BUILDING INNOVATION
Conference

PRECAST PROTECTS LIFE
Healthy Buildings

Jim Schneider, LEED AP

Executive Director, PCI Mountain States

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Speaker:
Jim Schneider, LEED AP

- Executive Director of the PCI Mountain States chapter, which covers Colorado, Idaho, Montana, Utah, and Wyoming.
- Has worked with architects, engineers and building professionals for nearly two decades.
- Previously the editor of several business publications, including *Eco-Structure*, Ascent, *Plumbing Engineer*, *PHC News*, and *Metalmag*.
- A regular contributor to several national and regional industry publications, including *Retrofit*, *Smart Buildings Technology*, *Retrofit Home*, *Ascent* and *Colorado Design & Construction*.
- Father of two, author, passionate about efficient, sustainable design, and thinks concrete is cool, even if my kids don't always believe it.


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Learning Objectives

1

Learn

Attendees will learn about attributes, benefits and considerations of using precast concrete in the holistic design of healthy buildings.

2

Understand

Participants will understand what a healthy building is, as well as related programs and definitions to measure them.

3

Discover

Attendees will discover ways that precast contributes to indoor environmental quality, fire/life safety, acoustics, daylighting and more.

4

Share

Case studies will highlight healthy buildings that utilized precast to accomplish their goals.

What is a “Healthy Building?”

“With humans spending 90 percent of our time indoors, our individual health is directly tied to the health of our buildings. Healthy Buildings are at the nexus of global health and sustainable development goals, operating across four pillars of health – Indoor Health, Resource Health, Economic Health, Environmental Health – and underpinned by Public Health.”

-- Harvard T.H. Chan School of Public Health

What is a “Healthy Building?”

Indoor Health

The World Health Organization estimates that 25 percent of all diseases globally are attributable to the environment, resulting in more than 12 million deaths annually. Reducing the number of deaths and illnesses from hazardous chemicals is particularly important in interior spaces where humans spend approximately 90 percent of their time.

What is a “Healthy Building?”

Resource Health

Buildings are the largest, most resource intensive product on the planet, and as such the construction of new buildings come at the expense of our natural systems. The land needed for our cities, the materials and water needed for our buildings, and the waste generated by our buildings are putting a strain on global resource health. Green building strategies, net-zero approaches, and green chemistry principles hold promise to minimize the adverse impact of buildings on our natural systems and resources.

What is a “Healthy Building?”

Economic Health

Green building principles and ideologies minimize environmental impact, support construction jobs, higher property values and conditions for higher worker productivity. For owners and developers, green buildings result in 3 percent higher rent premiums and 7 percent higher cash flow as well as higher occupancy rates and transactional prices. For tenants, employees in green buildings regularly report greater indoor air quality and fewer “sick building symptoms” in green buildings.

What is a “Healthy Building?”

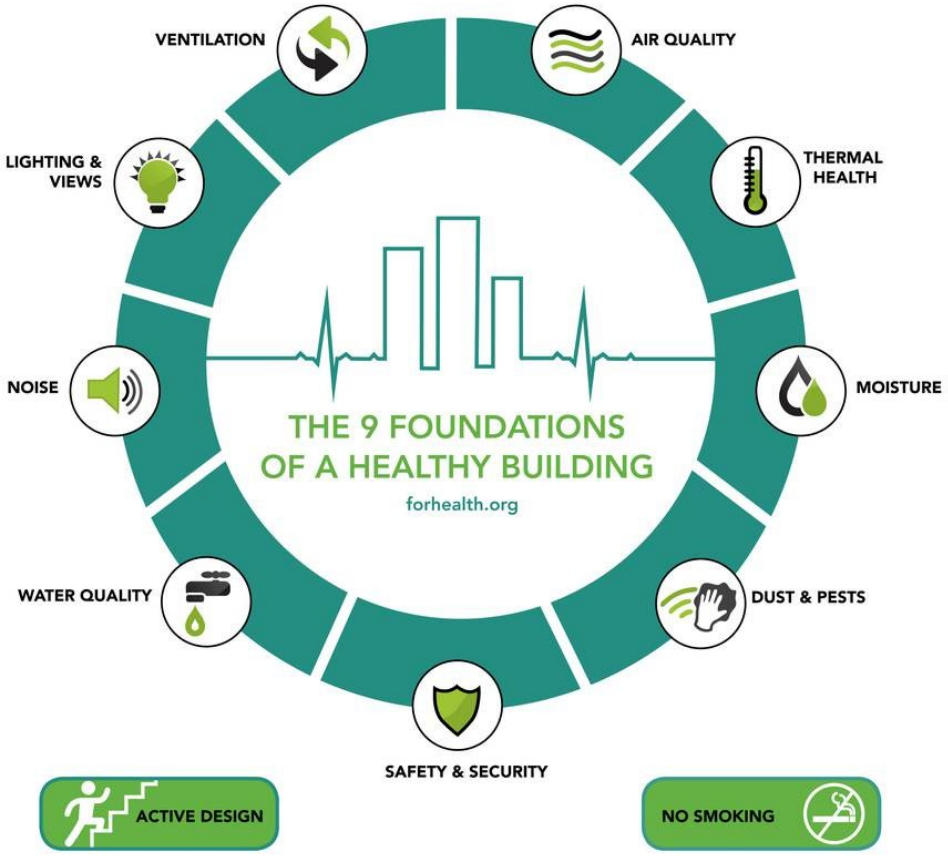
Environmental Health

Buildings are responsible for 30 percent of global greenhouse gas emissions that warm the planet. One of the biggest opportunities to improve environmental health needs to come from the building sector. Energy use intensity of green buildings is typically 20-40 percent lower than a typically constructed building. Reducing energy consumption results in fewer health harmful air pollutants emitted to the atmosphere.

