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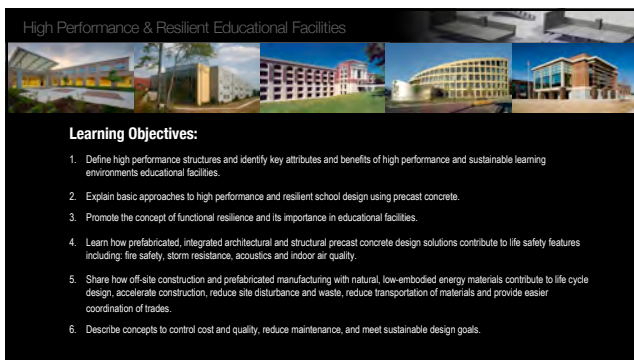
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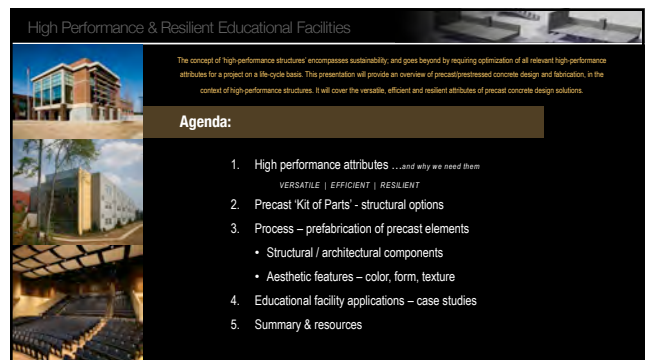
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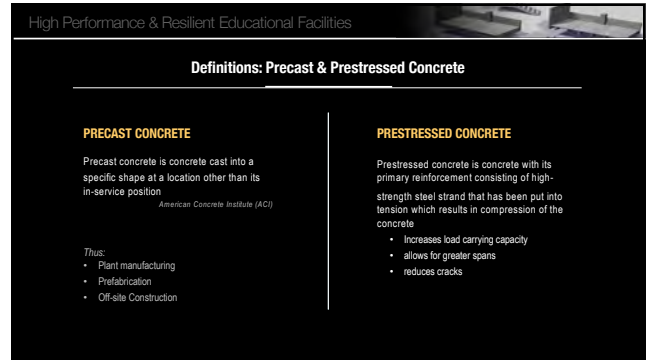
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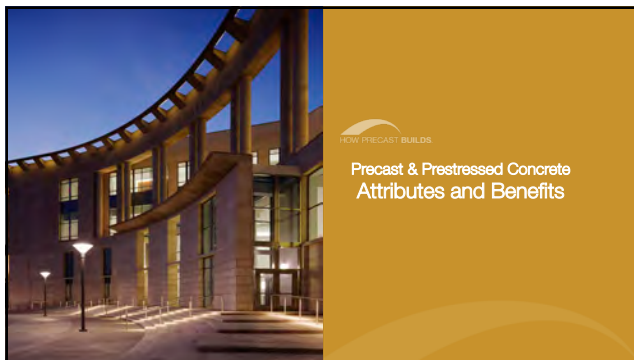
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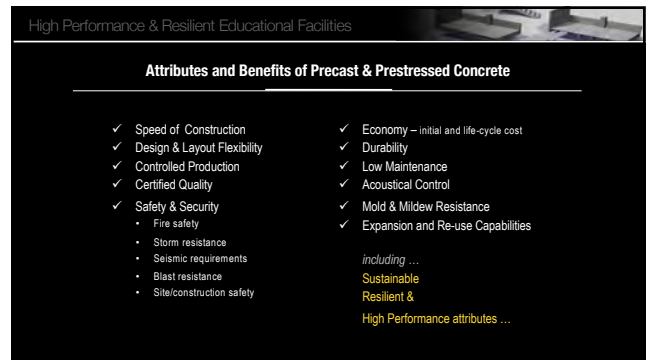
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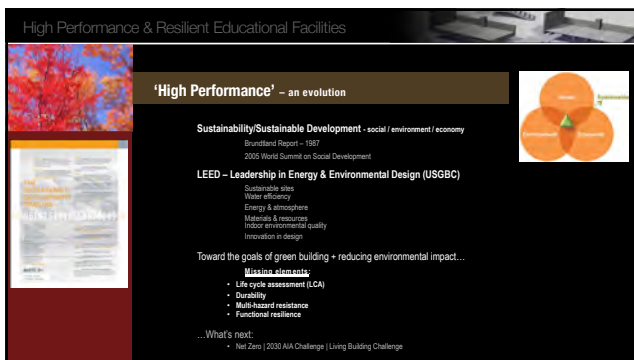
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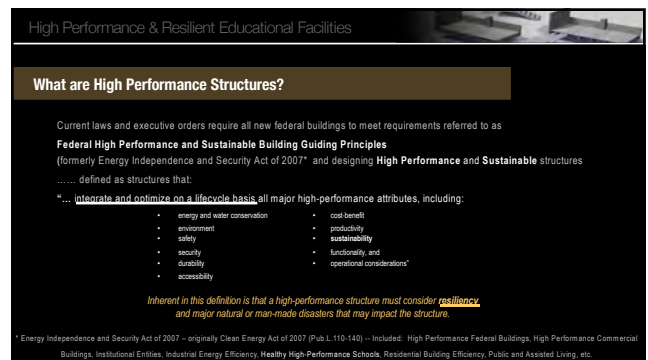
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High Performance & Resilient Educational Facilities

