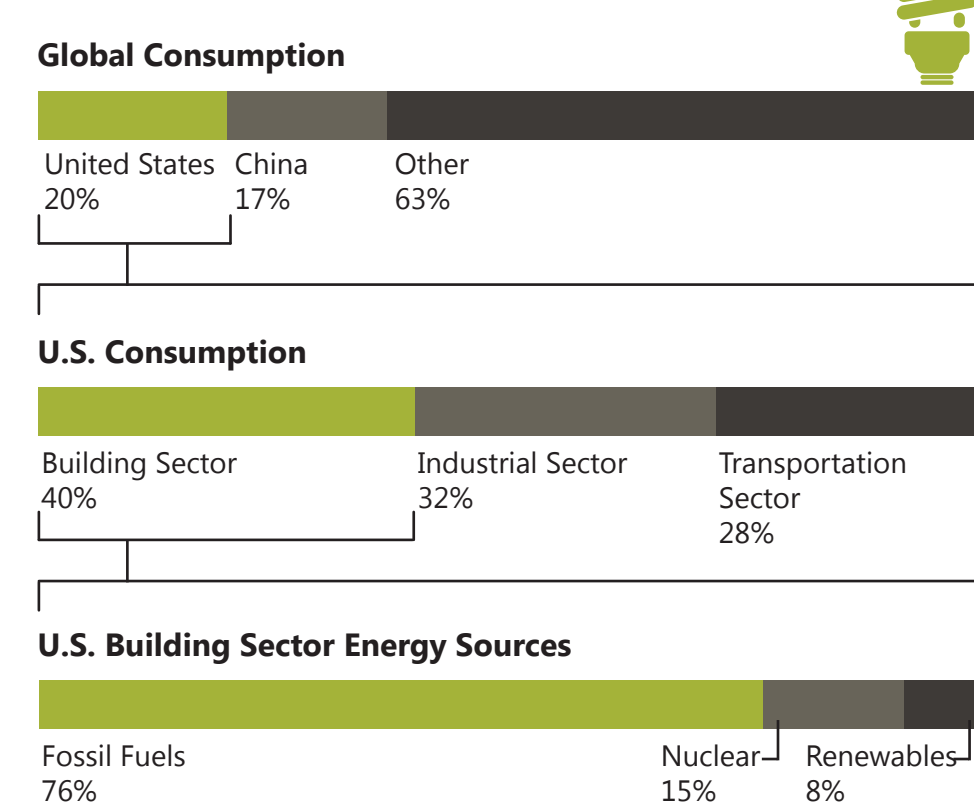




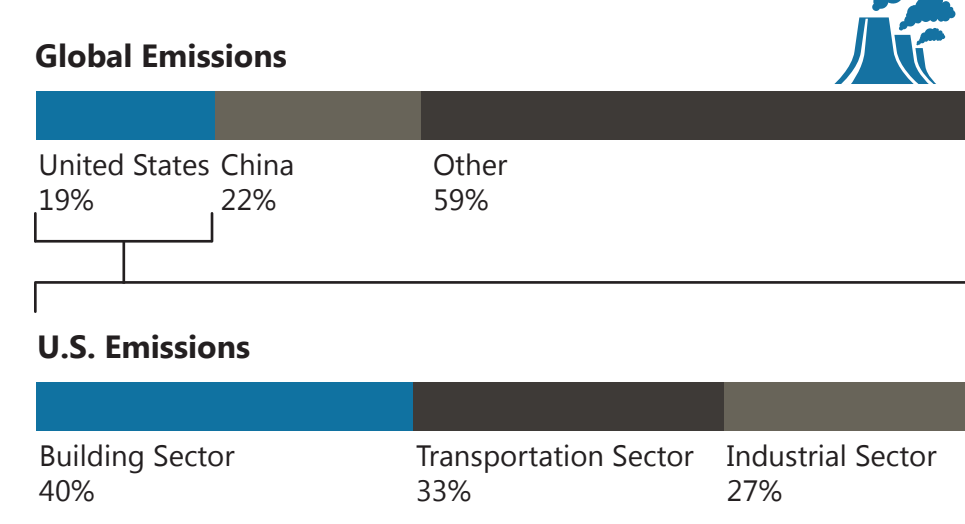
Improved Life Cycle Performance for Construction of Big Box Retail

Life Cycle Analysis Factors

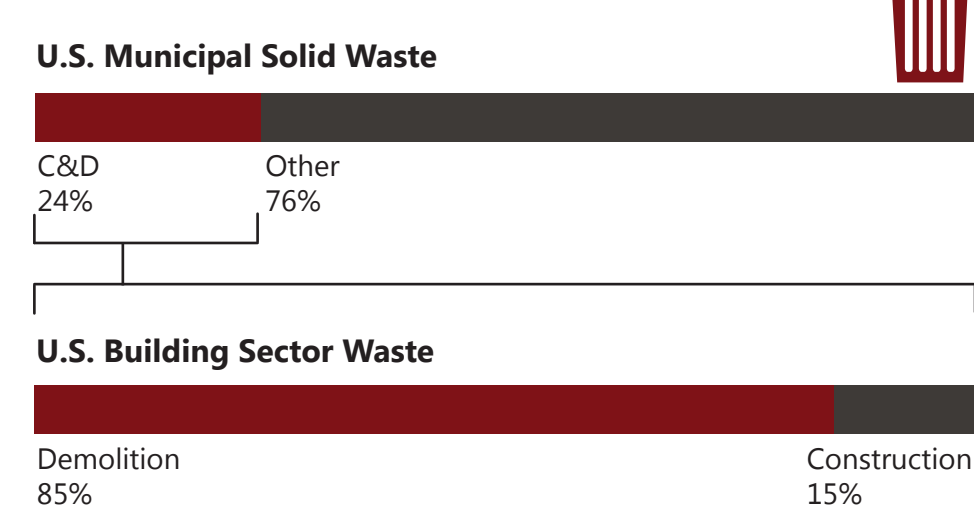
Energy Consumption



CO2 Emissions



Waste Generation



U.S. Building Sector Waste

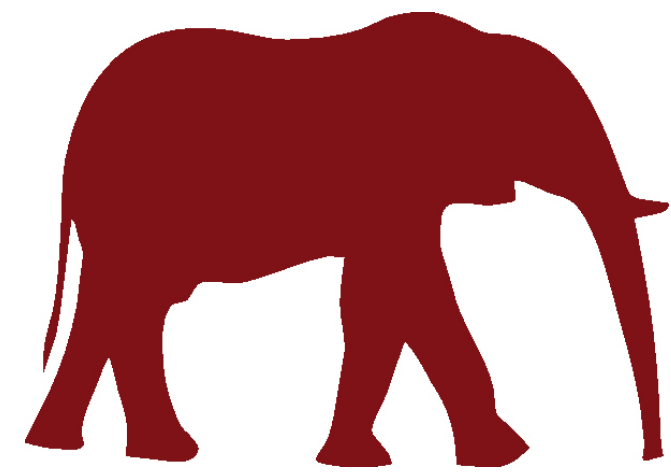
30 to 35 million tons annually = 15,000 lbs X 4,300,000



1 American house uses approximately **41,000 MJ** annually



1 passenger car emits approximately **7.5 tonnes of CO₂** annually



1 adult male elephant weighs **6.8 tonnes**

Walmart by the Numbers

2011 Sales in the U.S.:

\$307.7 billion Walmart

\$78.3 billion The Kroger Co.

\$65.8 billion Target

641 million total square footage of the island of Manhattan

698 million total square footage of Walmart's U.S. stores in 2011

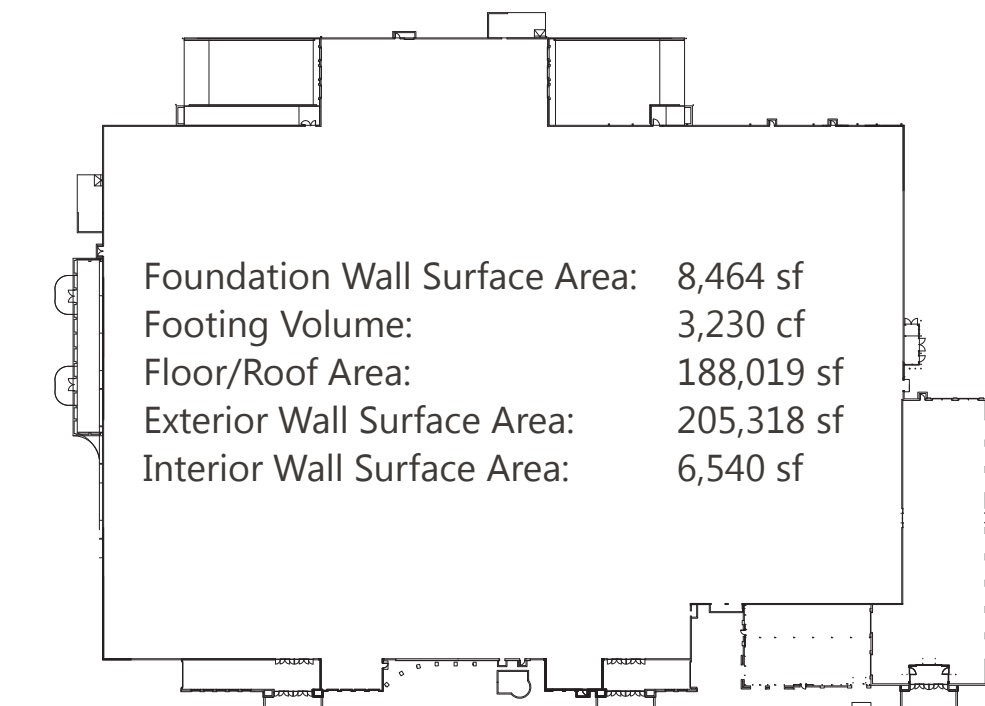
3,029 number of supercenters in the U.S. in 2011

185,000 average square footage of a Walmart supercenter

146 number of abandoned Walmart stores in the U.S. listed as available for lease or sale as of 2011