What is a “Healthy Building?”

Allen and Ari Bernstein of the Harvard T.H. Chan School of Public Health published The 9 Foundations of a Healthy Building:

1. Ventilation
2. Air quality
3. Thermal health
4. Moisture
5. Dust and pests
6. Safety and security
7. Water quality
8. Noise
9. Lighting and Views



What is a “Healthy Building?”

Precast concrete can have a positive impact on many of the 9 Foundations of a Healthy Building:

1. Ventilation
2. Air quality
3. Thermal health
4. Moisture
5. Dust and pests
6. Safety and security
7. Water quality
8. Noise
9. Lighting and views

Advantages to Healthy Buildings

- Provide safety and wellbeing to occupants and users.
- Create a comfortable environment for those inside.
- Encourage greater productivity, focus and engagement.
- People are much more willing to spend time in spaces they feel are healthy, safe and comfortable.

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Precast Concrete is Healthy

- Contributes to good indoor air quality.
- Enables thermal efficiency and comfort.
- Excellent sound attenuation properties
- Flexibility aids daylighting design.
- Passive fire resistance
- Protection from multi-hazards, such as storms, earthquakes, fires, etc.

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Measuring Healthy Buildings

WELL Building Standard

One of the most widely recognized healthy building frameworks is the WELL Building Standard.

Launched in 2014 by the International WELL Building Institute.

WELL Building Standard

Grounded in medical research that explores the connection between buildings and occupant health.

It is performance-based system for measuring, certifying, and monitoring features of the built environment.

Examines impacts to human health and well-being, through air, water, nourishment, light, fitness, comfort and mind.

Fitwel

Originally created by the U.S. Centers for Disease Control (CDC) and Prevention and U.S. General Services Administration.

CDC remains involved, but the Center for Active Design was selected as the licensed operator of Fitwel.

Fitwel was developed by experts in public health, facility management, and design, and is supported by over 7,000 research studies.

Fitwel

Main Scorecard Categories of Fitwel Include:

1. Location
2. Building Access
3. Outdoor Spaces
4. Entrances and Ground Floor
5. Stairs
6. Indoor Environment
7. Workspaces
8. Shared Spaces
9. Water Supply
10. Prepared Food Areas
11. Vending Machines and Snack Bars
12. Emergency Preparedness

Other Programs

- **LEED:** USGBC's green building certification program has a credit category dedicated to indoor environmental quality.
- **Living Building Challenge:** One of the seven categories – called "Petals" – of this program is "Health and Happiness."
- **HPD Collaborative:** Health Product Declarations (HPDs) provide a full disclosure of the potential chemicals of concern in products by comparing product ingredients to a set of priority "hazard" lists based on the GreenScreen for Safer Chemicals and additional lists from other government agencies.

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Indoor Environmental Quality

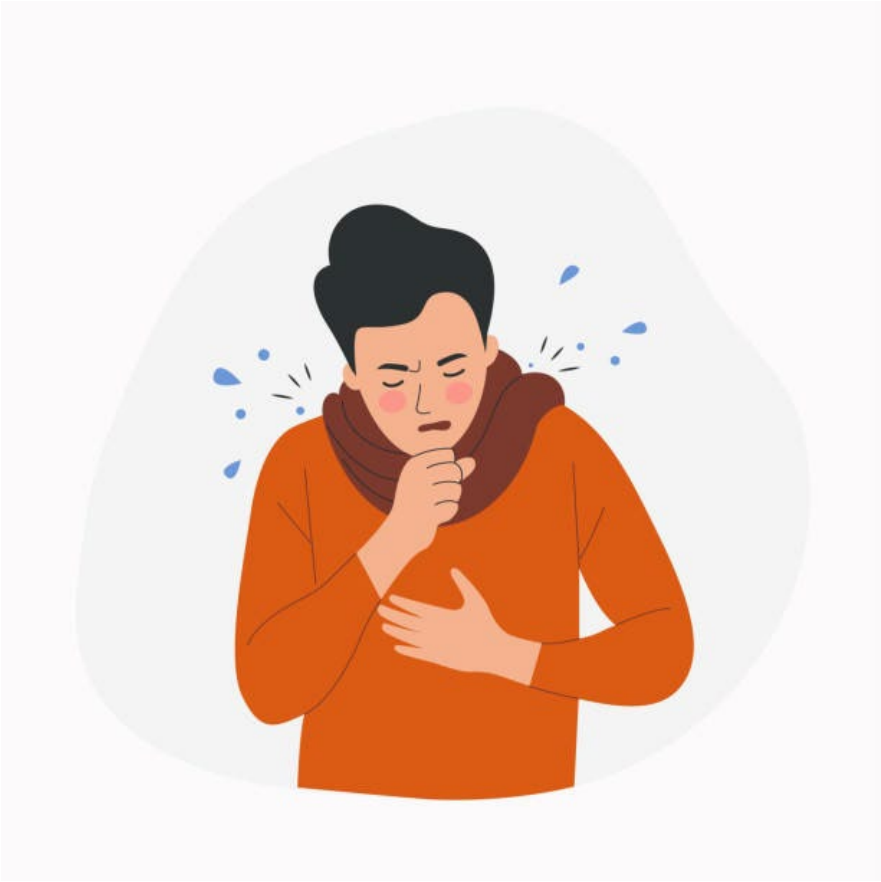
Why is IAQ Important?

"Indoor air quality is a global issue. Both short- and long-term exposure to indoor air pollution can cause a range of health issues, including respiratory diseases, heart disease, cognitive deficits, and cancer. As one prominent example, the World Health Organization estimates 3.8 million people worldwide die every year from illnesses attributable to harmful indoor air."

