Alternate Blocking Materials

NSRP Panel Project PP 23-018

Outline

- DM Consulting Introduction
- Introduction to Drydocking
- Example & Traditional Methods of Block Construction
- Description of New Materials
- Cost Comparison
- Carbon Footprint
- Implementation, Testing, & Deliverables
- Technology Transfer

DM Consulting – Dry Dock Experts

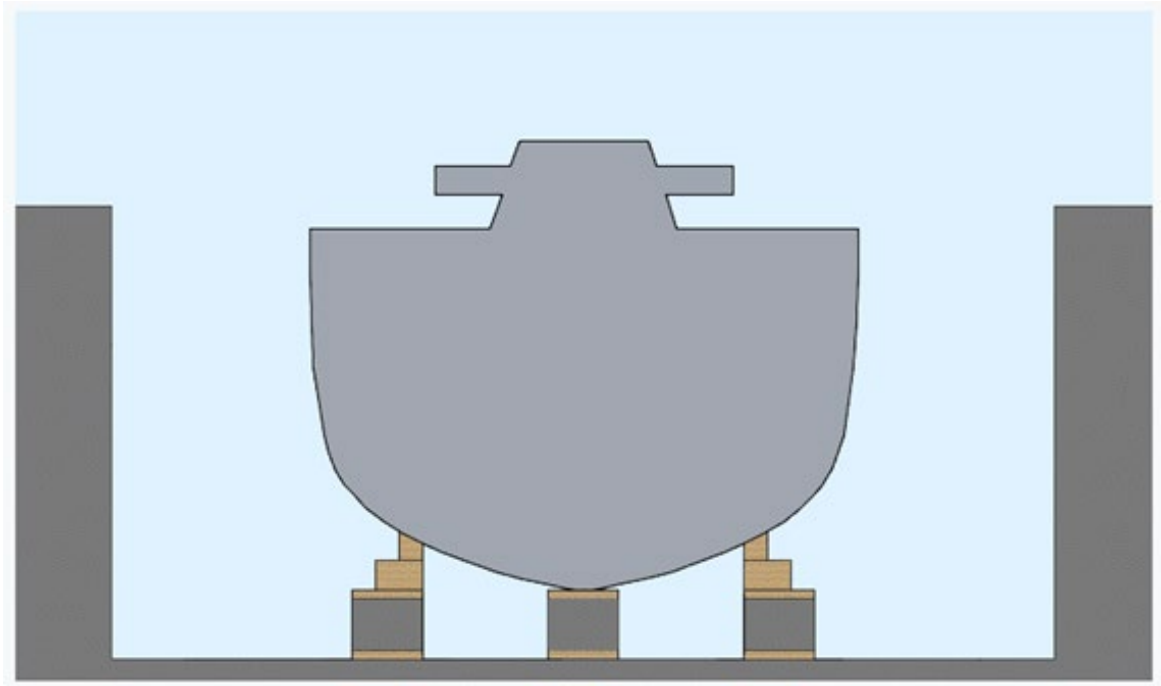
- Established 2000
- Certified Dock Masters
  - 5000+ Drydocking operations.
  - 150+ Years Combined Experience
- Training, Consulting
- Dry Dock Acquisitions
- Technology Advocates
  - 3D Scanning
  - Software Development
  - Modern Supports
  - Monitoring Systems