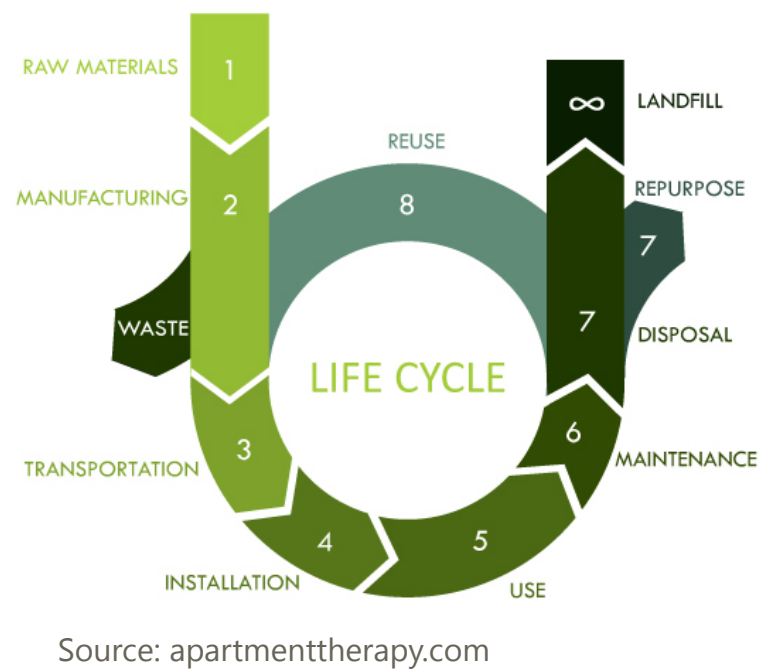
110 number of new supercenters Walmart plans to open in the U.S. in 2012 (210 total stores)

Typical Walmart Supercenter



Life Cycle Analysis

The Life Cycle Analysis of a building is the process of accounting for the impacts of the building resulting from the materials and processes associated with the production, use, and recycle/reuse/or disposal of the building at the end of its life. This includes harvesting raw materials, manufacturing of products, transportation of materials and products, assembly into a structure, maintenance and operations during use, and disposal at the end of its useful life.



LCA is a way of quantifying and analyzing many different factors which affect the human environment, one of which is embodied energy. **Embodied Energy** of a building is defined as the total energy input consumed during the life cycle of the materials and products of the building. A life cycle analysis could also include factors like CO₂ emissions, ozone depletion, and/or human respiratory effects to name a few. Currently, there are a number of sources which are producing life cycle data. Unfortunately, there is no standard by which these values are weighted so conflicting data exists.

Athena EcoCalculator

The Athena Sustainable Materials Institute (www.athenamsi.ca) is a Canadian not-for profit whose objective is "to foster sustainability of the built environment, by meeting the building community's need for better information and tools that allow environmental considerations to be factored into the design process."

The EcoCalculator Software, used in this project, was created by the Athena Institute as a free spreadsheet software available by download on their website. The software analyzes 7 assembly categories for 8 different impact measurements (see right). It references data that the Athena institute has completed as well as the National Renewable Energy Laboratory's (NREL) research and data. For each category, the user inputs the area or volume associated with that assembly. The last tab summarizes the results with graphs for each impact measurement.

The software does have some limitations. It is limited in the types of materials and construction assemblies to choose from. Any material that is relatively new or unique is not included. You can not edit/add assemblies to the spreadsheet; you may only use what they provide. The software also makes a number of assumptions. For example, column heights are set to 10 ft with bays of 30' x 30'.

ASSEMBLY TYPE	Square Footage	Percentage of total	Fossil Fuel Consumption (MMBtu)	Weighted Resource Use (kg CO ₂ e/kg)	GWP (Global Warming Potential) (kg CO ₂ e/kg)	Acidification Potential (kg SO ₂ e/kg)	Human Health Respiratory Effect Potential (kg PM _{2.5} eq/kg)	Eutrophication Potential (kg N eq/kg)
2x4 Wood stud wall 16" o.c.	0.0		31.41	5.8369	1.45	0.64	0.94	296
2x4 Wood stud wall 24" o.c.	0.0		30.84	5.2729	1.41	0.63	0.97	266
2x4 Wood stud wall 24" o.c.	0.0		44.45	7.9259	2.30	1.06	13.10	389
1-5/8" x 3-5/8" Steel stud 16" o.c.	0.0		37.47	4.5814	1.94	0.75	10.43	541
1-5/8" x 3-5/8" Steel stud 24" o.c.	0.0		35.40	4.3300	1.78	0.71	10.24	449

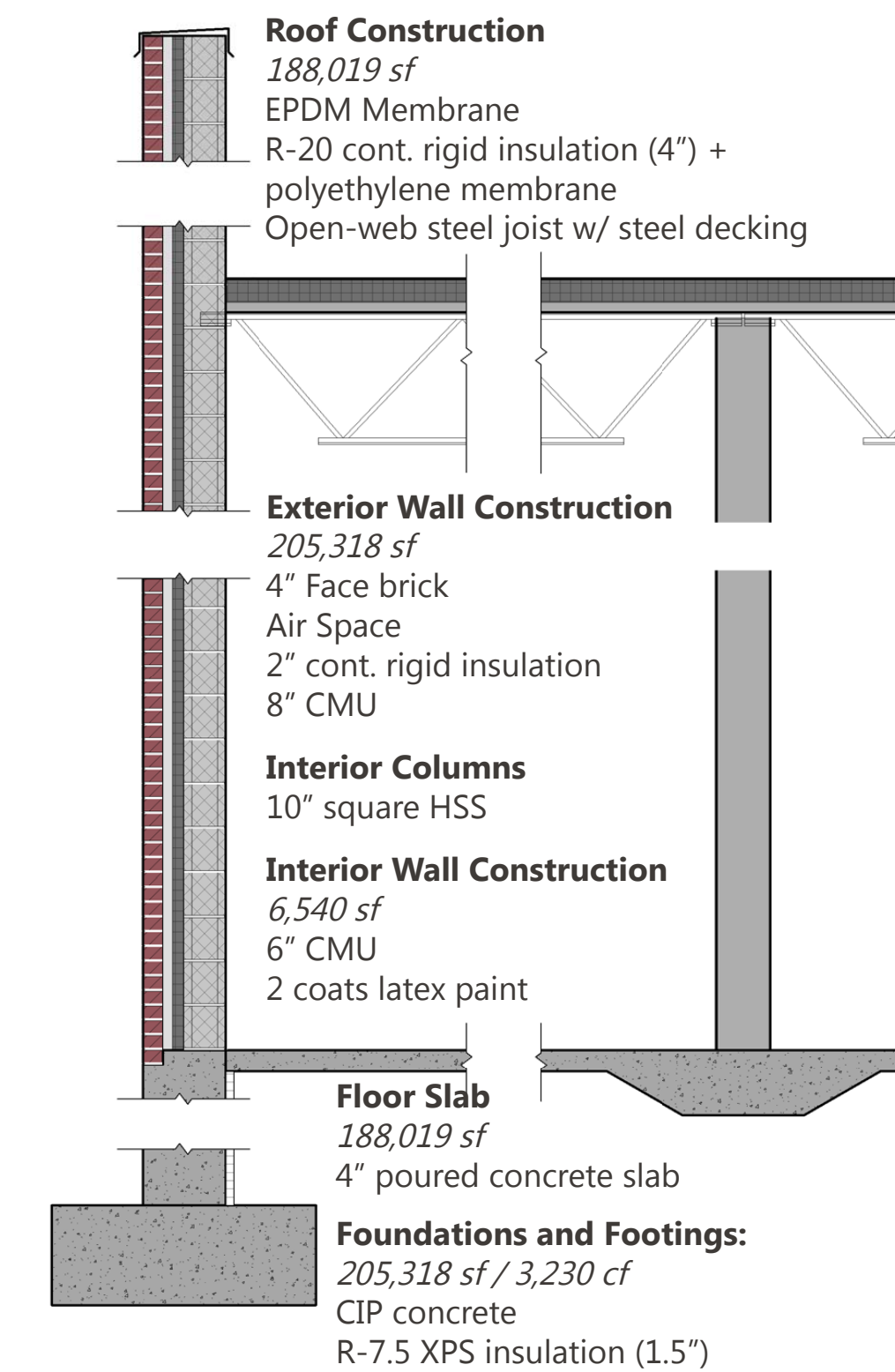
Assembly Categories

- Foundations and Footings
- Columns and Beams
- Intermediate Floors
- Exterior Walls
- Windows
- Interior Walls
- Roofs

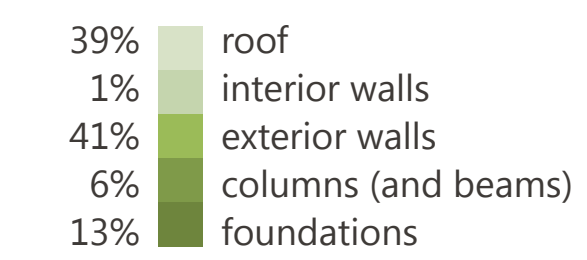
Impact Measurements

- Energy Consumption
- Material Resource Use
- Global Warming Potential
- Acidification Potential
- Human Health Respiratory Effect Potential
- Aquatic Eutrophication Potential
- Ozone Depletion Potential
- Smog Potential

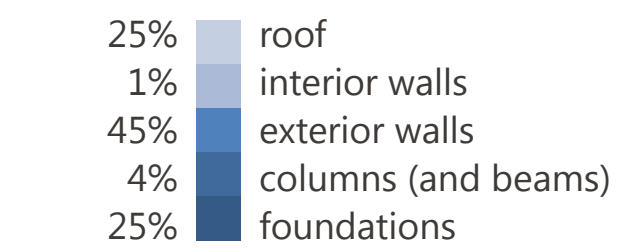
Current Walmart Supercenter Construction



