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## Sustainable Structures Built with Engineered Wood



Presented by: Roy Frederick

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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## Webinar Attendee Survey




Roy Frederick

<https://www.apawood.org/sustainable-structures-survey>

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### Course Description

As society seeks a more sustainable future, sustainable building construction is becoming more important. This program looks at sustainability in the construction industry and the role of wood construction, specifically, designing with engineered wood products. Participants will learn best practices to improve design, specification and installation of sustainable solutions using engineered wood systems.



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### Learning Objectives

- Understand sustainability, its importance and the impact it has on the construction industry, from the forest to the home.
- Recognize the role that wood construction plays in the future of sustainable construction.
- Describe the benefits of engineered wood products and how harvesting, manufacturing and using these products lessen impacts on the environment.
- Use best practices for sustainability in the design, specification, and installation of engineered wood products.



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### Today's Agenda

1. What is a sustainable structure?
2. How do you compare building materials?
3. Why is wood sustainable?
4. What are the sustainable benefits of Engineered Wood Products?
5. What best practices can you implement in your building design and construction today?



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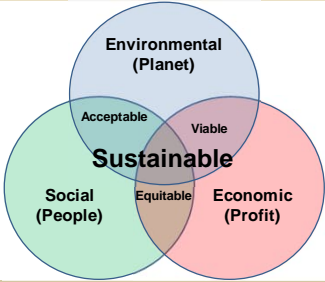
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### Sustainability



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### Sustainability

▪ Climate Change



Credit: NASA.gov



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### Sustainability

- Climate Change
- Population Increase



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### Sustainability

- Climate Change
- Population Increase
- Resource Depletion



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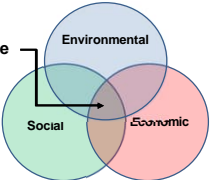
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### What is a sustainable structure?

- Maximize efficiency in resources:
  - Energy
  - Water
  - Materials
- Minimize impact through complete building life cycle:
  - Human health
  - Environment



EPA United States Environmental Protection Agency

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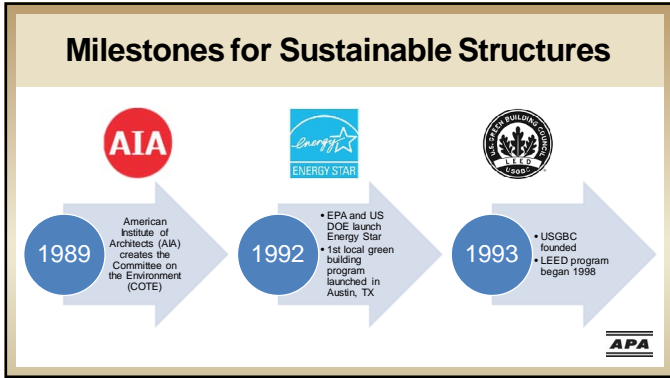
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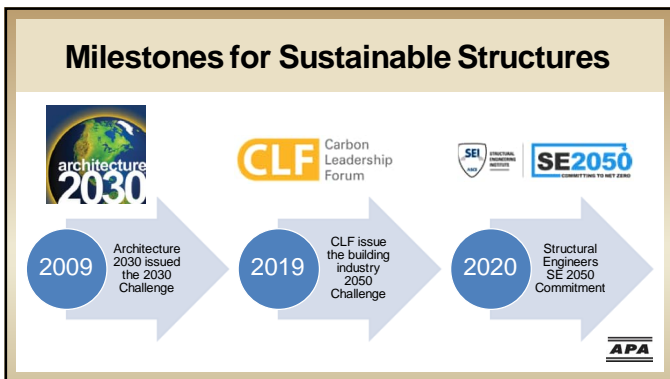
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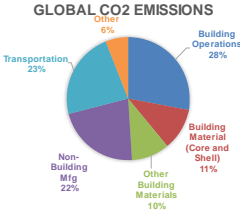
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## Sustainability