High Performance Attributes and Benefits of Precast

VERSATILE	EFFICIENT	RESILIENT
Aesthetic Versatility	Site Efficiency	Structure Durability
Virtually any color, form, and texture	Minimal site disturbance	Long service life
Facade integration	Negligible waste	Barrier wall system
Historic compatibility	Accelerated construction	Functional resilience
Structural Versatility	Energy and Operational Efficiency	Multi-Hazard Protection
Load-bearing envelopes	Stable performance	Storm resistance
Economical sections	Thermally efficient	Earthquake resistance
Long open spans	Low life-cycle costs	Blast resistance
Use Versatility	Risk Reduction	Life Safety and Health
Recyclable	Design assist	Indoor environmental quality
Decorative reuse	Reduced detailing and trades	Passive fire resistance
Adaptive reuse	Enhanced profitability	Meets FEMA 361!

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High Performance & Resilient Educational Facilities

'DESIGNING FOR DISRUPTION'

In 2017 the United States experienced an alarming series of natural disasters. It has been a month since hurricanes wreaked havoc in Texas, Louisiana, Florida, South Carolina, Georgia, Puerto Rico and the U.S. Virgin Islands. Throughout the fall, California suffered nearly perpetual wildfires. Significant social, economic and environmental consequences will be felt into 2018 and beyond.

Millions died. Thousands of homes and other structures were destroyed... One word in the map above alone highlights that nearly the entire United States is subject to one or more of the risks. Although specific occurrences are largely unpredictable, exposure to these risks is predictable. And we must be better prepared!

ALL PERSPECTIVE: Cur Schmitt FAAR, 2018 AIA President
AIA ARCHITECT - The Journal of the American Institute of Architects

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High Performance & Resilient Educational Facilities

Resilient – Tornado resistance

Chapman High School after June 2008 Tornado.

Chapman, Kansas June 11, 2008
1/2 mile wide tornado

Chapman Elementary & Middle School after June 2008 Tornado

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High Performance & Resilient Educational Facilities

Resilient – Tornado resistance

May 22, 2011, 5:41 p.m.
Devastation struck the southwestern Missouri community of Joplin.

An EF-5 tornado was on the ground for 20 minutes, traveled along a 13-mile path, and destroyed or damaged 10 schools, including Joplin High School.

