HKUST Research Related to the Housing Development in Hong Kong

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HKHA Research and Development Forum

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Overview

Research at HKUST that may be of interest to HKHA

- Structural Engineering and Materials
  - Seismic design and seismic vulnerability assessment of buildings (JS Kuang)
  - Design optimisation of tall buildings (CM Chan)
  - Waste utilisation and high insulation concrete, construction materials (Z Li and Chris Leung)
- Geotechnical Engineering
  - Green slope engineering (Charles Ng)
  - Piling (Limin Zhang)
  - Seismic stability assessment of slopes and retaining structures (Gang Wang)
- Construction Management
  - Performance-based building management (Eric Zhang)
  - Construction IT and supply chain (Jack Cheng)

Seismic design and seismic vulnerability assessment of tall buildings

- Earthquake-resistant design of buildings
- Seismic vulnerability assessment of tall building structures
- Code and regulation developments for seismic design of RC buildings
- Experiment of large-scale concrete structures and components

Current methods of seismic assessment of buildings (three levels)

1. Level one

Simple model and less calculation – suitable to quick assessment of simple building. Main purpose of level one methods is to screen out deficient buildings from a large population.

2. Level two

Rationale model and acceptable amount of computation for quick assessment of buildings. It is more restrictive than level one, but is simpler than level three. Main purpose of level two methods is to screen out deficient buildings from a large population, but more accurately than level one.

Development by HKUST: Drift-spectrum method of analysis

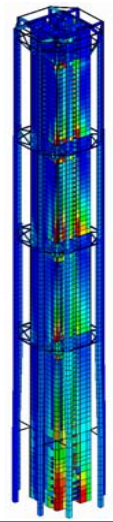
3. Level three

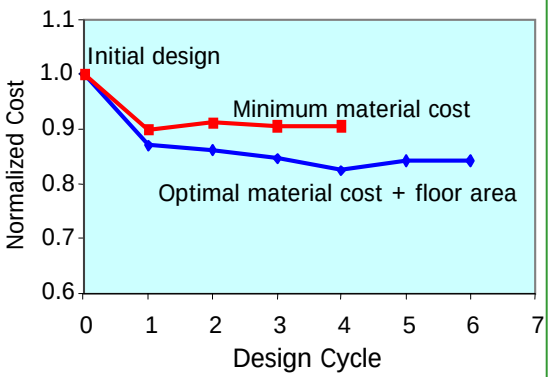
Complicated model and heavy computation – suitable to very detailed assessment of buildings. The main purpose of level three methods is to identify the deficiencies of buildings for strengthening and retrofit.

Development by HKUST: Incremental substitution procedure; MDOF continuum model

Computational design optimisation of tall buildings

Structural Optimisation by Evolutionary Computation





Research topics

- Aerodynamic shape optimisation for minimising wind load effects on tall buildings
- Evolutionary computation for lean and green design of tall buildings
- Performance-based hazard resistant design optimisation of tall buildings

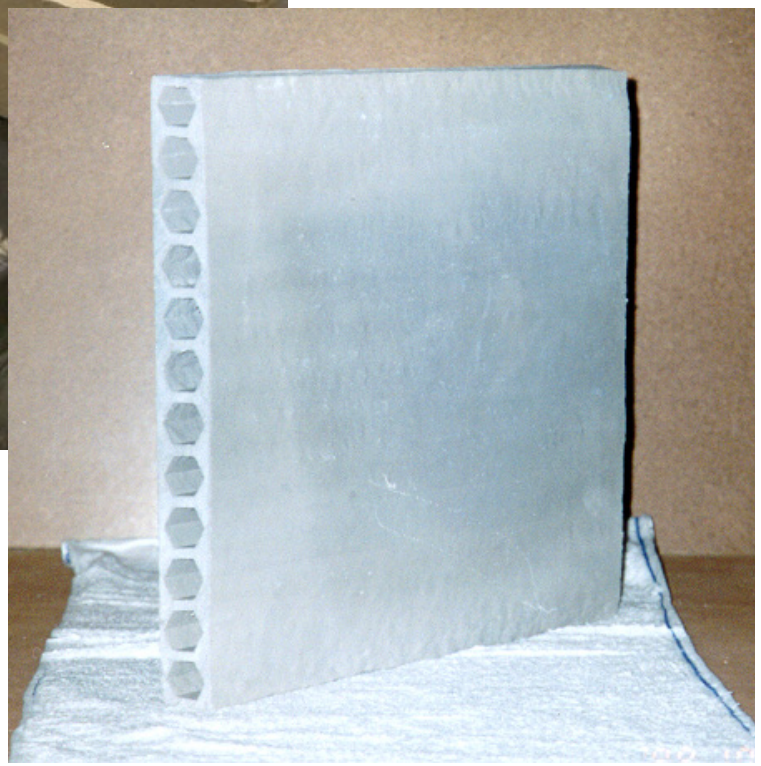
Major benefits

- Direct cost savings
- Reduction in construction material, time and energy
- Enhanced performance and value of property
- Improved greenness of built environment