**Comprehensive Change**



**GLOBAL CO2 EMISSIONS**



Category	Percentage
Building Operations	28%
Transportation	23%
Non-Building Mfg	22%
Other Building Materials	19%
Building Material (Core and Shell)	11%
Other	6%

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## Carbon Accounting 101



*A Carbon Explainer - APA – The Engineered Wood Association ([apawood.org](http://apawood.org))*

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### Carbon Accounting 101

- Carbon accounting
- Embodied carbon

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### Carbon Accounting 101

Zero Net Energy ➔ Carbon Neutral

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### Carbon Accounting 101

Operational energy ➔ Operational carbon

PRODUCT		CONSTRUCTION		USE		END-OF-LIFE	

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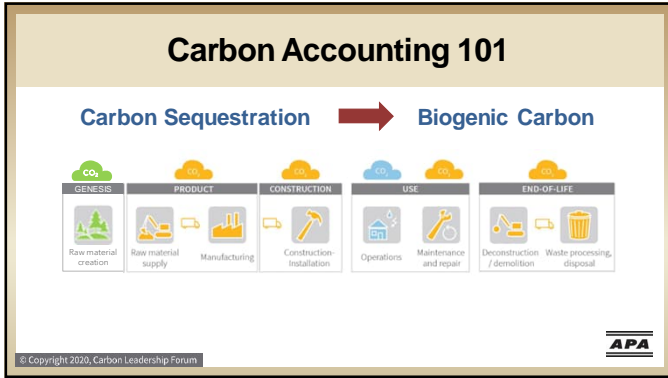
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### Carbon Accounting 101

- **Environmental Product Declaration (EPD)**
- Compliance with ISO standards
- Adherence Product Category Rule (PCR)
- Third party certification of the LCA process
- A list of the life cycle stages considered in the analysis

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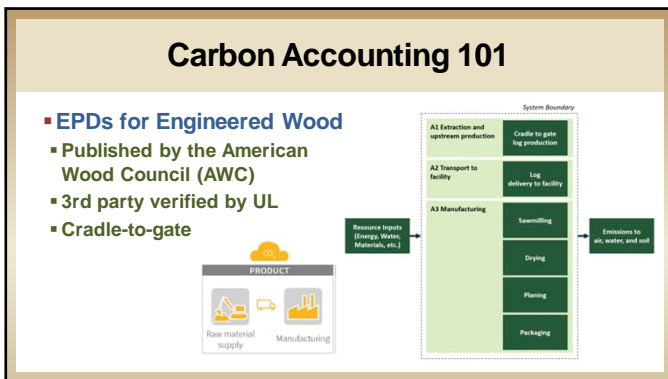
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# Carbon Accounting 101

## Construction



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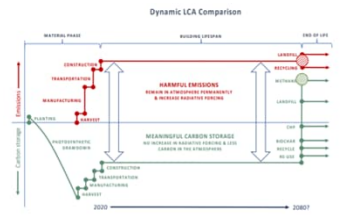
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# Carbon Accounting 101

## Use

- Operations
- Maintenance and repair



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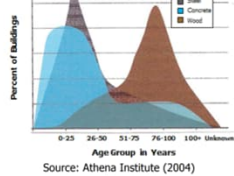
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# Carbon Accounting 101

## End-of-Life



Demolition of 227 Buildings in Minneapolis/St. Paul, 2000-2003



Source: Athena Institute (2004)



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## Embodied Carbon

- Adaptive Reuse
- [ReuseWood.org](http://ReuseWood.org)

END-OF-LIFE

Deconstruction / demolition    Waste processing, disposal

**REUSE  
REDUCE  
RECYCLE**

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## Carbon Accounting 101

- End-of-Life

END-OF-LIFE

Deconstruction / demolition    Waste processing, disposal

**C&D Debris Generation Composition by Material (before processing), 2018**  
600 Million Tons

Material	Percentage
Concrete	67.0%
Asphalt Concrete	17.8%
Wood Product	6.8%
Asphalt Shingles	2.5%
Brick and Clay Tile	2.0%
Drywall and Plasters	2.3%
Steel	<1%

