

**Recycling/
Reuse/
Disposal**



**Resource
Extraction**



Manufacturing



**On-site
Construction**



**Occupancy/
Maintenance**



Demolition



**Athena
Institute**

Emerging LCA Tools for Green Building

Wayne Trusty

SFI Annual Conference

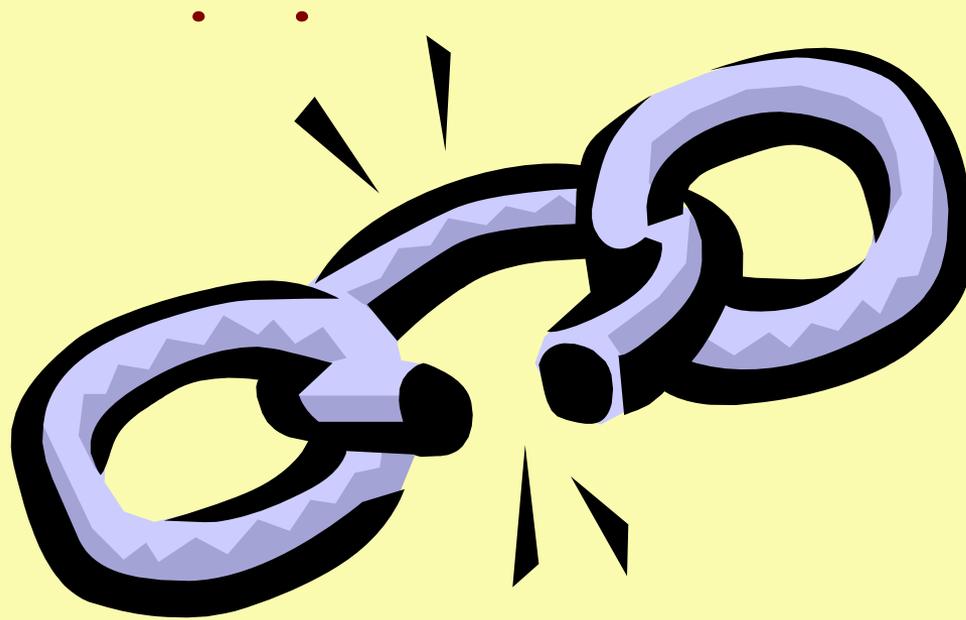
September 24, 2008

Emerging ANSI Standards

- u GBI/ANSI Standard 01-2007P: ***Green Building Assessment Protocol for Commercial Buildings***
- u ASTM: ***Standard Specification for the Minimum Attributes of a Building that Promotes Sustainability***
- u NAHB: ***National Green Building Standard™***
- u ASHRAE/USGBC/IESNA Std 189: ***High-Performance Green Buildings***