162 lives were lost.

Joplin High School was a total loss.

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High Performance & Resilient Educational Facilities

A 98,000 SF freestanding former Shopko replaced concrete big box space attached to a mall was identified as one of the few standing buildings in Joplin with the space available to house an interim high school for 1,200 students. The space previously sat vacant for 10 years.

Two days after the storm Joplin Schools Superintendent promised school would start on time August 13. To complete this feat, the district relied on a team to design and construct an interim high school within 55 business days.

2012 CEFPI James D. MacConnell Award Winner – Joplin Interim High School
Joplin Public Schools, Joplin, MO
CDA Architects & GLR Group

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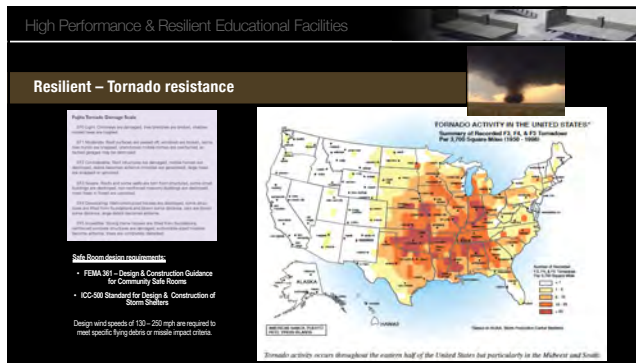
High Performance & Resilient Educational Facilities

Also on May 22, 2011, the Joplin, MO tornado demolished St. Mary's Catholic Church and School. The only thing left standing was the iconic cast iron cross that marked the entrance to the church.

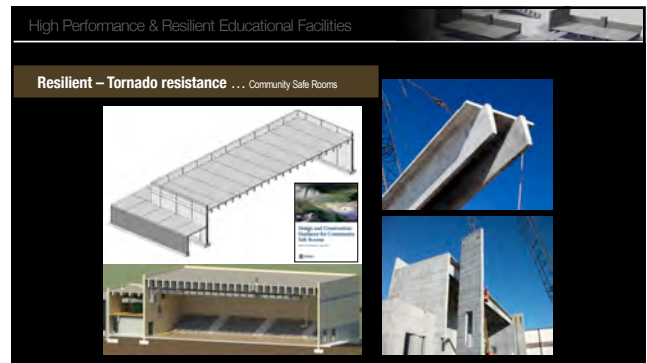
St. Mary's Catholic Church and School
Joplin, MO
Architect: RDC/Darling & Design

