



**TARDEC**



**Army Composite Bridging Applications  
Supporting  
The Army's Future Combat System  
&  
Future Force**

**March 31, 2004**

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## Report Documentation Page

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14. ABSTRACT <b>This brief presents U.S. Army composite bridging research and technology, which is intended to support the Future Force. It provides a review of the current state of mobile military bridging followed by an overview of the Future Force requirements. The current fleet has short comings as the Army is transforming the Future Force. Current composite technology efforts to address the requirements of the Future Force are the Composite Army Bridge (CAB) and the Modular Composite (MCB). The CAB is a technology demonstrator, which successfully demonstrated the ability of a reinforced plastic structure to withstand the aggressive crossings of military vehicles (i.e. M1, HET w/M1). The MCB successfully demonstrated that a composite joint could be designed, which can support the required design loads for a 25m span. Concepts are presented, which will address the requirements of the Future Force.</b>			
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The background of the slide is a collage of various military vehicles and equipment. At the top, there's a long bridge structure. Below it, several military trucks and heavy machinery are visible, including what looks like a large transport truck, a smaller utility vehicle, and a tractor-like machine. The images are somewhat faded and overlaid with a grid pattern.

# Army Composite Bridging Applications

## Briefing Overview

Mobile Military Bridging Overview

Future Force (FF) Requirements - Challenges for Assured Mobility

Current Composite Prototype Efforts

Future Composite Conceptual Efforts

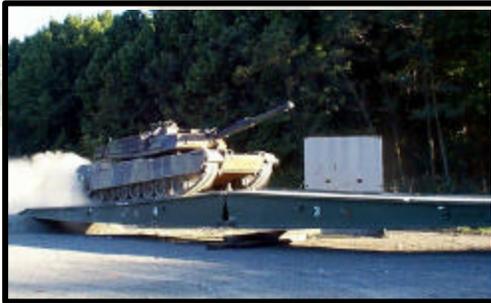
# Mobile Military Bridging Overview

## Current Bridging Systems



# Mobile Military Bridging Overview

## Production Systems



# FF Requirements-Challenges for Assured Mobility

## Unit of Action (UA) & Unit of Employment (UE)

### Organic Gap Crossing Technology for UA

- Span Wet and Dry Gaps from 1.5– 4.0 meters
- Support MLC 30 Tracked/Wheeled Vehicles
- Width 3.35 meters
- Mounted on Unmanned and/or Manned platforms
- UA Platform w/Gap Crossing Equipment C-130 Transportable

### Augmented Gap Crossing Tech for UE

- Incrementally Spanning Gaps:
  - Assault Bridging - up to 25 meters
  - Tactical Bridging - up to 200 meters
  - Focused Logistics - unlimited
- MLC to Match Formation: MLC 30-70W/T; MLC100 W
- Mounted on Unmanned and Manned FCS Interoperable Vehicles
- System C-130 Transportable
- Deployed Bridge Air Transportable by CH-47
- Family of Modular Bridging for Wet and Dry Bridging

# FF Requirements-Challenges for Assured Mobility

## The Challenges for Assured Mobility

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- Vehicles Lighter compared to Current Systems
  - Less Counterbalance
  - Gaps remain the same
- Air & Ground Transport
  - C-130 Packaging
  - Volume, Weight & Quantity for Ground Transport
- Interoperability with FCS
  - Scalable: Gap, MLC & Multilane Capability
  - Automation Requirements

# FF Requirements-Challenges for Assured Mobility

## Requirement Implications

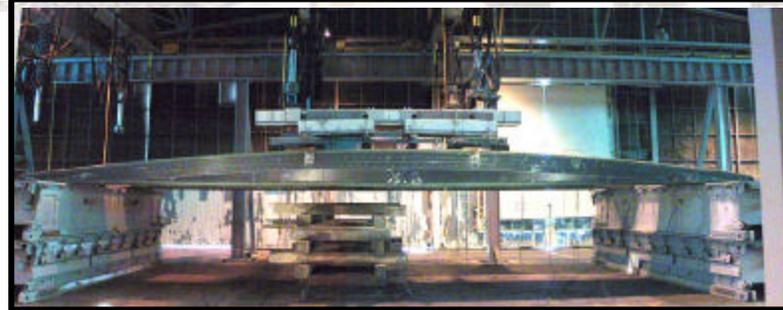
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- Use of Modeling and Simulation Techniques
- Application of Light Weight Materials, such as Composites
- Innovative Life-Cycle Safe Structural Designs
- Incremental Technological Steps

# Current Composite Prototype Efforts

## Composite Army Bridge (CAB)



### Test Results

- 2000+ MLC 70/100 crossings in the Field
- 18,000 MLC 70 simulations in Lab.