Recent CSA workshop to consider the Canadian outlook and options

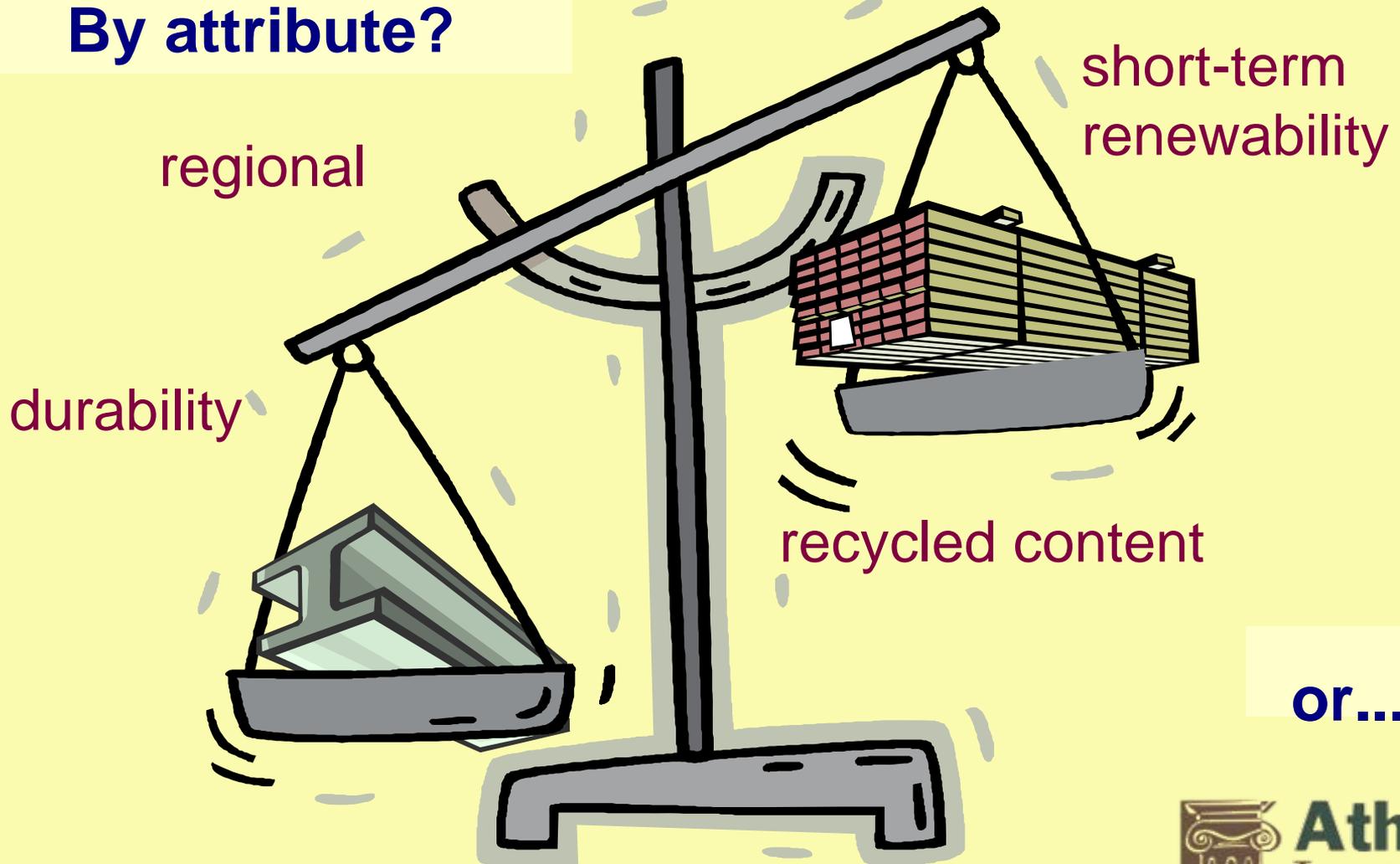
Materials and resources
credits are especially
weak in rating systems .



• • • and very
controversial

Weighing material options

By attribute?



or...

