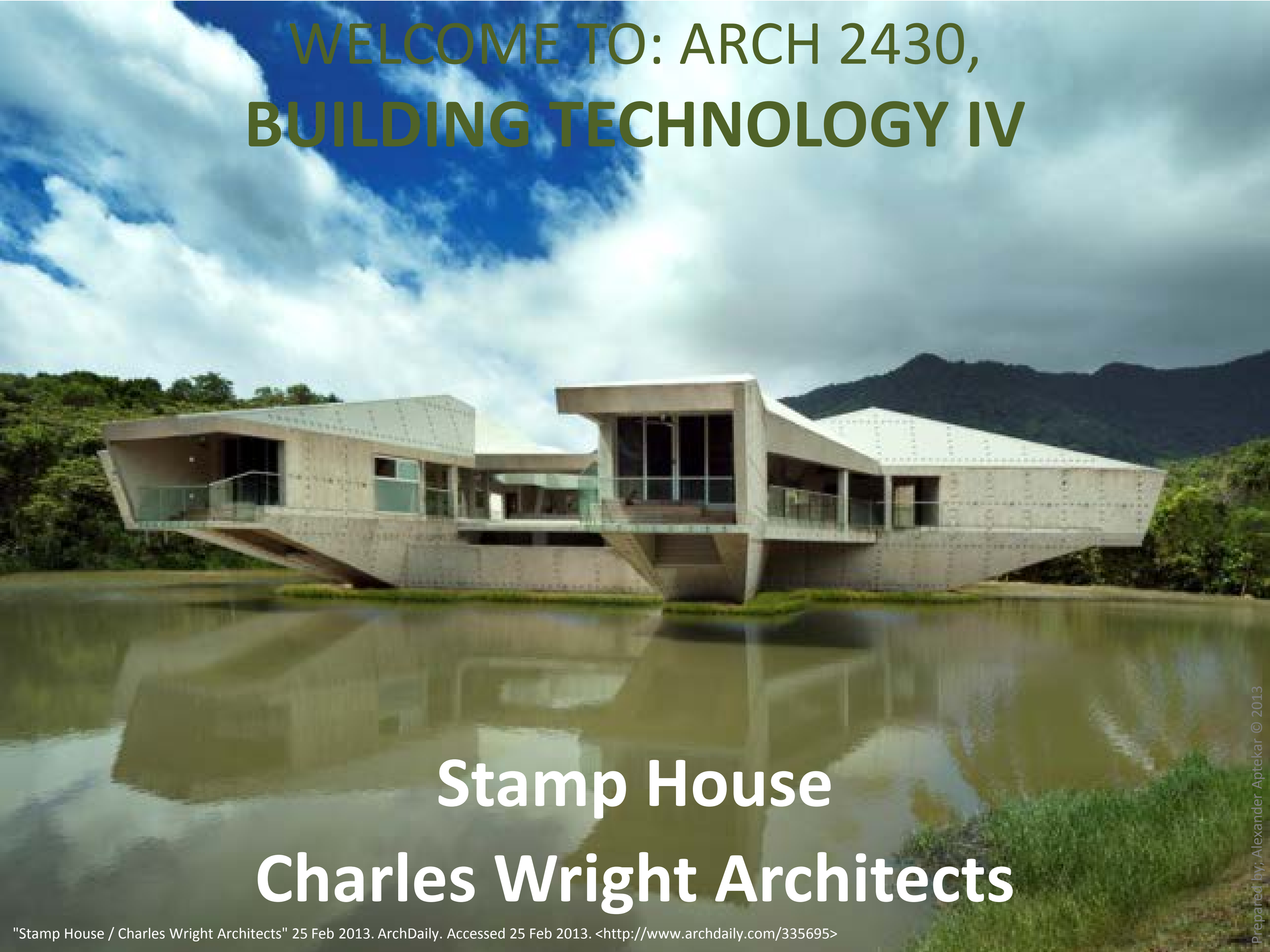
WELCOME TO: ARCH 2430,
BUILDING TECHNOLOGY IV



Stamp House
Charles Wright Architects

"Stamp House / Charles Wright Architects" 25 Feb 2013. ArchDaily. Accessed 25 Feb 2013. <http://www.archdaily.com/335695>

Structural Review, Concrete Formulas & Cores

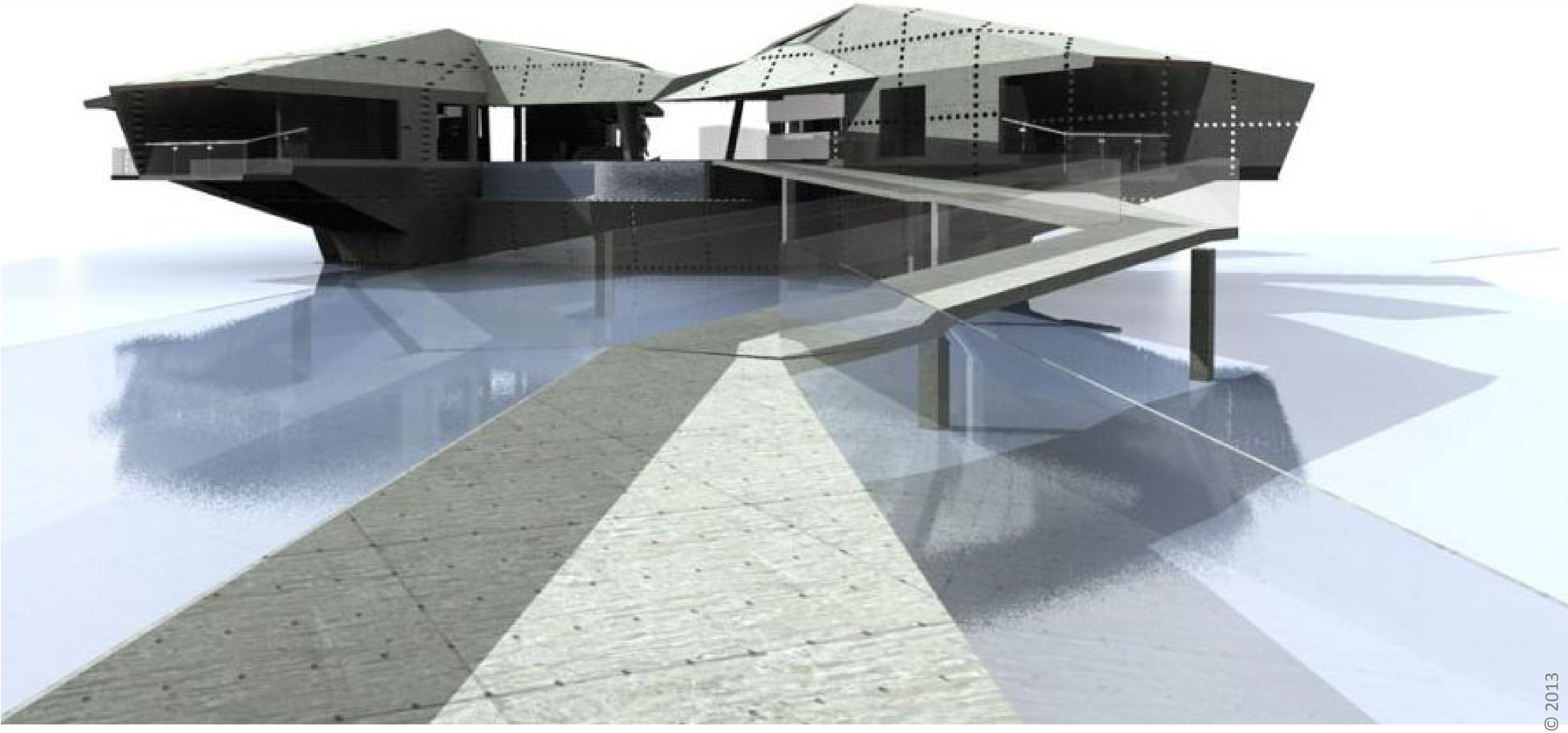
Week four: Class 08

<u>Lecture:</u> Site:

a. Case study
b. Concrete formulas
c. Drawing list and due dates
d. Sketch assignment three

<u>Lab</u> [Computer Topics]:

a. Student team structural presentation
b. Concrete formula selection
c. Core progress review



Stamp House

Charles Wright Architects

http://www.homeimprovementpages.com.au/connect/charleswrightarchitects/service/29540

