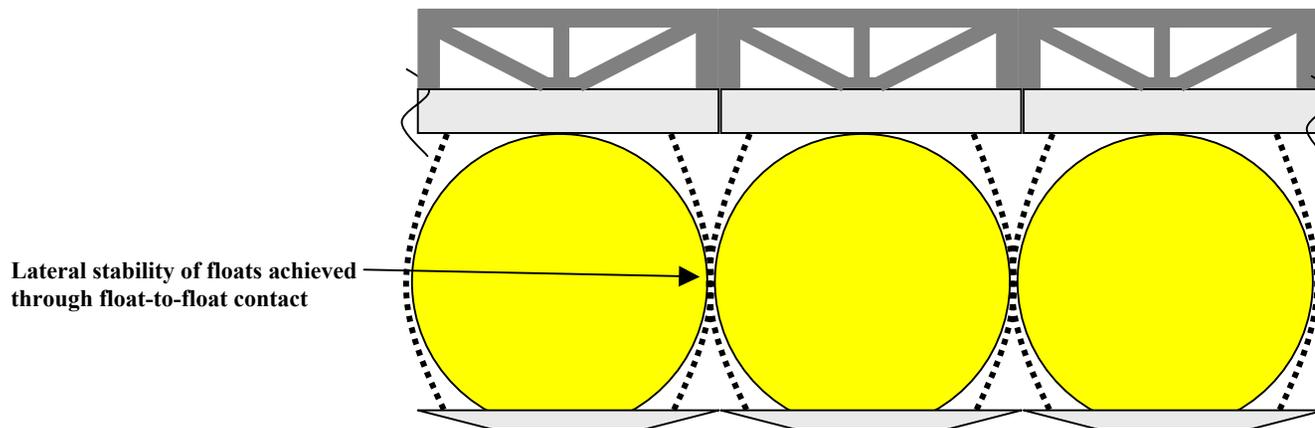
Design Details

Individual Units



Side View

Units as a Stiffened Section



Side View

Unit Design