-- National Institute of Environmental Health Sciences

Why is IAQ Important?

- EPA reports that VOCs often cause eye, nose, and throat irritation, nausea, and can also damage the liver, kidney, and central nervous system.
- These are especially harmful to those with chemical sensitivities.
- It is important to utilize materials that reduce the amount of harmful chemicals in the indoor environment.



Indoor Environmental Quality: Low Emitting Materials

Using precast walls reduces the off gassing often attributed to other materials.

Many finishes do not require painting or coatings

Because precast concrete is inert – it does not require VOC-based preservatives like wood products do.

Indoor Environmental Quality: Low Emitting Materials

Textured interior walls can provide aesthetic alternatives to VOC-emitting paints or wall board.

Concrete is inorganic and doesn’t permit the growth of mold.

Precast is also a vapor barrier, keeping unwanted moisture out.

Moisture Management

Moisture results in mold, damage to interior, etc.

Mold requires a combination of the following conditions:

- Fungal spores settling on the surface
- Oxygen availability
- Optimal temperatures between 40 – 70 °F
- Nutrient available (wood, paper, cellulose based materials)
- Moisture (liquid or relative humidity above 70%)

The first four conditions are met in almost every building.

The key remaining factor is moisture, which may be controlled by adhering to sound construction practices

Moisture Management

- Moisture directly - prevent leaks – maintain flashing, joints, roofing, etc.
- Vapor diffusion - the process by which water vapor migrates through a wall system and it's components such as gypsum, concrete, insulation and paint (molecular level).
- Moisture through exfiltration/infiltration – moisture in the air that is moved through an envelope
- Manage condensation - Moisture vapor turning to a liquid on interior surfaces, due to RH and temperature.

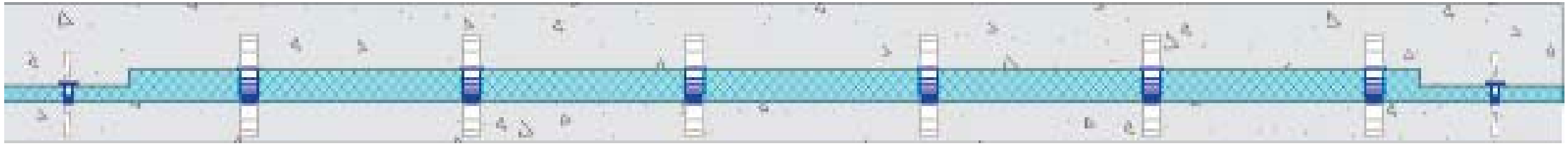
To Control Heat, Air and Moisture:

- Use integral, continuous insulation
- Reduce/eliminate thermal bridging
- Utilize thermal mass and account for it in HVAC design
- Prevent or reduce air infiltration/exfiltration (air barrier)
- Reduce moisture vapor infiltration (vapor retarder/barrier)
- Reduce condensation potential by controlling RH and surface temperatures

Precast Concrete:

- Can include integral insulation
- Can essentially eliminate thermal bridging
- Has thermal mass
- Is an air barrier
- Is a vapor retarder at 3 inches thick

Precast can combine all of these into one efficient system.



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Occupant Comfort

Occupant Comfort

"Indoor environmental conditions (thermal, noise, light, and indoor air quality) may affect workers' comfort, and consequently their health and well-being, as well as their productivity. [A] study aimed to assess the relations between perceived indoor environment and occupants' comfort examined the modifying effects of both personal and building characteristics…. The highest association with occupants' overall comfort was found for noise, followed by air quality, light and thermal satisfaction."

-- *"Perceived Indoor Environment and Occupants' Comfort in European "Modern" Office Buildings: The OFFICAIR Study," from the National Institutes of Health*