Location: Queensland, Australia

Project Team: Charles Wright, Richard Blight, Justine Wright, Darcy Shapcott

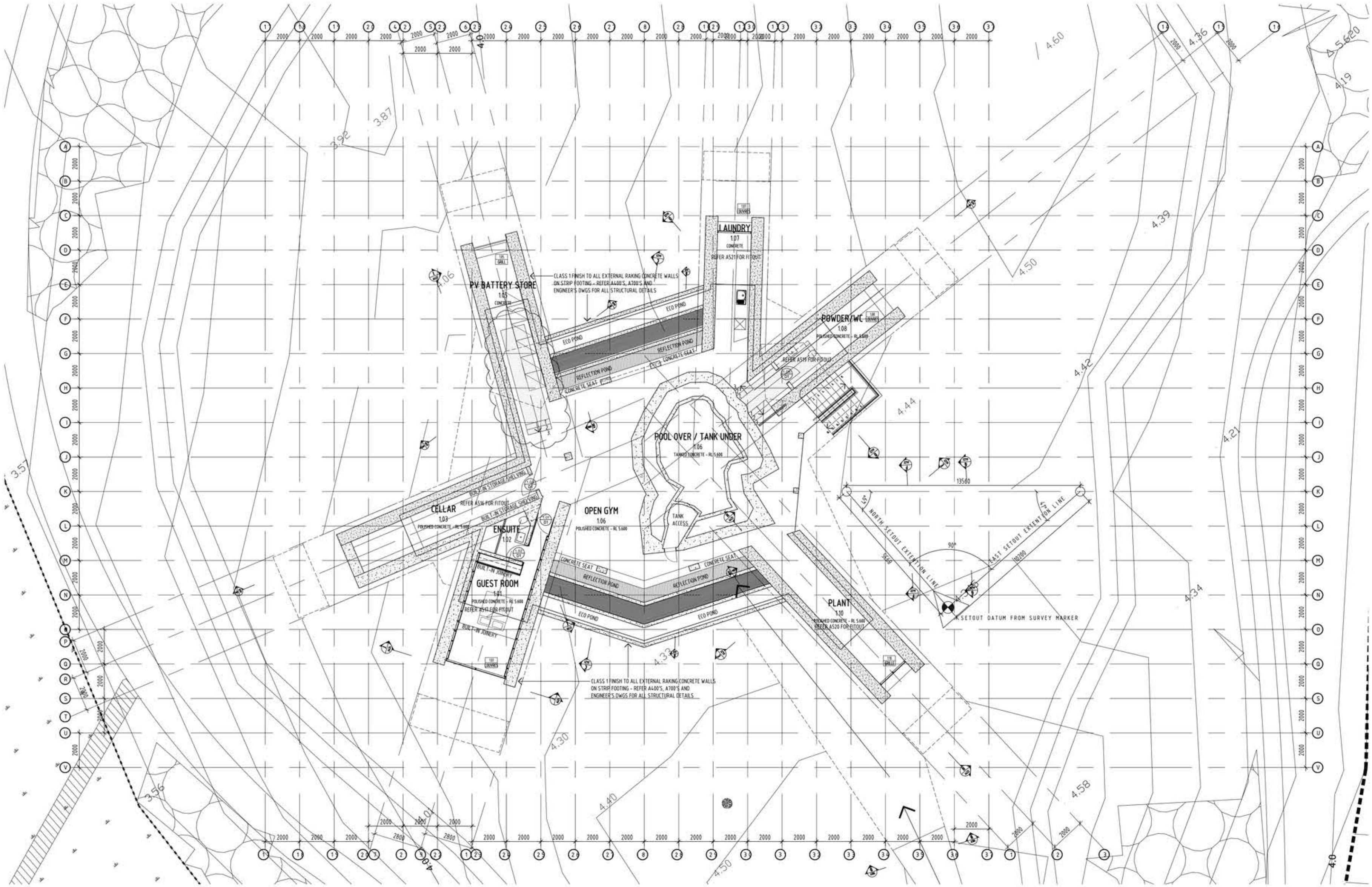
Year: 2013

"Stamp House / Charles Wright Architects" 25 Feb 2013. ArchDaily. Accessed 25 Feb 2013. <http://www.archdaily.com/335695>

Structural Engineering: G&A Consultants Pty Ltd

Civil Engineering: McPherson MacLean Wargon Chapman

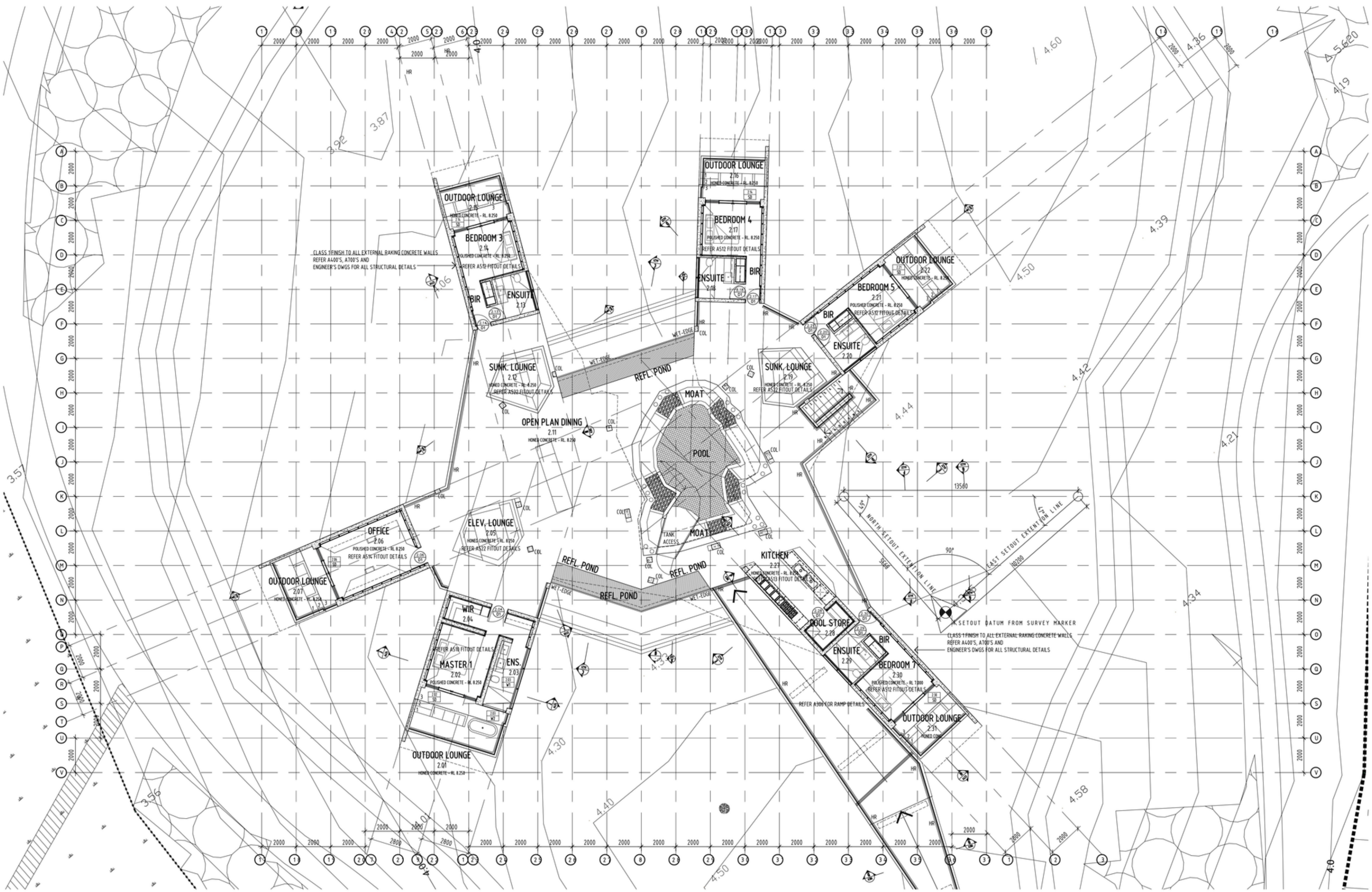
http://www.homeimprovementpages.com.au/connect/charleswrightarchitects/service/29540



Stamp House

Floor Plan 1

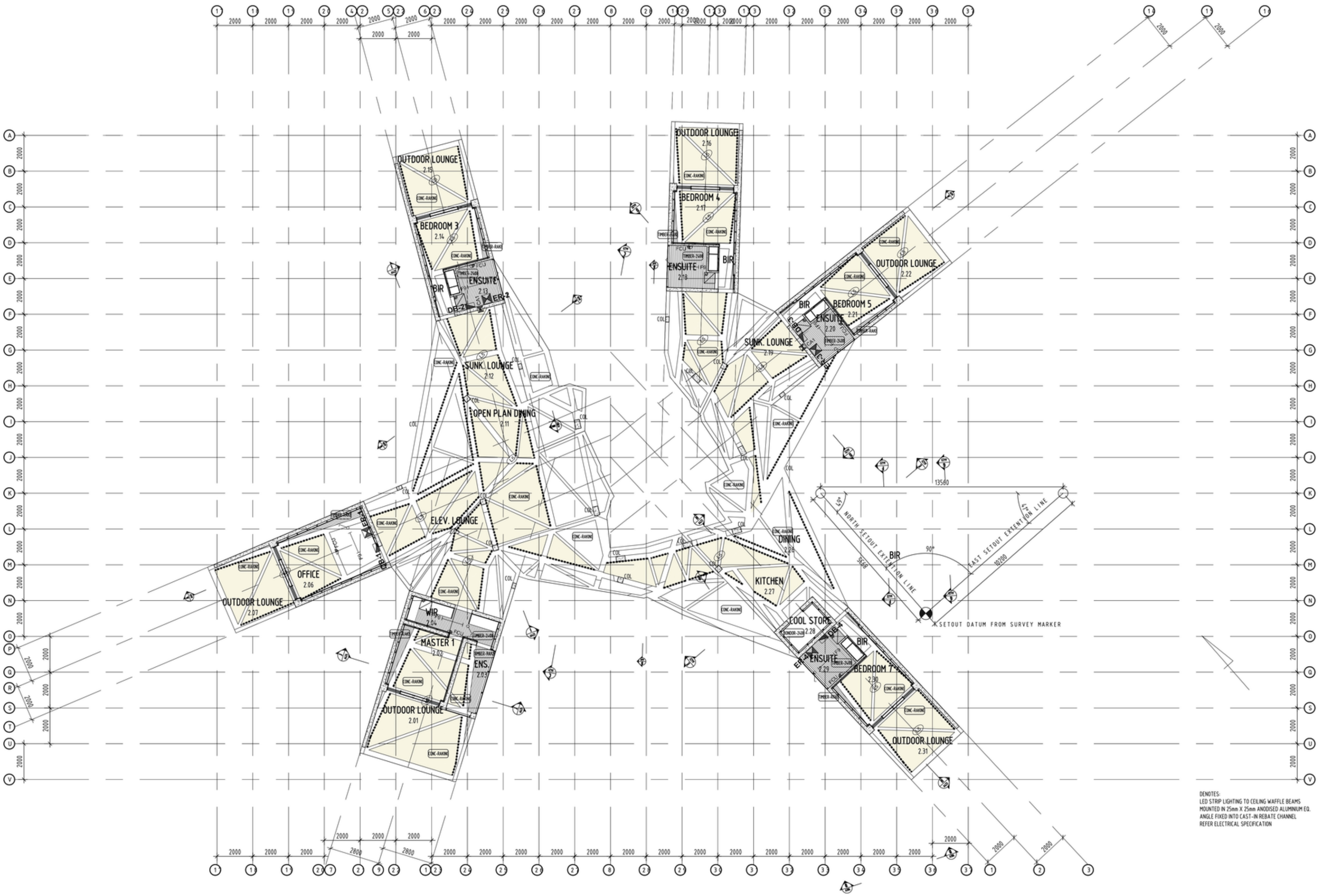
"Stamp House / Charles Wright Architects" 25 Feb 2013. ArchDaily. Accessed 25 Feb 2013. <http://www.archdaily.com/335695>



Stamp House

Floor Plan 2

"Stamp House / Charles Wright Architects" 25 Feb 2013. ArchDaily. Accessed 25 Feb 2013. <http://www.archdaily.com/335695>