Notable buildings optimised including

- 420-m IFC II, Hong Kong
- 484-m ICC, Hong Kong
- 600-m Tianjin 117 Tower, Tianjin
- 610-m Guangzhou TV and Sightseeing Tower

Utilisation of industry by products: Extruded door frame with waste wood particles and Honeycomb-sectioned panel with fly ash



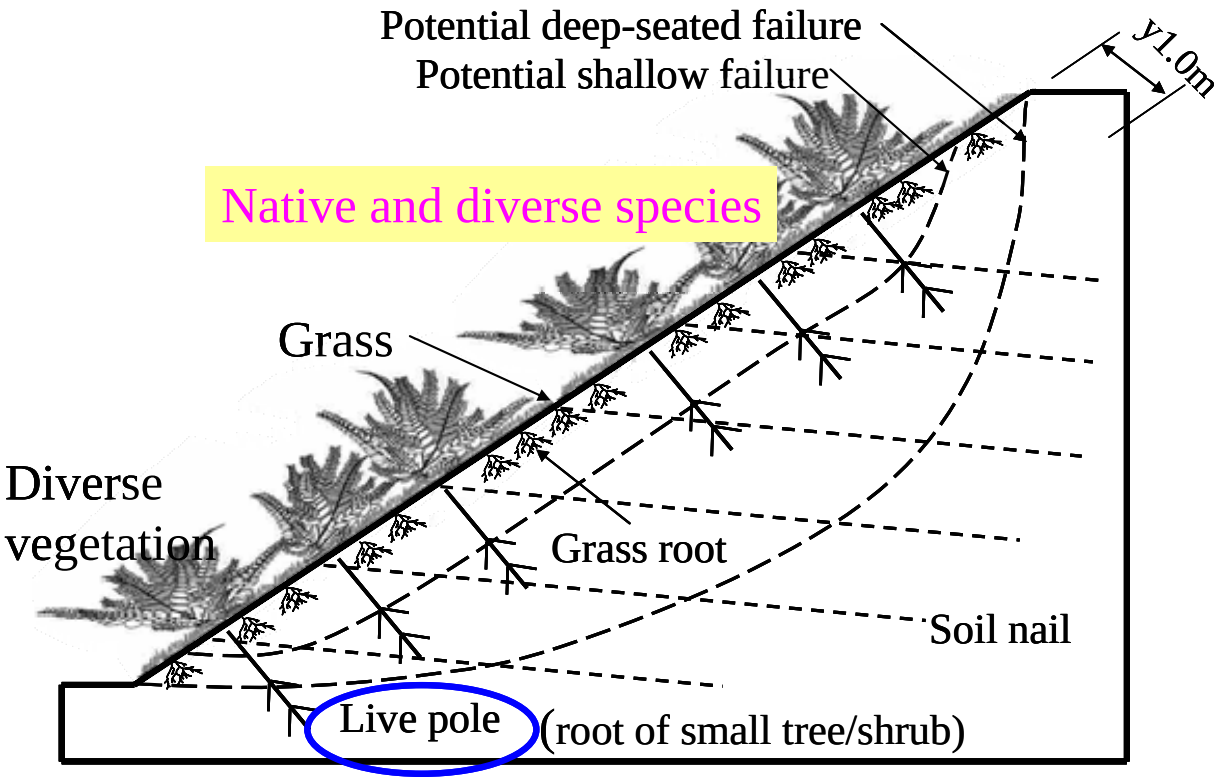
Functional-structural extruded panel
(Heat insulation with phase change materials)

Green slope engineering for Hong Kong

Prime objectives

- To investigate and improve our fundamental understanding of root-soil-water interactions
- To develop an innovative reliability-based design concept and guidelines for "integrated bioengineered live slope cover" for Hong Kong

Self-regenerative and sustainable (almost maintenance free)