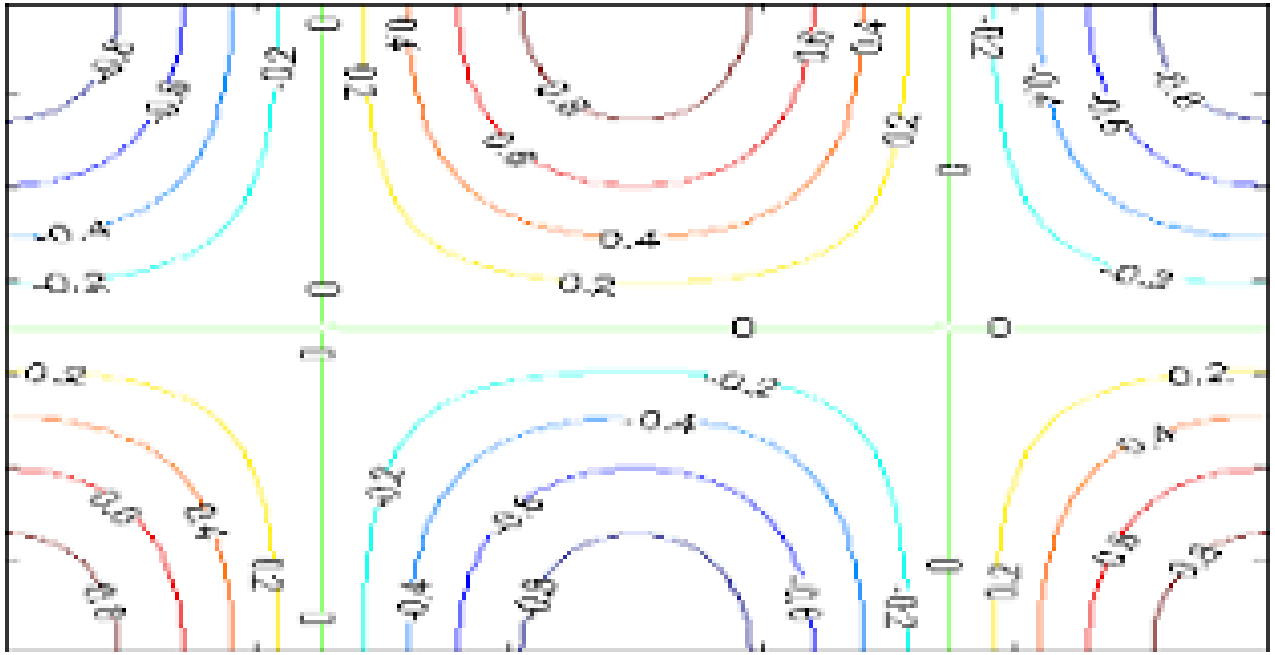
Sound Design

“Unwanted sound that is allowed to enter from outside of a building can be distracting or even harmful to people inside. Sound flowing between rooms or spaces in a building in all directions (i.e. through walls, floors, ceilings, etc.) can create similar negative indoor experiences. Controlling the transfer of unwanted sound between spaces reduces noise, improves the indoor environment, contributes to sustainable design and is ultimately good for the people who use the building.”

-- “Acoustical Control in Buildings”

Sound Design

- Good acoustics are important to overall indoor environmental quality and occupant comfort.
- Our ears are designed to hear sound from one direction, and if we are hit from all sides, it reduces concentration and increases fatigue.



Sound Transmission Class (STC) Ratings

The ability of a barrier to reduce the intensity of airborne sound is designated by its STC rating.

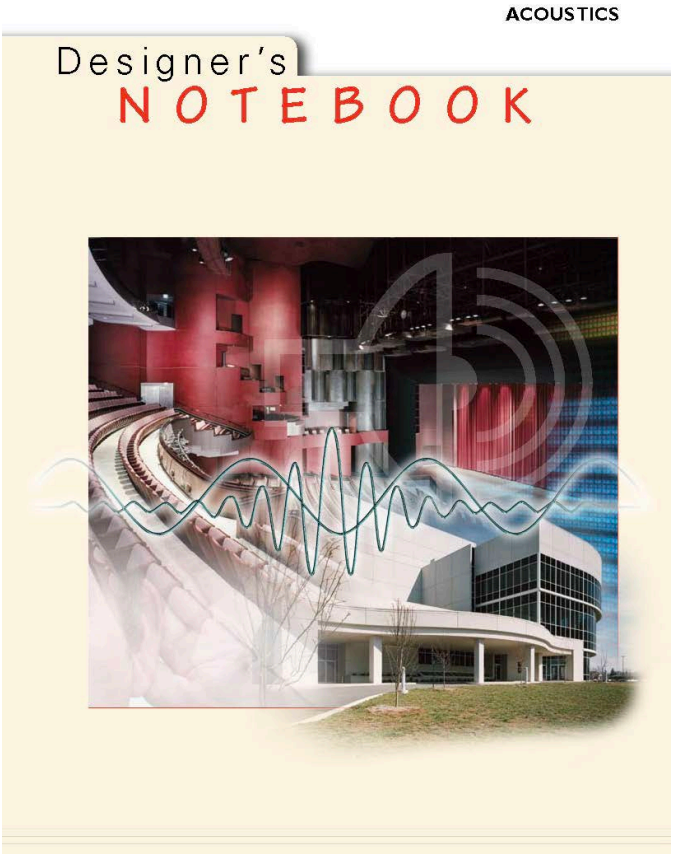
- **25** Normal speech can be understood quite easily and distinctly through wall
- **35** Loud speech audible but not intelligible
- **40** Onset of "privacy"
- **45** Loud speech not audible; 90% of statistical population not annoyed
- **50** Very loud sounds such as musical instruments or a stereo can be faintly heard; 99% of population not annoyed
- **60+** Superior soundproofing; most sounds inaudible

Precast for Sound Attenuation

- The inherent mass of precast concrete makes it an excellent sound barrier, with STC ratings of about 55.
- As the unit weight of a precast concrete wall or floor increases, the STC also increases.
- Precast concrete walls, floors, and roofs typically do not require additional treatments to provide adequate sound insulation.

Precast for Sound Attenuation

- If greater sound insulation is required, it can be obtained by using a resiliently attached layer of gypsum board or other absorptive building material.
- Precast concrete floors in combination with resilient materials can control impact sounds as well.
- One common solution consists of good quality carpeting mounted on resilient padding.



Lighting Design

- Natural light has been shown to be an important element of occupant comfort and health.
- Daylighting creates a visually stimulating and productive environment for occupants in all buildings, without undesirable side effects, such as glare, excess of contrast or reflection.
- Creating optimum daylighting is a combination of material and design.
- Considerations include layout, site orientation, shading, etc.

Precast for Light Comfort

Long spans allow for open areas well suited for daylighting.

Precast concrete floor systems can span large distances with shallow floor plates and column-free spaces to help achieve these credits.

Precast concrete can also be exposed on ceilings to reflect light deep into interior spaces.

Indoor Temperature

Maintaining consistent interior temperature helps facilitate greater concentration, focus and productivity.

Precast can help create energy-efficient, comfortable spaces.