By environmental performance → LCA

Acid rain damage



Resource depletion

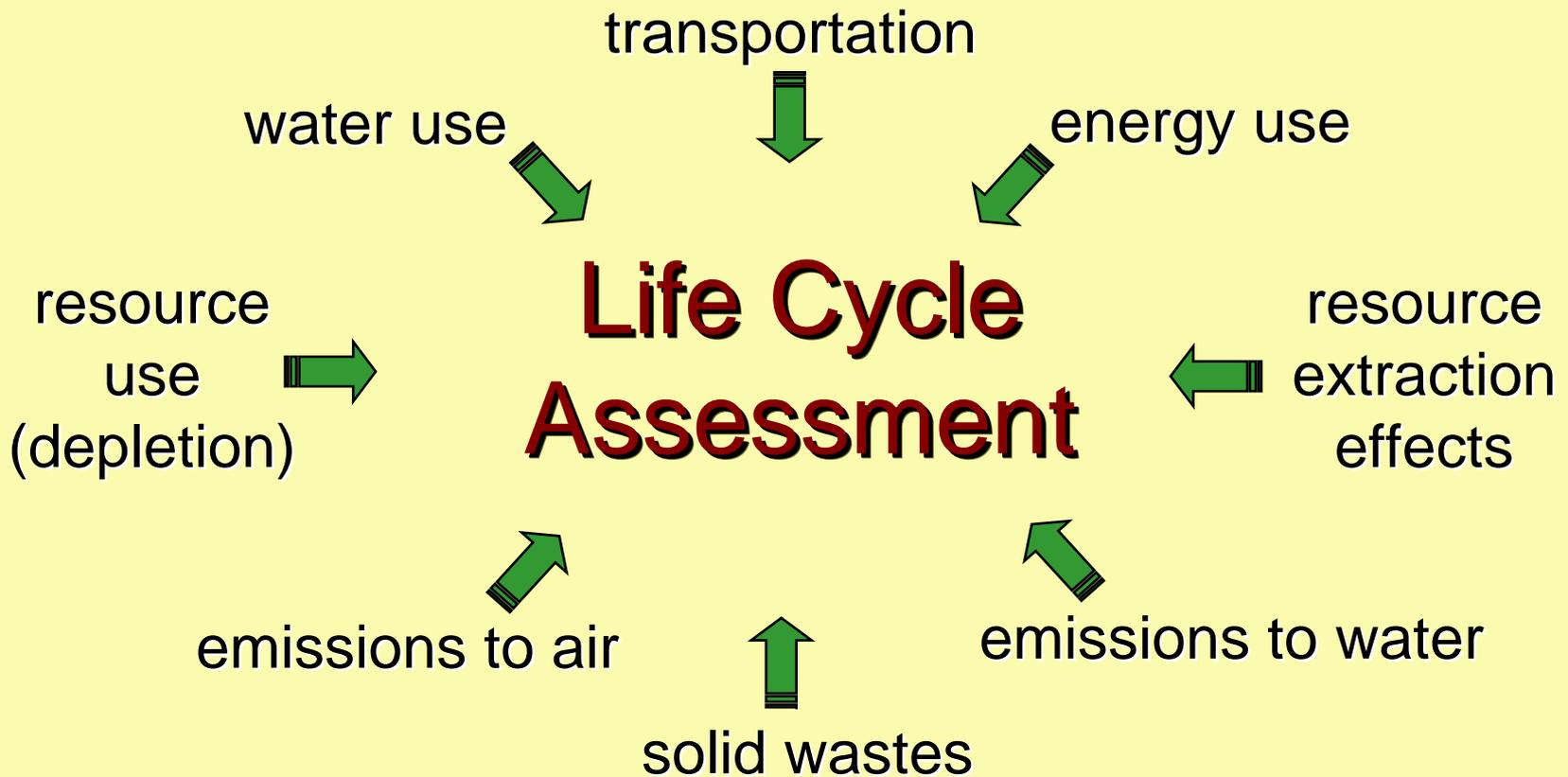
Air pollution



Climate change



Water pollution



A methodology for assessing the environmental performance of a product over its full life cycle

Life Cycle Assessment is not the same as Life Cycle Costing!

LCA → physical units

LCC → \$



**Complementary
methods**

The image shows a construction site. In the foreground, there are several large stacks of light-colored wooden planks, likely pine or spruce, arranged in neat piles. The wood grain is clearly visible. In the background, a building is under construction. The walls are made of light-colored masonry or concrete blocks. There are several windows with white frames and dark shutters. The roof is partially visible, showing a brown shingle pattern. The sky is overcast with grey clouds. The overall scene is a typical construction site for a residential building.

LCA in Relation to Buildings

The LCA Tool Kit

Level 1 — Product Focus

1A - For LCA practitioners

✓ SimaPro, GaBi, Umberto

1B - LCA in the background

✓ BEES

Level 2 — Assembly Focus

ATHENA® *EcoCalculator*

✓ Funded by GBI for use in Green Globes™ rating system

✓ General use version available

Level 3 — Whole Building

ATHENA® *Impact Estimator*

✓ LCA in the background

Assessment and Rating Systems

✓ Green Globes

✓ LEED

✓ Minnesota Design Guidelines

✓ NAHB Green Home Guidelines



LCA in Assessment and Rating Systems



LCA integration options

Award points for:

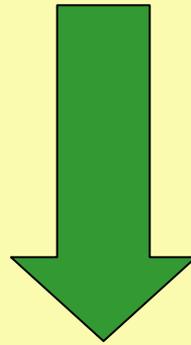
1. Selecting highly ranked building assemblies from a pre-rated list
2. Making decisions based on the use of an LCA tool
3. Achieving specific performance levels at the whole building level