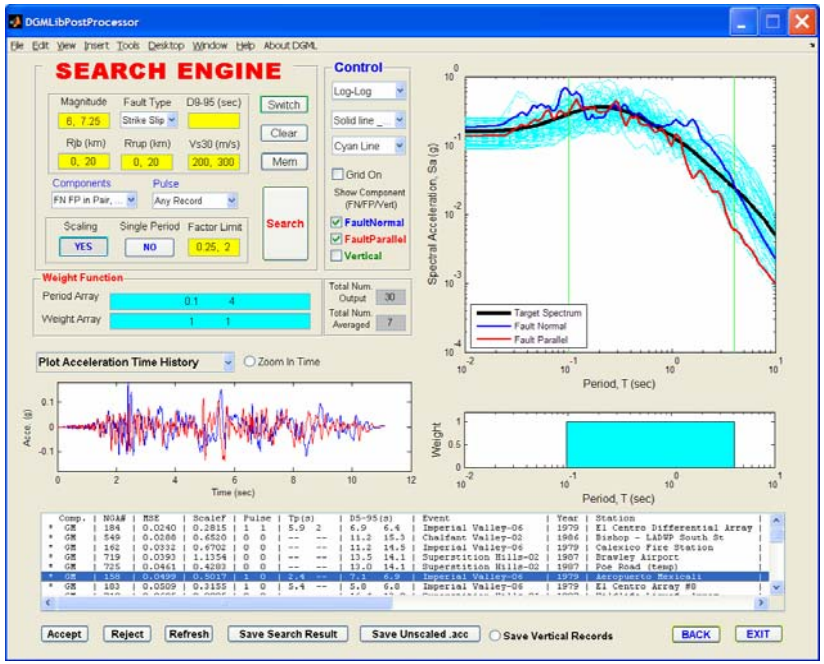
Housing Authority Research Fund

Study of termination criteria and acceptance criteria for long driven piles and jack piles

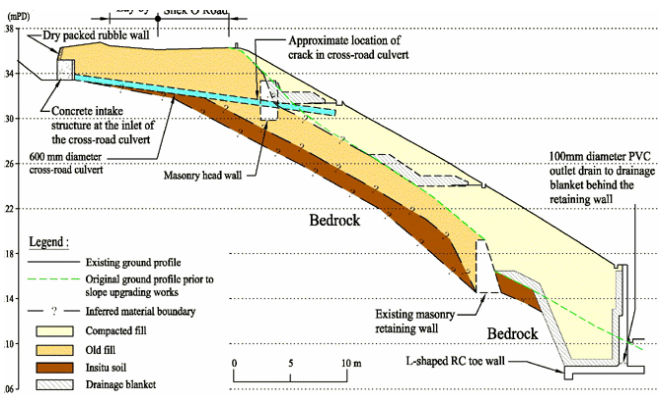
- Hong Kong Driven Pile Database
- Termination criteria for long driven piles
- Termination criteria for jack piles
- ICU/BD pre-submission enquiry paper “Proposed final set criteria based on wave equations for steel H-piles”

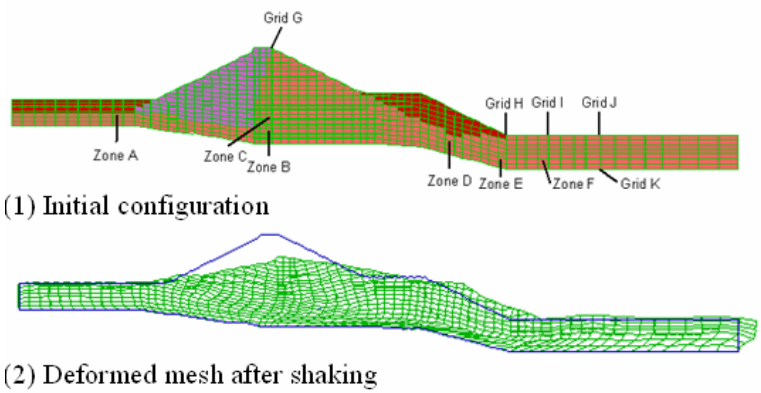
Seismic stability assessment of loose fill slopes and retaining structures