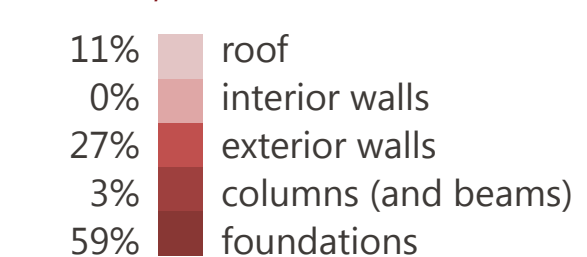
FOSSIL FUEL CONSUMPTION
125,350,941 MJ



GLOBAL WARMING POTENTIAL
8,472 tonnes CO₂

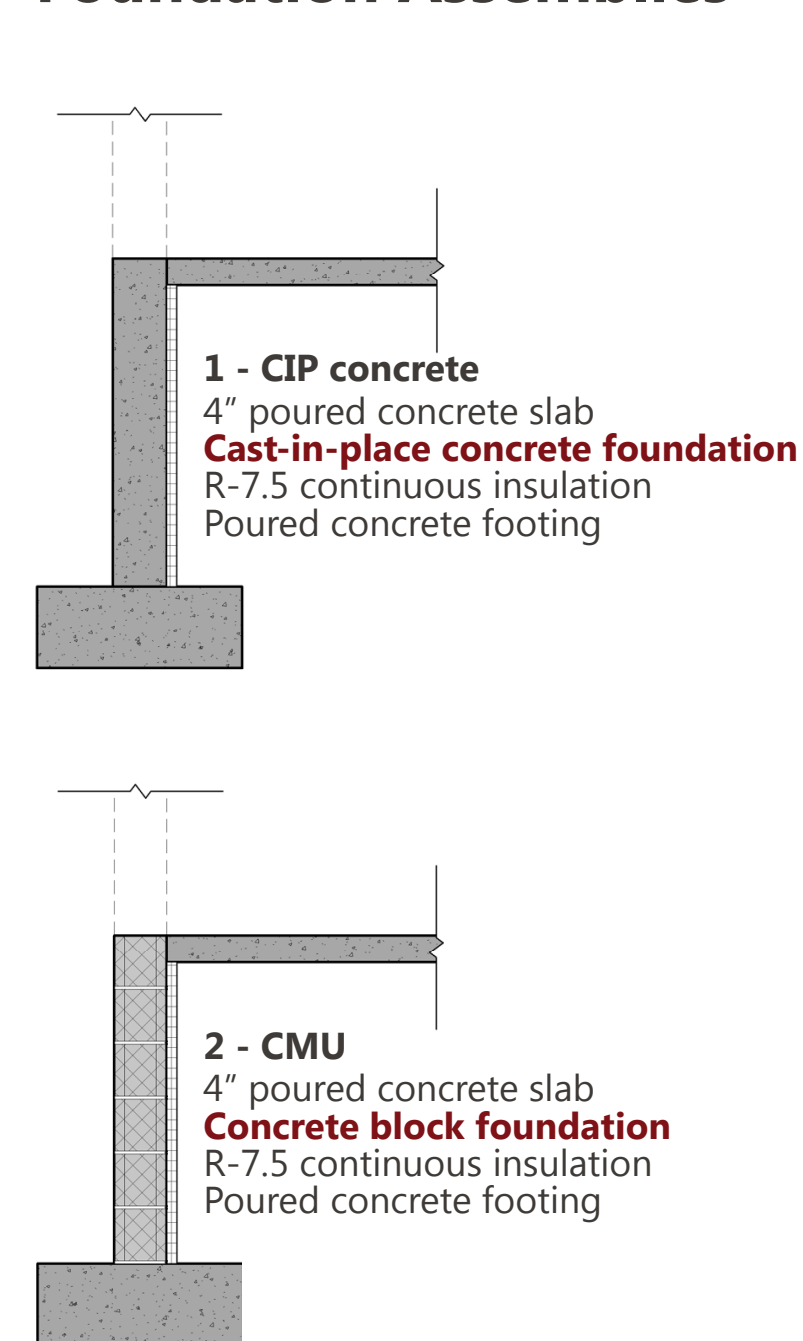


RESOURCE CONSUMPTION
23,990 tonnes

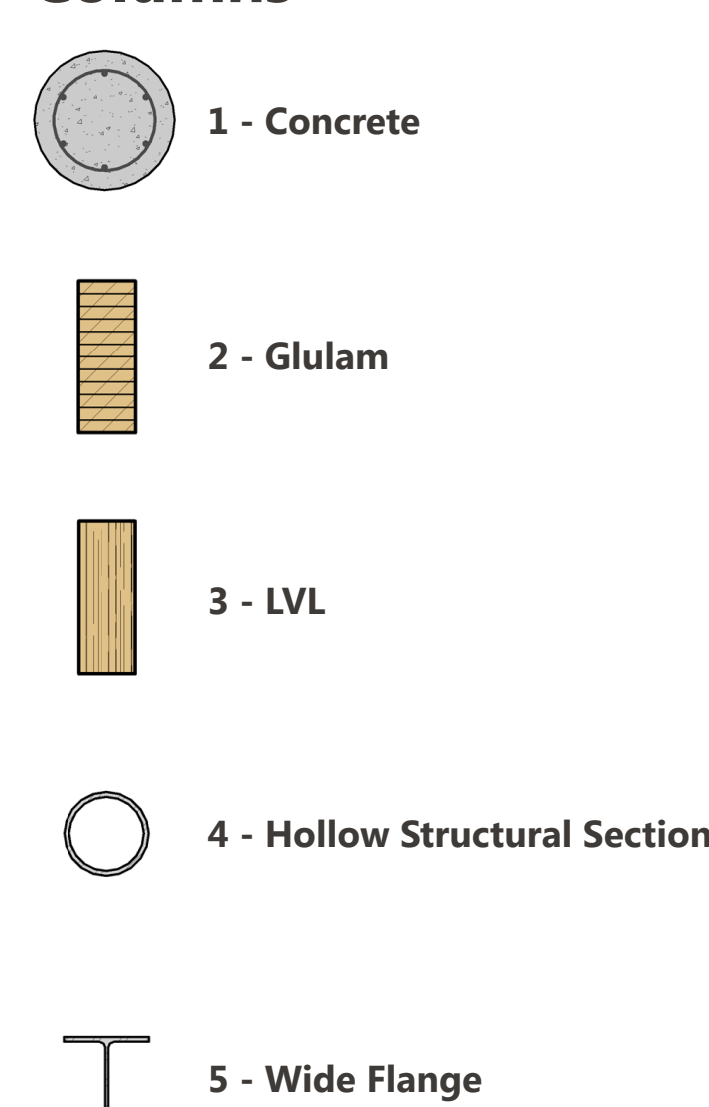