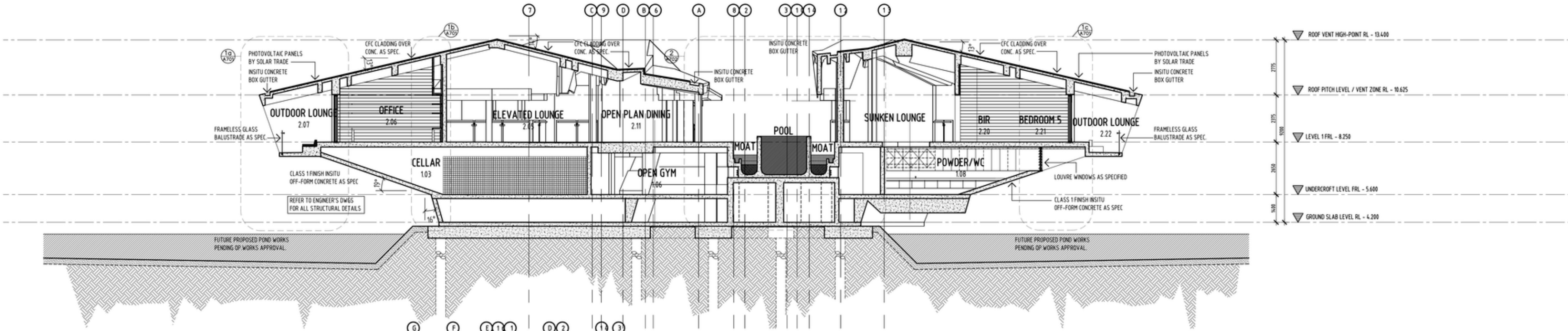


Stamp House
Floor Plan 3

"Stamp House / Charles Wright Architects" 25 Feb 2013. ArchDaily. Accessed 25 Feb 2013. <http://www.archdaily.com/335695>

Stamp House

"Stamp House / Charles Wright Architects" 25 Feb 2013. ArchDaily. Accessed 25 Feb 2013. <http://www.archdaily.com/335695>



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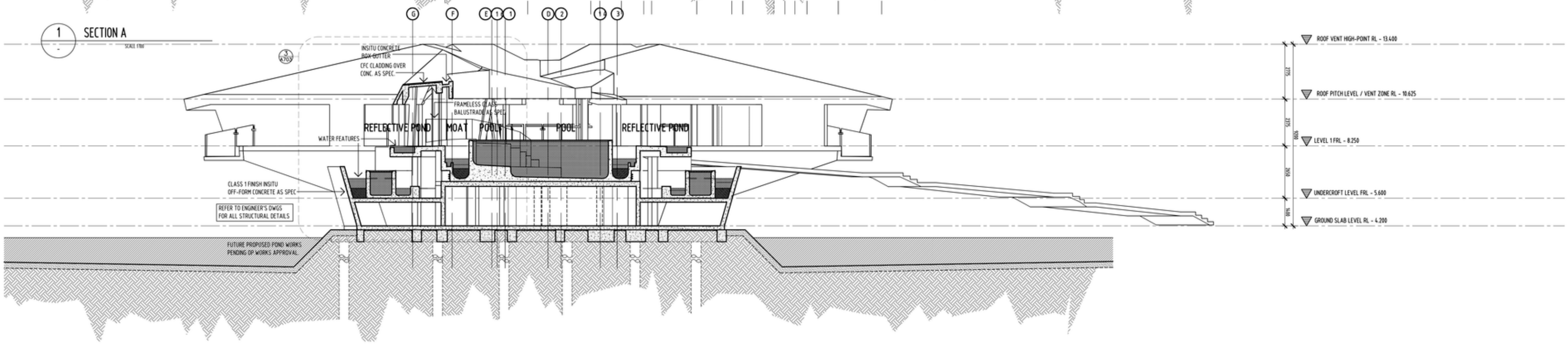
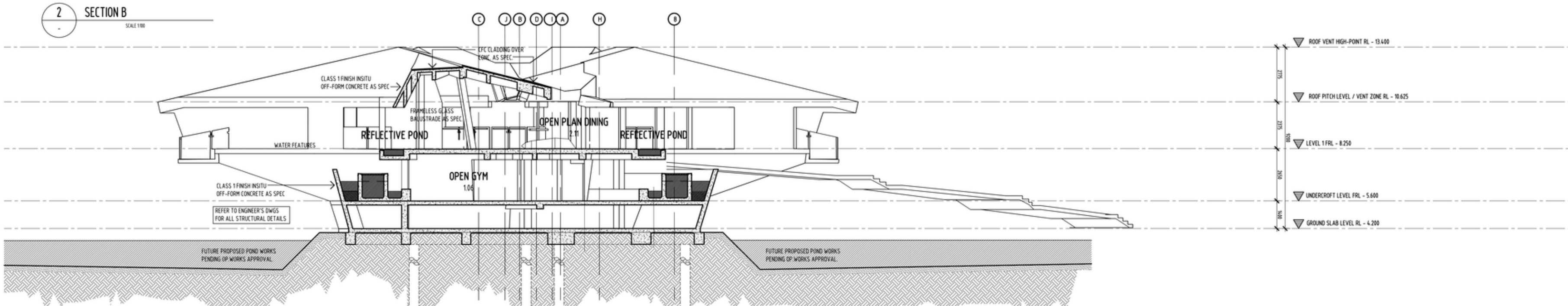


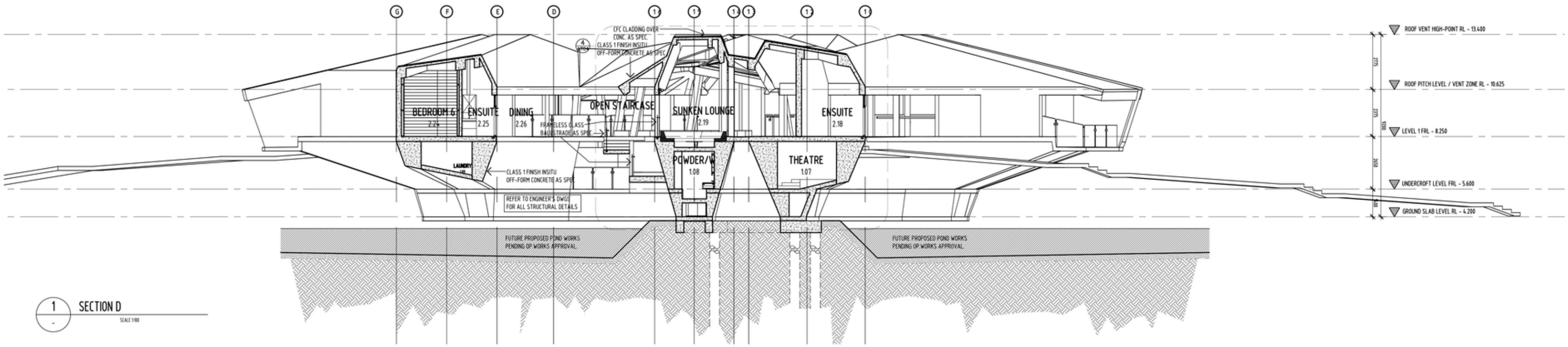
2 SECTION B



3 SECTION C

Stamp House
Sections Group 1

"Stamp House / Charles Wright Architects" 25 Feb 2013. ArchDaily. Accessed 25 Feb 2013. <http://www.archdaily.com/335695>



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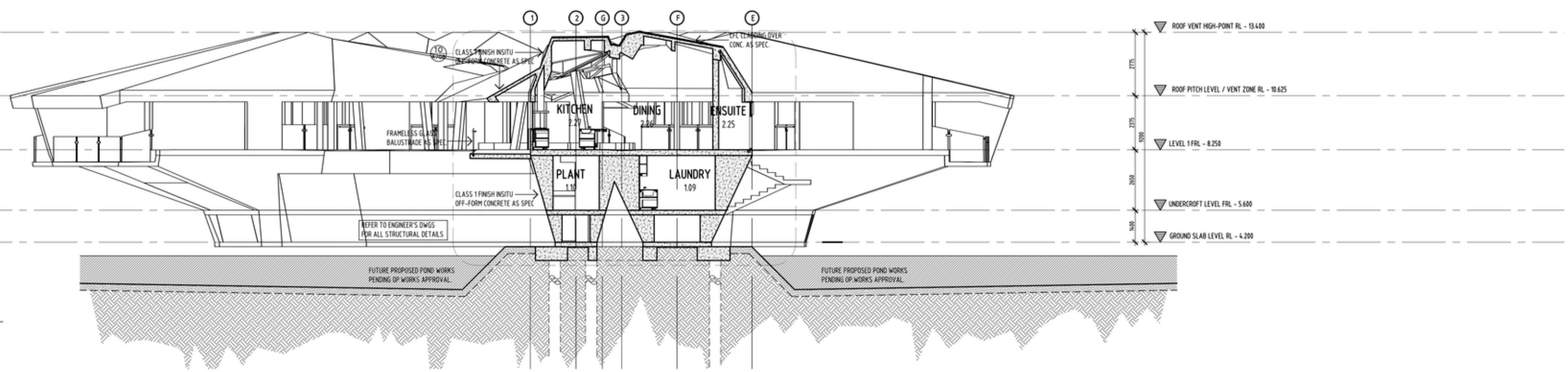