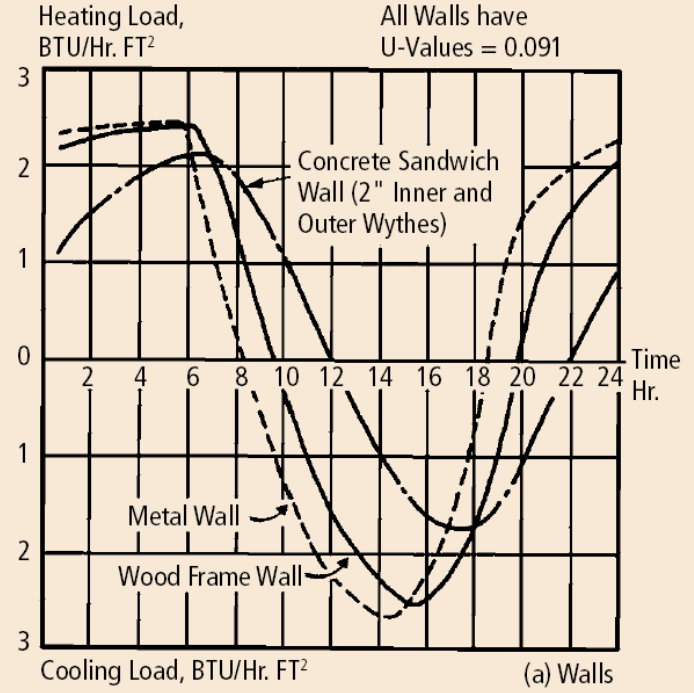
Utilizing thermal mass means buildings need less energy to heat and cool.

Thermal mass also contributes to more consistent and even indoor temperatures.

Thermal Mass

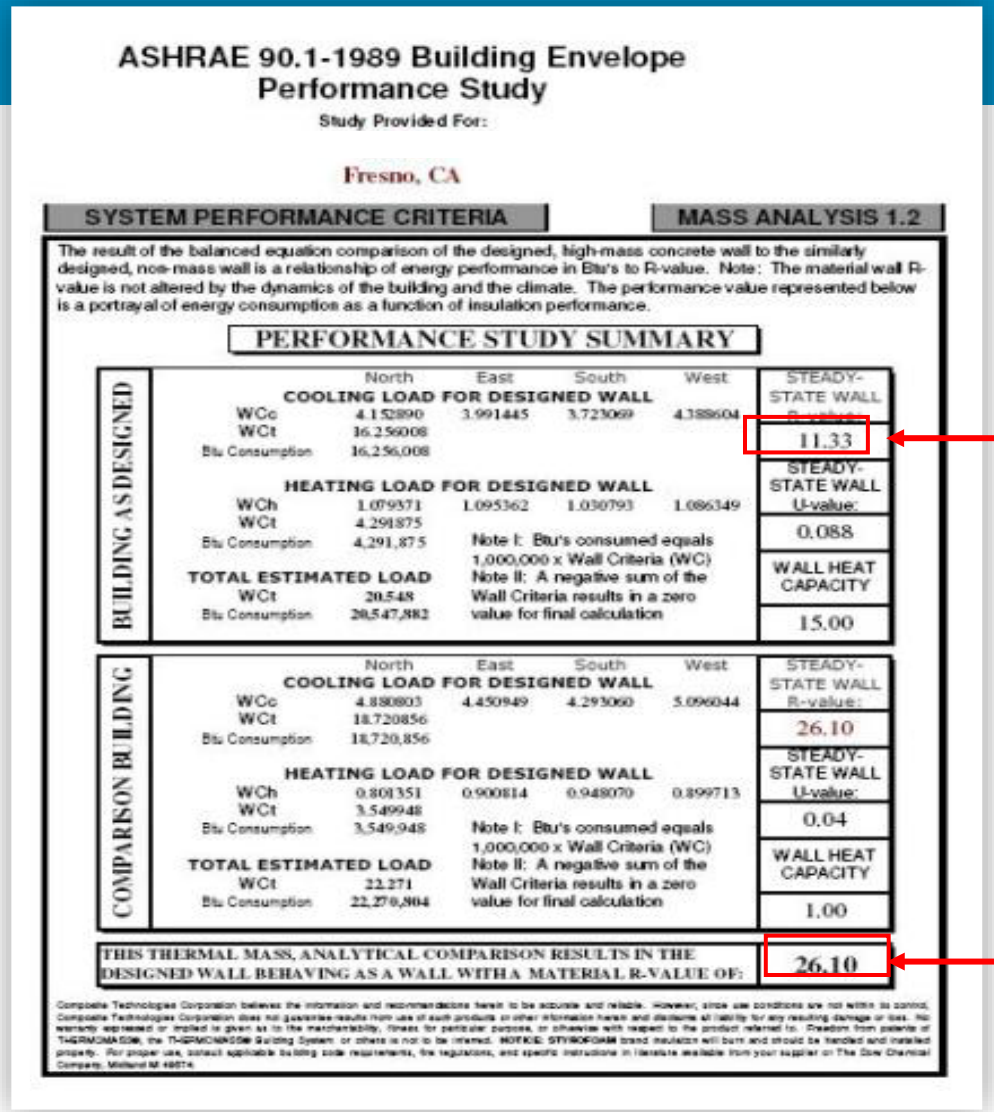
- Absorbs outside and inside heat and slowly releases
- Thermal mass effect delays the onset of peak heating or cooling loads
- Thermal mass effect may reduce peak demand/energy consumption and enable downsized HVAC systems
- Reduces indoor temperature fluctuation to improve occupant comfort
- Thermal mass effect varies by climate

Fig. 5.3.17(a-c) Heating and cooling load comparisons.



Overall Thermal Performance

Thermal Mass improves the overall performance of the envelope



ASHRAE 90.1-1989 Building Envelope Performance Study

Study Provided For:

Fresno, CA

SYSTEM PERFORMANCE CRITERIA | **MASS ANALYSIS 1.2**

The result of the balanced equation comparison of the designed, high-mass concrete wall to the similarly designed, non-mass wall is a relationship of energy performance in Btu's to R-value. Note: The material wall R-value is not altered by the dynamics of the building and the climate. The performance value represented below is a portrayal of energy consumption as a function of insulation performance.