LCA in Green Globes

- υ Basically LCA education credits at present (option 2)
 - » encourage selecting materials with the lowest life cycle environmental burden
 - » but no firm benchmarks or measures
- υ Work completed on the assembly ranking approach (option 1)
 - » ATHENA EcoCalculator the basis for Green Globes credit calculator
 - » points based on performance relative to benchmarks for each of several measures (e.g., global warming potential)
 - » basic tool reviewed by BRE, NIST, others
 - » assemblies reviewed by Green Globes ANSI committee
 - » recently out for public comment

LCA Into LEED

- ∪ September 2004 kick-off meeting
- ∪ Working Groups
 - » Recommend how best to implement LCA-based credits
 - Goal and scope
 - Technical LCA issues
 - Weighting of impact measures
- ∪ Goal and scope WG recommended assembly ranking approach
- ∪ Accepted by USGBC board
- ∪ Work underway to detail the approach using the Athena EcoCalculator





ATHENA[®] Impact Estimator for buildings

LCA-Based level 3 whole building tool for use at the conceptual design stage

- Shows environmental effects of changes in shape, design or material make-up of a building
- Allows designers to optimize operating+embodied energy effects over the complete building life cycle
- A range of indicators without weighting

Takes Account Of

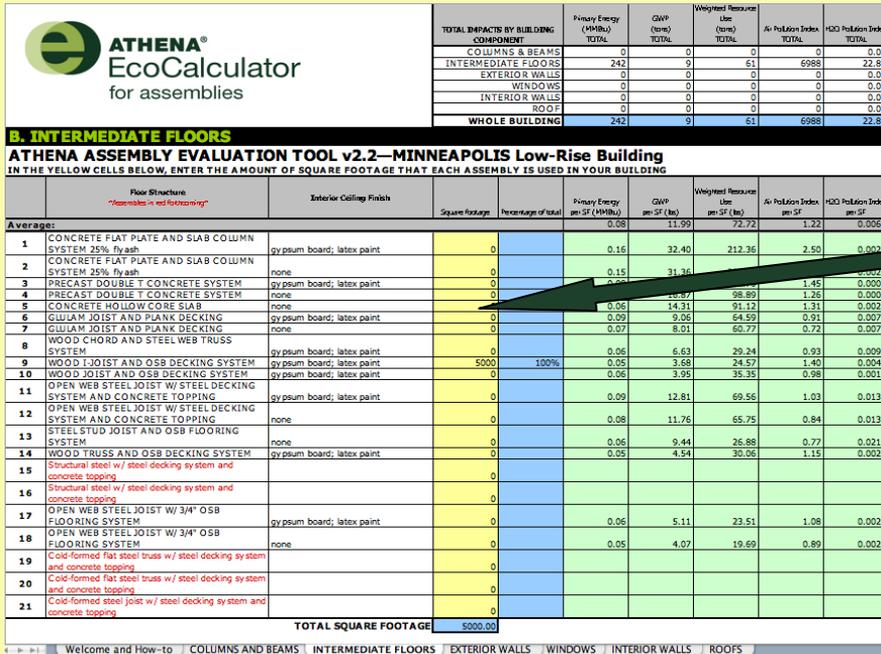
- Resource extraction
- Manufacturing and on-site construction
 - ✓ Including recycled content
- All related transportation
- Maintenance and replacement cycles
- Demolition and land filling
- Operating energy effects

LCA-Based level 2 tool for evaluating and comparing the environmental effects of assemblies

- Initially developed for GBI for use in Green Globes
 - ✓ Developed in association with Morrison Hershfield and UMN Center for Sustainable Building Research
- Currently covers several hundred assemblies
- Uses 5 environmental impact indicators
- Green Globes[™] credits better than average performance
 - ✓ For each indicator within an assembly category
- Free generic versions on the Athena Institute web site