Scenario-based ground motion selection



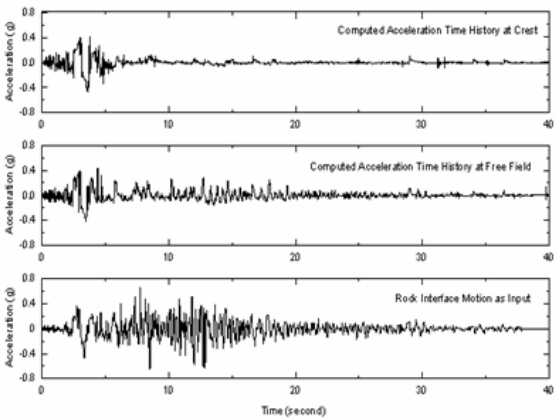
Simulation of earthquake-induced deformation and liquefaction of embankment





(1) Initial configuration

(2) Deformed mesh after shaking



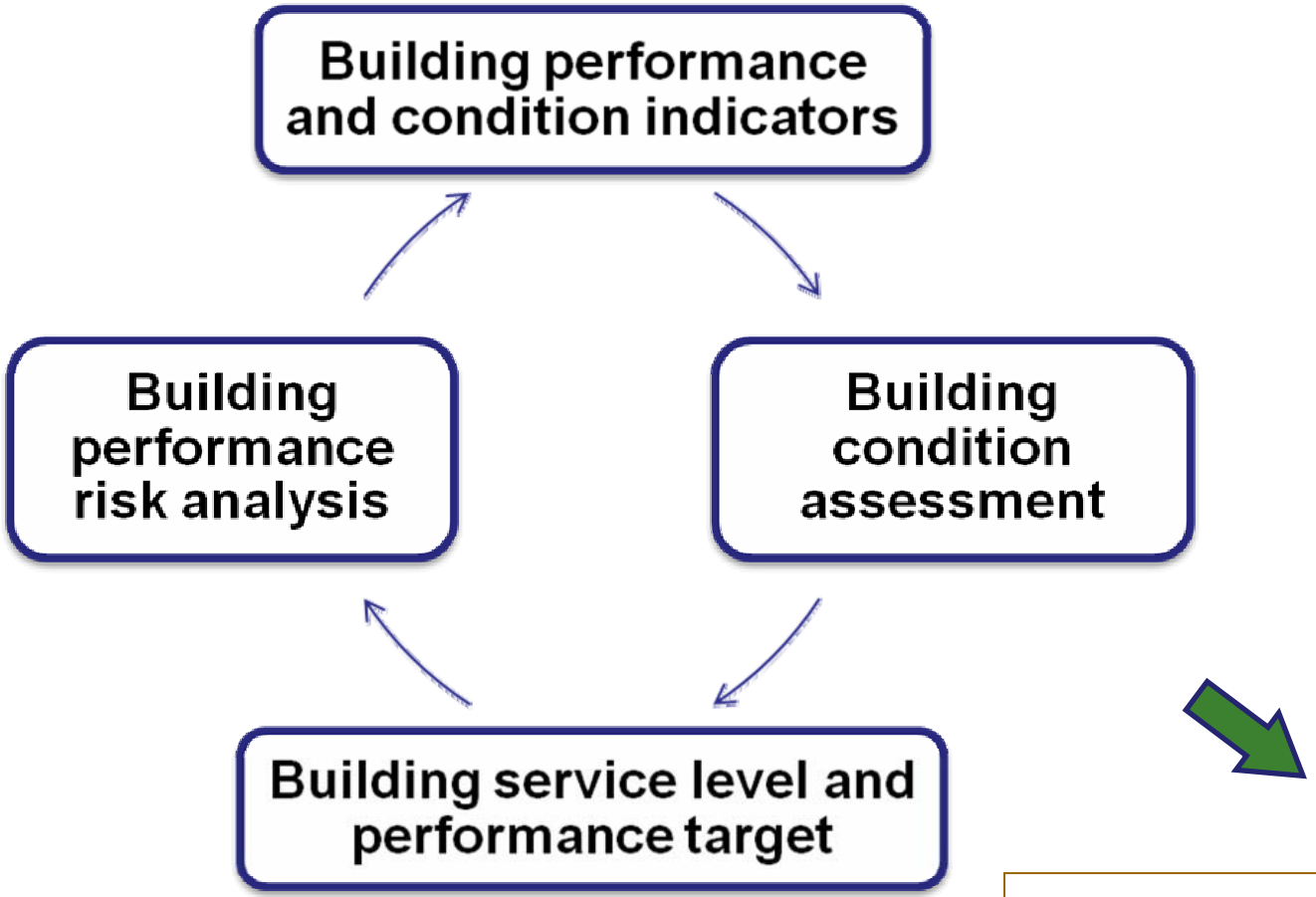
(3) Input and computed ground motions

An engineered fill slope below Shek O Road

Potential collaborations in geotechnical engineering

- Problems associated with long driven piles, jack piles, and bored piles
- Slope greening and stabilisation technologies
- Geotechnical earthquake analysis and design
- Geotechnical risk assessment
- Reuse of existing foundations for community redevelopment
- Excavation support and utilisation of underground spaces
- Cleaning of polluted grounds
- Limit-state design methodologies and codes in geotechnical engineering