Drydocking

Drydocking

Keel Blocks

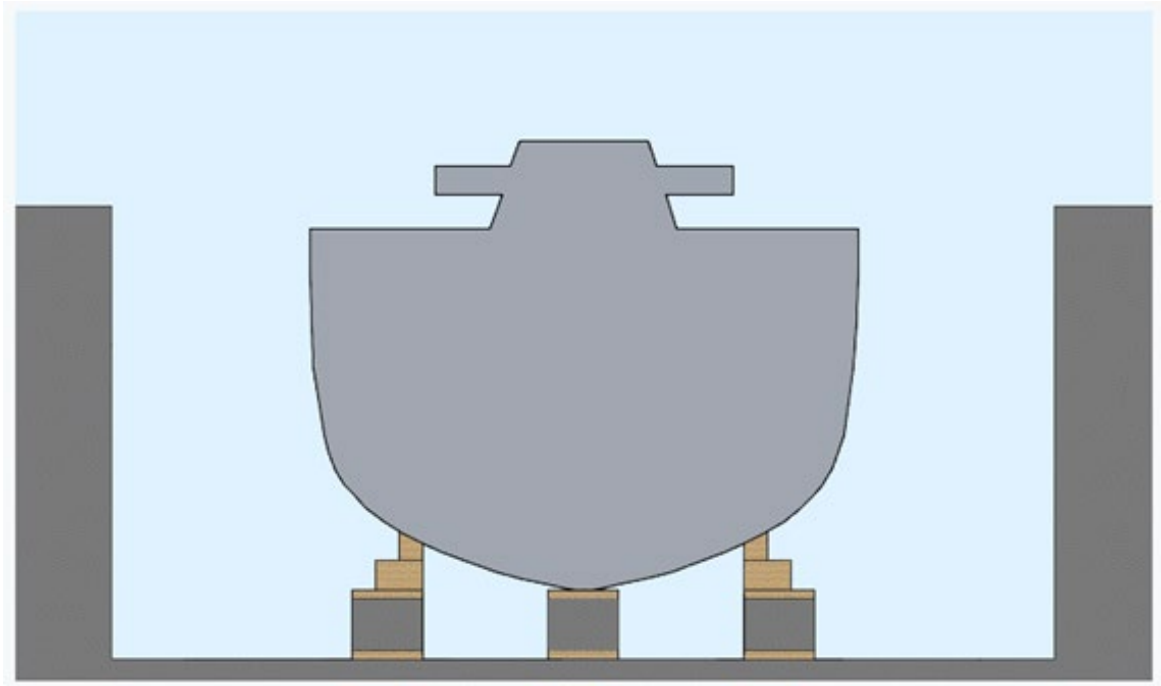
Support most of a ship's weight



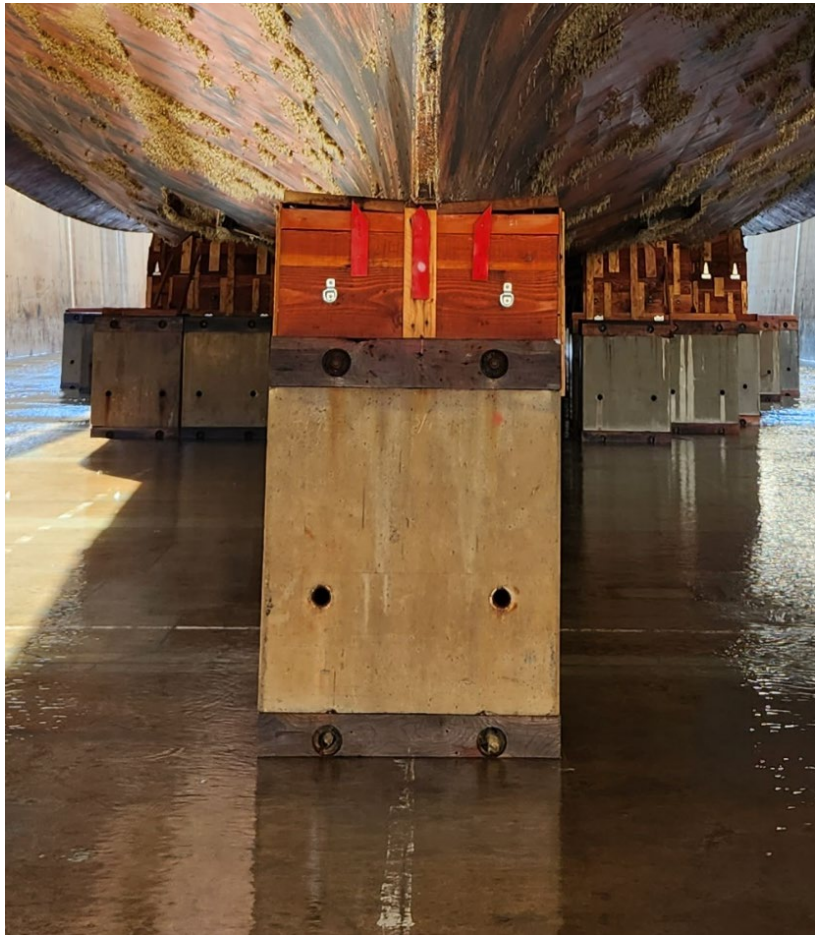