Assembly Options

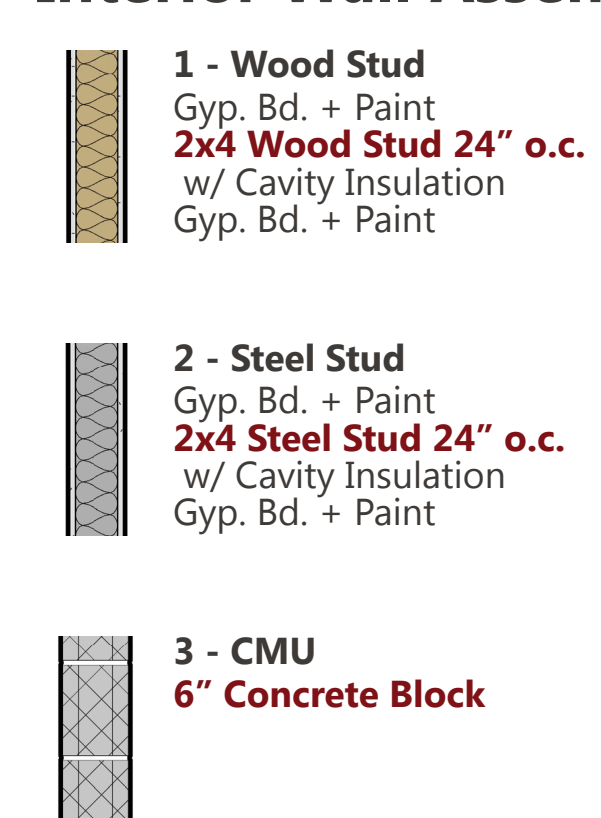
Foundation Assemblies



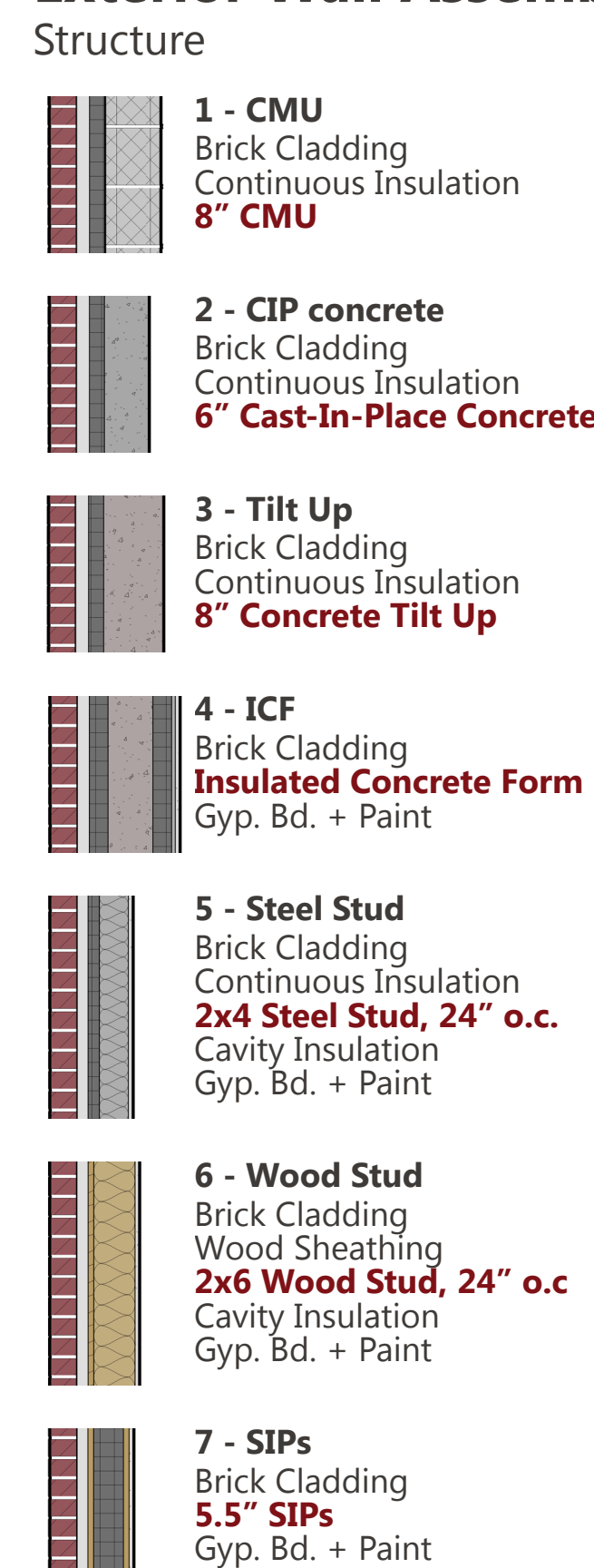
Columns



Interior Wall Assemblies



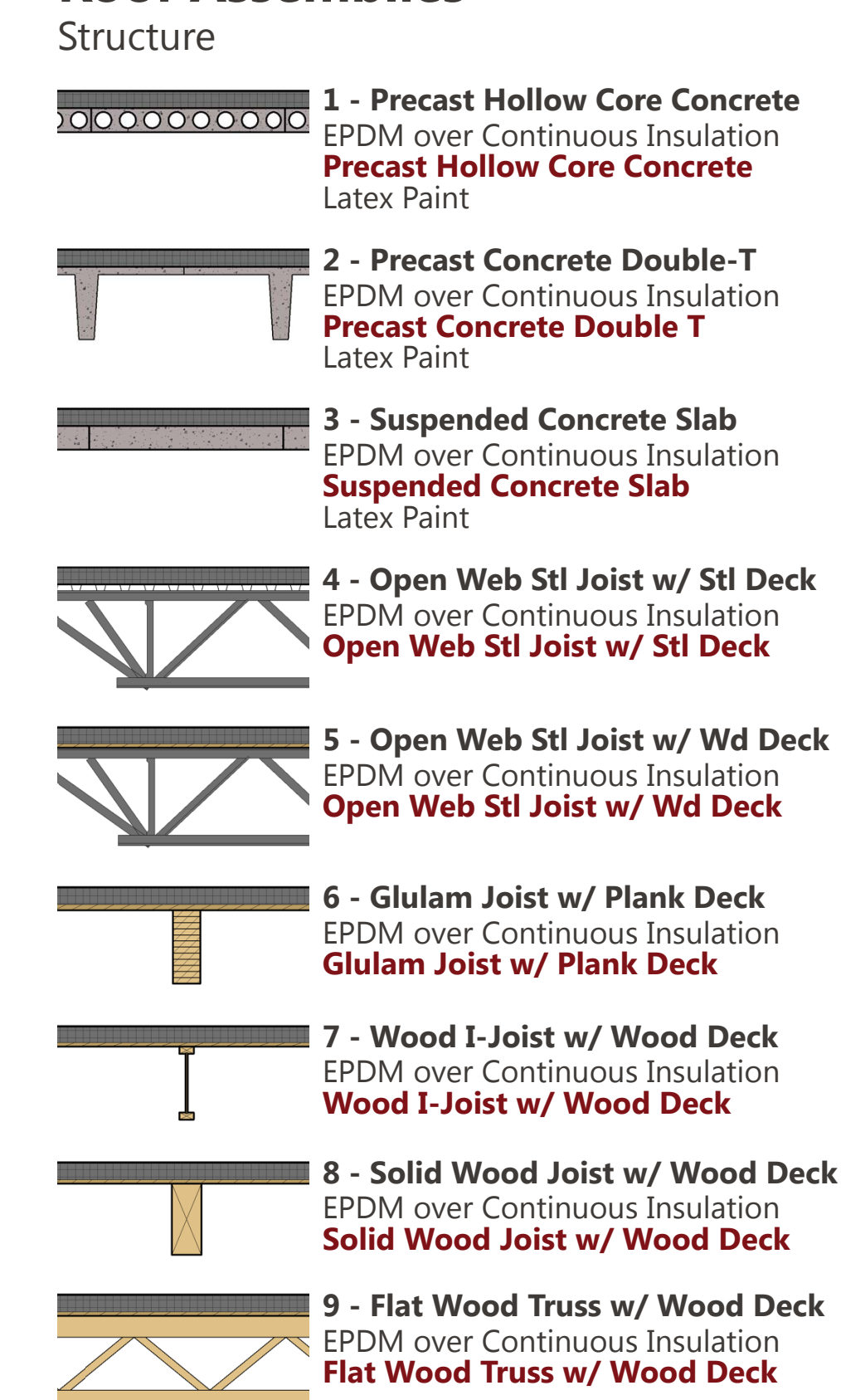
Exterior Wall Assemblies



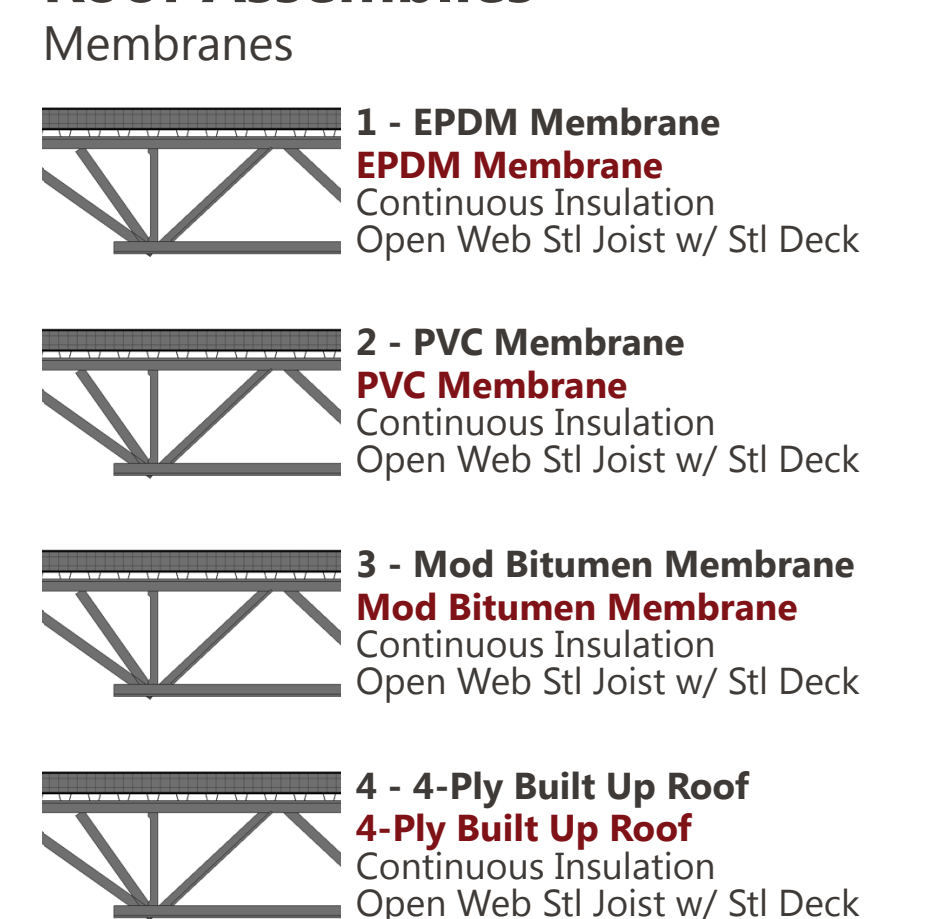
