Army Composite Bridging Applications
Supporting
The Army’s Future Combat System
&
Future Force
March 31, 2004

Brian K. Hornbeck
Team Leader, Bridging Team
Engineer and Logistics Equipment
(586) 574-5608
hornbecb@tacom.army.mil
**ABSTRACT**

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 shortcomings 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.
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

- 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

- 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)

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

Test Results
- 2000+ MLC 70/100 crossings in the Field
- 18,000 MLC 70 simulations in Lab.
Current Composite Prototype Efforts
Composite Army Bridge (CAB)

Trade Off Metrics

![Graph showing trade-off metrics between cost and weight for different prototypes and designs.]

- **Comparable Aluminum Bridge (Baseline-MLC 70)**
- **High Cost/High Weight**
- **Low Cost/Low Weight**
- **Prototype MLC 70 Design**
- **MLC 100 Production 100 Units**
- **Prototype MLC 100 Design**
Current Composite Prototype Efforts
Composite Army Bridge (CAB)

- CAB Design and Testing.
- Finite Element Analysis.
- Composite Bridge Engineering and Rehabilitation Program.
- Material Property Evaluation.
- Subscale Wear Tests
- Environmental Materials Testing – Cold & Hot Weather Coupon Testing
- User Input and Feedback.
- Technology Reinvestment Program.
- Bridge Infrastructure Renewal Program.
- Low Cost Composites Manufacturing.
- Full Scale Field & Wear Testing.
- Technical Advisors for Design, Requirements & Vehicle Interface.
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
**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**

Full Scale Modular Composite Bridge (MCB) Test Components
Current Composite Prototype Efforts
Modular Composite Bridge (MCB)

Building Block Approach

Develop two basic 7-meter building block components

Ramp Section
3" step
(1.9)
275" (6.9 meter)
256" (6.5 meter)
31"

Pin Joints

Interior Section
276" (7 meter)

Assemble two ramps and two interior sections into a 27 meter Bridge

226" (5.7 meter)
276" (7 meter)
1064" (27 meter)
276" (7 meter)
236" (6.5 meter)

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

(c) John Kosmides
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

Baseline Fabrication Process for MCB is SCRIMP
Operating Environment Defined for MCB

Tension Rail %s
(40/40/20)

Lug Rail Transition %s
(40/40/20)

Lug Wrap %s
(65/35/0)
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

Comparison of Tension Rail Load Distribution for 27-meter MCB Bridge and MCB Test Specimen ($P_1 = P_2 = 70,500$ lb)

Tension Joint = 455,800 lb

Bridge Station (feet)
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

Smart Repair Kit For Composite Bridges (SRK)

- Standard compressed air supply develops 25 - 30" Hg in unit
- Power supply
  - Input voltage: 120 or 240 vac
  - 50 or 60 Hz
- Heatcon 116 unit
  - Size: 15"L x 14"W x 15"H
  - Weight: 35 lb
- Chart recorder
- Vacuum line to repair area
- Thermocouples to monitor repair temperatures
- Patch
- Nylon vac b
- Silicone rubber heater blanket
- Output power to heater blanket
  - Voltage: same as input
  - Current: 30 Amps @ 120 vac
  - 20 Amps @ 240 vac
- Vac valve/quick disconnect unit
Current Composite Prototype Efforts
Smart Repair Kit For Composite Bridges (SRK)

Pressure (Psi)

Baseline
Repair

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
• 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

Boom
Bridge Section (2)
Outriggers

Dry Gap Concept

Wet Gap Concept

Bridge Section (3)
Floats (6)
Deflated

Air Compressor
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

Raw Material Kits, Tooling

Lay-Up and Infusion Area (3)

Curing Oven (3)

Tool Storage, Controls, Clean-Up or Winding Area (2)

Conceptual Configurations

Four Basic Building Blocks to Fabricate Any Length

27-meter
34-meter
58-meter
89-meter

Army Composite Application WVU 31 Mar 04
Future Composite Conceptual Efforts
On Site Manufacturing-On Demand Bridging

Seemann Composites Incorporated (SCI), Gulfport, MS

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Questions?

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