Drydocking

Side Blocks

Keep vessel upright



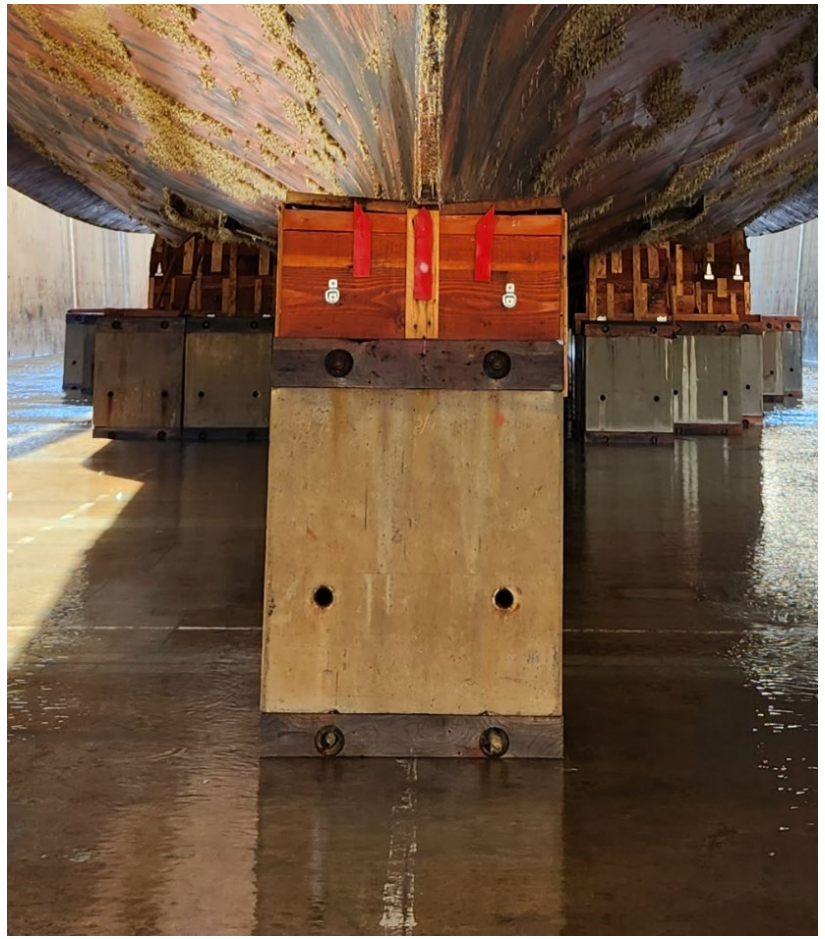
Drydocking



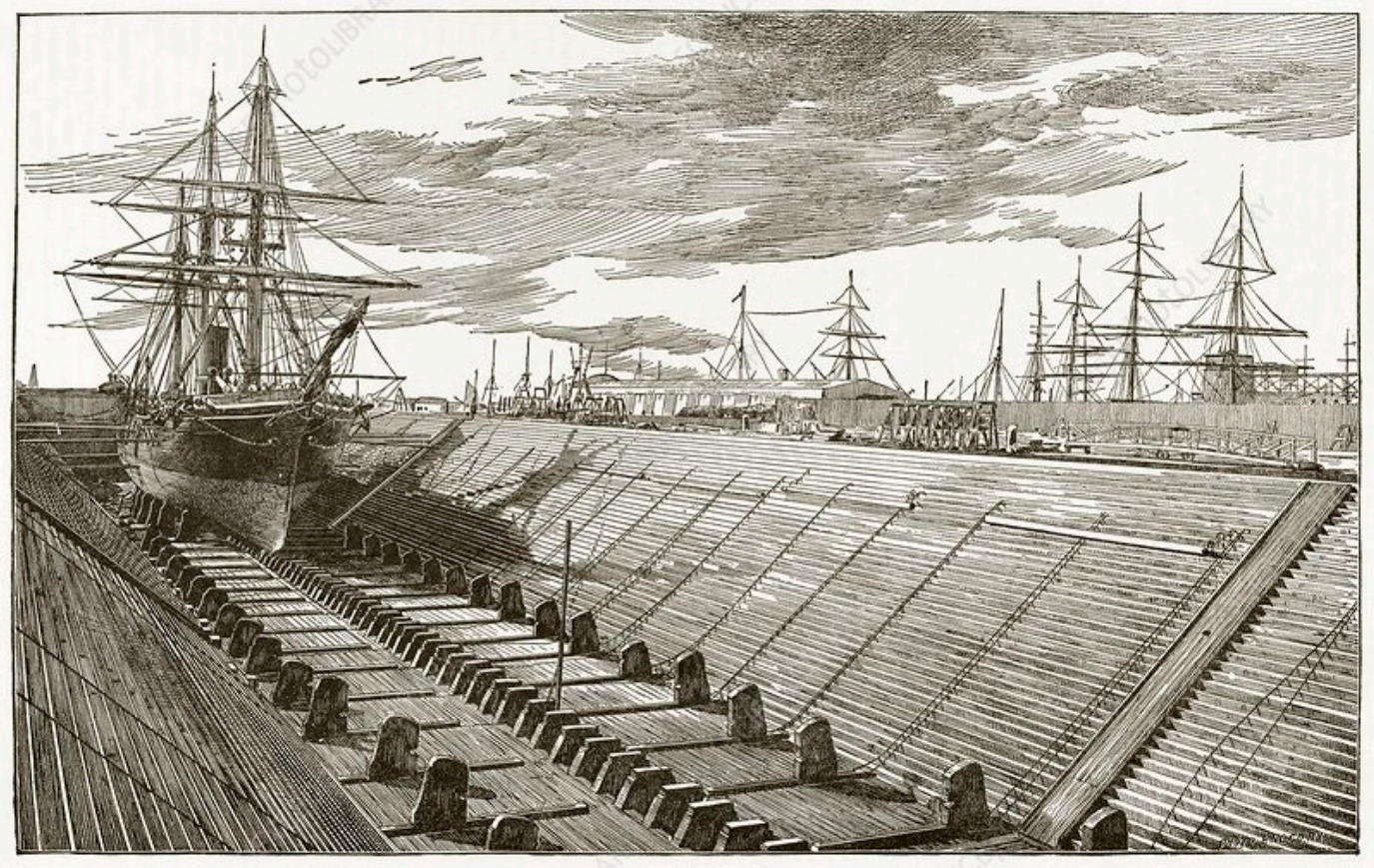
Example of Wood Used (DDG)

- 7.5 ft block height (shaft removal)
- 5.5 ft base block + 2 ft of soft wood
- 80 Blocks total (KB + SBs)
- Max SB height = 5 ft
- ~2600 ft^3