Exterior Wall Assemblies



Roof Assemblies



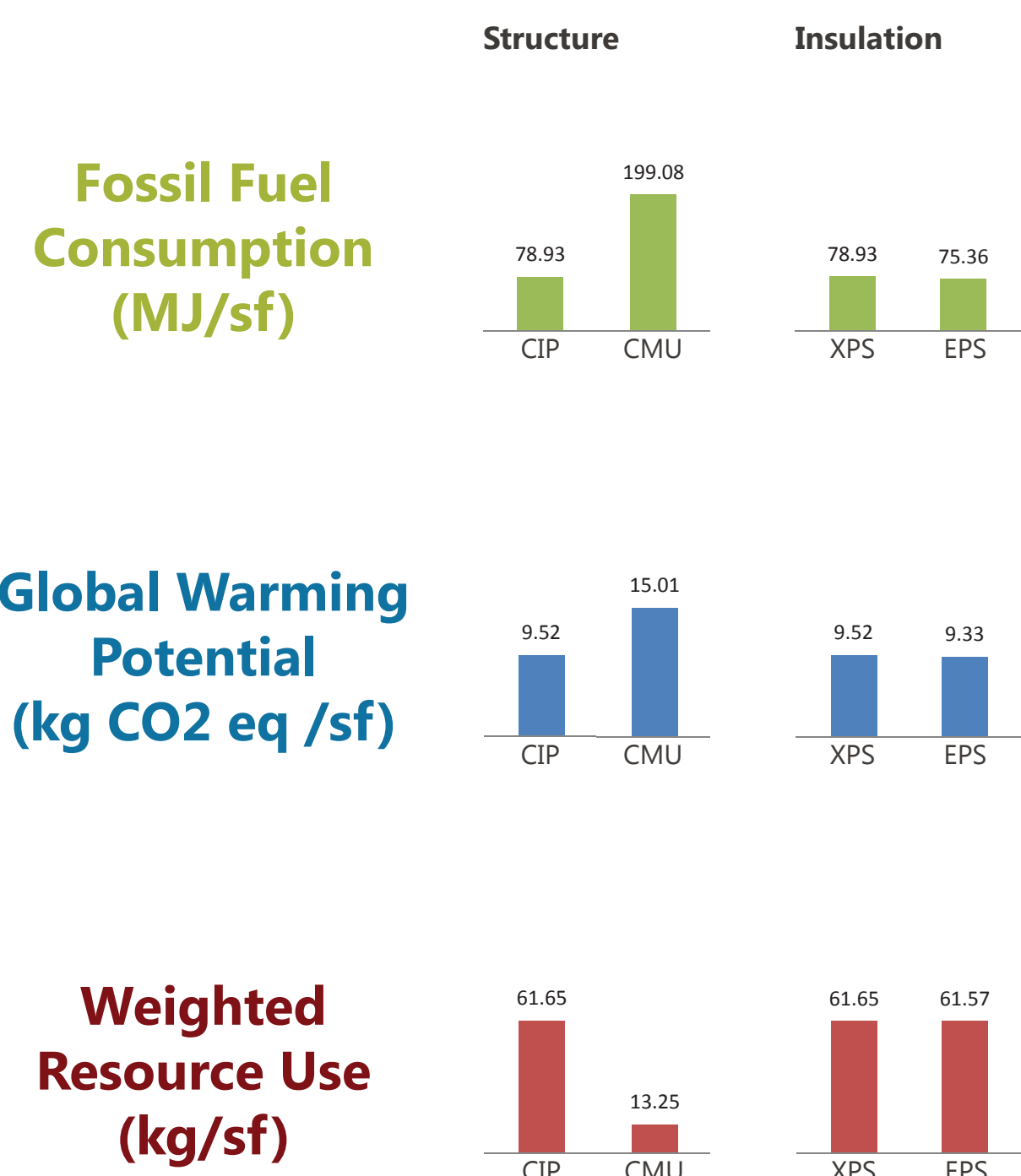
Roof Assemblies



Assembly LCA data

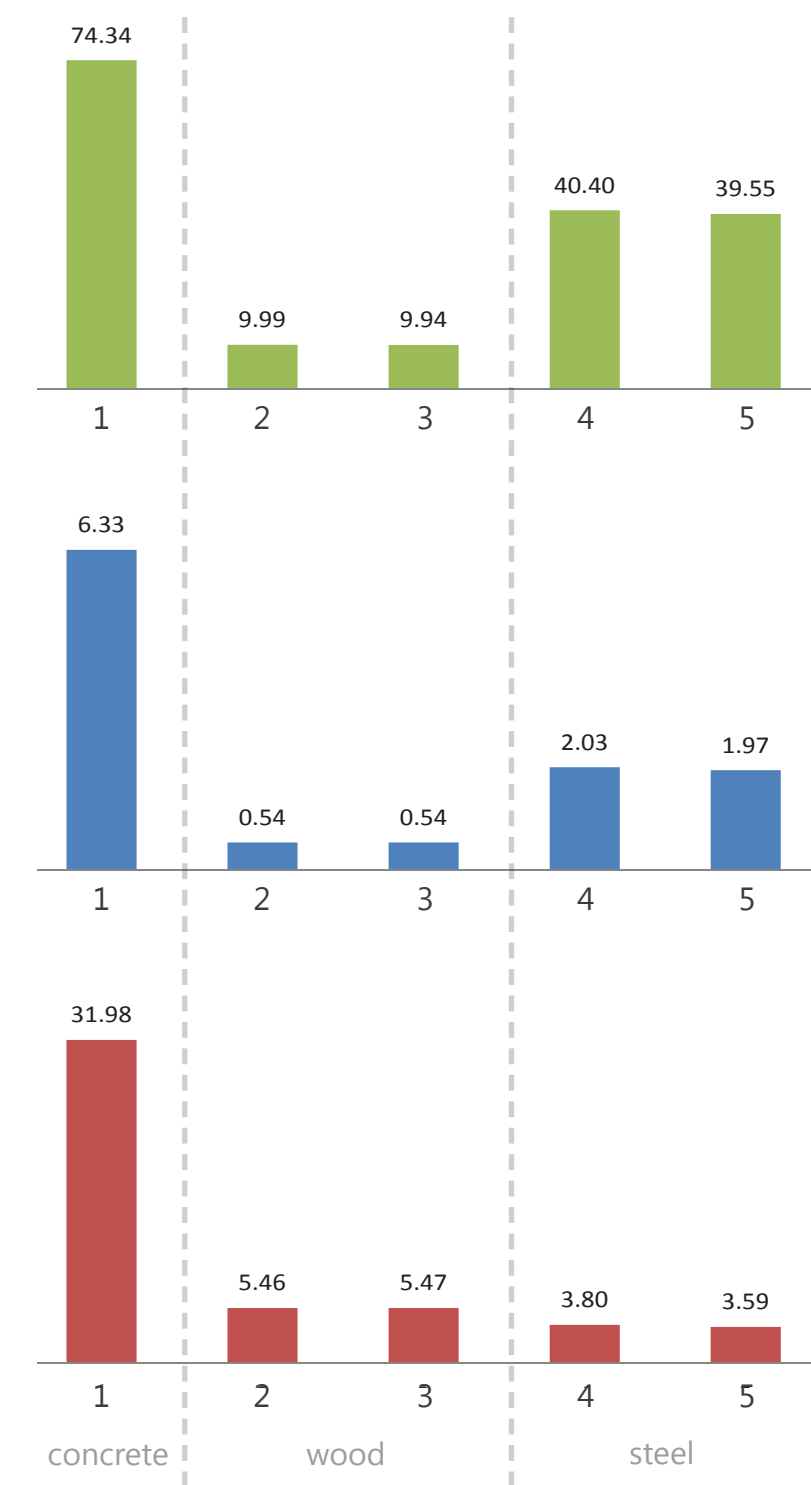
Foundation Assemblies

NOTES:
Insulation data based on CIP foundation.