Performance-based building maintenance

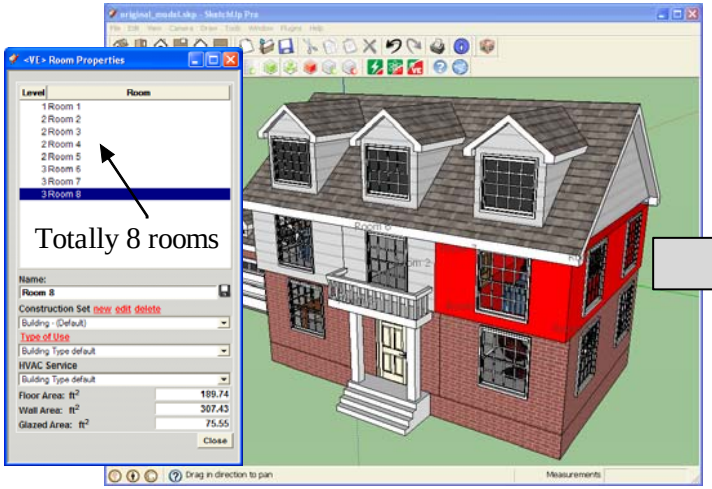


- **Building deterioration model**
- **Optimisation models for life cycle building maintenance works**

Construction information technology

- Building information modelling (BIM):

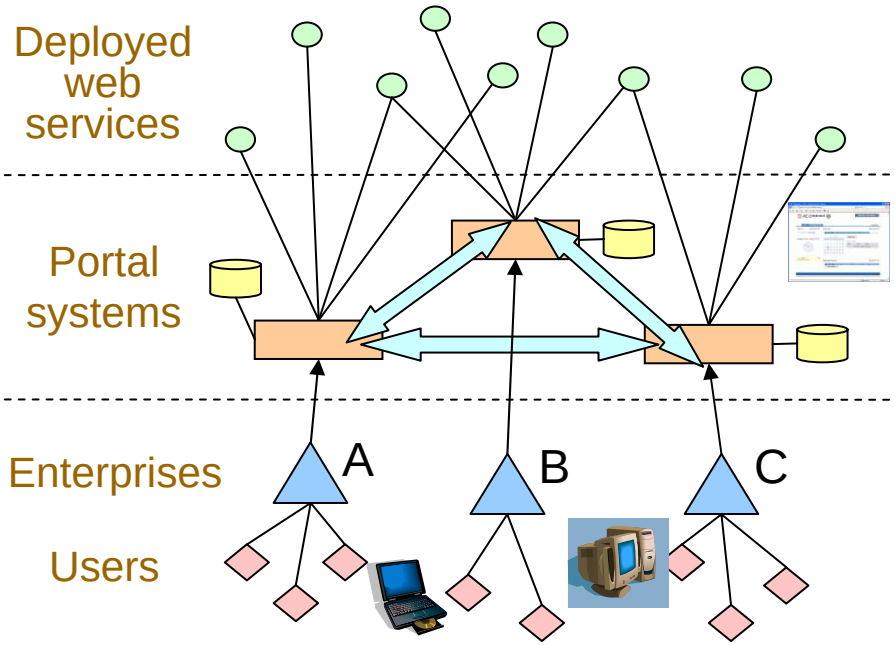
  for architectural design, building performance prediction, and construction management