- Softwood lifespan = 2 years
- Rubber lifespan = 10 years



Block Construction History

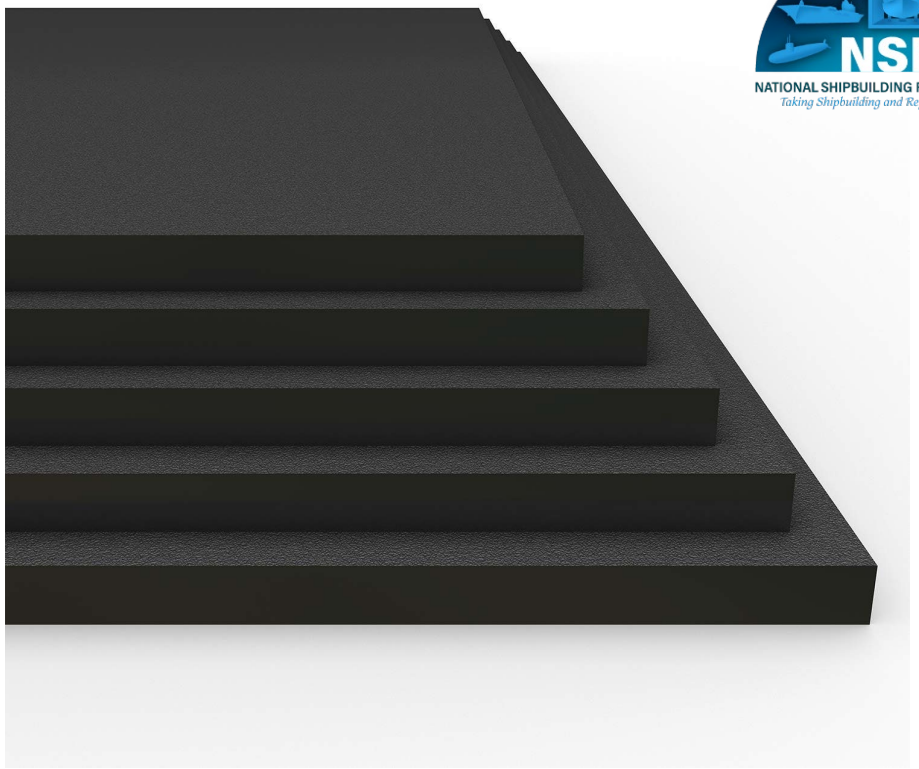


New Materials

- High Density Polyethylene (HDPE)
  - Goal is to replace hard and/or soft wood caps
- Neoprene Pads
  - Goal is to replace hard and/or soft wood caps
- Fiber Reinforced Concrete (FRC)
  - Goal is to replace traditional steel reinforced concrete

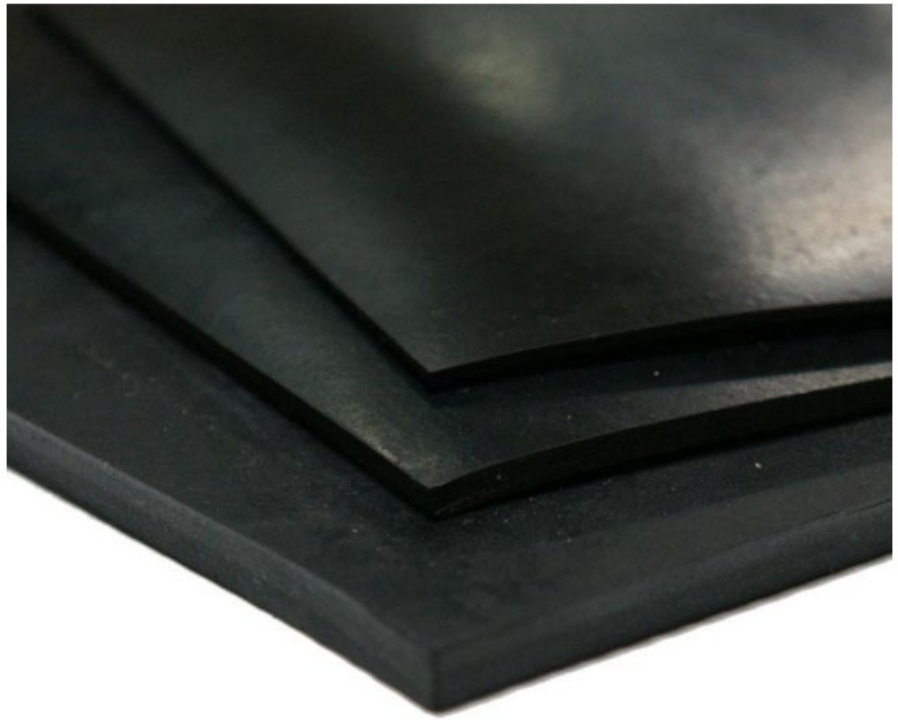
HDPE

- Similar to wood in strength, construction, & density
- Completely waterproof & UV Stabilized
- Will not rot
- Can be easily repaired without having to be replaced.
- Can be constructed from recycled plastic and can be recycled at end of useful life.



