

# greening structural systems of buildings

research description and report

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# investigators

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# sponsors

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# research goals

The purpose of this research is to discover what limits the ability of building design and construction professionals to use environmentally responsible materials in the structural systems of buildings.

We interviewed Oregon-based building design professionals with experience incorporating structural materials that are more environmentally responsible than the materials used in conventional practice.

# research goals

This research identifies gaps in information as well as gaps in access to or availability of green materials for structural use that will:

- 1) help Oregon-based material producers better understand the needs of designers who are responsible for green material selection.
- 2) inform curriculum development for graduate level courses and professional continuing education.
- 3) identify future research opportunities related to the development and evaluation of green structural materials.

# research process

- The survey process was divided into two phases.
- **Phase I** was a series of *eight* exploratory interviews with individuals, conducted by phone or in person, who assisted us in refining questions and identifying potential participants in the focus group discussions of Phase II.
- In **Phase II** expert opinion about information gaps in the evaluation of green materials was collected through interviews conducted in *four* focus groups, two in Portland and two in Eugene.

# research participants

Over thirty professionals in architecture, engineering, construction and development participated.

40% architects

30% engineers

20% construction

10% development, consulting and research

50% of participants are LEED AP

# overview of research to date

- from the transcripts of the four group interviews, the frequency of responses to a survey question was recorded
- the results presented here reflect the responses with the greatest frequency
- the number in parentheses “(#)” next to each response notes the number of group interviews the response came up in (max = 4)

# question 1 | performance criteria

How do design teams establish performance criteria for materials used in the structural systems of green building projects and how are the approaches for wood, steel, concrete and masonry similar or different?

# question 1 | performance criteria

- code (4)
- cost (4)
- height, size, form (3)
- program – structural bay size required (2)  
“an office might have long span steel or residences might have concrete”

“Picking the structural system and then having to make it green are separate conversations.”

## question 1b | improving materials

Once the decision about which structural material will be used, how do design teams improve the green aspects of the chosen material and system?

# question 1b | improving materials

- material efficiency within the structural system, using less materials (4)
- carbon footprint (3)
- using a high percentage of fly ash (2)

"I'm not sure if sustainability itself chooses the system as much as once the system is chosen we're getting a lot better at extracting every drop of sustainability out of it."

# question 1c | green advocates

Who are the primary advocates for a greener-than-standard performance objective? Owners? Developers? Designers?

# question 1c | green advocates

- owner/developer (3)
- design team (3)
- specification writer with input from others (2)

"If everybody is... working collaboratively [to make the project more sustainable], but the electrical engineering isn't on that wavelength. That's going to have a major impact on how efficient that system is and it may have impact on other systems."

## question 1d | LEED and structures

In your experience with LEED certified projects, how did meeting a LEED standard inform structural materials selection?

Are there changes that could be made to LEED criteria that would better accommodate locally produced products without sacrificing (or, preferably, improving) sustainability results?

## question 1d | LEED and structures

- LEED has little impact on structural selection (2)
- increased focus on recycled content (2)
- availability and cost of FCS timber (2)
- lack of benchmarks for structures (2)

"As far as structural system selection goes, LEED is pretty much a just a side note."

"Right now LEED doesn't care if I specify a design really lazily, and I have 50% more steel in the building."

# question 1e | performance levels

On building projects with green design agendas that did not use LEED, Living Building or Green Globe prerequisites, how did project teams define green structural materials performance levels or requirements?

# question 1e | performance levels

- material efficiency, reducing overdesign (2)
- durability and life-cycle (1)

"If you can give credit for those buildings that are designed beyond the code to provide an immediate occupancy [after a seismic event] type structure that performs at a much higher level. In the event that something does happen and you don't have to tear that building down and rebuild it again."

## question 2 | beyond material selection

Are there other aspects of the structural system, besides material selection, that you think need to be considered to optimize green building outcomes? Or to facilitate green materials integration?

"The most sustainable thing you can do is build really good buildings that people will want to keep for a long time."