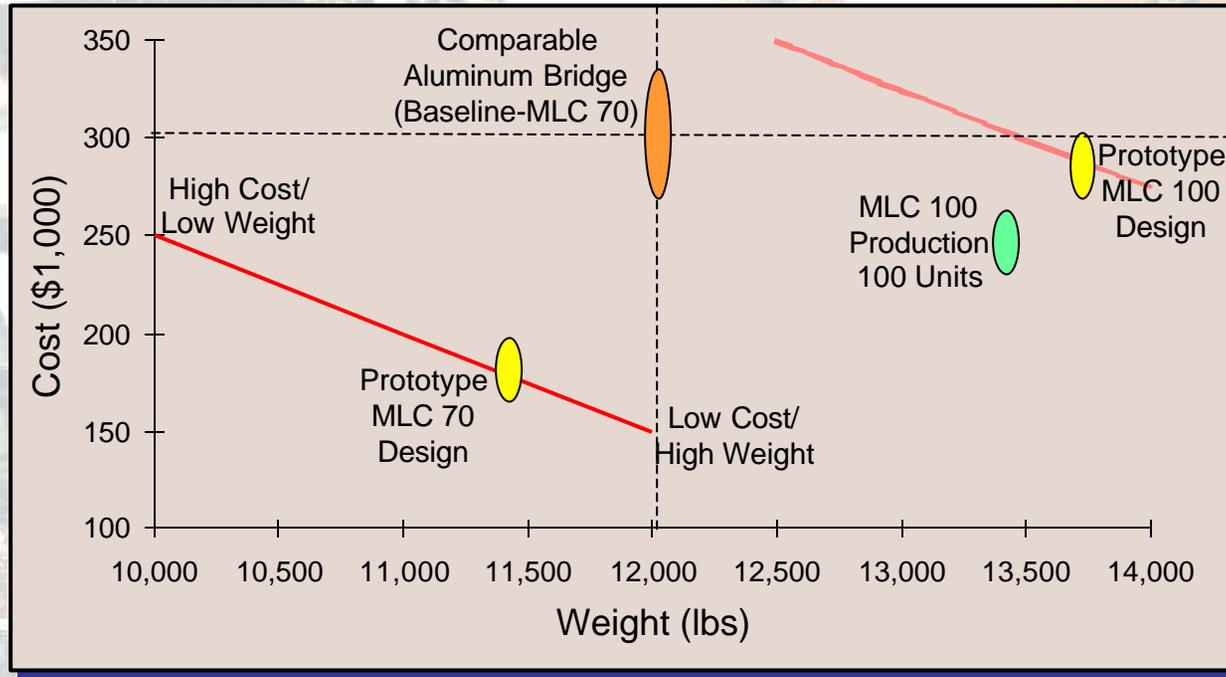
### Critical Design Parameters

- |                   |                 |
|-------------------|-----------------|
| • Maximum Span:   | 12 meters       |
| • Maximum Length: | 14 meters       |
| • Width:          | 4.01 meters     |
| • Rating:         | MLC 100 (T & W) |
| • Weight:         | < 6,000 kg      |
| • Minimum Life:   | 5,000 crossings |

# Current Composite Prototype Efforts

## Composite Army Bridge (CAB)

### Trade Off Metrics



# Current Composite Prototype Efforts

## Composite Army Bridge (CAB)



**Defense Advanced Research Projects Agency**

- Project Management.
- Technology Reinvestment Program.
- Bridge Infrastructure Renewal Program.



**US Army, Tank Automotive Research Development & Engineering Center**

- Technical Advisors for Design, Requirements & Vehicle Interface



**University of California, San Diego**

- CAB Design and Testing.
- Finite Element Analysis.



**SEEMANN COMPOSITES INC.**

- Low Cost Composites Manufacturing.



**UNIVERSITY OF DELAWARE**

- Composite Bridge Engineering and Rehabilitation Program.
- Material Property Evaluation.
- Subscale Wear Tests



**ABERDEEN TEST CENTER U.S. ARMY ABERDEEN TEST CENTER ABERDEEN TEST CENTER ABERDEEN TEST CENTER ABERDEEN TEST CENTER ABERDEEN TEST CENTER**

- Full Scale Field & Wear Testing.