Neoprene Pads

- Readily available world wide
- Will provide better flexibility than wood
- Will not rot
- When bonded with steel plates top and bottom, should have an expected service life of 20 years.



FRC

- Quicker to produce blocks
- Blocks tend to spall less, lengthening service life
- Same or better strength for same value

Benefits

- All materials are expected to have a longer service life (expected approx. 5 times soft wood)
- All materials can be recycled at the end of their service life
- All materials are expected to have similar or better mechanical properties than current technology
- The proposed materials are new to our industry, but they are not new materials

Cost Comparisons

- Example Case of Using HDPE or Neoprebe instead of soft wood for the soft cap
- 60 Concrete blocks, topped with hard wood and a soft wood cap
- Block length = 3.5’
- Block Width = 4’
- Soft Cap = 2”
- Soft Cap Vol = 210 cu ft
- Assume 6 dockings per year
- Assume 1 hour for a crew of 3 at $40 / hour labor

Cost Comparisons

Description	Wood 2x4x8 Yellow Pine	HDPE 54x48x1/2 Marine Grade	Neoprene Pads
Volume per Piece (cu ft)	1.5” x 7.5” x 8’ = 0.292 cu ft	54” x 48” x ½” = 0.75 cu ft	1 per block
Quantity	720	280	60
Unit Cost	$3.35	$256	$2,538
Extended Cost (Initial Cost)	$2,412	$71,680	$152,280
Labor Cost	$7,200	$7,200	$7,200
Install Cost	$9,612	$78,880	$159,480
% Replacement per Docking	100%	5%	2%
Annual Maintenance Cost	$57,672	$23,664	$19,138
10 Year Cost	$586,332	$315,520	$350,856

Cost Comparison

- Fiber Reinforced blocks will cost approximately the same as traditional blocks.
- Expected life span 33% more than traditional reinforced blocks (15 yrs vs. 20 yrs)

Carbon Footprint

- Wood can be considered net reduction in carbon for traditional wood construction
  - This comes from sequestering wood in structure rather than consuming it
  - Dry docking application is not standard use of wood
- HDPE and polymer carbon footprints are higher than wood when considering material alone.
- Reduction in labor will greatly affect swing the calculation in favor of the proposed materials.

Carbon Footprint

- Average American uses 16 tons of carbon per year
- Average work hours are 2,000 hours per year
- Labor hours = 16 tons / 2000 hours = 0.008 tons / hour
- Labor hours for docking = 3 labor-hours / block * 60 blocks = 180 hours per docking for soft cap alone
- Assume initial install labor is the same.

Description	Wood 2x4x8 Yellow Pine	HDPE 54x48x1/2 Marine Grade	Neoprene Pads
% Replacement per Docking	100%	5%	2%
Labor per Docking	180 hours	9 hours	3.6 hours
Tons CO2 per Docking	1.44	0.072	0.029
Tons per Year	8.64	0.432	0.173

Implementation

- Going to purchased and install new materials in place of traditional materials onto test blocks at the following shipyards:
- Gulf Copper Shipyard, Port Arthur, TX
  - Testing HDPE & neoprene caps
- Navy Shipyard, San Diego, CA
  - Testing HDPE & neoprene caps
- Mare Island Dry Dock, Vallejo, CA
  - Testing fiber reinforce concrete blocks

Testing

- Key Factors:
  - Quantify the labor involved with proposed materials and compare to traditional wood soft caps
  - Quantify the projected lifespan as compared to traditional soft wood so that the percentage replacement rate per docking can be calculated

- Take measurements of materials before & after dockings. Measurements will be compared.
- General observations to be made before and after dockings (such as rips / tears, etc.).
- Material lab will be provided control & post-docking samples for material testing.

Deliverables

- All results will be compiled into one single, final research paper.
- Paper will contain project description, drawings, costs, photographs, lab results, etc.

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