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[https://www.epa.gov/sites/production/files/2021-01/documents/2018\\_ff\\_fact\\_sheet\\_dec\\_2020\\_fnl\\_508.pdf](https://www.epa.gov/sites/production/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508.pdf)

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## Carbon Accounting 101

- End-of-Life

END-OF-LIFE

Deconstruction / demolition    Waste processing, disposal

**Wood Debris Destination**

Destination	Percentage
Landfill	73%
Fuel	18%
Compost/Mulch	6%
Manufactured Products	3%

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[https://www.epa.gov/sites/production/files/2021-01/documents/2018\\_ff\\_fact\\_sheet\\_dec\\_2020\\_fnl\\_508.pdf](https://www.epa.gov/sites/production/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508.pdf)

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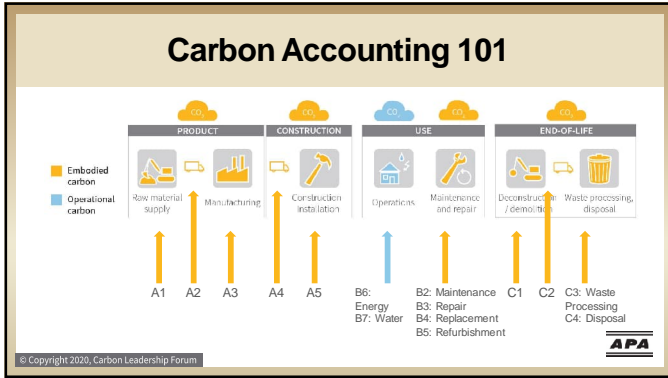
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RFO Mark Tibbets Encourage you to note that C&D debris, including wood, goes to “C&D landfills” not “landfills.” Municipal solid waste landfills generate methane, and while the science is not complete making that distinction between waste types may become more important.

Roy Frederick, 2022-09-22T19:41:49.548



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### Carbon Accounting 101

- Life Cycle Assessment (LCA)
- Bill of materials
- LCA software: Athena, GaBi, SimaPro, Tally, EC3, OneClick
- Environmental Product Declaration (EPD)

The diagram is credited to the APA logo.

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The diagram is credited to the APA logo.

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### The Carbon Factor

- 33% of total land in the US is forest
- Annual net timber growth is 36% higher than removals
- 1.4 tons of CO<sub>2</sub> is sequestered in every 1 ton of wood
- US forest offset nearly 15% of total greenhouse gases

APA Form F305

Forest products account for 28 percent of the total U.S. greenhouse gas emissions.

For every ton of wood removed from a forest, 1.4 tons of CO<sub>2</sub> are sequestered in the wood.

Each year, the U.S. plants over 1 billion trees and Canada plants over 600 million trees.

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### Sustainability – Forest Facts

#### US and Canada

- North America has more certified forests than anywhere else in the world.
- Each year, the U.S. plants over 1 billion trees and Canada plants over 600 million trees.
- Demand for forest products keeps forests as forests.
- Global carbon dioxide emissions could be reduced by as much as 31% if builders used wood instead of steel and concrete.

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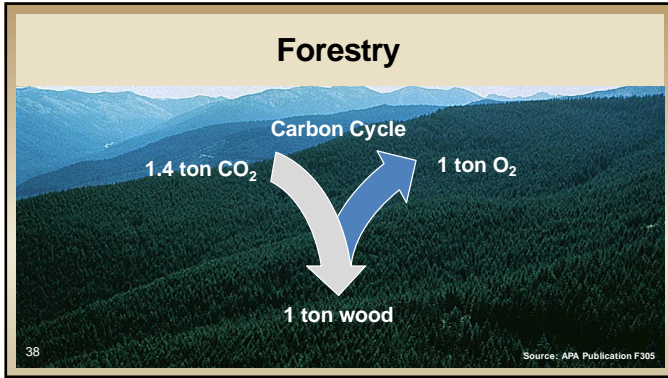
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### Forestry