Simple to Use

results in spreadsheet form



ATHENA EcoCalculator for assemblies

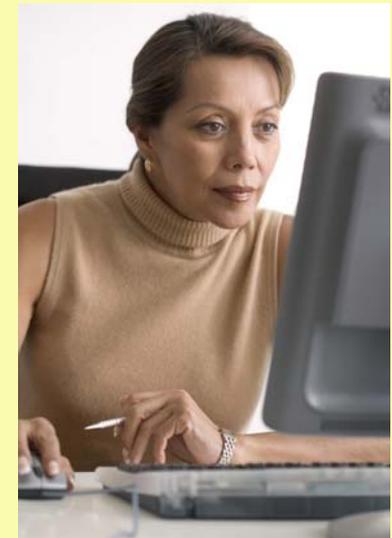
TOTAL IMPACTS BY BUILDING COMPONENT		Primary Energy (MWh) TOTAL	GWP (tons) TOTAL	Weighted Resource Use (tons) TOTAL	Air Pollution Index TOTAL	HDD Pollution Index TOTAL
COLUMNS & BEAMS		0	0	0	0	0.00
INTERMEDIATE FLOORS		242	9	61	6988	22.83
EXTERIOR WALLS		0	0	0	0	0.00
WINDOWS		0	0	0	0	0.00
INTERIOR WALLS		0	0	0	0	0.00
ROOF		0	0	0	0	0.00
WHOLE BUILDING		242	9	61	6988	22.83

B. INTERMEDIATE FLOORS

ATHENA ASSEMBLY EVALUATION TOOL v2.2—MINNEAPOLIS Low-Rise Building
IN THE YELLOW CELLS BELOW, ENTER THE AMOUNT OF SQUARE FOOTAGE THAT EACH ASSEMBLY IS USED IN YOUR BUILDING

Item	Area Structure	Interior Ceiling Finish	Square Footage	Percentage of total	Primary Energy (MWh)	GWP (tons)	Weighted Resource Use (tons)	Air Pollution Index	HDD Pollution Index
Average:									
1	CONCRETE FLAT PLATE AND SLAB COLUMN SYSTEM 25% fly ash	gy psum board; latex paint	0	0	0.16	32.40	212.36	2.50	0.0073
2	CONCRETE FLAT PLATE AND SLAB COLUMN SYSTEM 25% fly ash	none	0	0	0.15	31.34	207.29	2.45	0.0073
3	PRECAST DOUBLE T CONCRETE SYSTEM	gy psum board; latex paint	0	0	0.07	14.11	89.89	1.26	0.0036
4	PRECAST DOUBLE T CONCRETE SYSTEM	none	0	0	0.06	14.31	91.12	1.31	0.0035
5	CONCRETE HOLLOW CORE SLAB	gy psum board; latex paint	0	0	0.09	9.96	64.59	0.91	0.0073
6	GLULAM JOIST AND PLANK DECKING	none	0	0	0.07	8.01	60.77	0.72	0.0073
7	GLULAM JOIST AND PLANK DECKING	gy psum board; latex paint	0	0	0.06	6.63	29.24	0.93	0.0099
8	WOOD CHORD AND STEEL WEB TRUSS SYSTEM	gy psum board; latex paint	5000	100%	0.05	3.68	24.57	1.40	0.0046
9	WOOD JOIST AND OSB DECKING SYSTEM	gy psum board; latex paint	0	0	0.06	3.95	35.35	0.98	0.0019
10	WOOD JOIST AND OSB DECKING SYSTEM	none	0	0	0.09	12.81	69.56	1.03	0.0139
11	OPEN WEB STEEL JOIST W/ STEEL DECKING SYSTEM AND CONCRETE TOPPING	gy psum board; latex paint	0	0	0.08	11.76	65.75	0.84	0.0139
12	OPEN WEB STEEL JOIST W/ STEEL DECKING SYSTEM AND CONCRETE TOPPING	none	0	0	0.06	9.44	26.88	0.77	0.0217
13	STEEL STUD JOIST AND OSB FLOORING SYSTEM	gy psum board; latex paint	0	0	0.05	4.54	30.06	1.15	0.0024
14	WOOD TRUSS AND OSB DECKING SYSTEM	Structural steel w/ steel decking system and concrete topping	0	0	0.05	4.07	19.69	0.89	0.0024
15	WOOD TRUSS AND OSB DECKING SYSTEM	Structural steel w/ steel decking system and concrete topping	0	0	0.05	4.07	19.69	0.89	0.0024
16	WOOD TRUSS AND OSB DECKING SYSTEM	none	0	0	0.05	4.07	19.69	0.89	0.0024
17	OPEN WEB STEEL JOIST W/ 3/4" OSB FLOORING SYSTEM	gy psum board; latex paint	0	0	0.05	4.07	19.69	0.89	0.0024
18	OPEN WEB STEEL JOIST W/ 3/4" OSB FLOORING SYSTEM	none	0	0	0.05	4.07	19.69	0.89	0.0024
19	Cold-formed flat steel truss w/ steel decking system and concrete topping	gy psum board; latex paint	0	0	0.05	4.07	19.69	0.89	0.0024
20	Cold-formed flat steel truss w/ steel decking system and concrete topping	none	0	0	0.05	4.07	19.69	0.89	0.0024
21	Cold-formed steel joist w/ steel decking system and concrete topping	gy psum board; latex paint	0	0	0.05	4.07	19.69	0.89	0.0024
22	Cold-formed steel joist w/ steel decking system and concrete topping	none	0	0	0.05	4.07	19.69	0.89	0.0024
TOTAL SQUARE FOOTAGE			5000.00						