PERFORMANCE STUDY SUMMARY

BUILDING AS DESIGNED

	North	East	South	West	STEADY-STATE WALL R-value:
COOLING LOAD FOR DESIGNED WALL					11.33
WCc	4.152890	3.991445	3.723069	4.388604	
WCt	16.256008				
Btu Consumption	16,256,008				
HEATING LOAD FOR DESIGNED WALL					STEADY-STATE WALL U-value:
WCh	1.079371	1.095362	1.030793	1.086349	0.088
WCt	4.291875				
Btu Consumption	4,291,875				WALL HEAT CAPACITY
TOTAL ESTIMATED LOAD					15.00
WCt	20.548				
Btu Consumption	20,547,882				

Note I: Btu's consumed equals 1,000,000 x Wall Criteria (WC)
Note II: A negative sum of the Wall Criteria results in a zero value for final calculation

COMPARISON BUILDING

	North	East	South	West	STEADY-STATE WALL R-value:
COOLING LOAD FOR DESIGNED WALL					26.10
WCc	4.880803	4.450949	4.293060	5.096044	
WCt	18.720856				
Btu Consumption	18,720,856				
HEATING LOAD FOR DESIGNED WALL					STEADY-STATE WALL U-value:
WCh	0.801351	0.900814	0.948070	0.899713	0.04
WCt	3.549948				
Btu Consumption	3,549,948				WALL HEAT CAPACITY
TOTAL ESTIMATED LOAD					1.00
WCt	22.271				
Btu Consumption	22,270,804				

Note I: Btu's consumed equals 1,000,000 x Wall Criteria (WC)
Note II: A negative sum of the Wall Criteria results in a zero value for final calculation

THIS THERMAL MASS, ANALYTICAL COMPARISON RESULTS IN THE DESIGNED WALL BEHAVING AS A WALL WITH A MATERIAL R-VALUE OF:	26.10

Material R-Value of R-11.33 performs as R-26.10

- Can help reduce sizing of HVAC equipment

(tonnage reductions up to 37%)

Fresno, CA

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Life Safety

Life Safety

- The first responsibility of any building is to protect the lives and safety of the occupants inside.
- Life safety is an important consideration for healthy buildings.
- A healthy building keeps those inside safe from threats such as fire, severe storms, and earthquakes.

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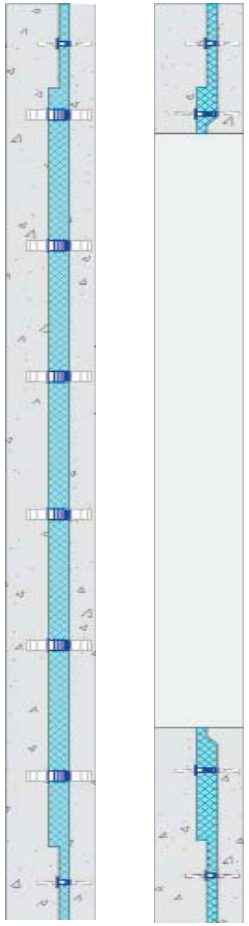
Case Studies

Case Study – Catholic University

Catholic University – Ext. Wall System



•Precast Concrete SWP with combo thin-brick and exposed concrete
•2.5” Ext. conc. – 2” ISO c.i. - 4.5” Int. conc.
•Non-composite design eliminates thermal bowing
•Fiber-composite connectors eliminate thermal bridges
•Wall system has R-value of 14.25
•Integral Insulation with perm rating of 0.03, provides integral vapor barrier
•There is no cavity for moisture to collect
•Exposed interior concrete maximizes the thermal mass effect and provides durable finish
• 4 + Hour Fire Endurance Rating
• Sound Transmission Class (STC) Rating of 54

Catholic University – Int. Wall System

Thermal Image – Post Occupancy

- Eastern Exposure; 2.5” Thick Exterior Concrete and Thin-Brick Veneer Shaded in **Blue: 29.9** °F
- Open Windows, Represented in Yellow: 60.6 ° F

Case Study – South Carolina Children's Theatre, Greenville, S.C.

- **Owner:** South Carolina Children's Theatre, Greenville, S.C.
- **Architect:** Craig Gaulden Davis Inc., Greenville, S.C. .
- **Engineer:** The Fuller Group, Greenville, S.C.
- **General Contractor:** Triangle Construction Company Inc., Greenville, S.C.
- **PCI-Certified Producer:** Metromont, Greenville, S.C.

South Carolina Children's Theatre, Greenville, S.C.

- In addition to meeting the requirements of structural, fire, and life safety codes; increased cooling capacity for crowds; as well as lighting and acoustics, the project team wanted to create a focal point for the community

- With limited budget, the nonprofit theatre group needed a durable and versatile material that could also meet stringent acoustic and insulative demands. Precast concrete was ideally suited

South Carolina Children's Theatre, Greenville, S.C.

- Precast provides a large, column-free open space ideal for this type of space.
- Thermal mass of the concrete reduces the daily temperature swings on the building by absorbing and releasing heat slowly, shifting air-conditioning and heating loads to allow smaller, more-efficient heating, ventilating, and air-conditioning systems

South Carolina Children's Theatre, Greenville, S.C.

"We had to be creative with the use of materials to stay within budget. The theater has to be acoustically isolated, so the structure has to help with that separation. To [isolate outside noise] you need mass. In the past, theaters were often constructed with various veneers and masonry block for the acoustic separation, but for the SCCT project, precast provided a perfect material to prevent outside noise from entering the space. We didn't have to do anything extra on the interior to achieve that."