#### Benefits of Timber Harvesting

- Promotes forest regeneration.
- Increases biodiversity
- Improves timber quality and increases value



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### Forestry

#### Benefits of Timber Harvesting

- Promotes growth productivity and efficiency
- Enhances wildlife habitat



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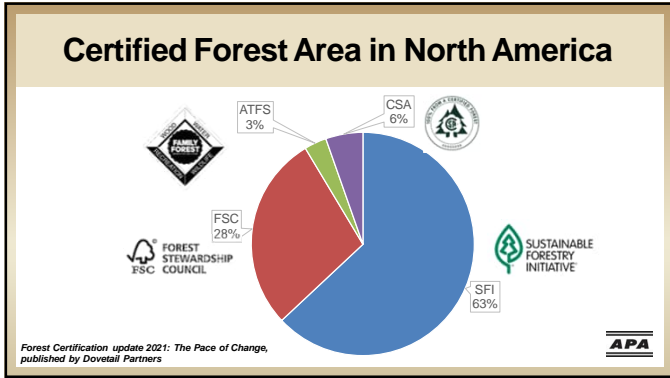
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### Forest Certification and APA Members

	FSC	ATFS	PEFC	CSA	APFS	OTHER
Boise Cascade LLC	X	X	X	-	-	-
Georgia-Pacific Wood Products LLC	-	X	-	-	-	-
Herdal Mutual Plywood Corporation	-	-	-	X	-	X
Hood Industries, Incorporated	-	X	-	-	-	X
Hunt Forest Products, Inc.	-	-	-	-	X	-
LP	-	X	-	-	-	-
Pacific Wood Laminates, Inc.	X	-	-	-	-	-
Pottlatch Corporation	X	-	-	-	-	X
Roseburg Forest Products Company	X	-	-	-	-	-
RoyMavin	X	-	-	-	-	-
Scotch Plywood Company, Inc.	-	X	-	-	-	-
Svensen Group Mfg. LLC	-	X	-	-	-	X
Timber Products Company -- Grants Pass	-	X	-	-	-	-
Toko Industries Ltd.	-	-	X	X	-	-
West Fraser	X	X	X	-	-	X

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### Design Concepts

**Biophilic Design**

- Environmental Features
- Natural shapes and forms
- Light and space
- Evolved human-nature relationship

*Nature in Design: The Biophilia Effect - APA – The Engineered Wood Association (apawood.org)*

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### Sustainability – On-demand Webinars



WEBINAR  
**SUSTAINABLE CHOICES**  
Wood Products in Industrial Applications



WEBINAR  
**Wood as a Sustainable Building Material**

Available at [www.apawood.org](http://www.apawood.org)




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### Wood Carbon Calculator



[www.woodworks.org/resources/woodworks-carbon-calculator](http://www.woodworks.org/resources/woodworks-carbon-calculator)




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### Today's Agenda

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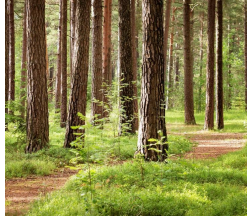
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### Sustainable Benefits of Engineered Wood

- Produced from small dimension lumber harvested from managed and sustainable forests
- Timber resource utilization optimized using a wide range of lumber grades
- Custom lengths = less waste
- Manufacturing involves low energy use process
- Uses low formaldehyde emitting adhesives



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### Sustainable Benefits of Engineered Wood

#### Predictability

- Consistent dimensions
- Straight
- Predictable
- Less Shrinkage
- Less Crowning
- Long Lengths



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### Sustainable Benefits of Engineered Wood

#### Performance

- Longer lengths and stronger members



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### Sustainable Benefits of Engineered Wood

#### Span Further

@ 24"o.c.: Sawn 2x12 (max. 17'-1")	→ 11-7/8" i-joist (max. 20'-2")	+18%
@ 4ft. o.c.: Sawn 4x14 (max. 19'-4")	→ LVL 3-1/2x14 (max. 22'-3")	+15%
@ 8ft. o.c.: Sawn 6x16 (max. 20'-9")	→ GLB 5-1/2x16 (max. 24'-8")	+18%
	OR 7-layer x 8ft. CLT panel (max. 29'-3")	+41%