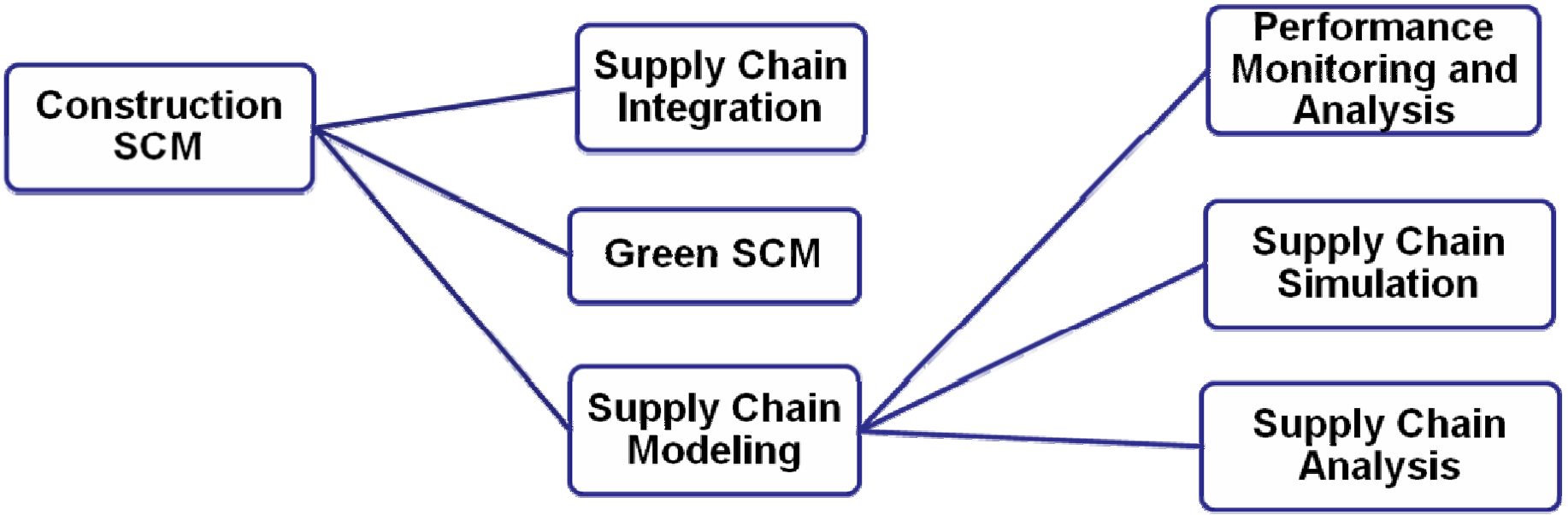
Predicted Building Energy Consumption

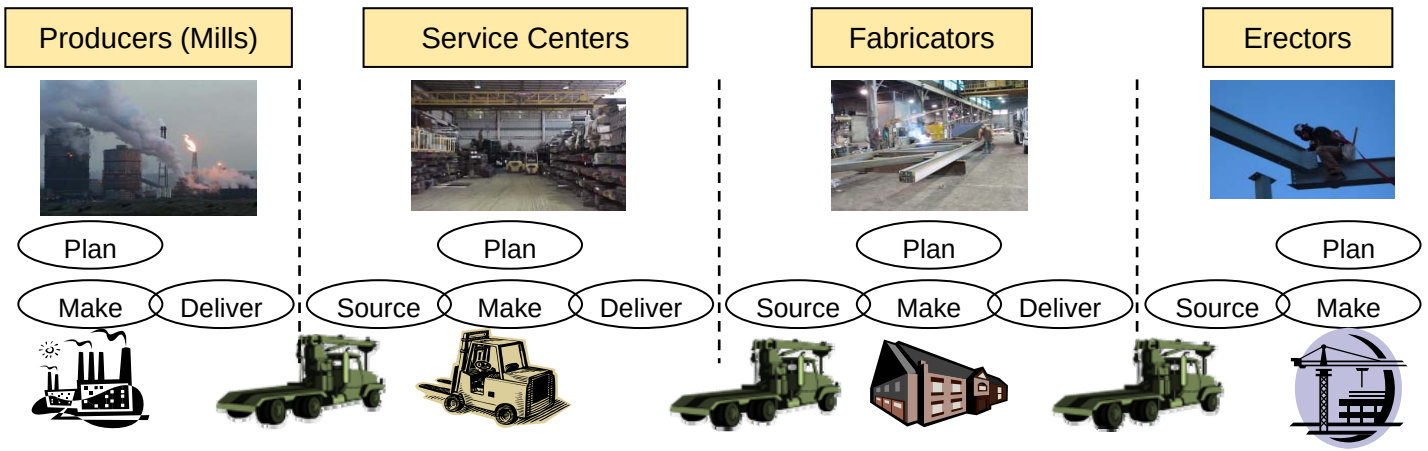
Heating	43%
Cooling	7%
Lights	13%
Equipment	37%
Total	54.85 MBtu/yr

- Web-based distributed information and communication technologies



Construction supply chain management (SCM)





Multiple layers in a structural steel supply chain