Army Composite Bridging Applications
Supporting
The Army’s Future Combat System
&
Future Force
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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.
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
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

- Comparable Aluminum Bridge (Baseline-MLC 70)
- High Cost/High Weight
- Low Cost/Low Cost/
- Low Weight
- MLC 100 Production
  100 Units
- Prototype MLC 100 Design
- Prototype MLC 70 Design

Cost ($1,000) vs Weight (lbs)
Current Composite Prototype Efforts
Composite Army Bridge (CAB)
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

Ramp Section
3" step
(1.9)
225" (5.71 meter)
256" (6.5 meter)
31"

Interior Section
276" (7 meter)
28"

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

226" (5.7 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 Kosmatka
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

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 Rail Force (lb)

Bridge Station (feet)

Tension Joint $= 455,800$ lb

$P_1$

$P_2$

24"
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

- **Boom**
- **Outriggers**
- **Bridge Section (2)**
- **Dry Gap Concept**

- **Wet Gap Concept**
- **Bridge Section (3) Floats (6) Deflated**
- **Air Compressor**
Future Composite Conceptual Efforts
On Site Manufacturing-On Demand Bridging

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

Lay-Up and Infusion Area (3)
Tool Storage, Controls, Clean-Up or Winding Area (2)
Curing Oven (3)
Centrally Control and Oven (2)
Lay-Up and Infusion Area (3)
Future Composite Conceptual Efforts
On Site Manufacturing-On Demand Bridging

Seemann Composites Incorporated (SCI), Gulfport, MS
Questions?

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