Note: Spans assume a Live load = 40psf and Dead Load = 10psf with an L/480 (LL deflection limit)



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### Sustainable Benefits of Engineered Wood

#### Less waste

- Longer lengths cut to size to reduce jobsite waste
- Engineered wood products are a system



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### Sustainable Benefits of Engineered Wood

#### Manufacturing

- Uses Biowaste
- Low Energy
- Lowest



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## Bio Preferred

- Managed by the U.S. Department of Agriculture
- Goal is to increase the purchase and use of biobased products.
- Reduces our nation's reliance on petroleum
- Increases use of renewable agricultural resources





<https://www.biopreferred.gov/BioPreferred/faces/pages/AboutBioPreferred.xhtml>

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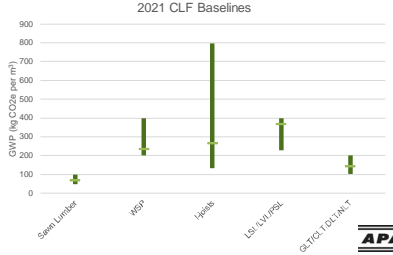
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## Engineered Wood and Sustainability

- Embodied carbon
  - Material baseline





Material	Embodied Carbon (kg CO <sub>2</sub> e/m <sup>3</sup> )
Swain Lumber	~100
WSP	~250
Heidelberg	~800
LSI 1.0/1.0/1.0	~350
GLT/CLF/CLF/CLF	~150



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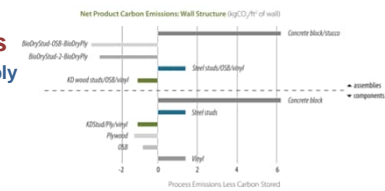
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## Embodied Carbon

### Net Product Carbon Emissions


- Wall Structure Assembly vs. Components





Category	Item	Carbon Emissions (kg CO <sub>2</sub> /ft <sup>2</sup> )
Concrete block/brick	Concrete block/brick	~5.5
	Steel stud, OSB sheaf	~2.5
Concrete block	Concrete block	~5.5
	Steel stud	~2.5
Process Emissions Less Carbon Sequestered	WSP	~0.5
	OSB	~0.5

Source: Upple & Edmonds, 2009



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## Embodied Carbon and Materials

**Embodied carbon intensity diagrams**

Carbon Intensity Summary of Studied Buildings  
Modules A-C  
(kg CO<sub>2</sub>e / m<sup>2</sup>)

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## Engineered Wood and Sustainability

### Green Building Specifications

	WSP	glulam	i-joists	SCL	CLT
California Air Resources Board & CALGreen	Exempt based on ASTM E1333 testing!				same ?
US Green Building Council LEED v4	✓	✓	✓	✓	✓
National Green Building Std. ICC 700-2020	✓	✓	✓	✓	same ?
EPA Indoor airPLUS	✓				

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## More is not always better

**Steel and concrete use more:**

- Energy
- Emit more greenhouse gases
- Release more air and water pollutants during manufacturing

APA Form F305

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## More is not always better

**Net Carbon Emissions**

NET CARBON EMISSIONS	
MATERIAL	NET CARBON EMISSIONS FROM PRODUCTION*
Framing Lumber	33
Brick	88
Glass	154
Recycled steel (100% recycled content)	220
Concrete	265
Concrete block	291
Recycled aluminum (100% recycled content)	309
Steel (virgin)	694
Plastic	2,502
Aluminum (virgin)	4,532

\*By Climate Inc.  
Source: U.S. EPA (2016). Values are based on life cycle assessment and include gathering and processing of raw materials, primary and secondary processing, and transportation. Study assumed carbon content for wood at 49 percent.