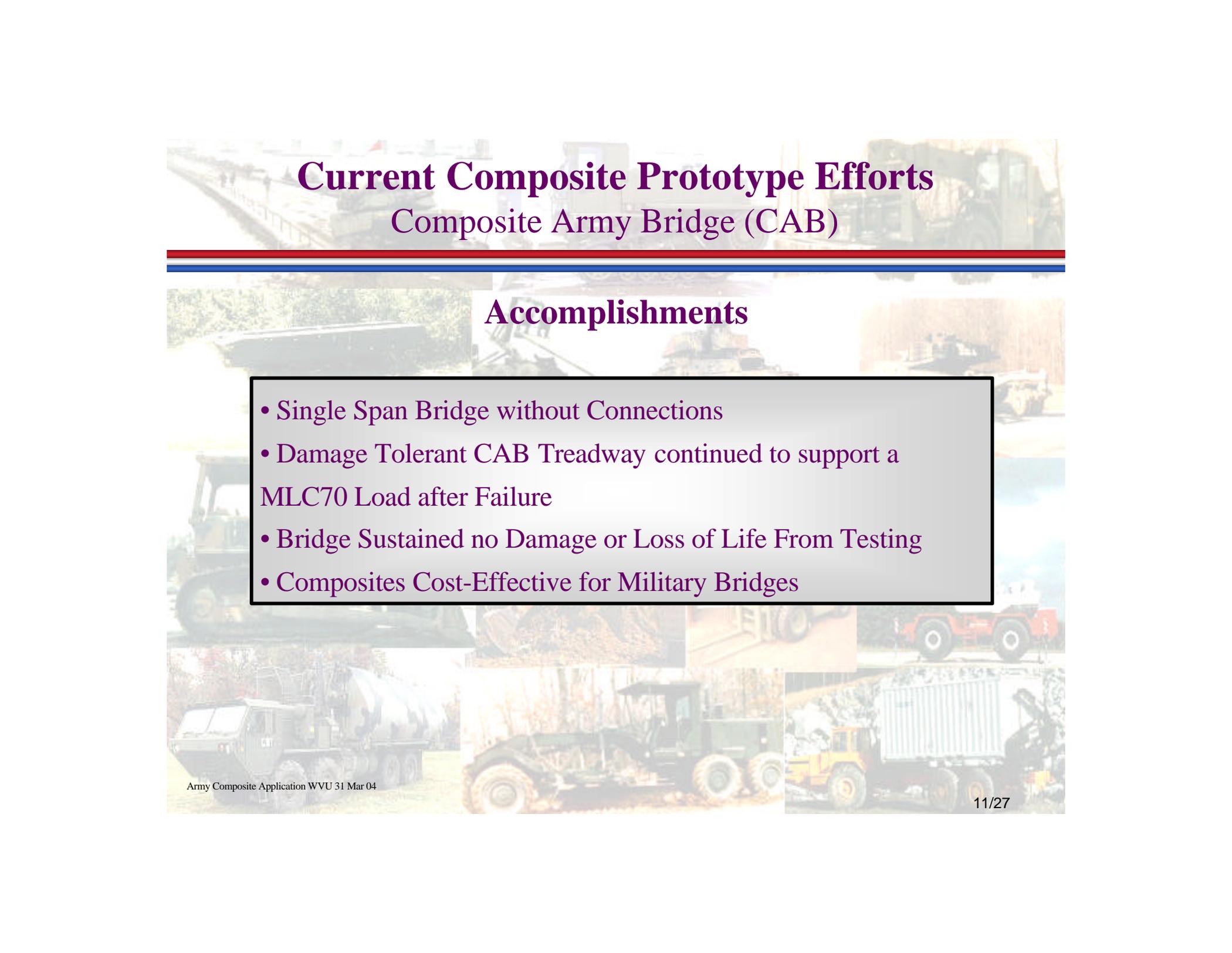
**US Army Engineer School**

- User Input and Feedback.



**Cold Regions Research & Engineering Laboratory**

- Environmental Materials Testing  
– Cold & Hot Weather Coupon Testing

The background of the slide is a collage of various military vehicles and infrastructure. At the top, there's a long bridge with a red and blue stripe below it. Below that, there are several images of military trucks, including a large green truck with a white container, a smaller green truck, and a red truck. There are also images of what appear to be military tanks or heavy machinery. The overall theme is military engineering and transport.

# Current Composite Prototype Efforts

## Composite Army Bridge (CAB)

### Accomplishments

- Single Span Bridge without Connections
- Damage Tolerant CAB Treadway continued to support a MLC70 Load after Failure
- Bridge Sustained no Damage or Loss of Life From Testing
- Composites Cost-Effective for Military Bridges

# Current Composite Prototype Efforts

## Full Scale Modular Composite Bridge (MCB) Test Components



### Critical Design Parameters

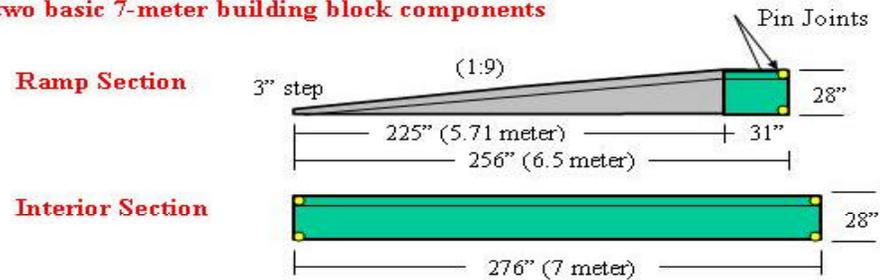
- Maximum Gap: 25 meters
- Width: 4.0 meters
- Rating: MLC 65 (Tracked & Wheeled)
- Minimum Life: 5,000 crossings

# Current Composite Prototype Efforts

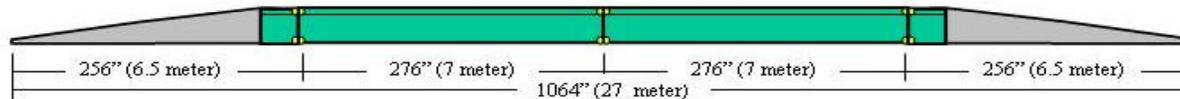
## Modular Composite Bridge (MCB)

### Building Block Approach

**Develop two basic 7-meter building block components**



**Assembly two ramps and two interior sections into a 27 meter Bridge**



**Bridges can be made in lengths of 13, 20, 27, and up to 34 meters (for BCT role only).**



(c) john kosmatka

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# Current Composite Prototype Efforts

