


2011 Wood Structures Symposium  
UMass, Amherst

## Sustainable Building Materials: Emerging Technologies

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## Environmental Conservation



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## Emerging technologies

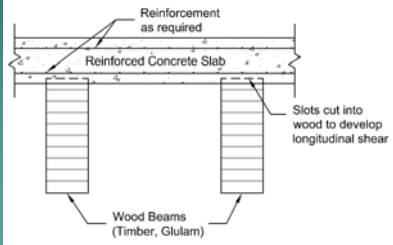
- Wood-concrete composites
- Laminated Bamboo Lumber




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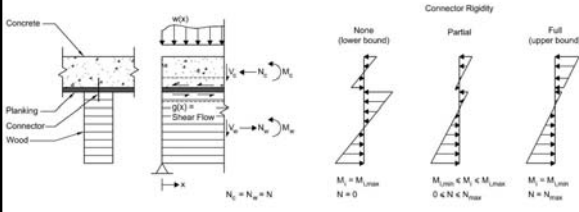
## Wood-concrete composites

- Hybrid composite construction method
- Used since 1930s (timber bridges)



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## Composite action



- Partial composite action → depends on fastener
- Analysis: Eurocode 5  
– Clouston and Schreyer (2008) ASCE Practice Periodical on Structural Design and Construction, Vol. 13, No. 4

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## Benefit of composite action

Wood	Wood-concrete composite	
		
	Strength	Stiffness
→	Increase up to	Increase up to
	<b>2 times</b>	<b>4 times</b>

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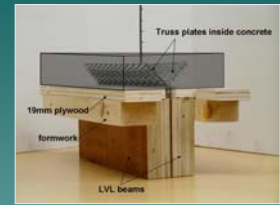
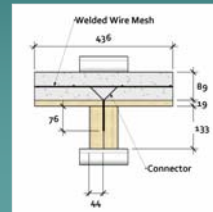
## Commercial shear connectors

Bertsche connector

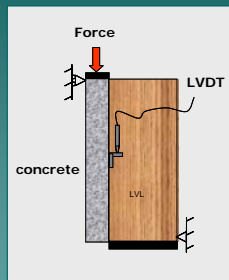


## UMass Truss-Plate System

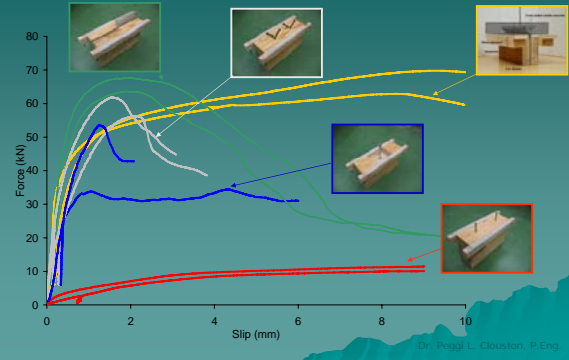
- ◆ Commercial truss plates
- ◆ 2 side-by-side 1.9E ES LVL
- ◆ 19mm plywood permanent formwork



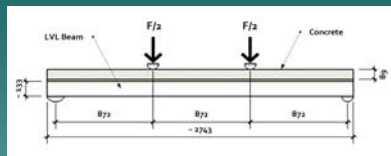
## Push out test setup



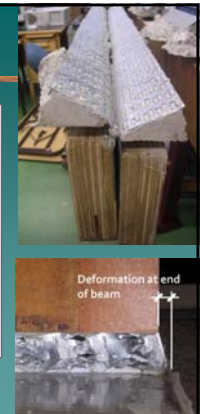
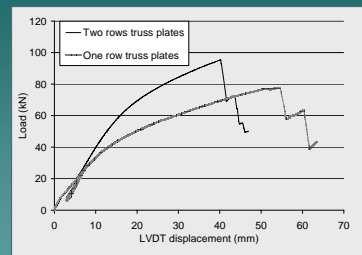
## Load-slip results



## Beam Tests Setup



## Beam Test Results



## WCCs and Mill Restoration



MASS MoCA – Museum of Contemporary Art

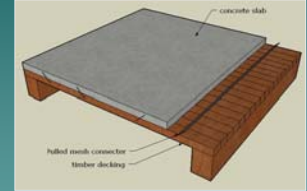
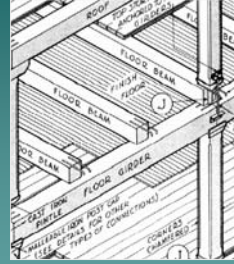
\* reuse of bricks, natural stone, timber



19th century paper mill

## WCCs and Mill Restoration

Standard mill construction



- Clouston and Schreyer (2011) Journal of Constructed Environment

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## Wood-concrete bridge project

- ◆ Long-term performance in extreme climates



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## UMass Research on bio-based composites

- ◆ Bamboo



- ◆ fastest growing plant currently known
- ◆ 3-8 years to maturity
- ◆ Specific strength greater than steel or wood

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## Biobased materials are the future

- ◆ Wood, hemp, flax, bamboo + biopolymers
- ◆ Automotive, sport, building products
- ◆ Technological road map for U.S. DOE
  - 10% of all basic chemical building blocks will be renewable sources by 2020
  - **50% by 2050**



Laminated wood bike frame  
Sylvan Cycles

## Laminated Bamboo Lumber study



- Mahdavi, Clouston and Arwade (2011)  
Journal of Materials in Civil Engineering, Vol. 23, No. 7

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## Student projects ...



## More information ...

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## Wood engineering

- ◆ More structurally demanding applications today



Prince George Airport, British Columbia, Equilibrium Engineering Inc.

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## Contemporary uses of wood ...



Richmond Olympic Speed Skating Oval, British Columbia, 2010

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