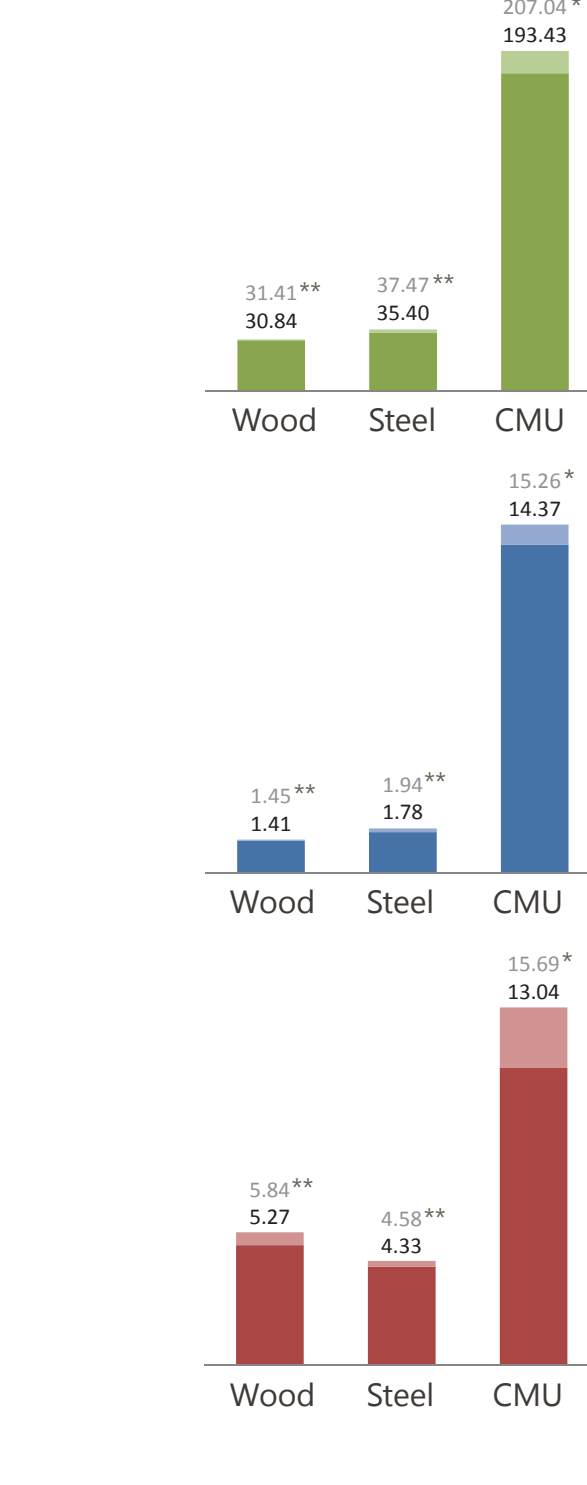
Columns

NOTES:
Data based on load bearing exterior wall values



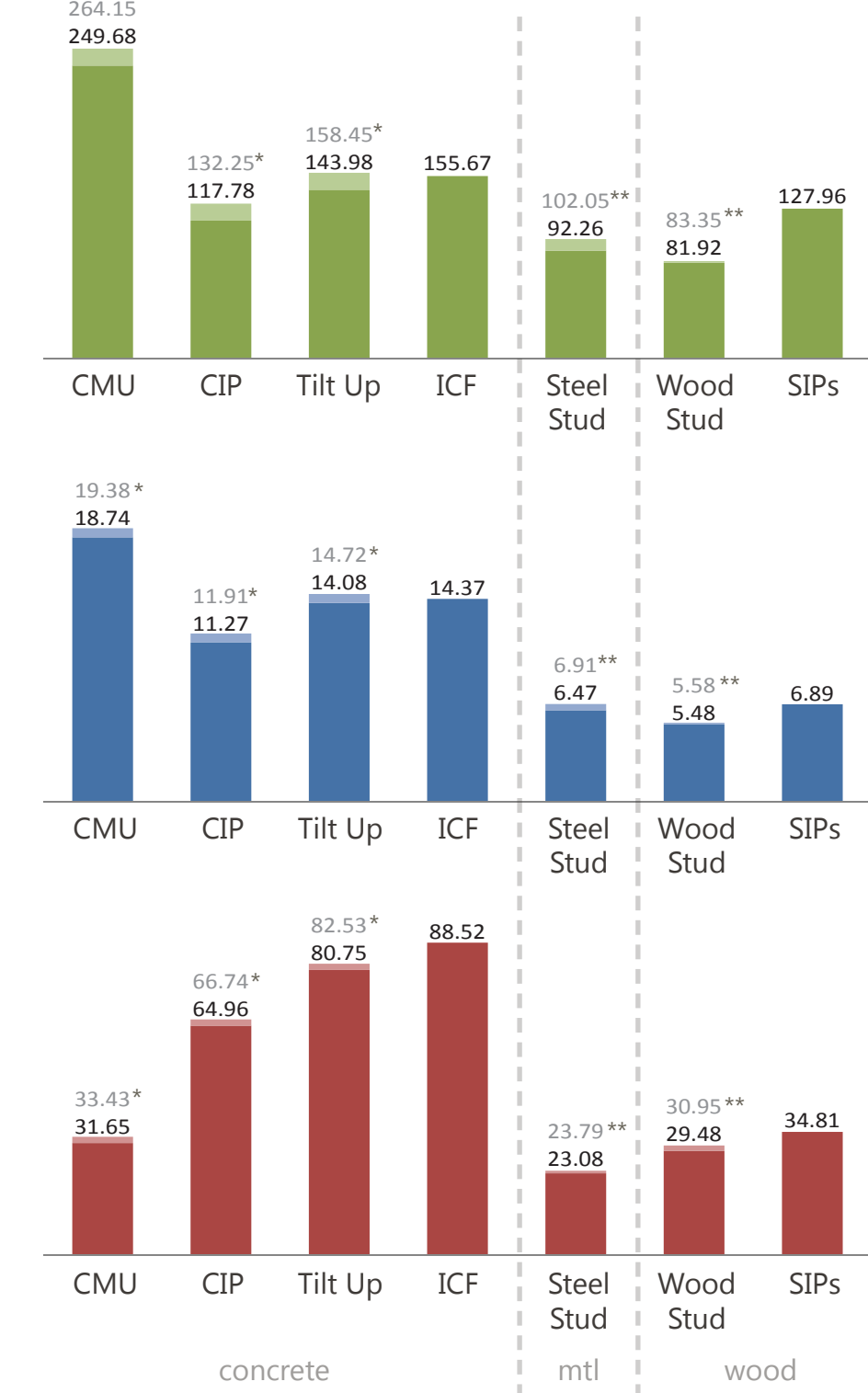
Interior Wall Assemblies

NOTES:
*Gyp. Bd. + Paint on interior
**studs 16" o.c.



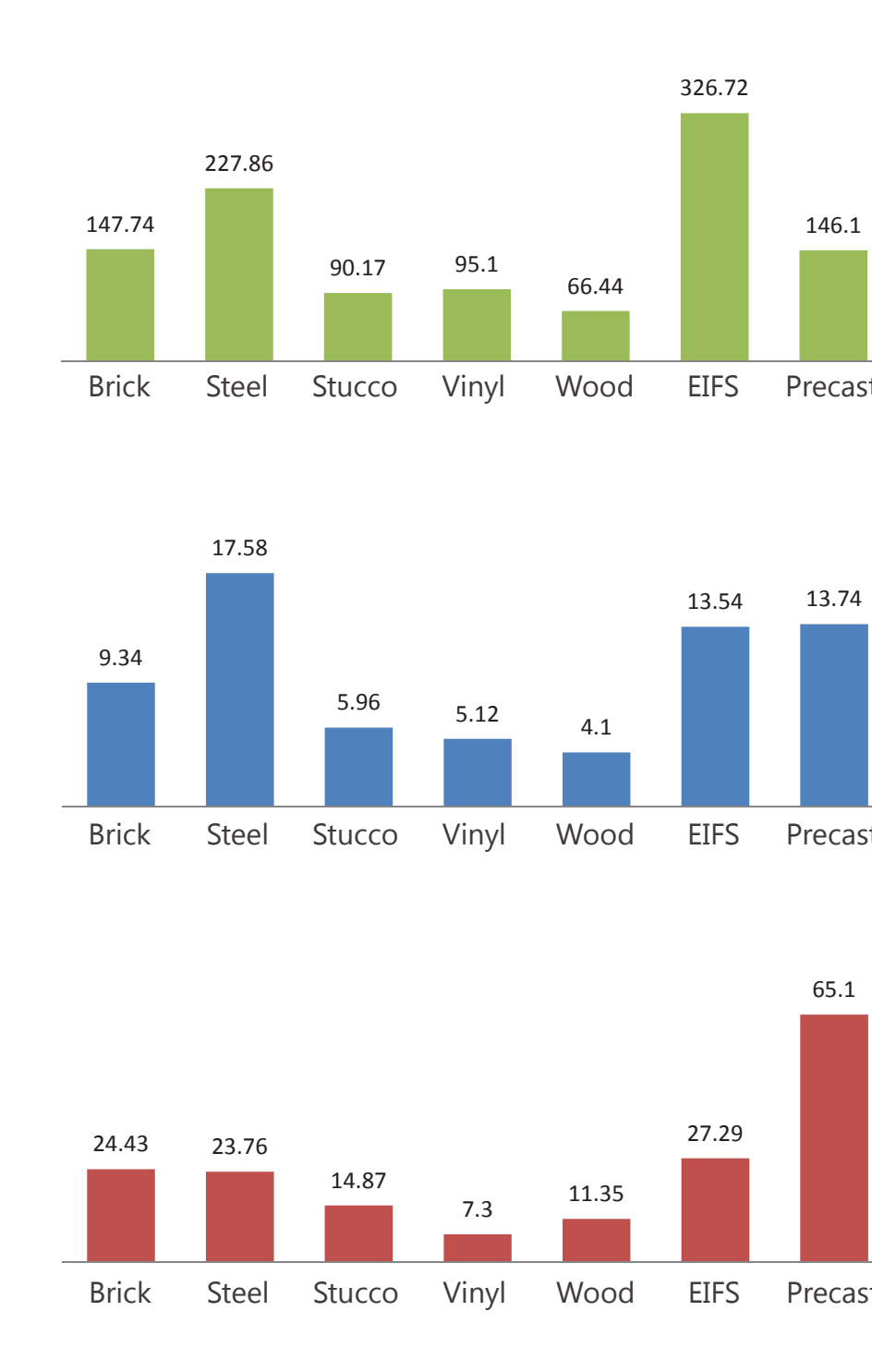
Exterior Wall Assemblies Structure

NOTES:
Comparison based on brick cladding values
*Gyp. Bd. + Paint on interior
**studs 16" o.c.