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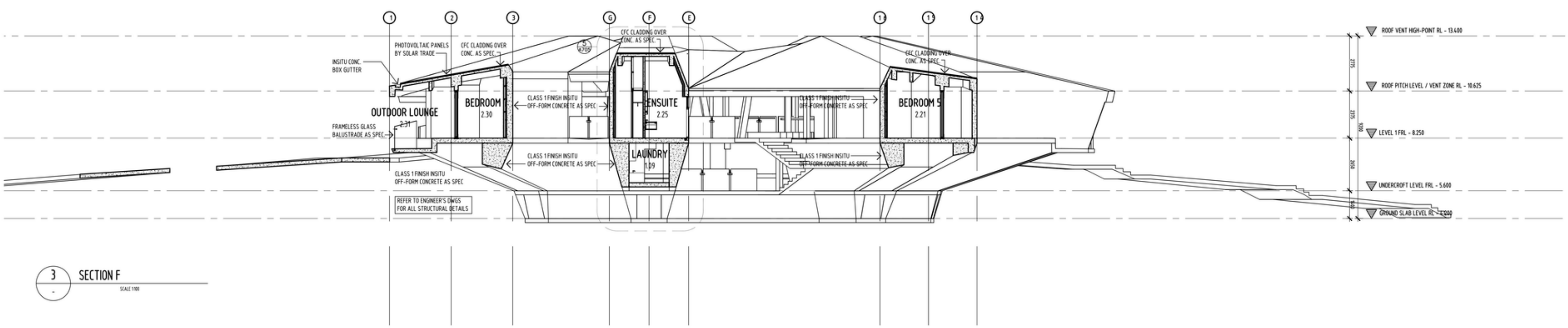
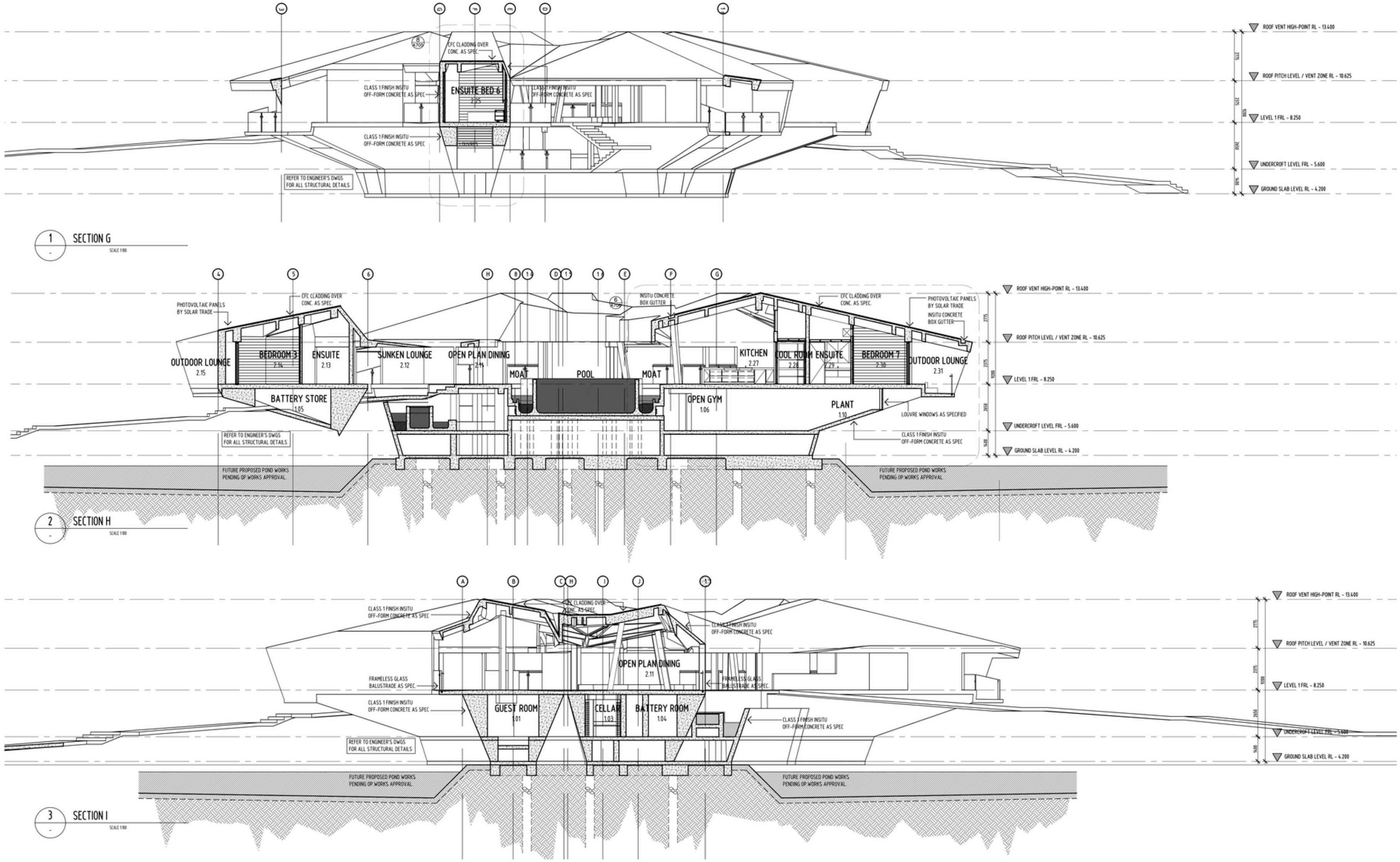


3 SECTION F

Stamp House
Sections Group 2

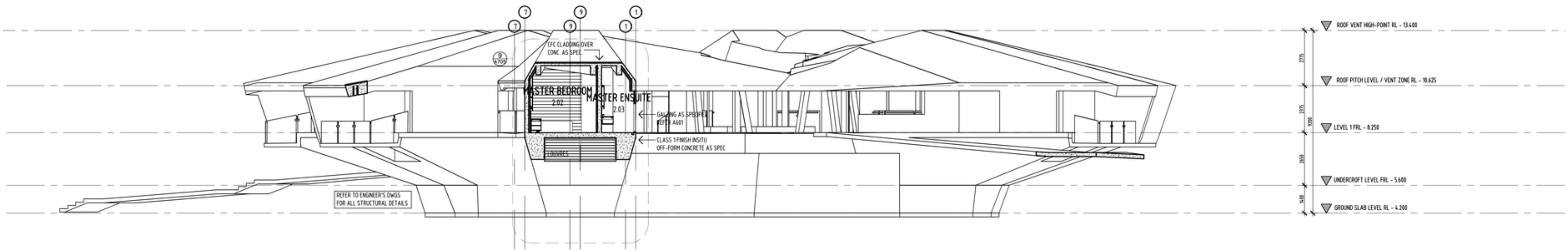
"Stamp House / Charles Wright Architects" 25 Feb 2013. ArchDaily. Accessed 25 Feb 2013. <http://www.archdaily.com/335695>



Stamp House

Sections Group 3

"Stamp House / Charles Wright Architects" 25 Feb 2013. ArchDaily. Accessed 25 Feb 2013. <http://www.archdaily.com/335695>



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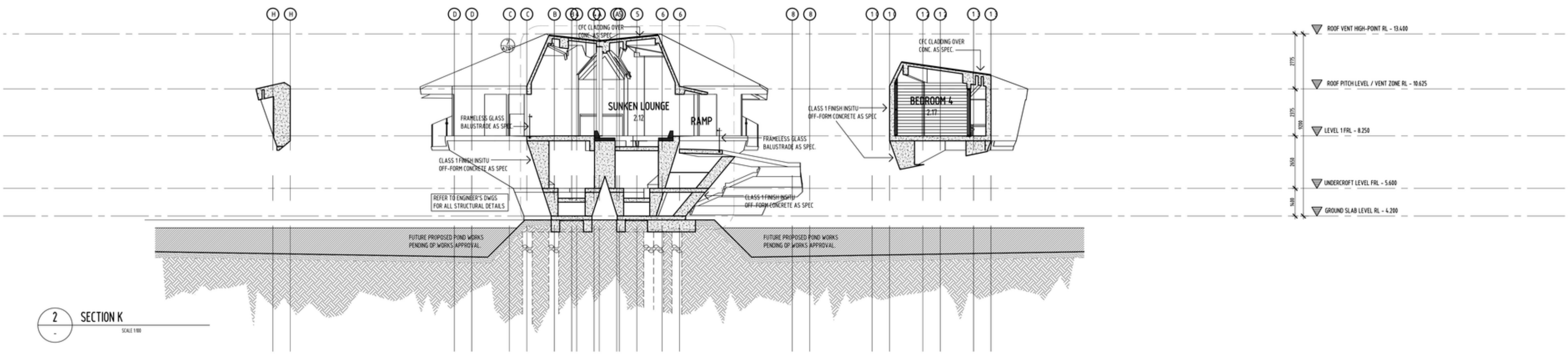


2 SECTION K

Stamp House

Sections Group 4

"Stamp House / Charles Wright Architects" 25 Feb 2013. ArchDaily. Accessed 25 Feb 2013. <http://www.archdaily.com/335695>


charles wright architects pty ltd
Architecture Interiors Urban Design Sustainable Design
PROJECTS
PROFILE
PUBLICATIONS
SERVICES
CONTACTS
Stamp House, Cape Tribulation QLD
(Under Construction)

Student team structural presentations

Take 15 minutes to prepare the following slides:

Team slides:

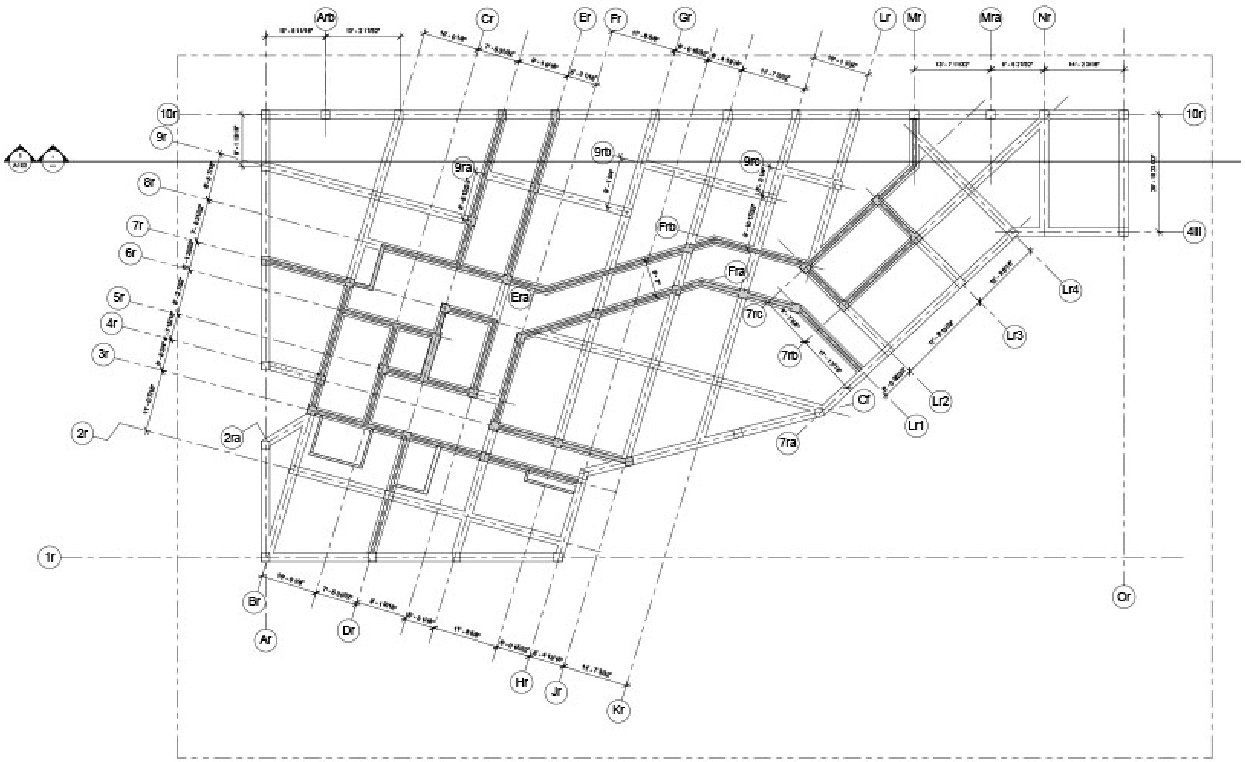
1. Overall three-dimensional image of the structure
2. North South section
3. East and West section
4. North and West elevations
5. South and East elevations