Best K-12 School
2015 PCI Design Awards

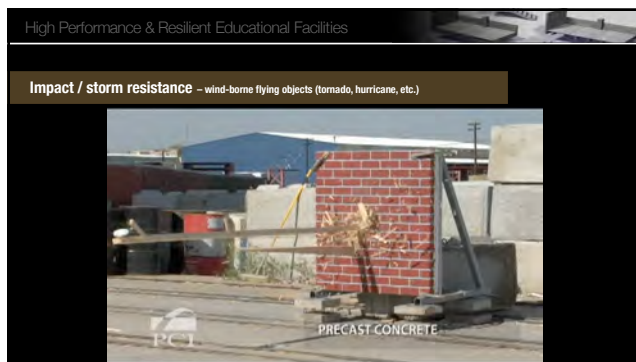
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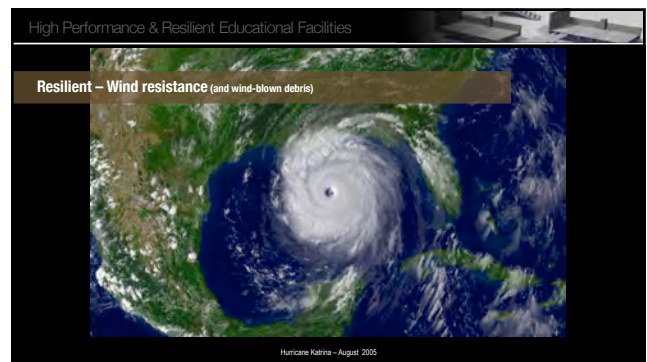
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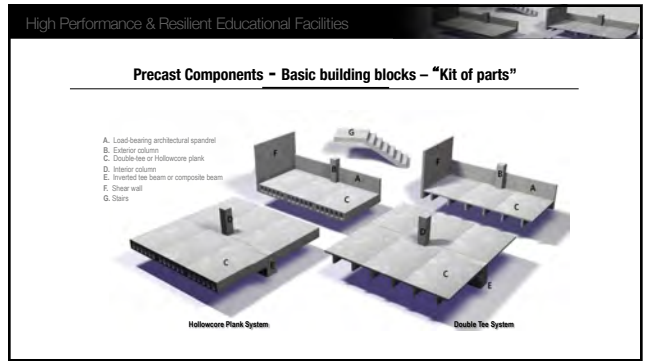
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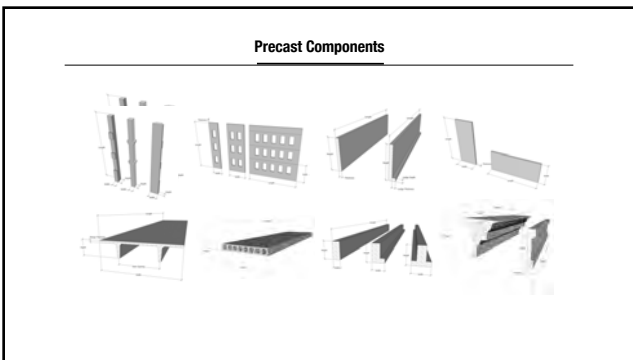
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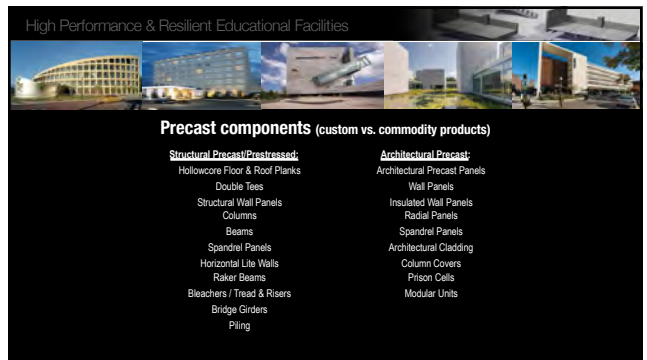
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High Performance & Resilient Educational Facilities

Context: SOLUTIONS vs. PRODUCTS

'Total' Precast Concrete Structures:

Solutions which integrate architectural and structural precast concrete components – to create the building's structural frame and panelized façade or building enclosure ...

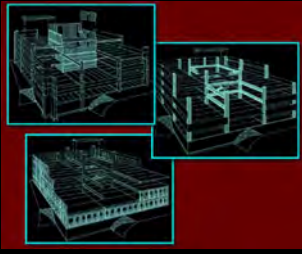
... often in the same components!

- ✓ accelerated construction
- ✓ greater durability, lower life cycle cost
- ✓ reduced risks...
 - fewer trades, general conditions
 - improved life safety
 - multi-hazard protection

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High Performance & Resilient Educational Facilities

Structural System Options



Using precast concrete components together as a complete structural system creates a design in which the whole is greater than the sum of the parts.

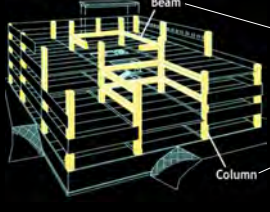
For example, combining precast prestressed hollowcore plank or double tees with precast beams and columns creates a durable, fire-resistant structure that is quick to erect and cost efficient due to the compressed construction schedule.

RESOURCE(s):
PCI Design Handbook, 8th Ed.