Users only fill in yellow cells



Instant answers

TOTAL IMPACTS BY BUILDING COMPONENT	Primary Energy (MMBtu) TOTAL	GWP (tons) TOTAL	Weighted Resource Use (tons) TOTAL	Air Pollution Index TOTAL	H2O Pollution Index TOTAL
COLUMNS & BEAMS	0	0	0	0	0.00
INTERMEDIATE FLOORS	242	9	61	6988	22.83
EXTERIOR WALLS	0	0	0	0	0.00
INTERIOR WALLS	0	0	0	0	0.00
ROOFS	0	0	0	0	0.00
WHO	9	61	6988	22.83	

9 tons CO2e cradle to grave 60 year life

B. INTERMEDIATE FLOORS
ATHENA ASSEMBLY EVALUATION TOOL v2.2—MINNEAPOLIS
IN THE YELLOW CELLS BELOW, ENTER THE AMOUNT OF SQUARE FOOTAGE THAT EACH ASSEMBLY OCCUPIES

	Floor Structure <i>(Assemblies in red font)</i>	Interior Ceiling Finish	Square Footage	Percentage of total	Primary Energy per SF (MMBtu)	GWP per SF (lbs)	Weighted Resource Use per SF (lbs)	Air Pollution Index per SF	H2O Pollution Index per SF
Average:					0.08	11.99	72.72	1.22	0.0060
1	CONCRETE FLAT PLATE AND SLAB COLUMN SYSTEM 25% flyash	gypsum board; latex paint	0		0.16	32.40	212.36	2.50	0.0025
2	CONCRETE FLAT PLATE AND SLAB COLUMN SYSTEM 25% flyash	none	0		0.15	31.36	208.54	2.31	0.0025
3	PRECAST DOUBLE T CONCRETE SYSTEM	gypsum board; latex paint	0		0.08	17.91	102.70	1.45	0.0006
4	PRECAST DOUBLE T CONCRETE SYSTEM	none	0		0.07	16.87	98.89	1.26	0.0006
5	CONCRETE HOLLOW CORE SLAB	none	0		0.06	14.31	91.12	1.31	0.0025
6	GLULAM JOIST AND PLANK DECKING	gypsum board; latex paint	0		0.09	9.06	64.59	0.91	0.0073
7	GLULAM JOIST AND PLANK DECKING	none	0		0.07	8.01	60.77	0.72	0.0073
8	WOOD CHORD AND STEEL WEB TRUSS SYSTEM	gypsum board; latex paint	0		0.06	6.63	29.24	0.93	0.0099
9	WOOD I-JOIST AND OSB DECKING SYSTEM	gypsum board; latex paint	5000	100%	0.05	3.68	24.57	1.40	0.0046
10	WOOD JOIST AND OSB DECKING SYSTEM	gypsum board; latex paint	0		0.06	3.95	35.35	0.98	0.0019
11	OPEN WEB STEEL JOIST W/ STEEL DECKING SYSTEM AND CONCRETE TOPPING						69.56	1.03	0.0139
12	OPEN WEB STEEL JOIST W/ STEEL DECKING SYSTEM AND CONCRETE TOPPING						65.75	0.84	0.0139
13	STEEL STUD JOIST AND OSB FLOORING SYSTEM						26.88	0.77	0.0217
14	WOOD TRUSS AND OSB DECKING SYSTEM						30.06	1.15	0.0024
15	Structural steel w/ steel decking system and concrete topping		0						
16	Structural steel w/ steel decking system and concrete topping		0						
17	OPEN WEB STEEL JOIST W/ 3/4" OSB FLOORING SYSTEM	gypsum board; latex paint	0		0.06	5.11	23.51	1.08	0.0024
18	OPEN WEB STEEL JOIST W/ 3/4" OSB FLOORING SYSTEM	none	0		0.05	4.07	19.69	0.89	0.0024
19	Cold-formed flat steel truss w/ steel decking system and concrete topping		0						
20	Cold-formed flat steel truss w/ steel decking system and concrete topping		0						
21	Cold-formed steel joist w/ steel decking system and concrete topping		0						
TOTAL SQUARE FOOTAGE			5000.00						