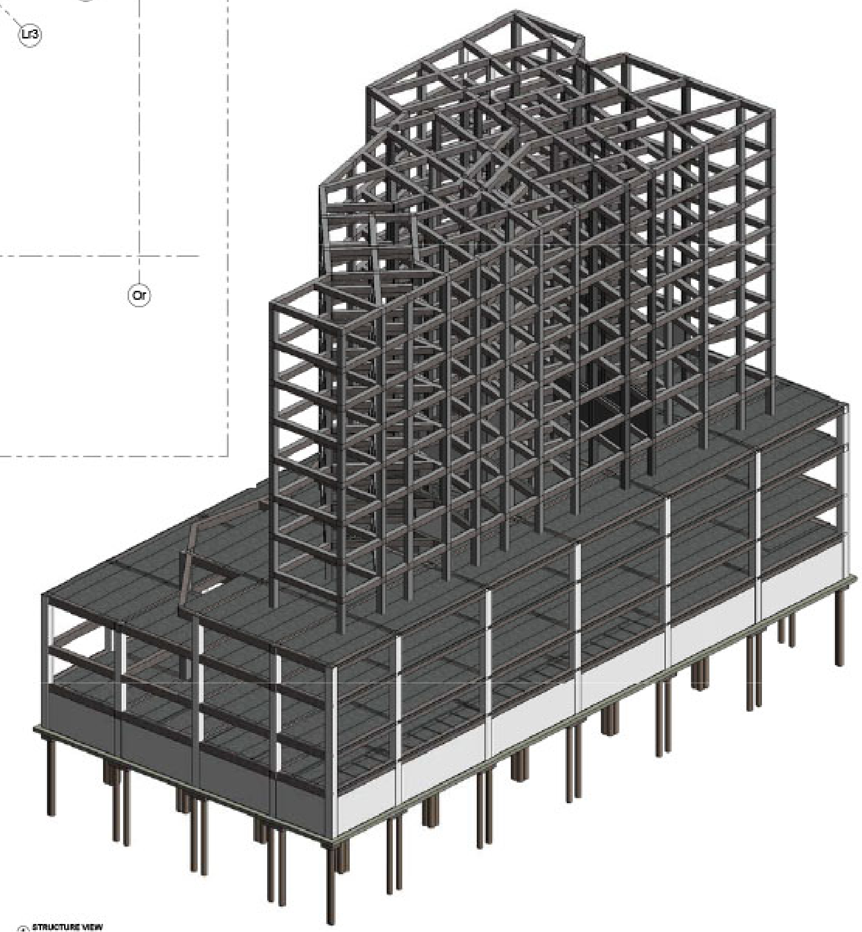
Individual team member slides:

1. Two overall three-dimensional image of the structure
2. Detail slide showing the rebar in connections
3. Structural plan showing column lines and their spacing
4. North South and East and West section
5. Detail slide showing the rebar in connections
6. [Optional] An elevation of all cardinal (North, South, East, and West) directions

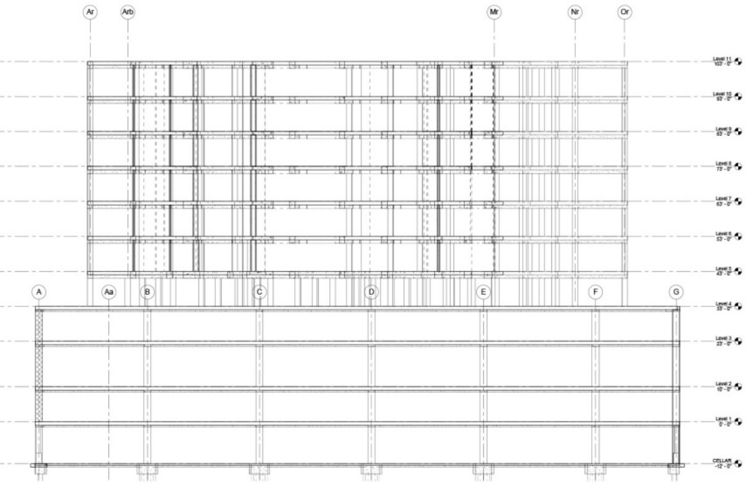
Be prepare to show your work and discuss your project and how you use the concrete system you researched.

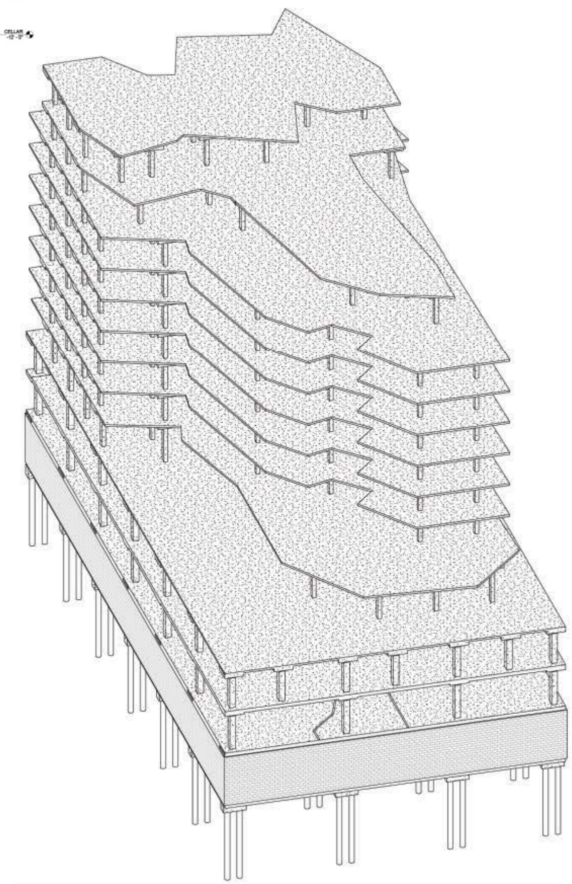
Student team structural presentations

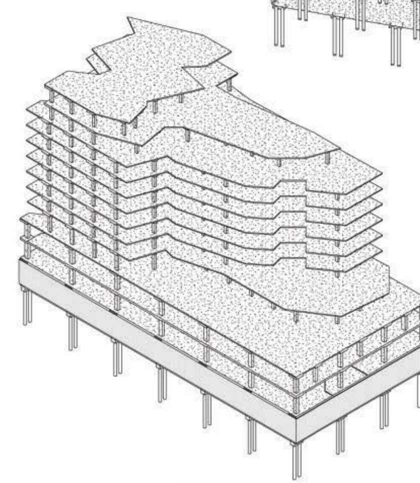


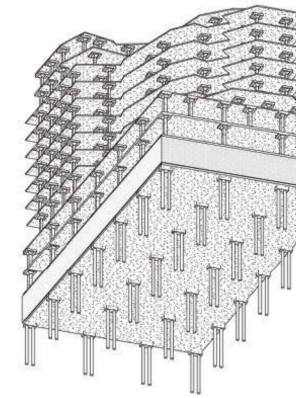


Student team structural presentations









Concrete Formulas

Supplementary Cementitious Materials

http://www.homeimprovementpages.com.au/connect/charleswrightarchitects/service/29540

CONCRETE: Components

- CEMENT

- AGGREGATES :
  - COURSE: CRUSHED STONE
  - FINE: SAND

- WATER

- (ADMIXTURES AS REQUIRED)

courtesy of PROF. S. VAIDYA

CONCRETE: Aggregates + Water

- Mixtures of concrete by volume:
- 60 -80% aggregates (gravel, sand, or crushed stone)*
- 15-20% portable water
- 10-15% Portland cement
- 2-8% air

*aggregates are divided into two distinct categories -fine and –coarse (typical ratio of 1 fine to 2 coarse)

CONCRETE: Admixtures

*Other ingredients are added to concrete to change its characteristics they are known as "**Admixtures**"*

- **Air-entraining**:

To increase workability of wet concrete

To reduce freeze-thaw damage

To make lightweight (non-structural) concrete

To add to its thermal qualities

- **Water-reducing admixtures**

- **Superplasticizers**:

To transform stiff concrete into a smooth flowing mixture without reducing its strength.

CONCRETE: Admixtures

Three the most common admixtures and their effects

- **Blast Furnace Slag**

(byproduct of steel production- hydraulic cement = reacts with water)

Increases strength
Decreases permeability
Increases workability
Reduces temperature rise

- **Fly ash** (residue from burning coal= $SiO_2 + CaO$)

Increases strength
Decreases permeability
Increases workability
Reduces shrinkage

- **Silica fume: fine powder**

(*from production of semiconductor chip manufacturing*)

Increases strength and decreases permeability

Slag Processing

Next, the iron and slag are separated as they exit the furnace.