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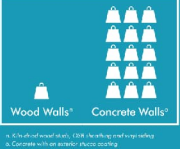
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## Carbon Savings

WALL CONSTRUCTION


WOOD SAVES 15 POUNDS of avoided CO<sub>2</sub> emissions for every square foot of wall area



a. 1/2" nominal wood wall studs, 2x8" top and bottom joist framing  
b. Concrete with one exterior/plaster finish


FLOOR CONSTRUCTION

WOOD SAVES 22 POUNDS of avoided CO<sub>2</sub> emissions for every square foot of floor area



a. Engineered wood 2 plies with OSB subfloor  
b. Steel joist with 2x10 subflooring

Source: Lippke, B. and Edmonds, L. Environmental Improvement Opportunities for Alternative Wall and Floor Design. 2009. CORRIM Phase II Research Report



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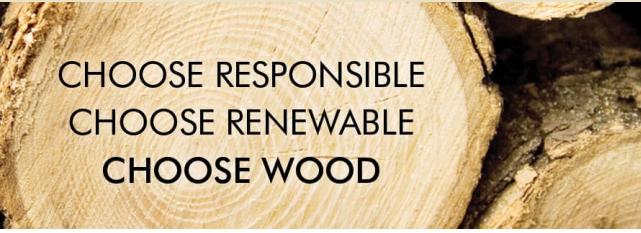
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## Wood is Sustainable



CHOOSE RESPONSIBLE  
 CHOOSE RENEWABLE  
 CHOOSE WOOD



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## Best Practices for Sustainability

- **Less is more**
  - Use light frame EWPs when you can
  - Use mass timber EWPs instead of steel and concrete construction
  - Use Biophilic Design
  - Expose your structure
  - Utilize advanced framing techniques



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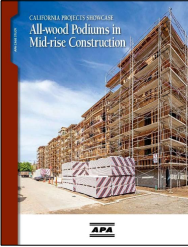

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## All-wood Podiums in Mid-rise Construction

APA Case Study, Form No. N110



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### Mass Timber

- Renewable resources
- Lower embodied energy
- 2021 IBC allows 18-story construction
- Cost benefits
- Recent projects:
  - 18-story student housing, Brock Commons (Vancouver, BC)
  - 25 story (19 = mass timber) apartment building, Ascent Tower (Milwaukee, WI)



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### Wood Shaft Walls

- Substitute Concrete/CMU shaft walls with wood



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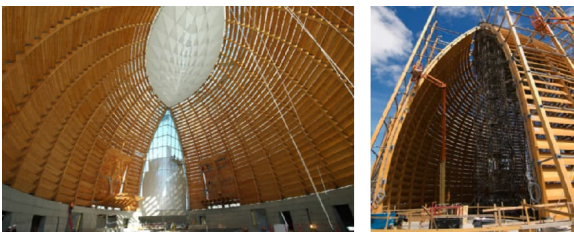
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### Use Biophilic Design



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RFO **1989 Loma Prieta Earthquake**  
Roy Frederick, 2022-09-22T20:10:26.463



## Case Study: Environmental Nature Center

- LEED Platinum building
- Expose your structure



APA Publication: K115

68

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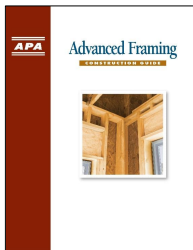
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## 2x6 Advanced Framing



APA Publication: M400



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## Green Rating Systems



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### Green Rating Systems

- Leadership in Energy and Environmental Design (LEED)