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High Performance & Resilient Educational Facilities

Rigid Frame System



Beam


Column

All lateral loads are transferred to a moment-resisting frame that ties beams and columns together with rigid connections. The need for shear walls is eliminated.

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High Performance & Resilient Educational Facilities

Interior Shear Wall System



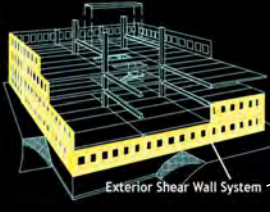
Interior Shear Wall System

Lateral loads are transmitted by floor diaphragms to a structural core of precast shear walls. The shear wall can be tied together vertically and at corners to form a structural tube that cantilevers from the foundation.

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High Performance & Resilient Educational Facilities

Exterior Shear Wall System



Exterior Shear Wall System

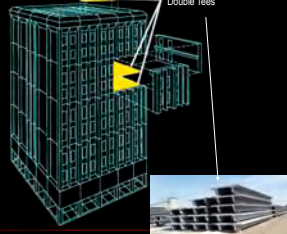
In general, an exterior shear wall system permits greater design flexibility because it eliminates the need for a structural core.

By combining gravity load bearing function with lateral load resistance, the exterior shear wall system is also, in general, more economical.


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High Performance & Resilient Educational Facilities

Double Tees

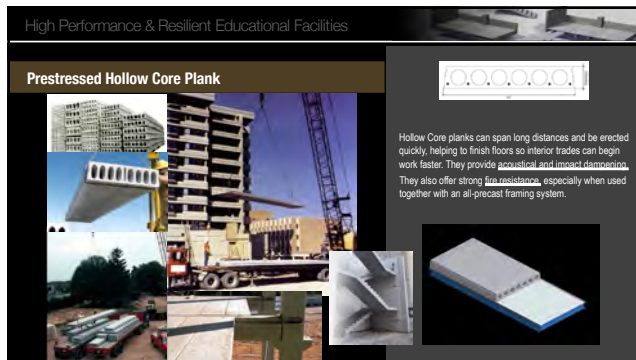


Double Tees

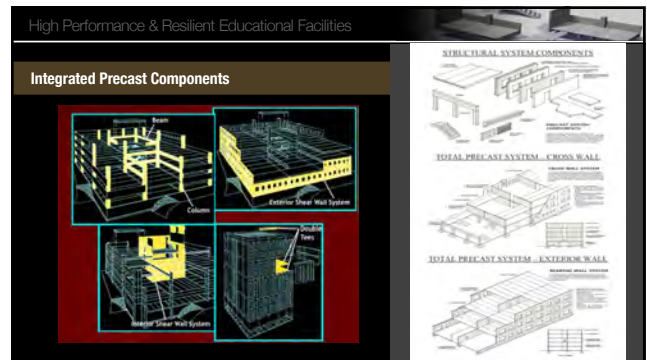


Double tees provide excellent roof and flooring units, spanning considerable distances and providing quick erection to close in a structure more quickly. They can expand a designer's options for floor layouts by eliminating interior columns and offering excellent fire resistance and durability.