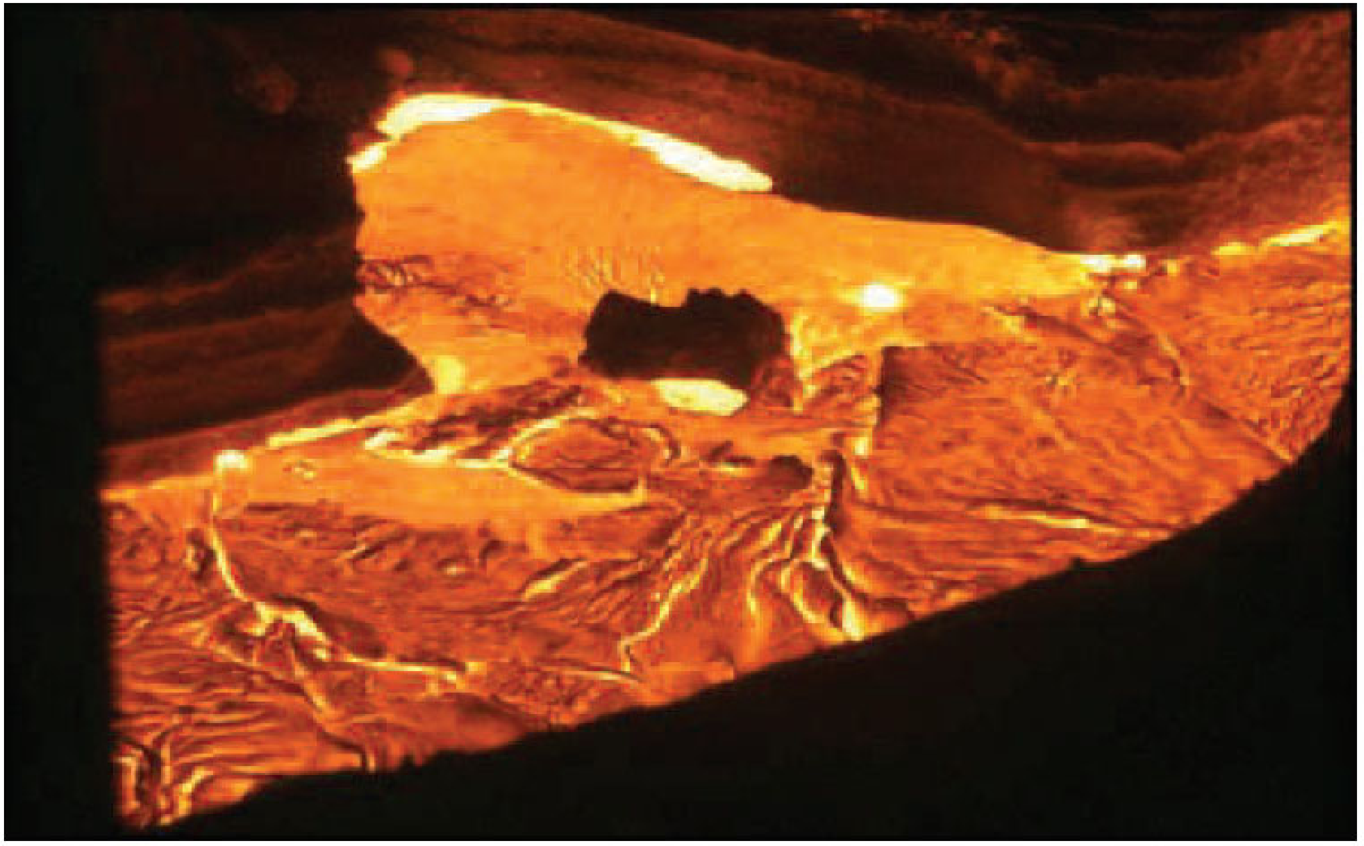


Image courtesy Slag Cement Association

Slag Processing

There are a number of ways blast-furnace slag can be processed.

If the slag is allowed to cool slowly, crystallization will occur; the resulting “air-cooled” slag has little or no cementitious potential, but is sometimes used as an aggregate.

In the case of slag cement, molten slag is rapidly cooled with large quantities of water (roughly 10:1 ratio) to form granules. This rapid cooling stops crystallization and vitrifies the slag. The granules have the appearance of coarse sand at this point, as shown in the lower image.

Images courtesy Slag Cement Association

Blast Furnace Slag

ASTM C 989

Slag cement is classified by grades using the Slag Activity Index, or SAI.

SAI is tested using standard mortar cubes, one made from 100% reference portland cement and one from a blend of 50% portland cement and 50% slag cement.

Using similar ages, the strength of the slag/portland blend is compared to the strength of the straight portland cement mix, and the ratio of the strengths compared. Note that the strength of the slag/portland mix must achieve the stated percentages to be classified a particular grade. The grade of slag does not necessarily predict job performance, as project materials and mixture proportions will influence actual performance.

http://www.holcim.us/

ASTM C 989 Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete (classified by Slag Activity Index with a reference Portland Cement)

- Grade 80 (SAI @ 28 days = 75%)
- Grade 100 (SAI @ 7 days = 75% and 28 days = 95%)
- Grade 120 (SAI @ 7 days = 95% and 28 days = 115%)

J. Miles Carey/Knoxville News Sentinel, via Associated Press

Fifteen homes like this one in Harriman, Tenn., were flooded with fly ash sludge on Monday after a storage pond wall broke

Published: December 24, 2008
(http://www.nytimes.com/2008/12/25/us/25sludge.html?pagewanted=all)

Fly ash

Fly ash is the result of the combustion of coal in coal-fired power plants.

Briefly explained, coal is pulverized prior to entering the furnace. Next, the combustion heats the boiler, generating steam that drives the turbines.

The ash from the combustion is pulled from the exhaust gasses in electrostatic precipitators, or mechanically in baghouses (filter collectors). To assure compliance with specifications, the ash is tested at prescribed intervals. The ash is usually ready for use without further processing.

http://www.projectsmonitor.com/OPED/cement-industry-needs-policy-on-fly-ash

http://www.holcim.us/

Fly ash

Fly ash is considered part of a group of materials known as pozzolans and is a widely used material in concrete.

Fly ash is classified by ASTM C 618. Note that in addition to fly ash, C 618 also classifies materials known as natural pozzolans (Class N), such as volcanic ash, but our focus here is on fly ash.

ASTM C 618 denotes two classes of fly ash: Class C and Class F. The class is determined by the chemical composition of the fly ash, based on the sum of the oxides of silica, alumina, and iron.

The sum of these oxides must be at least 50% of total mass of the ash for Class C and at least 70% for Class F ash.

http://www.holcim.us/

Fly ash

ASTM C 618
ASTM C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete

- Class F (SiO_2+Al_2O_3+Fe_2O_3 = 70.0, LOI = 6% max.) Often, but not exclusively, comes from the burning of bituminous coal and often has a calcium oxide content of less than 10%. Loss On Ignition, or LOI, is an indicator of the amount of unburned carbon left in the ash. It can affect some chemical admixtures in concrete.

- Class C (SiO_2+Al_2O_3+Fe_2O_3 = 50.0, LOI = 6% max.) Most often comes from the burning of sub-bituminous and lignite coal and may have a calcium oxide content above 20%.

- Class N (SiO_2+Al_2O_3+Fe_2O_3 = 70.0, LOI = 10% max.)

Natural materials like volcanic ash, diatomaceous earth, and metakaolin. Note that the class of fly ash does not strictly depend on the rank or type of coal.

http://www.holcim.us/

Fly ash

Appearance Variation

As indicated in the image below, the appearance of fly ash from different sources may vary.

Class C Class F

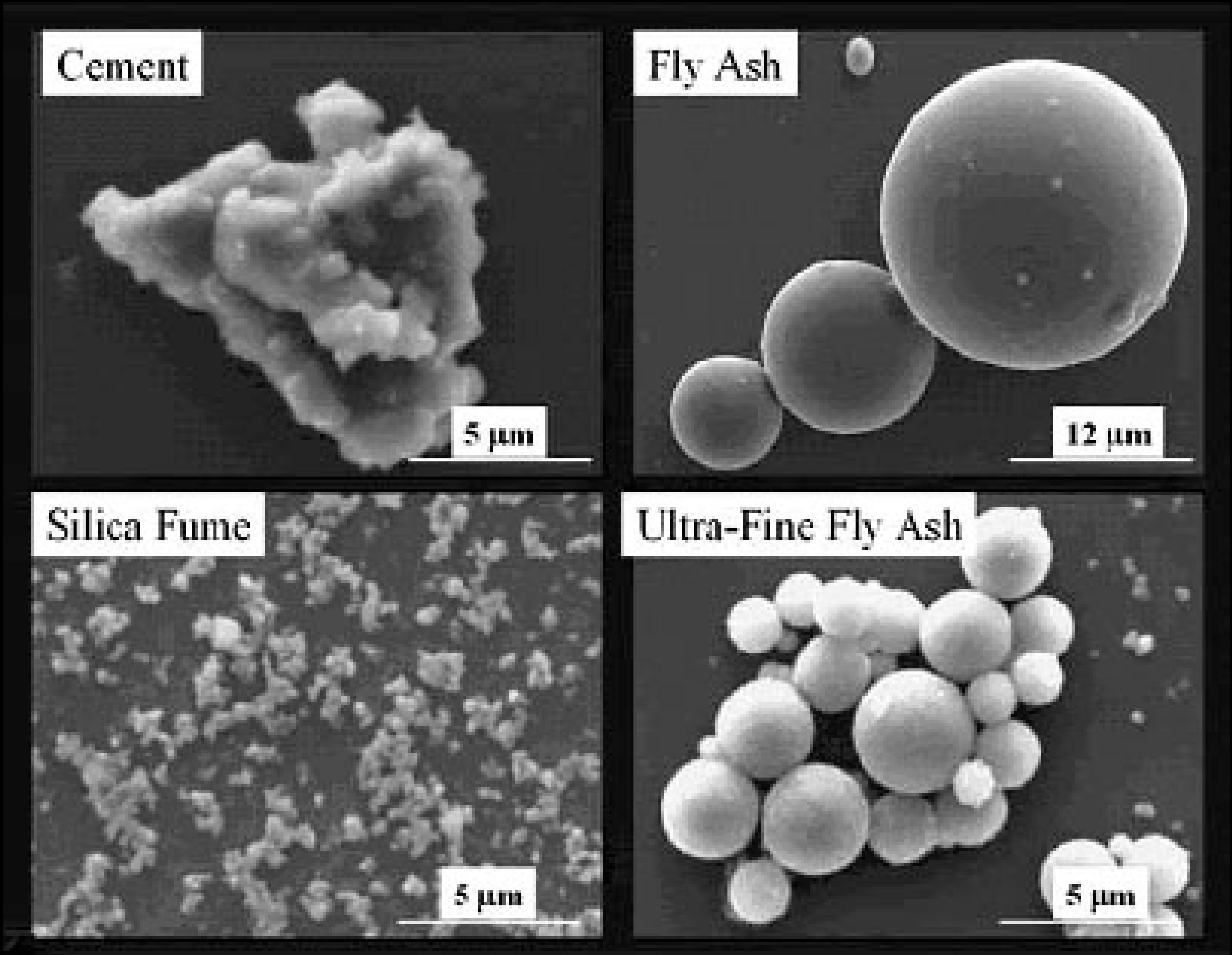
http://www.holcim.us/

Silica fume

Silica fume is a by-product of the silicon alloy manufacturing process. Coal, quartz, and wood chips are combined and processed in a smelting furnace to produce the alloys.

http://www.holcim.us/

Silica fume



http://www.fhwa.dot.gov/pavement/pccp/pubs/04150/chapt11.cfm

Silica fume

Properties of Silica Fume

The by-product from the process, silica fume, is contained and collected in filters.

Silica fume particles are extremely fine, roughly 100 times smaller than average size cement particles.

Concrete containing silica fume can have very high strength and can be very durable.