## Modular Composite Bridge (MCB)

### Full Composite Bridge Traditional Certification Path

#### Full Scale Assembled Bridges (6)

- 3 static (different spans)
- 3 fatigue (different spans - severe spectrum)

#### Components (7)

- Durability & Damage Tolerance (1 static, 1 fatigue)
- Full Scale Treadway section (1 static, 1 fatigue)
- Ramp Region (1 static)
- Full Scale Joint (1 static, 1 fatigue)

#### Sub-Components (60)

- Treadway Sidewall Buckling
- Deck Bending
- Tension & Compression Joint
- Deck to Sidewall Joint

#### Elements(300)

- Lug Performance
- Sandwich Beams
- Single Joints

#### Coupons (6000)

- Composites
- Adhesives
- Metallics

### MCB Phase I Joint Development & Test

#### Full Scale Assembled Bridges (0)

#### Components (1)

- 2 Half Treadways with full depth tension joint (combined static & fatigue)

#### Sub-Components (2)

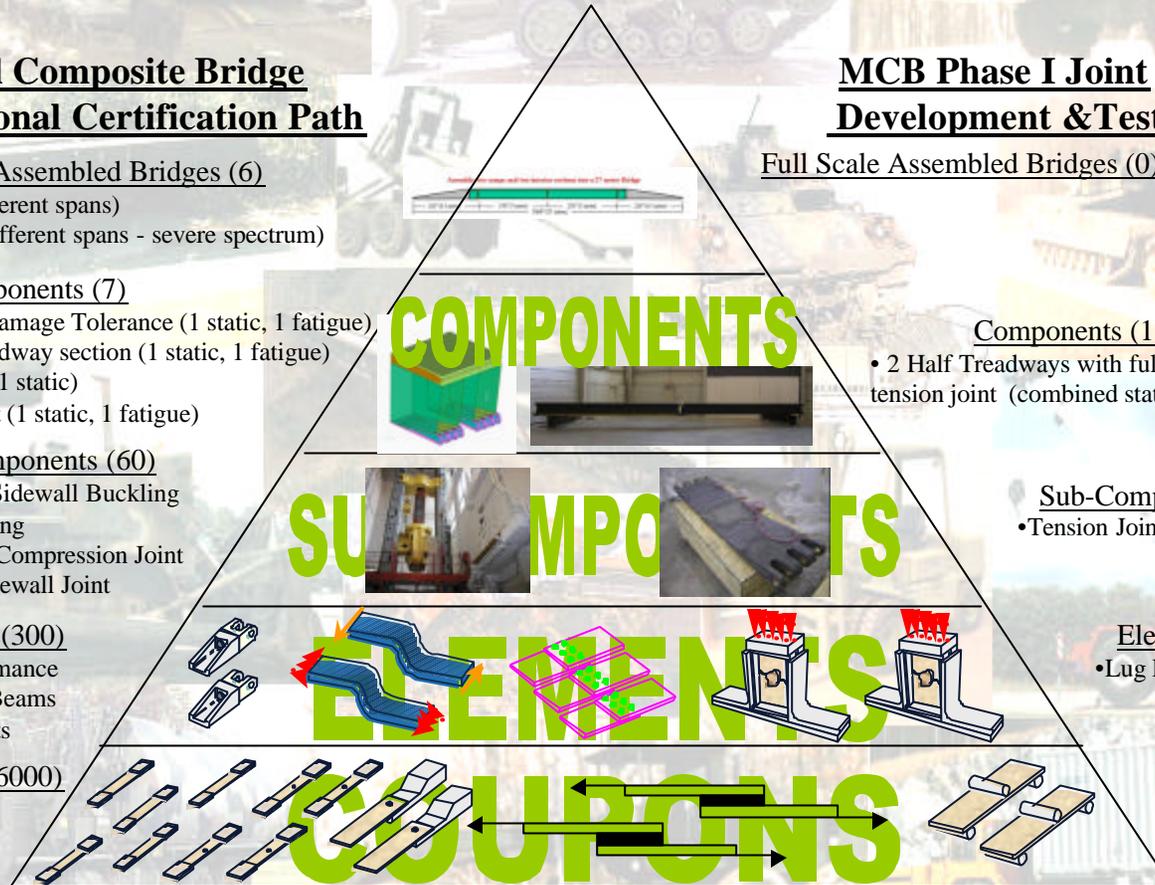
- Tension Joint

#### Elements(13)

- Lug Performance

#### Coupons (504)

- Composites
- Adhesives
- Metallics



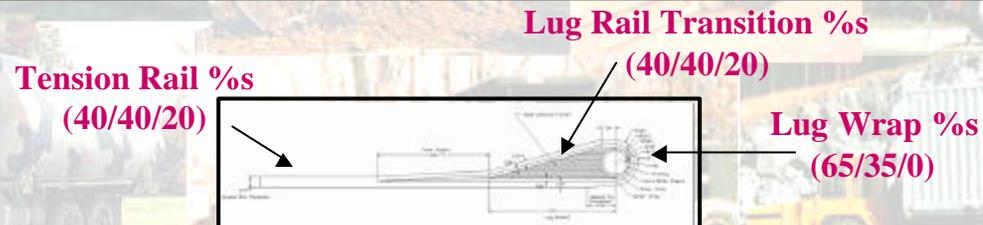
# Current Composite Prototype Efforts

## Modular Composite Bridge (MCB)

- Develop design numbers for critical sections of the MCB