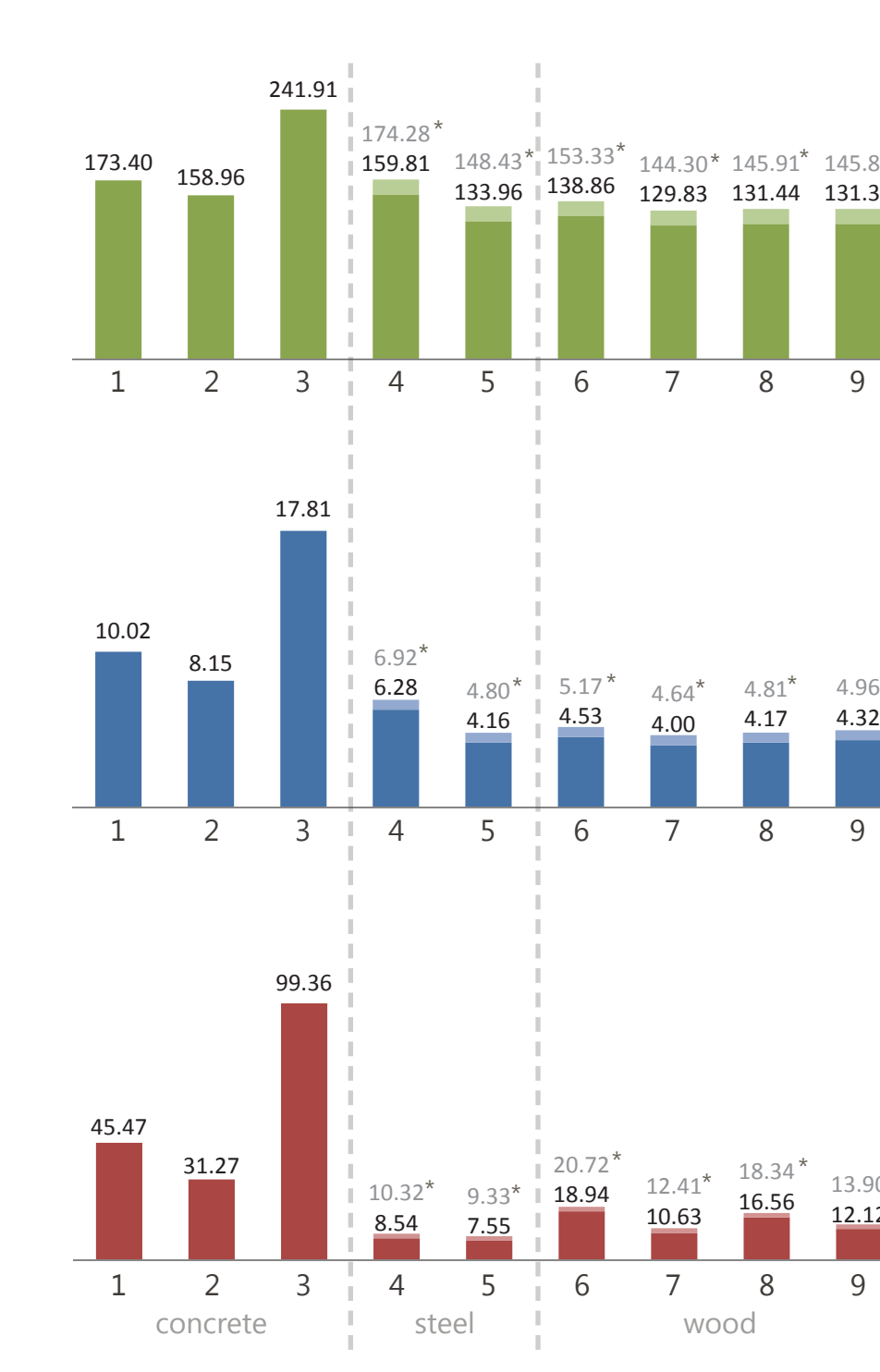
Exterior Wall Assemblies Cladding

NOTES:
Comparison based on metal stud values



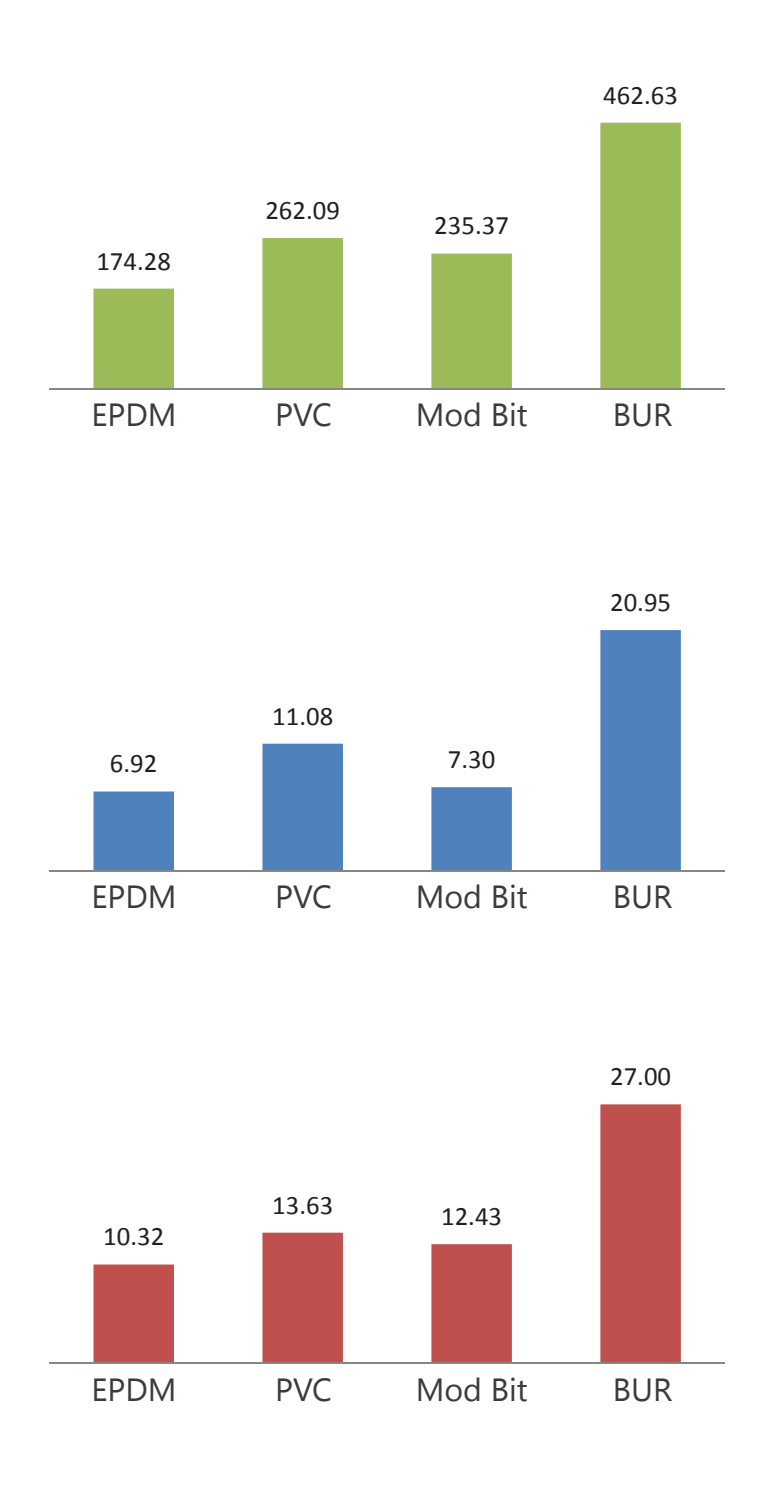
Roof Assemblies Structure

NOTES:
Comparison based on values for EPDM membrane over continuous rigid insulation
*Gyp. Bd. + Paint on interior



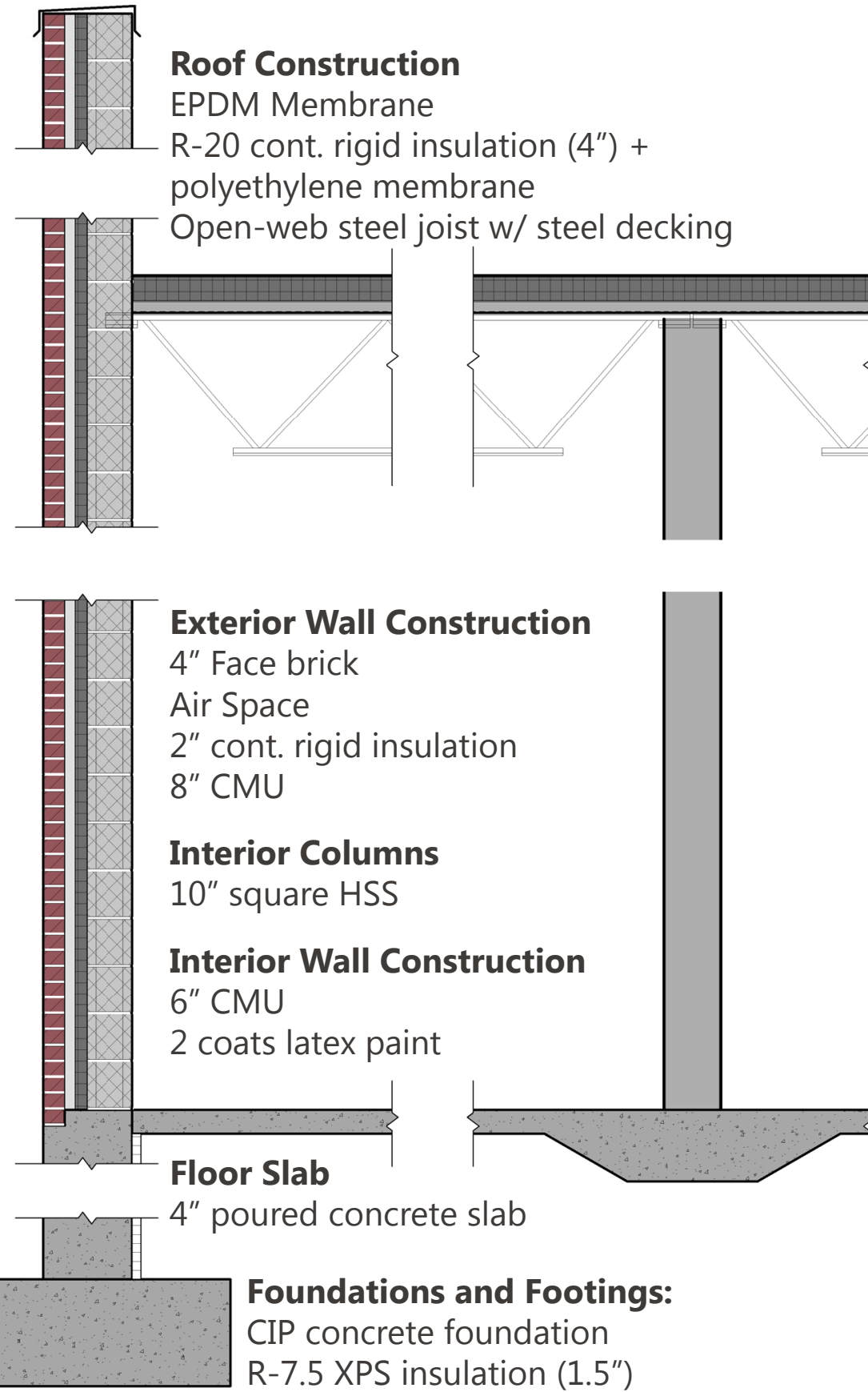
Roof Assemblies Membranes

NOTES:
Comparison based on values for rigid insulation on metal decking.
Only flat roof options are considered.