## question 2 | beyond material selection

- thermal mass (4)
- exposed structure to reduce interior finishes (3)
- acoustic properties (2)
- systems integration, system synergies (2)
- durability and longevity (2)

“What material actually helps you support the other things like energy savings, green roofs and things. The structural system is more thinking about what system will help us support the other MEP and architectural aspects.”

## question 3 | design constraints

Which of the following design constraints are most likely to pose challenges when teams attempt to use green structural materials?

## question 3 | design constraints

- cost (4)
- code and regulation compliance (4)
- availability of green structural materials (4)
- client expectations (3)
- construction time, methods, or quality (3)
- design/build team's understanding of green material options (3)
- time available to indentify and evaluate material alternatives (3)

## question 3 | design constraints

“If you don't have a really smart team that has been to this party before, your chance of coming out with a truly remarkable building are seriously hindered. It takes a team that already has a very good database on green building materials and their availability. It takes a team that has already developed a high-performance building and understands where the benefits are, where the pitfalls are, and how to maximize performance with the least effort. It takes more time to design the building appropriately. If the developer doesn't give the team enough time, then shame on them.”

## question 4 | information sources

What information sources do you currently use to select green materials for structural systems applications?

What information sources do you use when you have questions about the environmental impacts of structural material options?

## question 4 | information sources

- Environmental Building News (EBN) (3)  
[www.buildinggreen.com](http://www.buildinggreen.com)
- internet, google (3)
- consultants (2)
- canvassing or collaborating with other design professionals (2)
  
- looking forward to PHAROS (3)

## question 5 | information credibility

How do you determine the credibility or reliability of information about the the environmental advantages of green materials?

“The validity of the information is directly proportional to the amount of eyes that are on it.”

## question 5 | information credibility

- don't trust product representatives or literature (3)
- ask local vendors, superintendents, sub-contractors about their experience (3)
- third party certification (2)

“Most product research in the United States is done by manufactures of the products... we don't do enough about researching how products work once they are put in place in a really objective way.”

## question 6 | adequate information

Do you feel that the information available to you about green structural materials and components is adequate?

What information would make the task of designing for green structures more doable?

Are there any aspects of structural materials selection that require more assistance from consultants with green materials expertise?

## question 6 | adequate information

- information is not adequate (4)
- building information modeling (BIM) potential (3)
- unknowns about materials from other countries (3)
- benchmarks for structural systems (2)
- post-occupancy measurement and verification (2)
- carbon footprint labels for materials (1)
- a network of contractors willing to share green practices (1)

## question 7 | needed information

What does a person in your role (e.g. architect, structural engineer, specifier, construction manager, etc.) need to know to incorporate green materials into the structural systems of buildings?

What topics would you like to see covered in a continuing education program on green structural materials?

# question 7 | needed information

- how to work in an integrated design process (4)
- analysis tools (3)
- basic theory and ethics of sustainability (3)
- economics of sustainability (2)
- life-cycle analysis (2)

“Architects need to understand how engineers think so they can do more good.”

## question 7 | needed information

“If we do this out of concrete or steel that's going to cost you this much more per square foot but we don't say well but you are going to buy less of this and not have a ceiling. It takes an educated contractor and design team to be able to help the contractor access the cost transfers to understand the real net effect cost of something. I think a lot of green initiatives or materials or integrated systems get marked off before the real costs are understood.”

# wood

## pros

- locally available
- low carbon footprint

## cons

- not enough FSC wood available for any project larger than a house
- increased cost of certified wood
- limitations in use (size, height, occupancy)
- use of preservatives and formaldehyde-based glues creates indoor air quality issues

# steel

## pros

- small, standard members are available within a 500 mile radius
- high recycled content possible and often standard
- structural system could be designed for disassembly and reused/recycled

## cons

- larger members and certain shapes are only made overseas
- must be fireproofed in high-rise applications

# concrete

## pros

- materials are locally available
- can provide architectural finish

## cons

- high carbon footprint of portland cement
- varying fly ash availability, shipping fly ash from overseas to meet the demand
- quality of finish with high volumes of fly ash
- need new binders other than portland cement