  - Lower Tension Joint Region
  - Focus on critical environments for select properties
    - -50° F for Filled Hole Tension
    - 150° F Wet for Open Hole Compression and Shear
- Carbon Fiber(s)
  - 0 and 90 degree orientations were Fortafil 511
  - ±45 degree orientations were Toray T700
  - Stitched TRIAX
- Multiple resin “Mixes”
  - Shell 862 with Lindride 6k curing agent
- Structural Laminates (%0 / %±45/ %90) in 3 Regions of Interest in the Joint
- Use MIL-17 HDBK as Guideline for Data Collection and Reduction
  - Desire to Include Data in MIL-17 HDBK

Operating Environment Defined for MCB

Baseline Fabrication Process for MCB is SCRIMP



# Current Composite Prototype Efforts

## Full Scale MCB Test Components

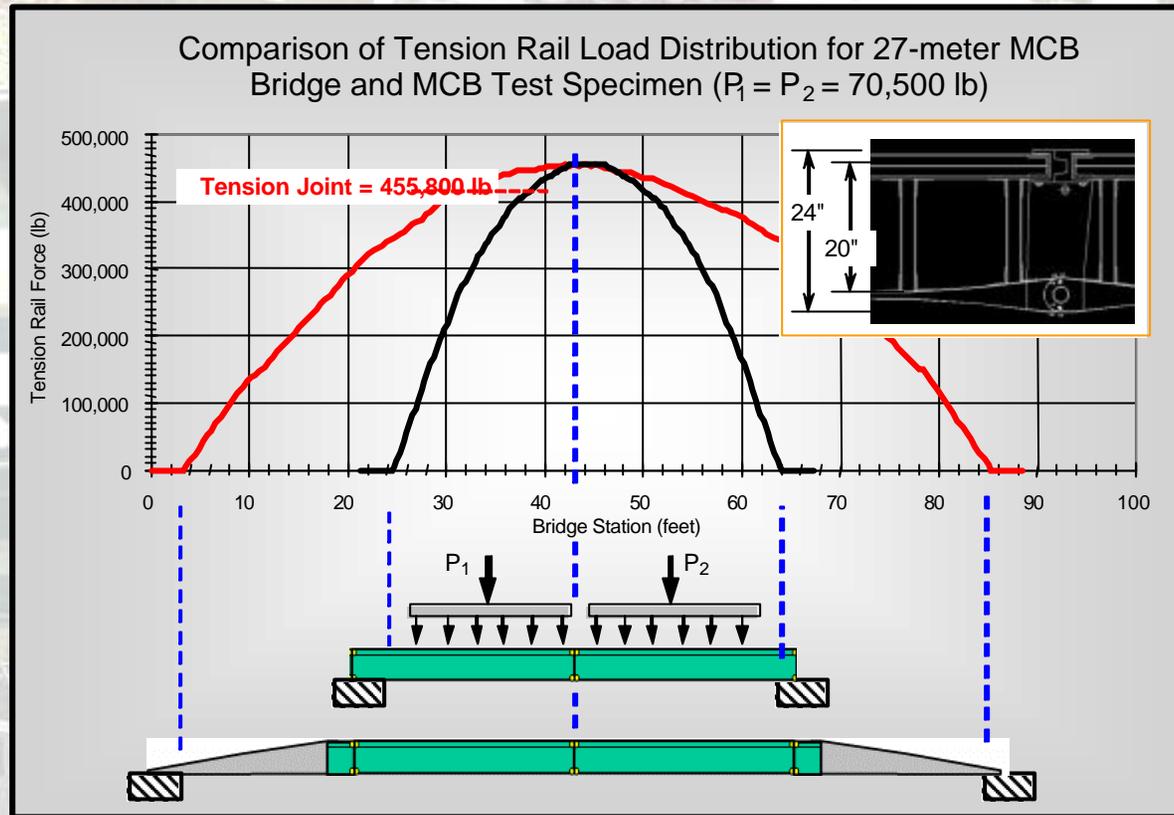
- C 1
  - Two 7 meter sections attached via Integral Lug Tension Joint and Upper Surface “Bird Beak” Compression Joint
  - 1,000 fatigue cycles to 100% Design Limit Load (DLL)
  - Subsequently Static Tested to Failure
    - Failed at 166% DLL load
      - Threshold/Objective Goal was 150/180%