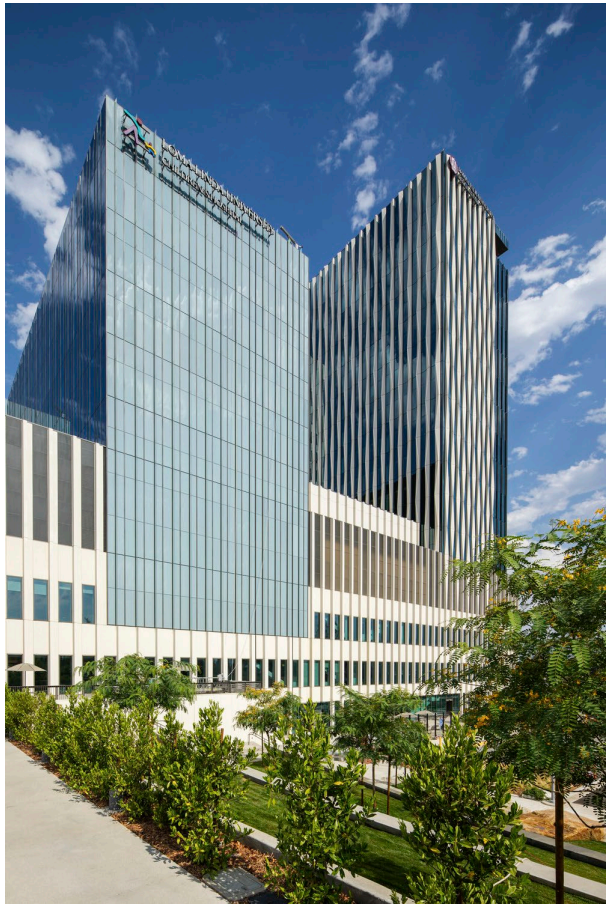
--John Hansen, principal at Craig Gaulden Davis Architecture

Case Study – Loma Linda University Medical Center Loma Linda, Calif.

- **Owner:** Loma Linda University Medical Center, Loma Linda, Calif.
- **Architect:** NBBJ, Seattle, Wash.
- **Engineer:** ARUP, Los Angeles, Calif.
- **Contractor:** McCarthy, Los Angeles, Calif.
- **PCI-Certified Precast Concrete Producer:** Willis Construction Co. Inc., San Juan Bautista, Calif.

Loma Linda University Medical Center
Loma Linda, Calif.

- Project needed to deliver the kind of exceptional indoor environmental quality required for medical facilities.
- The building also had to meet high seismic design requirements to ensure life safety.
- Precast was able to contribute to both, as well as deliver the desired aesthetic for both the adult and children's wing.



Loma Linda University Medical Center
Loma Linda, Calif.

- During an earthquake, its 126 base isolators will let the building move several feet in any horizontal direction without suffering major damage.
- Patient rooms are located along the perimeter and feature floor-to-ceiling windows to bring in as much natural light as possible.
- Sunlight also filters into the interior corridors, where health-care workers benefit from external views.

Loma Linda University Medical Center
Loma Linda, Calif.

The team evaluated the needs of health-care workers and patients in their plan to build a health-care facility for healing the whole body, spirit, and mind, while also being structurally sound.”

--Brian Uyesugi, principal at architecture and design firm NBBJ.

Summary

- Healthy buildings have significant benefits for the wellbeing and safety of occupants, and increasingly are becoming part of the holistic design of buildings of all kinds.
- Precast, prestressed concrete has numerous attributes that can contribute to the design of healthy buildings.
- An inert material, precast has no VOCs and enable good indoor air quality. It also has excellent sound attenuation, thermal comfort and advantages for daylighting strategies
- Durable and resilient, precast also keeps occupants safe from fire, storms, earthquakes and more.

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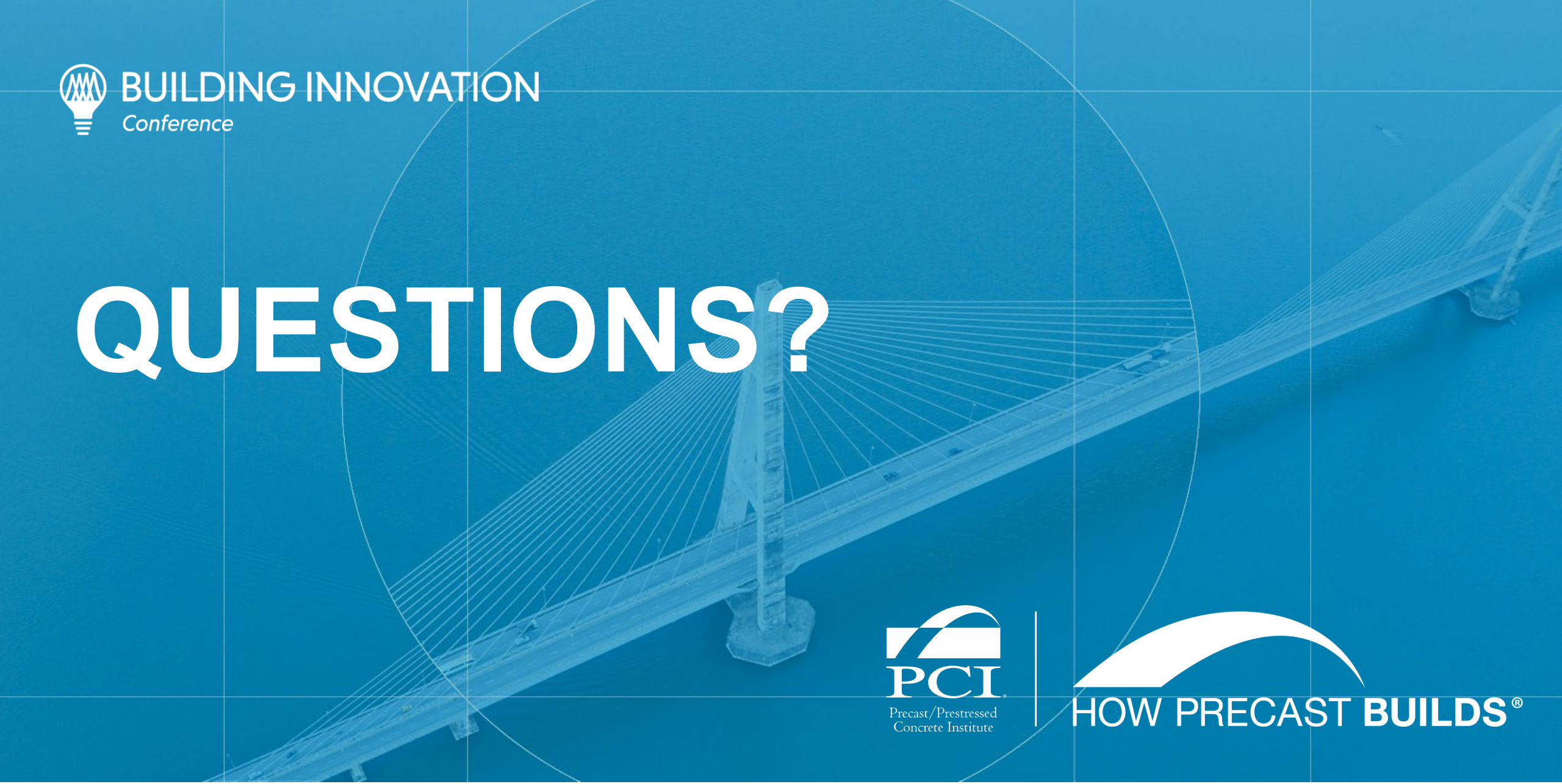
QUESTIONS?