ASTM C 1240, Standard Specification for Use of Silica Fume as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout is the standard that contains the requirements for silica fume used in concrete.

http://www.holcim.us/

CONCRETE: Admixtures

TABLE 2.4

COMPARISON OF CHEMICAL AND PHYSICAL CHARACTERISTICS — PORTLAND CEMENT. FLY ASH. SLAG CEMENT. AND SILICA FUME

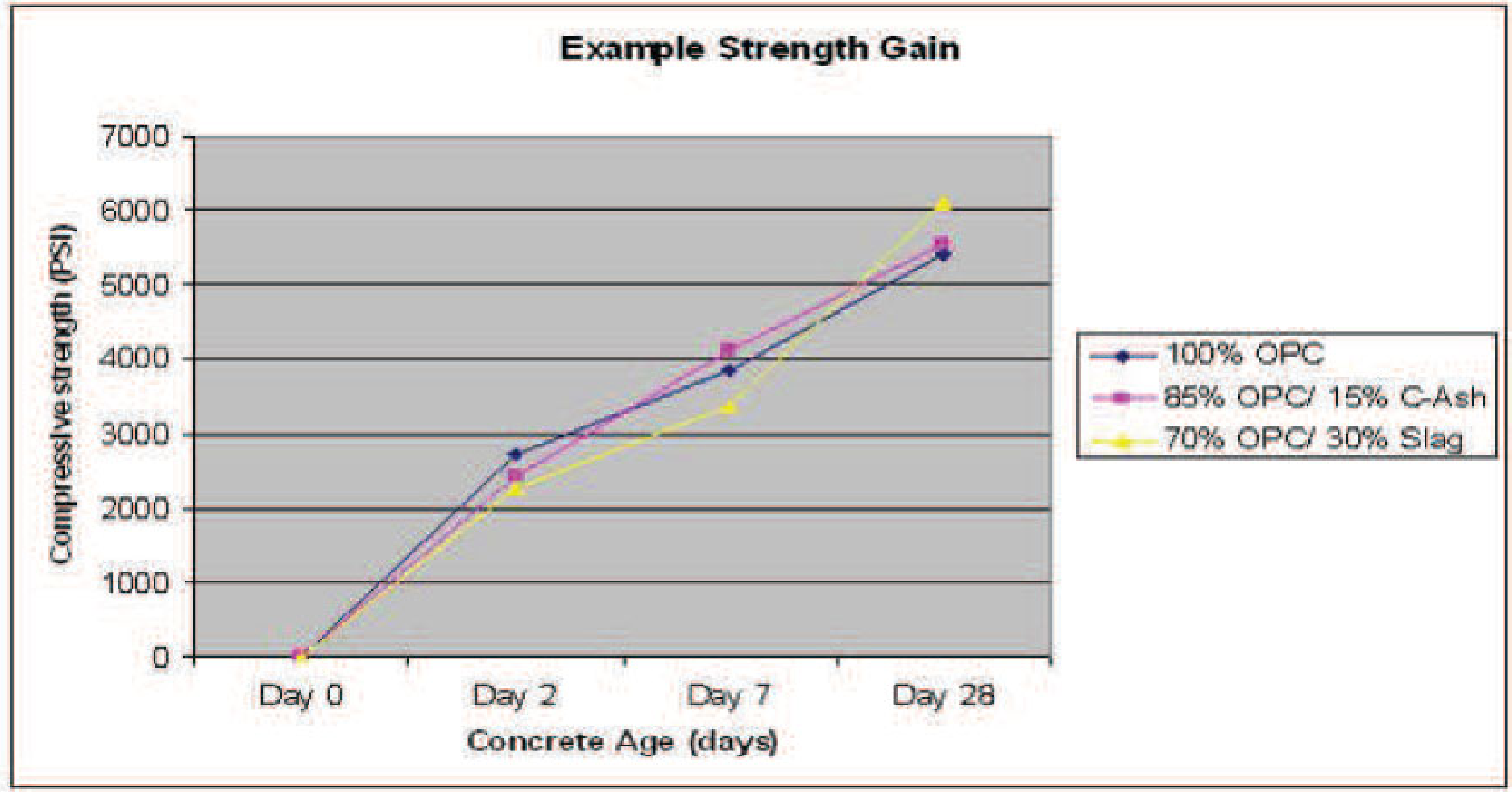
Note that these are approximate values. Values for a specific material may vary from what is shown. (Note 1)

PROPERTY	PORTLAND CEMENT	CLASS F FLY ASH	CLASS C FLY ASH	SLAG CEMENT	SILICA FUME
SiO_2 content, %	21	52	35	35	85 to 97
$Al2O_3$ content ,%	5	23	18	12	
Fe_2O_3 content ,%	3	11	6	1	
CaO content ,%	62	5	21	40	< 1
Fineness as surface area, m^2/kg *(Note 2)*	370	420	420	400	15,000 to 30,000
Specific gravity	3.15	2.38	2.65	2.94	2.22
General use in concrete	Primary binder	Cement replacement	Cement replacement	Cement replacement	Property enhancer

Note 1. Information from SFA and Kosmatka, Kerkoff, and Panarese (2002).
Note 2. Surface area measurements for silica fume by nitrogen adsorption method. Others by air permeability method (Blaine).

http://upload.wikimedia.org/wikipedia/en/2/25/Comparison_of_Chemical_and_Physical_Characteristics_Portland_Cement_-_Fly_Ash%2C_Slag_Cement%2C_and_Silica_Fume.jpg

Compressive Strength

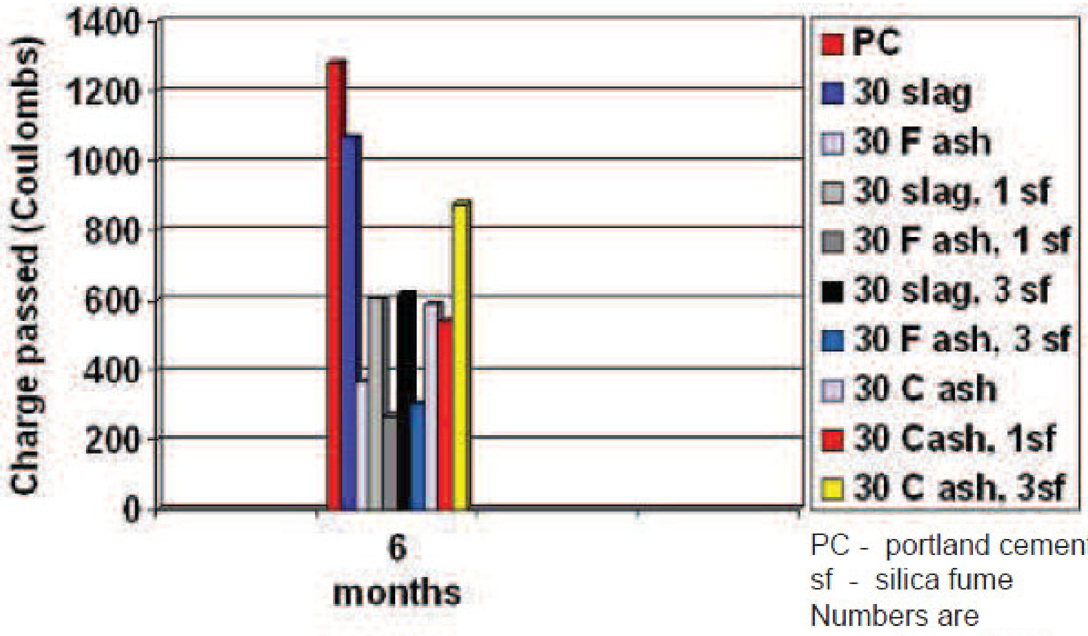


This chart is an example of how SCMs may react in concrete with respect to strength gain. Depending on the mixture proportions and materials, early strength is sometimes lower in concrete with SCMs than a control mix of 100 percent portland cement (OPC). As the concrete matures, the concrete with SCMs shows some increase in strength over the control mix. Individual mixes and materials may vary.

Information from Holcim (US) Internal testing, 520 Lb cementitious/ cu. yd, w/ cm= 0.48

Rapid Chloride Permeability

The Rapid Chloride Permeability test is based on electrical conductivity. Note that denser, less permeable concrete allows less charge to pass across the test specimen in a given time frame. Other factors can have an influence, including W/CM (Water-Cementitious Material Ratio), age of concrete, and mixture proportions. The test can provide comparisons for various mix combinations.

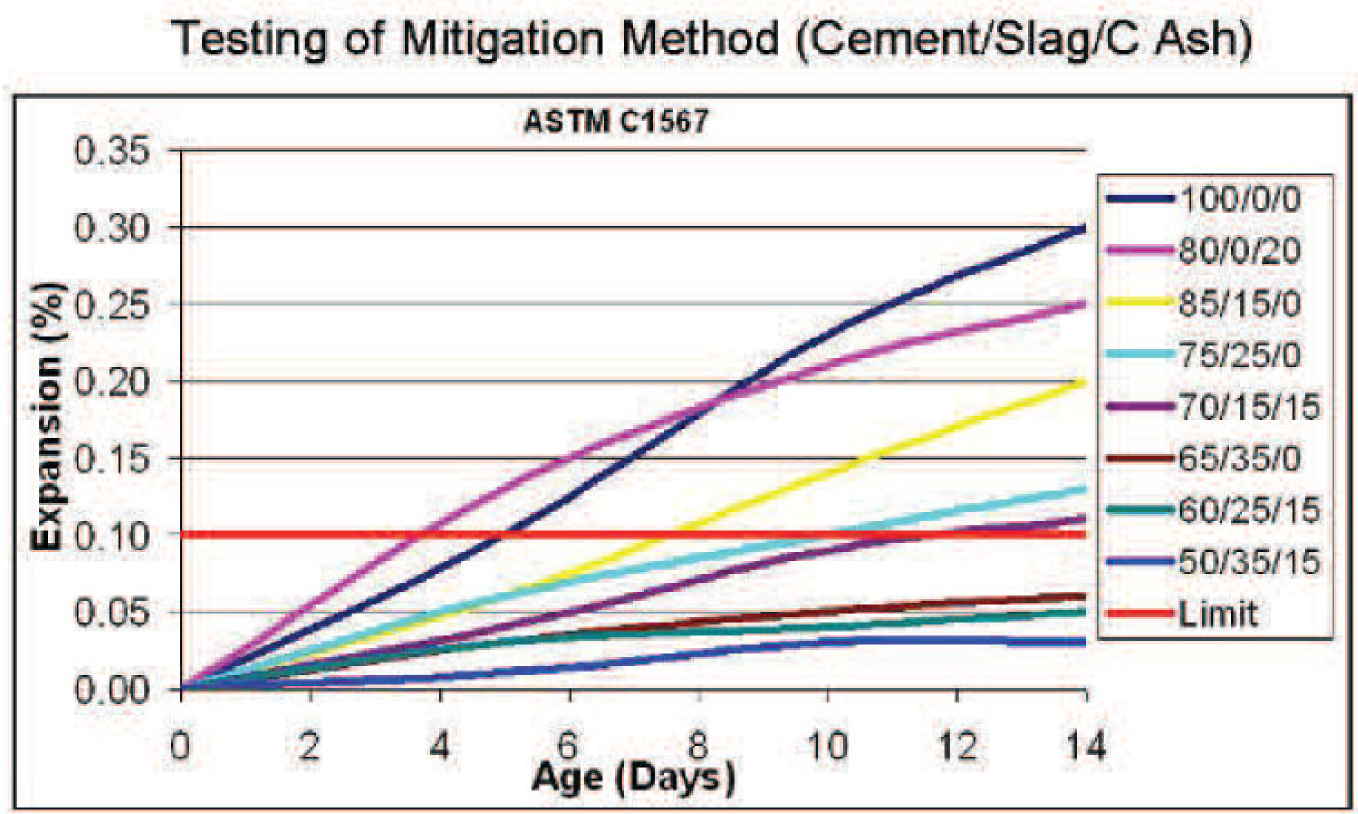


PC - portland cement
sf - silica fume
Numbers are percentage of total cementitious content