**Limited Building Block Program Successfully Used to Design, Develop, and Verify Lower Tension Rail Joint**

# Current Composite Prototype Efforts

## Full Scale MCB Test Components



# Current Composite Prototype Efforts

## Full Scale MCB Test Components Tests & Accomplishments

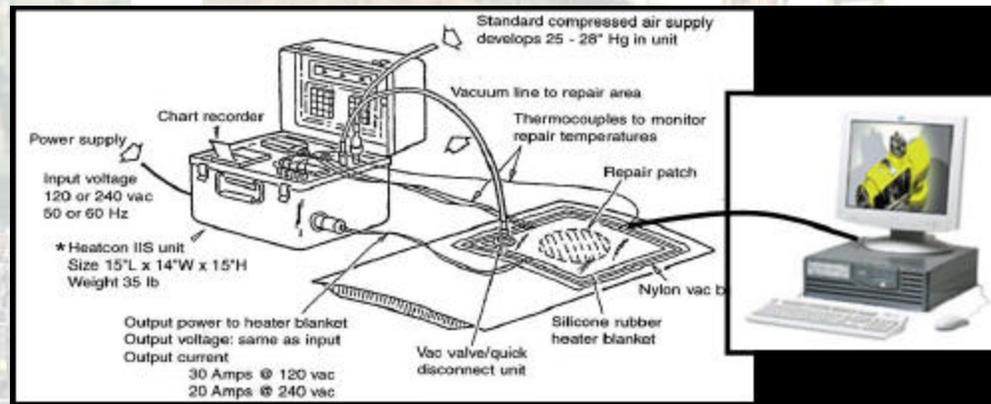


- **Failure Occurred in Joint, where desired, at 166% Limit Load**
- **Joints/Connections Feasible for Composite Military Bridges**

# Current Composite Prototype Efforts

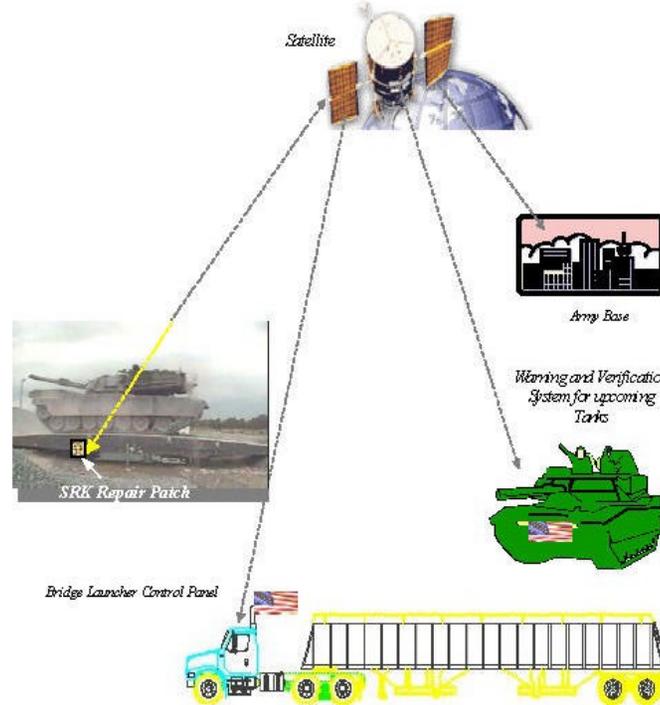
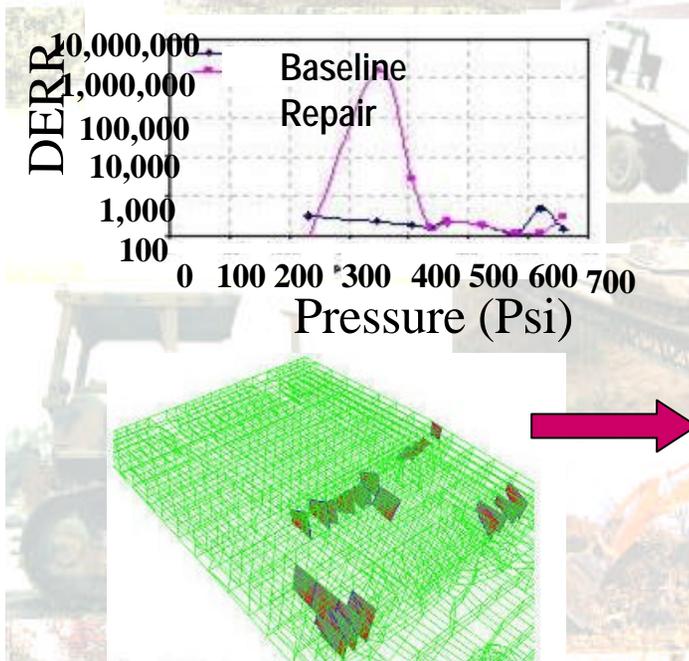
## Smart Repair Kit For Composite Bridges (SRK)

- Physics of Failure Approach through Modeling and Simulation
- Structural Failure
  - Where, When and Why?
- Approach Yields SMART REPAIR Solution and Methodology
- Demonstrate Co-relation with Actual MCB Bridge Module Failures
- Repair the MCB Modules per Methodology and Demonstrate Field/Depot Repair Efficacy through Tests



# Current Composite Prototype Efforts

## Smart Repair Kit For Composite Bridges (SRK)



M & S

Smart Repair Kit for Composite Bridges

# Future Composite Conceptual Efforts

## CAB & MCB Phase I Technology Transitions

- MCB Phase II for FF Prototype
- Longer Dry Support Bridge (DSB) Launch Beam
  - Current Aluminum Launch Beam Length 48m Restricts DSB Span Length to 40m
  - Goal to Increase Launch Beam Length to 60m to enable 52m DSB Span
- Joint Service Technology Efforts