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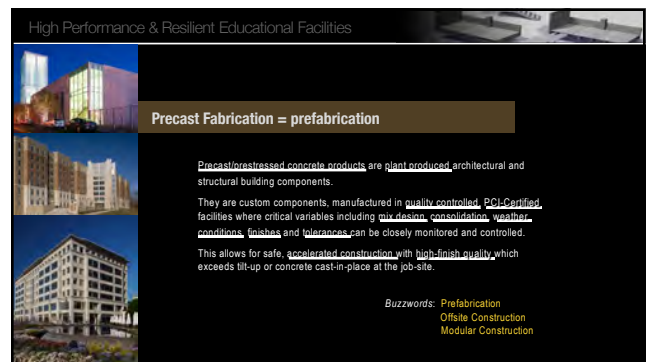
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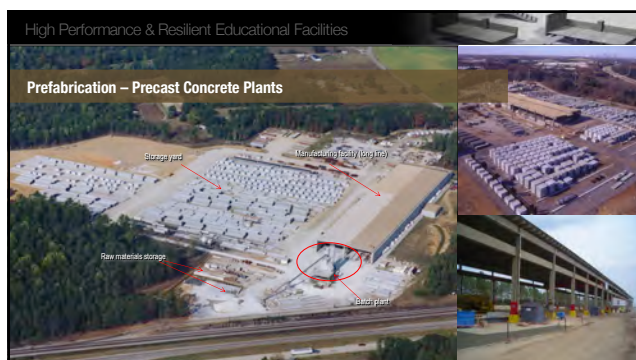
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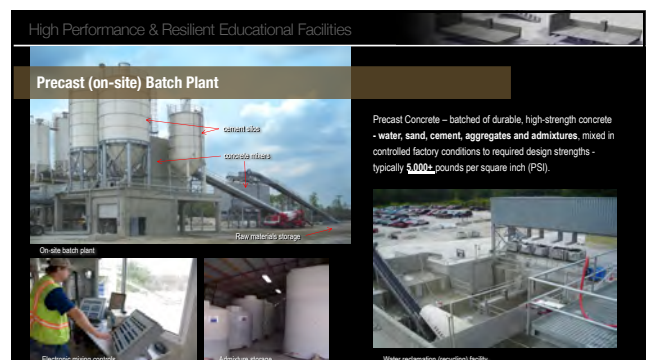
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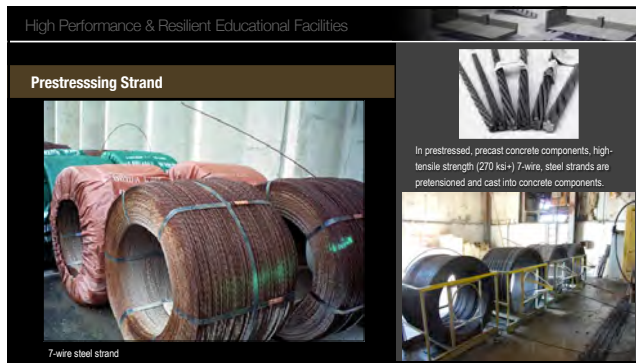
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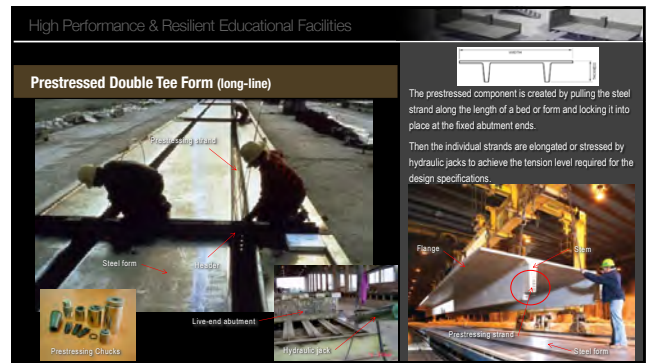
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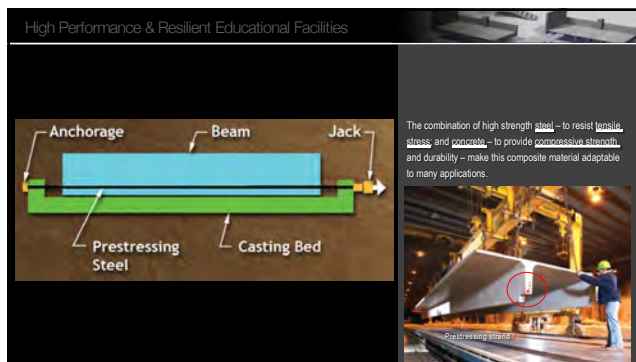
