Westwood Public Schools Hanlon Elementary School Building Project Sustainability Subcommittee 07.08.2020



# Agenda

- Timber Framing
- Current Decision Points
- Life Cycle Cost Analysis (LCCA)

## Carbon Management

## **Carbon: Why is Carbon Management Important?**

- **Operational** Carbon: released through fossil fuels
- **Embodied** Carbon: amount of carbon used to create a material

*i.e. steel has high amount of embodied carbon, meanwhile wood has a very low amount)* 



## **Structural Steel – Embodied Carbon**

#### Structural Steel's Role in Greenhouse Gas Emissions

Embodied carbon will be responsible for *almost half* of total new construction emissions between now and 2050.

Unlike operational carbon emissions, which can be reduced over time with building energy efficiency renovations and the use of renewable energy, embodied carbon emissions are locked in place as soon as a building is build. It is critical that we get a handle on embodied carbon now if we hope to phase out fossil fuel emissions by the year 2050.

#### Total Carbon Emissions of Global New Construction from 2020-2050 Business as Usual Projection



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## **Mass Timber Construction - Overview**



Conventional Construction: Steel Columns, Beams, Braces, and Decking Mass Timber: Glue Laminated Columns, Beams; Timber Decking

## Mass Timber Construction – Options



## Mass Timber Construction – Options



Level 1: Classroom Floor Area



Level 2: Classroom Floor Area + Roof Deck

## Mass Timber Construction – Safety

#### **Construction Classification – Building Code Definitions**

#### 602.2 Types I and II

Types I and II construction are those types of construction in which the building elements listed in Table 601 are of noncombustible materials, except as permitted in Section 603 and elsewhere in this code.





#### 602.3 Type III

Type III construction is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of any material permitted by this code. *Fire-retardant-treated wood* framing complying with Section 2303.2 shall be permitted within *exterior wall* assemblies of a 2-hour rating or less.

TABLE 601 FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

						_			
BUILDING ELEMENT	ΤΥΡΕ Ι		TYPE II		TYPE III		TYPE IV	TYPE V	
	Α	В	Α	В	Α	В	НТ	Α	в
Primary structural frame <sup>f</sup> (see Section 202)	3ª	2 <sup>a</sup>	1	0	1	0	HT	1	0
Bearing walls									
Exterior <sup>e, f</sup>	3	2	1	0	2	X	2	1	0
Interior	3 <sup>a</sup>	2 <sup>a</sup>	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions Exterior				See	Table	502			
Nonbearing walls and partitions Interior <sup>d</sup>	0	0	0	0	0	0	See Section 602.4.8	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1 <sup>1</sup> /2 <sup>b</sup>	1 <sup>b,c</sup>	1 <sup>b,c</sup>	0c	1 <sup>b,c</sup>	0	нт	1 <sup>b,c</sup>	0
			190.12			_			

## Mass Timber Construction – Safety

#### **Construction Classification – Allowable Areas**

TYPE OF CONSTRUCTION OCCUPANCY SEE TYPE I TYPE II TYPE III TYPE IV TYPE V CLASSIFICATION FOOTNOTES В В HT А В А А А В NS UL UL 26,500 14,500 23,500 14,500 25,500 18,500 9,500 Е S1 106,000 58,000 94,000 58,000 102,000 74,000 38,000 UL UL 43,500 SM UL 79,500 70,500 43,500 76,500 55,500 28,500 UL

 TABLE 506.2

 ALLOWABLE AREA FACTOR (A<sub>t</sub> = NS, S1, S13R, S13D or SM, as applicable) IN SQUARE FEET <sup>a, b</sup>

43,500 SF + 10,875 SF (Open Perimeter Increase) = <u>54,375</u> Allowable SF per Story

## Mass Timber Construction – Safety

**Construction Classification – Allowable Areas** 

First Floor Area = 85,000 SF

Introduce a Fire Wall

Create Two Buildings with Actual Area less than Allowable



## Mass Timber Construction – Cost

#### **Cost Estimates: \$25 - \$35 Per Square Foot**

Increased Coordination of Exposed Structure & M-E-P-FP Components Finishes – Less enclosure with finishes / more finish treatment of exposed systems Non-conventional construction type – labor force, sequencing, protection

Partial: \$300,000

0.4% of Construction Cost

Comprehensive: \$2,000,000 2.9% of Construction Cost

Combined: \$2,300,000



## Mass Timber Construction – Acoustics

#### **Three Primary Concerns**







### Transmission

### **Reflection / Reverberation**

**Mechanical** 

## Mass Timber Construction – Acoustics

## **Transmission – Comprehensive Mass Timber**







**Conventional Construction – STC 51** 

CLT Floor System – STC 50+

## Mass Timber Construction – Acoustics

## **Reflection / Reverberation**

**Absorptive Surfaces** 





#### **Conventional Construction**

#### **Mass Timber Options**

## Mass Timber Construction – Aesthetics



## Mass Timber Construction – Aesthetics



# **Embodied Carbon Savings**

#### **Partial Timber**

### Greenhouse gas emissions from:



70 metric tons

#### Comprehensive plus Partial Timber

### Greenhouse gas emissions from:



740 metric tons

# Timber Framing and Structural Framing Decision Points

## Steel

Contributes to greenhouse gas emissions

Costs less than Timber

Ease of Procurement and familiarity of conventional builds

## Timber

#### **Environmental Benefits:**

Greenhouse Gas Emissions, water use, waste reduction, total energy used in manufacturing, renewable building material, end of life re-use

#### **Challenges:**

Cost: \$25-\$35/sf premium

Acoustics

Unfamiliar to many contractors in New England region



Partial Add \$300K



7% Reduction in Embodied Carbon associated w structure

Comprehensive + Partial

Add \$2.3 M



75% Reduction in Embodied Carbon associated with structure

# Life Cycle Cost Analysis (LCCA)

Baseline: Natural Gas heating system

**Tier-1:** Fossil Fuel Free: Water-Source Heat Pump with supplemental electric boiler

Tier-2: Fossil Fuel Free: Geothermal Heating System

All three systems above include dehumidification ventilation and partial A/C in the Admin and Sp. Educational spaces

### **Considerations and Direction for Design Team:**

Add 100% AC as a sub-set to each tier or just one of the tiers?

Add Tier 3: Geothermal with supplemental natural gas boiler to reduce number of wells?

Window to Wall Ratio: New Energy Code uses 22% as baseline. We are currently at 25%

## Window To Wall Ratio

#### **Target 25% of Above Grade Wall as Fenestration**



Sunita Williams Case Study – 28.9% Window

Fenestration % of Above Grade Walls											
Sunita L. Williams Elementary School											
Component	Wall Area (SF)	Fenestration Area (SF)	Fenestration % of Wall								
Classrooms	33,035	10462	31.7%								
Gymnasium	4,852	903	18.6%								
Media Center	1,847	1001	54.2%								
Cafeteria	1,200	606	50.5%								
Administration	2,632	584	22.2%								
Total (Incl. Misc. & Operations)	50,009	14442	28.9%								

#### **Target Areas with Excess Fenestration**

Eliminate Excessive Compositional Glazing

**Right-size Daylit Program Areas** 

## Other Key Factor for Life Cycle Cost Analysis

• Assumptions for Occupancy Use – See below. **To be confirmed with school district** 



# Next Steps

July 23: School Building Committee: Timber Framing

- August 18: Sustainability Subcommittee: Heating/Cooling System
- August 25: School Building Committee: Heating/Cooling System