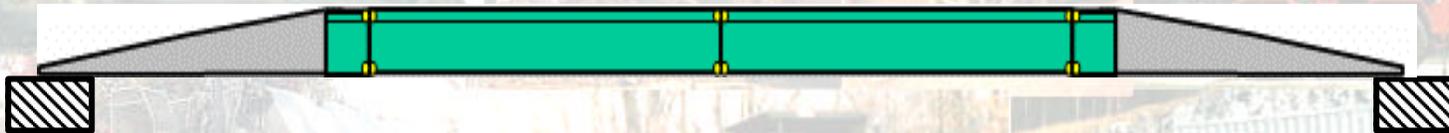
# Future Composite Conceptual Efforts

## MCB Phase II

- Design, Build & Test Prototype Treadway

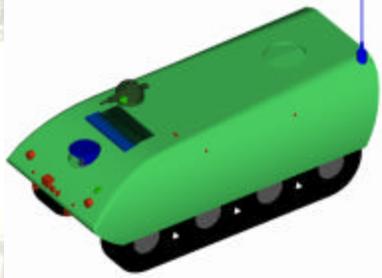
- Goals

- Capable of Incrementally Spanning Gaps up to 25 meters
- MLC 65 Tracked/Wheeled Vehicles
- Width 3.35 meters
- C-130 Transportable
- Deployed Bridge Transportable by CH-47
- Automation to Connect MCB Modules

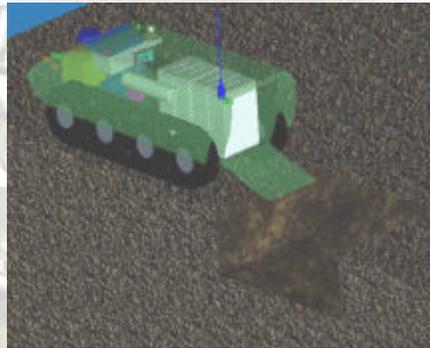


# Future Composite Conceptual Efforts

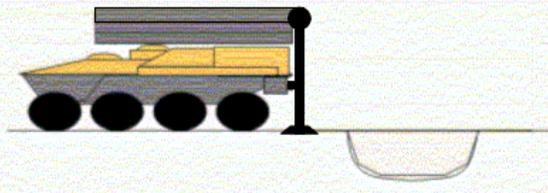
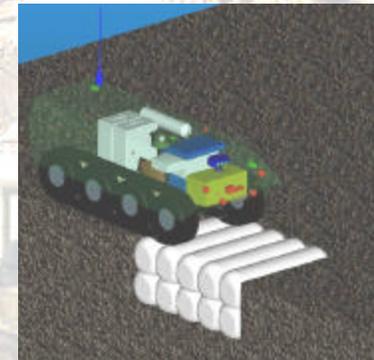
## Organic Gap Crossing Concepts for The FCS