Wood I-joist and OSB decking system, gypsum board, latex paint

Whole Building Context

- Results on a per unit area basis (e.g., per ft²)
 - ✓ Estimates based on much larger areas, e.g., 1000 linear feet of wall
- Components and loadings typical for central U.S.
- Owner occupied office buildings, 60-year lifespan
 - ✓ Affects maintenance and repair/replacement schedules
- Other specific assumptions:
 - ✓ Window to wall ratio
 - ✓ Concrete strength and fly ash content
 - ✓ Gypsum board type and thickness with latex paint
 - ✓ Live load for all intermediate floors, columns & beams, roofs
 - ✓ Bay sizes and column heights
 - ✓ External wall thicknesses depending on construction system
 - ✓ Stud size/strength and spacing
 - ✓ Sheathing and decking materials

EcoCalc Versions

- ∪ Current
 - » Northern USA averages
 - » Southern USA averages
 - » 8 Canadian regions
 - Vancouver, Calgary, Winnipeg, Toronto, Ottawa, Montreal, Québec, Halifax
 - » 4 US regions
 - Atlanta, Minneapolis, Orlando, Pittsburgh
- ∪ Coming 2008
 - » Los Angeles, New York, Seattle, other SW and central regions

All with hi-rise and low-rise versions

- About the Institute ▶
- Impact Estimator ▶
- EcoCalculator ▶
- Databases ▶
- Projects ▶
- Reports & Publications ▶
- Our Supporters ▶
- Site Info ▶
- Careers ▶
- What's New

NEW! Now downloading Version 2.3 of the FREE EcoCalculator

Now Includes:

Calgary, Halifax,
Montreal, Orlando,
Ottawa, Quebec City,
Toronto, Winnipeg

Please delete the previous version of the EcoCalculator and download the new version available [here](#).

WELCOME

At the Athena Institute, we believe that better information and tools are critical to achieving a sustainable built environment. We also believe that a life cycle assessment (LCA) approach to sustainability is the only way to create a level playing field for the vast array of building materials in use.

From our Canadian offices, and through our US affiliate, Athena Institute International, the not-for-profit Athena organization undertakes and directs innovative research and development activities that allow architects, engineers and others to factor environmental considerations into the design process from the conceptual stage onward.

Over the past decade, the Institute has developed groundbreaking software, world-class databases and customized consulting services—as well as a worldwide reputation in the field of sustainable building and LCA. We also offer the only tools in North America for the life cycle assessment of whole buildings and assemblies:



Allows users to evaluate whole buildings and assemblies based on internationally recognized LCA methodology.



Provides instant LCA results for more than 400 common building assemblies (free of charge).

Click the images above for more information.

www.athenaSMI.ca