Source- Minnesota Concrete Council, Concrete Durability Research- MCC.org

Alkali-Silica Reaction

When using SCMs to mitigate ASR, the amounts used must be sufficient to control the reaction. Long-term durability is the goal.



Source: Holcim (US); Michigan Concrete Paving Association Workshop, 2009

CONCRETE: Admixtures

- **Retarding admixtures**

  To slow curing time (more time to work the concrete)

- **Accelerating admixtures**

  To cure the concrete more rapidly

- **Corrosion inhibiters**

  To reduce rusting of reinforcing steel (exposed to road salts)

- **Freeze protection admixtures**

  Allows concrete to cure at temperatures as low as 20deg F.

- **Coloring agents**

  Dyes and pigment to change the color of concrete.

CONCRETE: Admixtures

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CONCRETE: Admixtures
-Optic Fibers

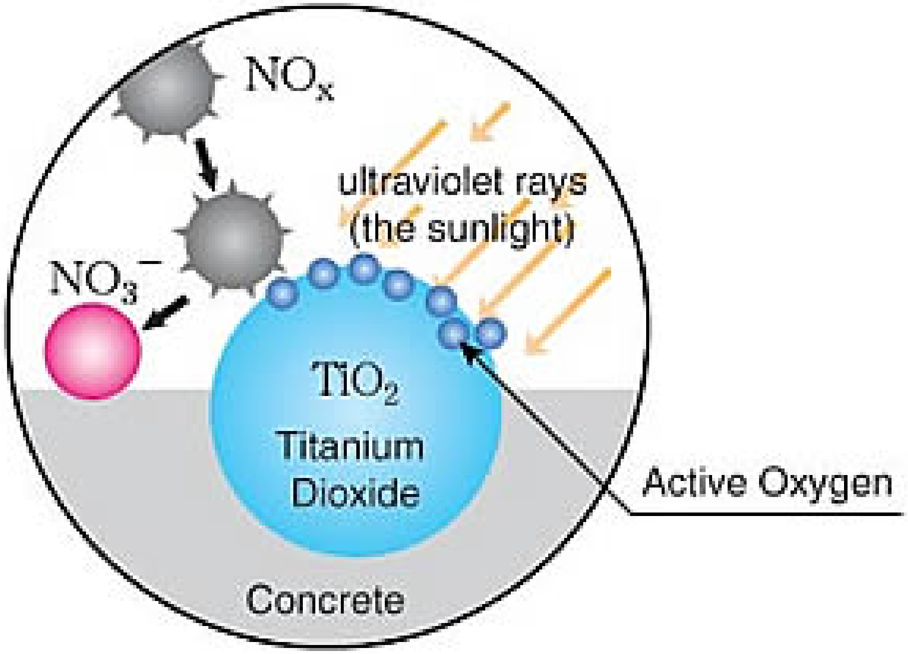
courtesy of PROF. S. VAIDYA

CONCRETE: **Admixtures** -Optic Fibers

courtesy of PROF. S. VAIDYA

CONCRETE: Photocatalytic

Self Cleaning Concrete: photocatalysts decompose organic materials on the surface. Dirt (soot, grime, oil and particulates) biological organisms (mold, algae, bacteria and allergens), air-borne pollutants (VOCs including formaldehyde and benzene; tobacco smoke; and the nitrous oxides (NOx) and sulfuric oxides (SOx) that are significant factors in smog), and even the chemicals that cause odors.



Catalyzed compounds break down into **oxygen, carbon dioxide, water, sulfate, nitrate** and other molecules that are either beneficial to or at have a relatively benign impact on the environment. Inorganic pollutants and stains, including rust, are not catalyzed.
The products of the catalytic reaction are easy to remove from the treated surface because the surface becomes **hydrophilic** — a term that means “water loving.” A hydrophilic surface prevents moisture from forming beads of water that may cause stains by attracting and holding dirt and then streaking the surface. Instead, moisture forms a thin film across a surface that interferes with the adhesion of dirt.
Rain or simple rinsing can then easily remove the dirt. – Concrete Décor 2005

http://www.concretedecor.net/All_Access/504/CD504_New_Tech2.cfm

CONCRETE: Photocatalytic

Jubiliee Church
Richard Meier
Rome, Italy 2003

courtesy of PROF. S. VAIDYA

CONCRETE: Photocatalytic

Jubiliee Church
Richard Meier
Rome, Italy 2003

courtesy of PROF. S. VAIDYA

CONCRETE: References

Exhibit at the National Building Museum: **Liquid Stone**

http://www.nationalbuildingmuseum.net/liquid_stone/#

http://www.holcim.us/

http://www.aggregateresearch.com/

http://www.concrete.org/general/home.asp

http://www.nrmca.org/

http://www.slagcement.org/

http://www.concrete.com/

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Stamp House

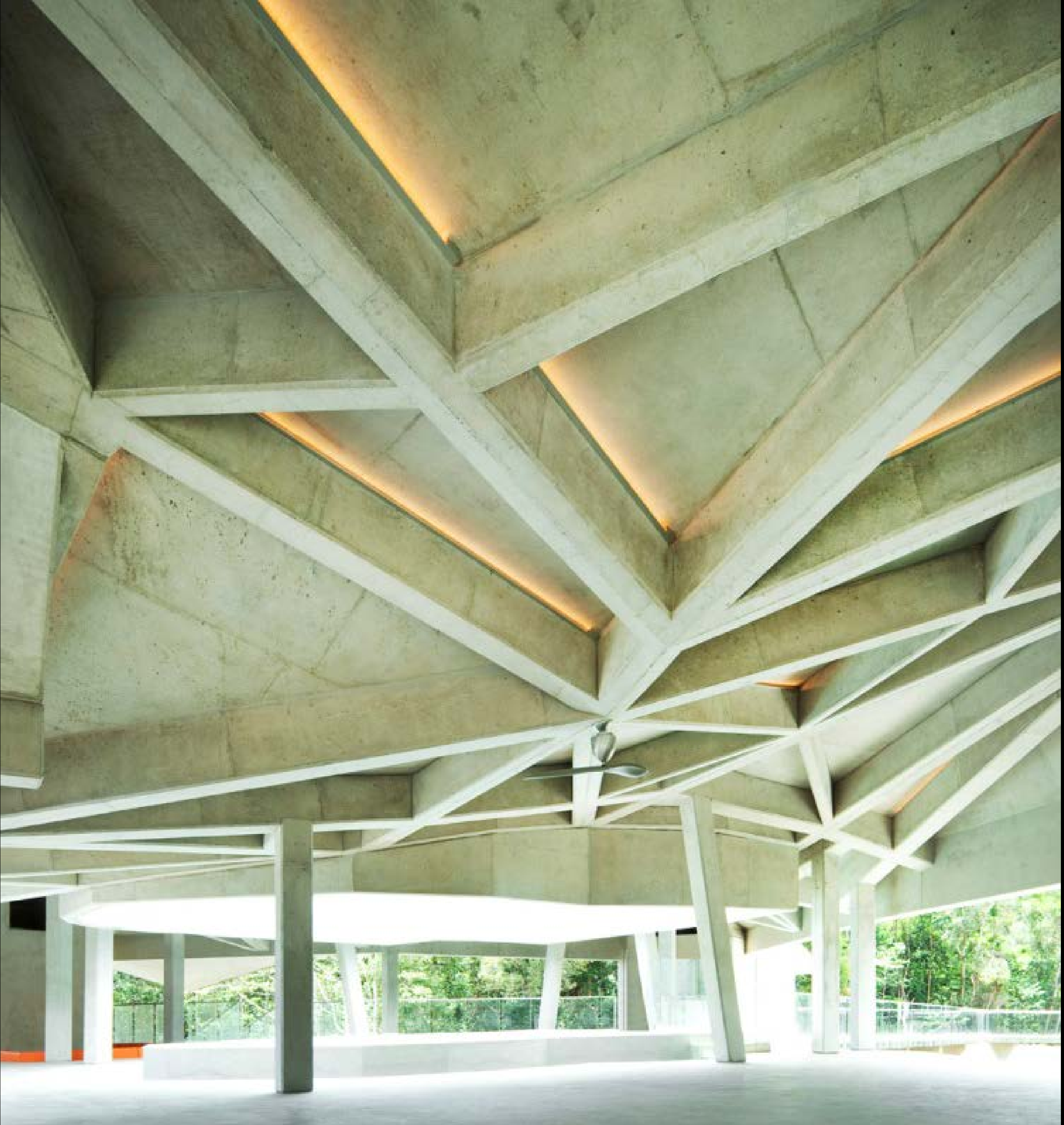
Concrete formula selection

Decide on a concrete formula with additive for your building. Write at least three paragraph reason why you're using the system. Add at least one supporting chart, illustration or diagram (excluding the diagrams in this PowerPoint) to support your decision.

Complete this assignment in class. Once you have created the paragraph descriptions to information to your structural sheets in the form of notes on your project. Attached the researched supporting documents be sure to footnote their sources.

Suggestion: divide the work by having one teammate writing one paragraph and remaining teammate to search for supporting documents.

Recommended paragraph topics
1. Which system you are using and what are its advantages.
2. What are the disadvantages of your system and how are you avoiding them.
3. In what way is system particularly appropriate to your building?



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