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### Green Rating Systems

- Green Globes



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### Green Rating Systems

- Living Building Challenge
- Bullitt Center:
  - ZNE + ZN Water



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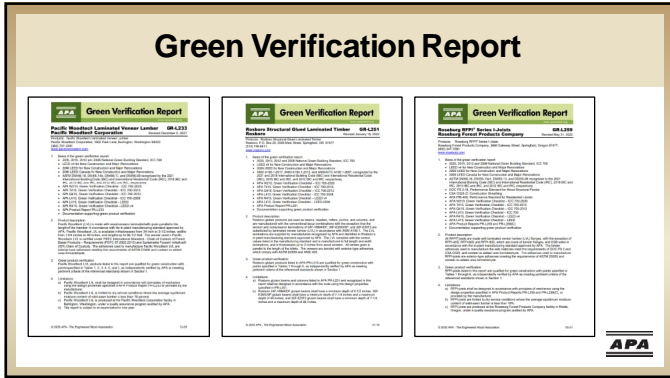
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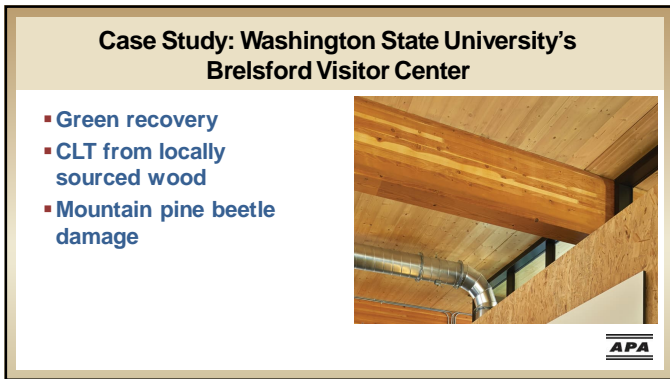
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### Case Study: Bethel School District

- Energy efficiency funds better education



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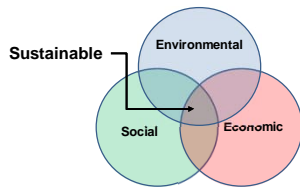
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### Case Study: Santa Barbara Apartments

- Value engineering save



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### Today's Agenda

1. What is a sustainable structure?
2. How do you compare building materials?
3. Why is wood sustainable?
4. What are the sustainable benefits of Engineered Wood Products?
5. What best practices can you implement in your building design and construction today?



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## APA Update Newsletter (www.apawood.org)

November 2020

### APA UPDATE

PUBLICATIONS, VIDEOS, CAD DETAILS AND MORE

Note: Due to Covid-19 control measures, we are unable to fulfil orders of printed publications at this time. These publications are available as downloadable PDFs.

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20 recorded webinars offer credits. Topics include framing for residential and non-residential construction, applications of engineered wood products, wall bracing, disaster-resistant design, sustainability of wood and more.

**BROWSE >**

**Wood University**

Two courses, Engineered Wood Basics and Design of Wood Connectors, offer up to eight units through AIA or AIA/CES.

[GO >](#)

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NEWLY REVISED

### Engineered Wood Construction Guide

The APA Engineered Wood Construction Guide, E30, is the authoritative guide to building engineered wood floor, wall and roof systems.

GET

**RECENT PUBLICATIONS**

- 1.00 2019 TECHNICAL SUPPORT MANUAL
- 1.00 2019 TECHNICAL SUPPORT MANUAL
- 1.00 2019 TECHNICAL SUPPORT MANUAL
- 1.00 2019 TECHNICAL SUPPORT MANUAL

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- 4.00 2020 COVID-19: YOUR APA AIA/CES COURSE

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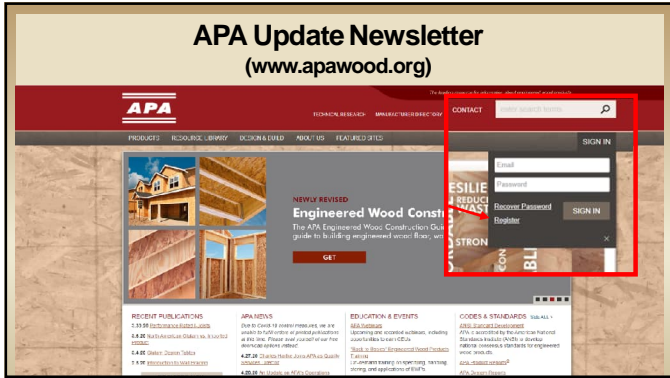
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