Results: Construction Type Comparisons

Current Walmart Construction Baseline

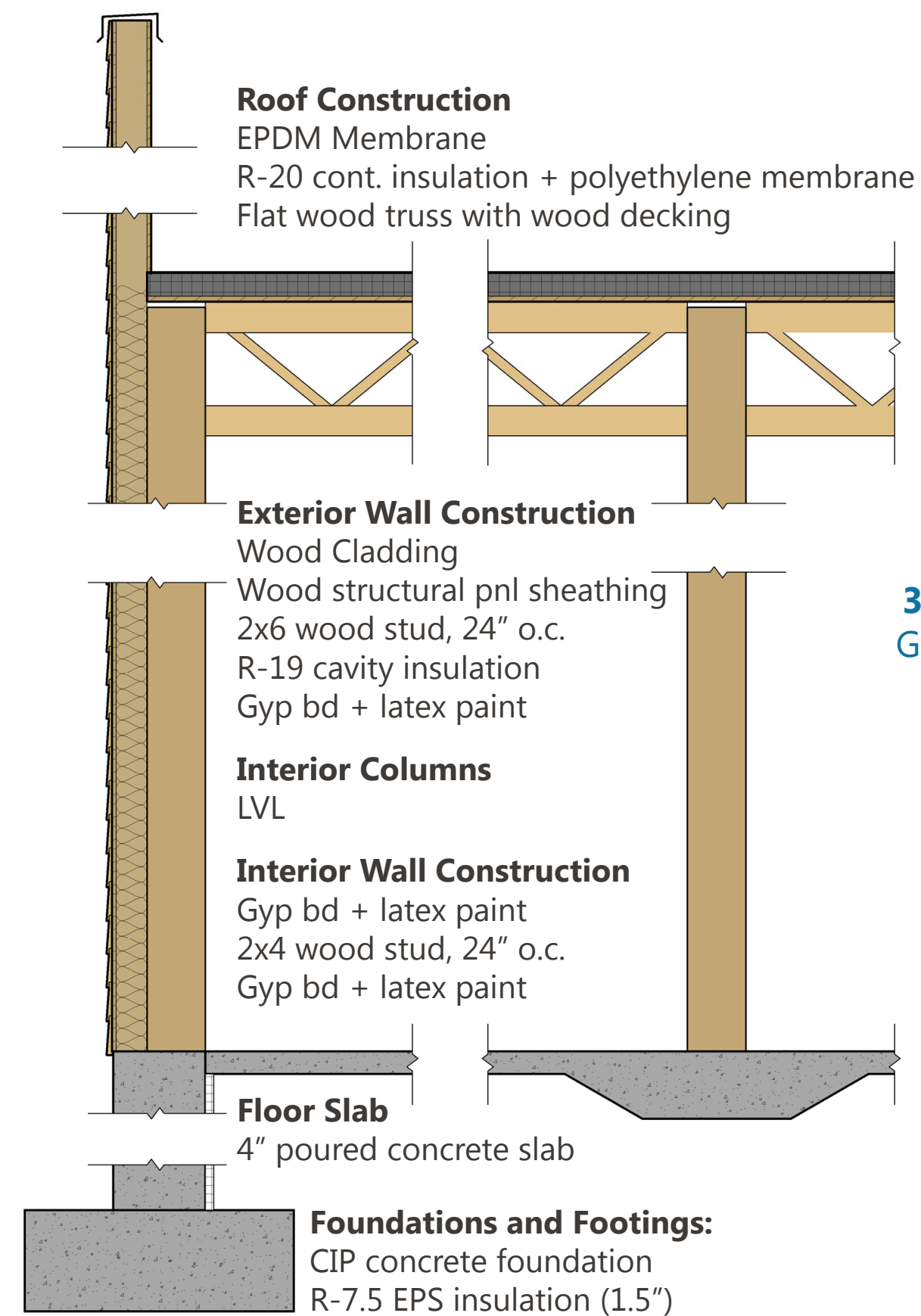


125,350,941 MJ FOSSIL FUEL CONSUMPTION

8,472 tonnes CO2 GLOBAL WARMING POTENTIAL

23,990 tonnes RESOURCE CONSUMPTION

Lowest EcoCalculator Values Condition All Wood Construction

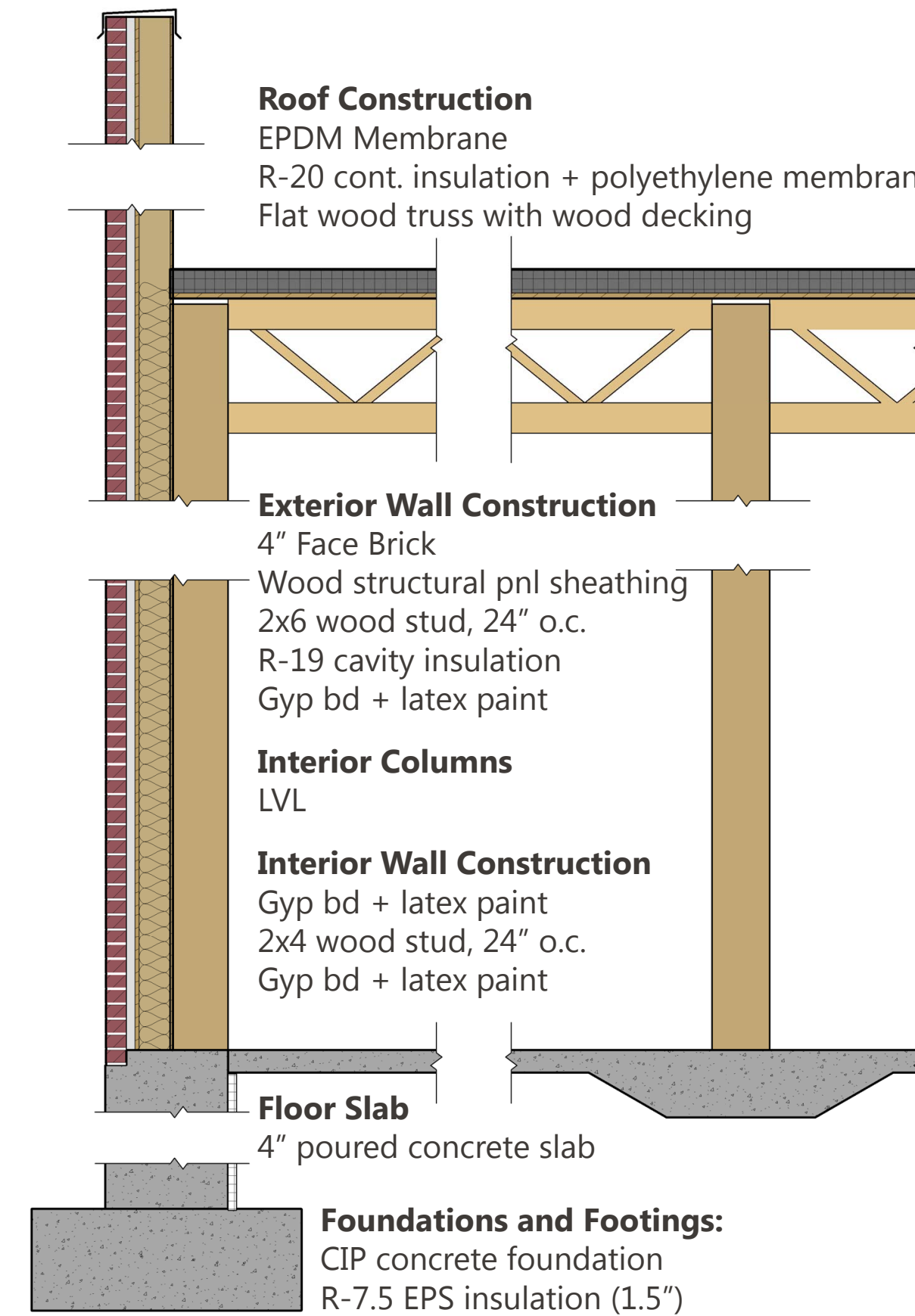


52,339,762 MJ FOSSIL FUEL CONSUMPTION 58.2% reduction

3,680 tonnes CO2 GLOBAL WARMING POTENTIAL 56.6% reduction

21,539 tonnes RESOURCE CONSUMPTION 10.2% reduction

Brick retains exterior aesthetic of existing assembly Interior is wood structure

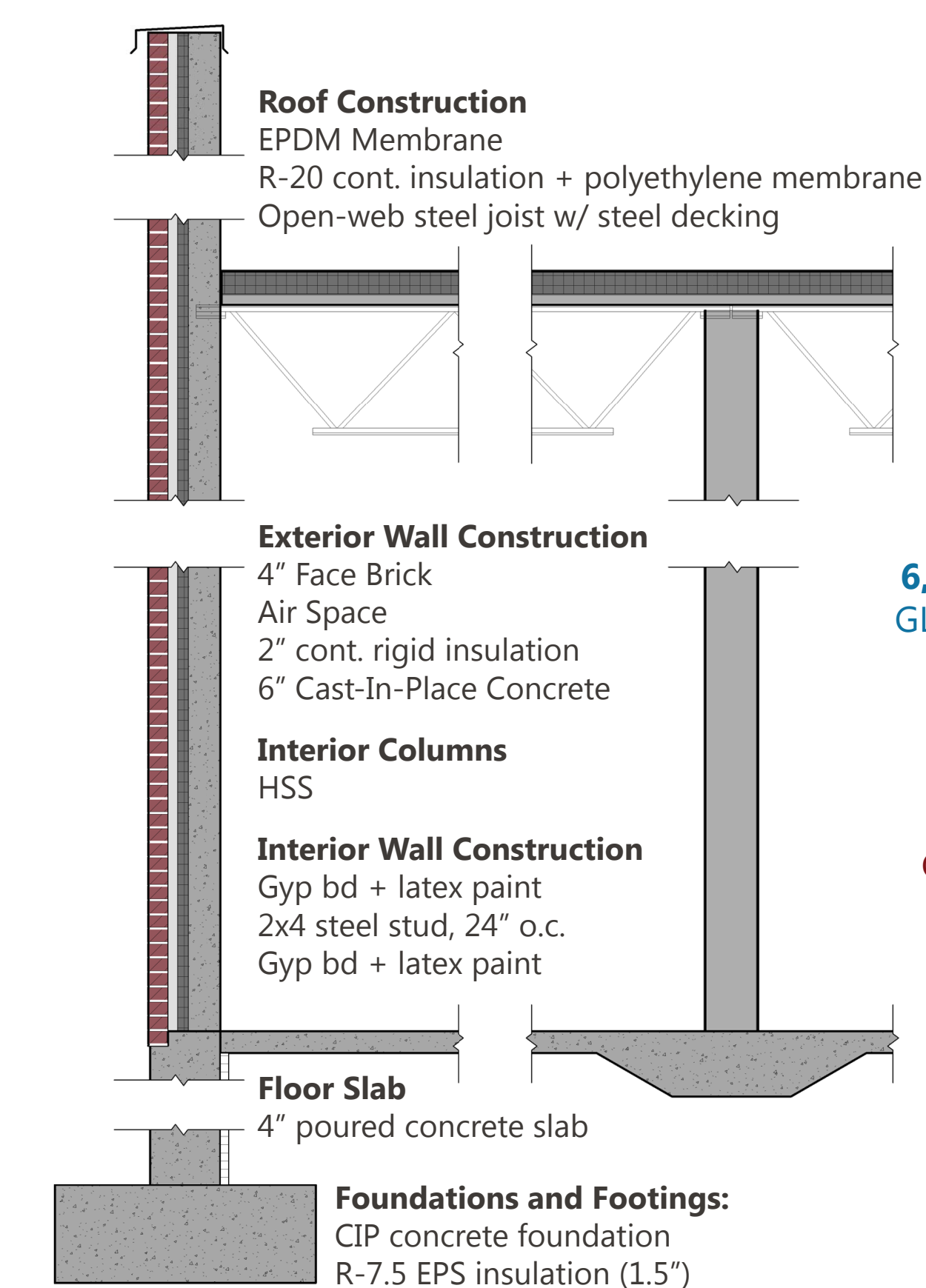


62,650,978 MJ FOSSIL FUEL CONSUMPTION 50% reduction

4,257 tonnes CO2 GLOBAL WARMING POTENTIAL 50% reduction

24,092 tonnes RESOURCE CONSUMPTION 0.43% increase

Retains interior and exterior aesthetic of existing Metal stud interior walls and CIP exterior structure



80,697,516 MJ FOSSIL FUEL CONSUMPTION 36% reduction

6,072 tonnes CO2 GLOBAL WARMING POTENTIAL 28% reduction

30,148 tonnes RESOURCE CONSUMPTION 26% increase

What impact would Walmart have if they switched to one of these constructions?

They would be able to...

*based on 110 supercenters per annum
**each icon equals 5,000 units

Fossil Fuel Consumption (MJ/sf)

Global Warming Potential (kg CO2 eq /sf)

Weighted Resource Use (kg/sf)