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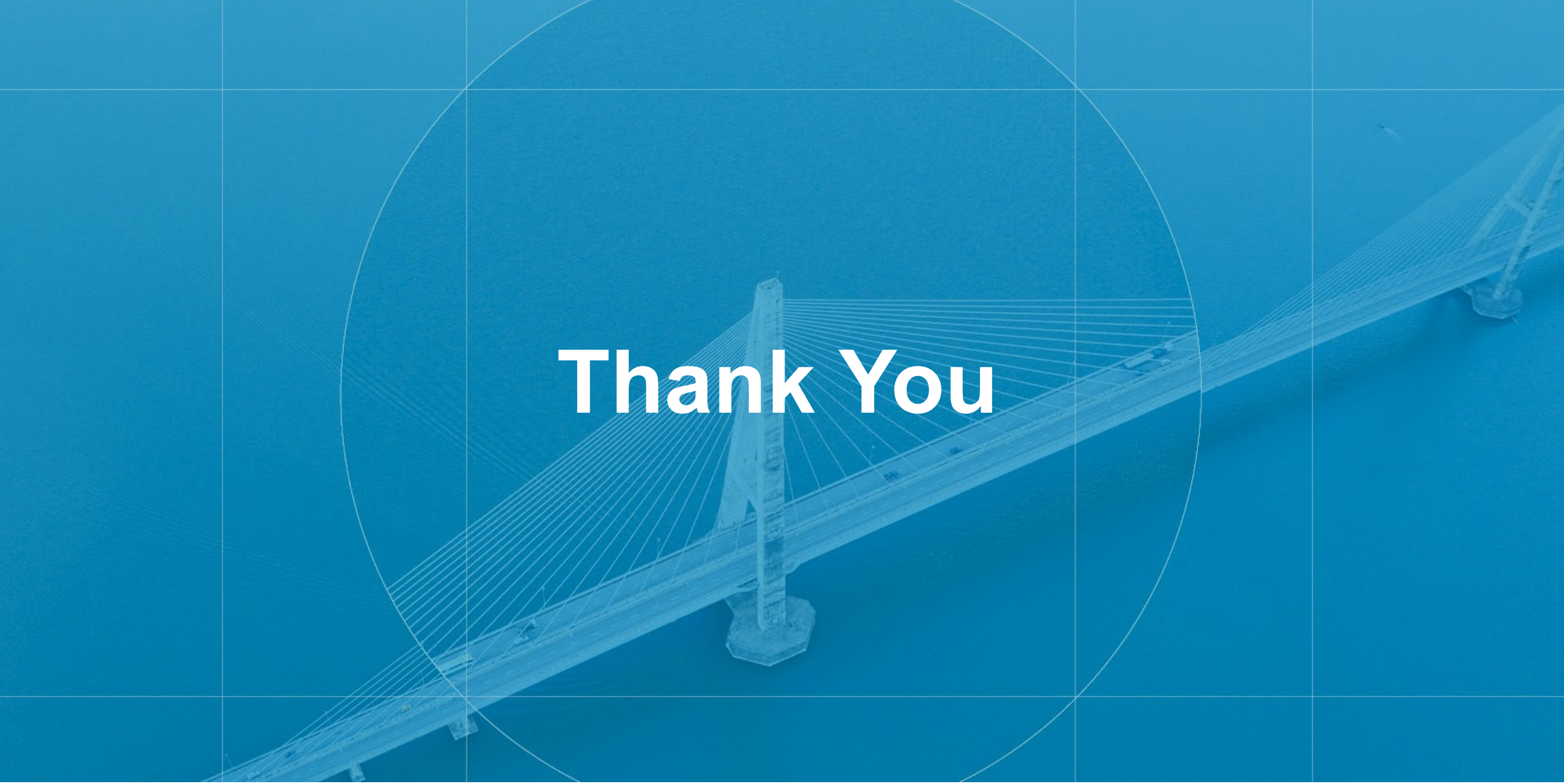

Thank You