Concept UA Vehicle



Air Inflation Fascines

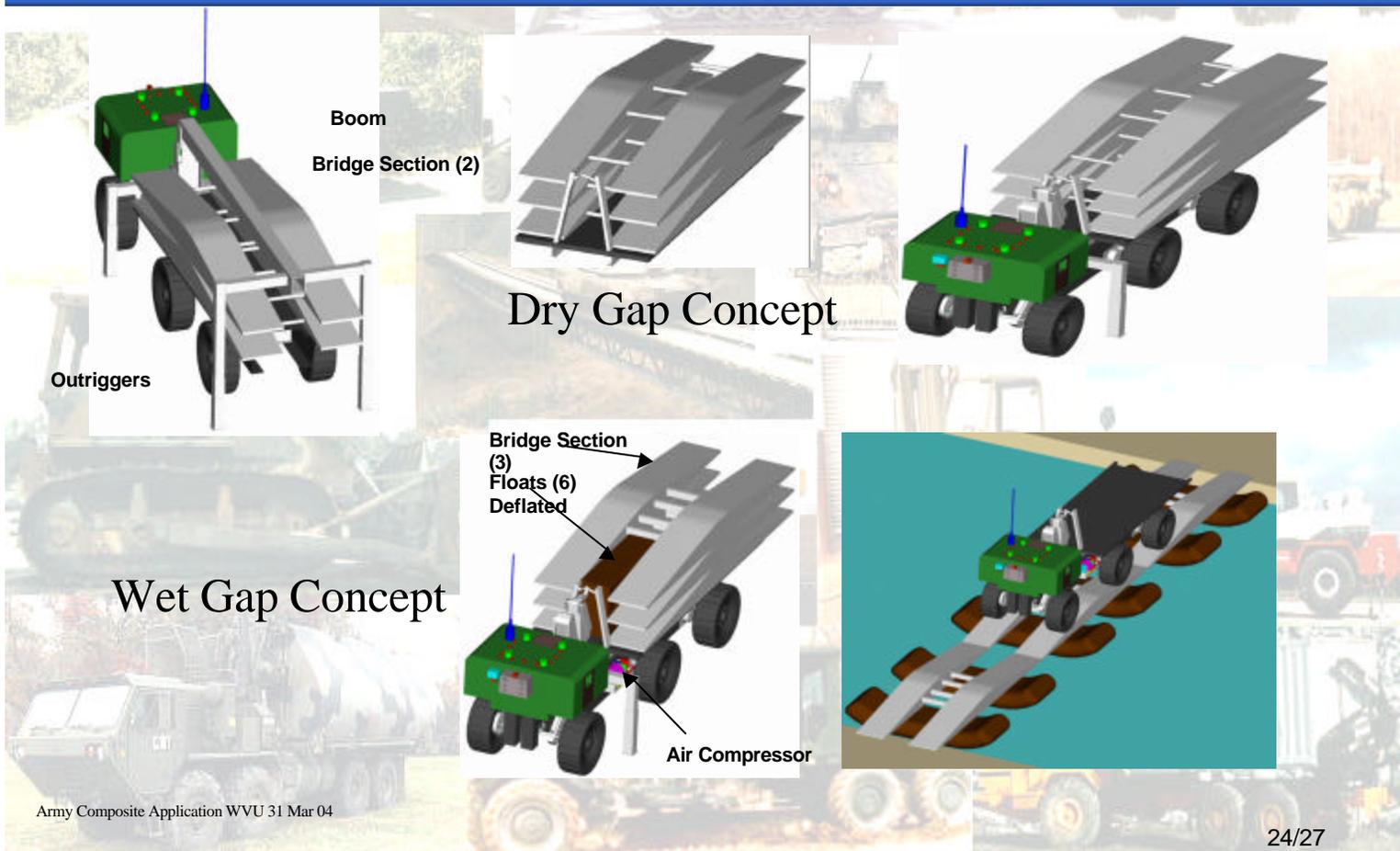


Composite Deck Panels

MLC 30  
Gaps 1.5-4.0 meters

# Future Composite Conceptual Efforts

## Augmented Gap Crossing Concepts for the FCS



# Future Composite Conceptual Efforts On Site Manufacturing-On Demand Bridging

Composite and Aerospace Structures Laboratory, University of California, San Diego, CA 92093-0085

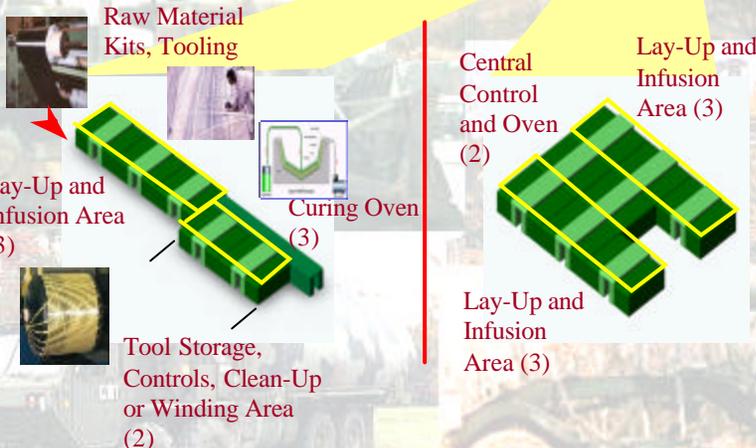
## Conceptual Factory

### MEF Shelters (20' x 8' x 8')

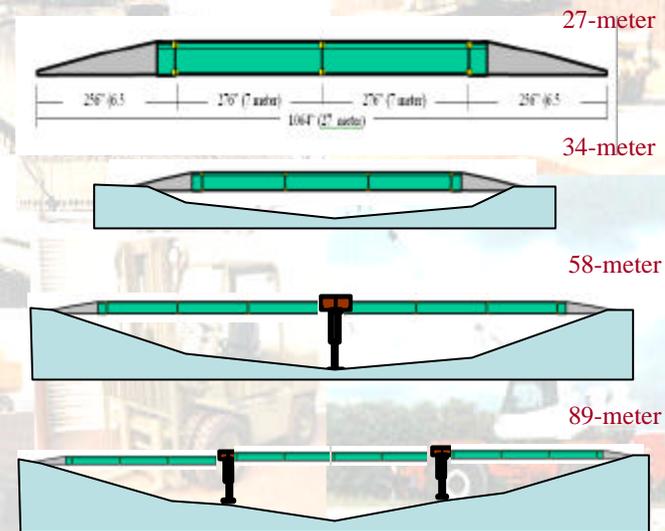
- Expandable into 24' x 20' Bridge Factory Floor
- Add insulation to create a cure oven (100°C)
- Contain Tools, Fiber Kits, Resin, Disposables



### Assemble Shelters into **Single or Dual-Path** Factory



## Conceptual Configurations



Four Basic Building Blocks to Fabricate Any Length

# Future Composite Conceptual Efforts On Site Manufacturing-On Demand Bridging

Seemann Composites Incorporated (SCI), Gulfport, MS



# Questions?

## Army Composite Bridging Applications Supporting The Army's Future Combat System & Future Force

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