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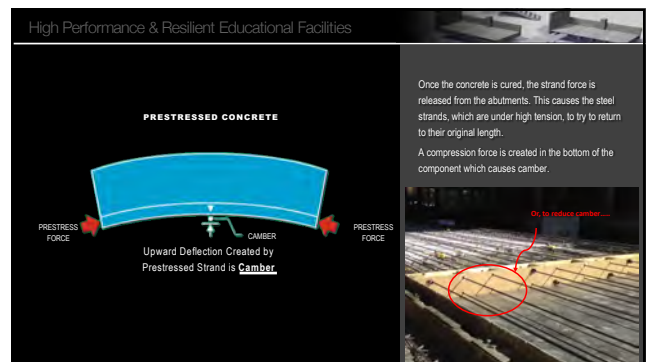
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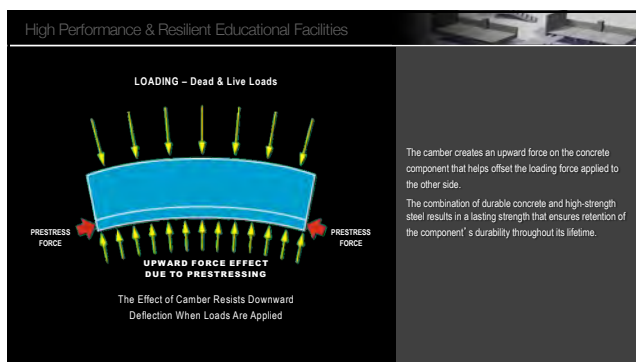
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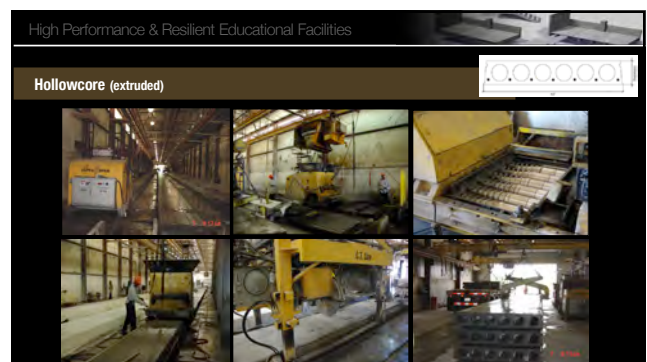
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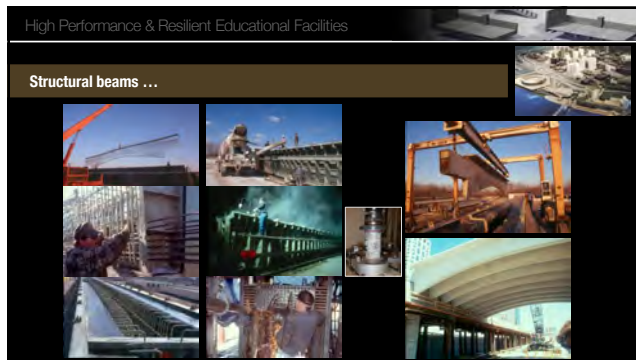
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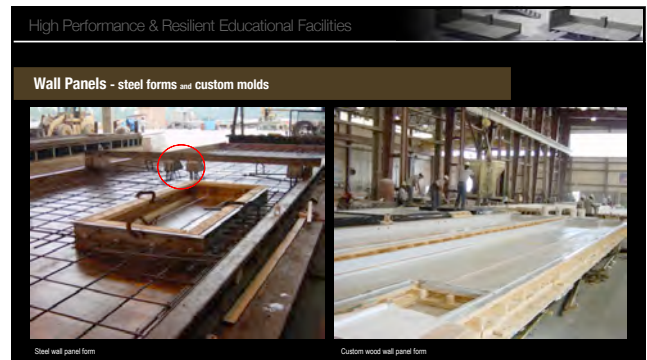
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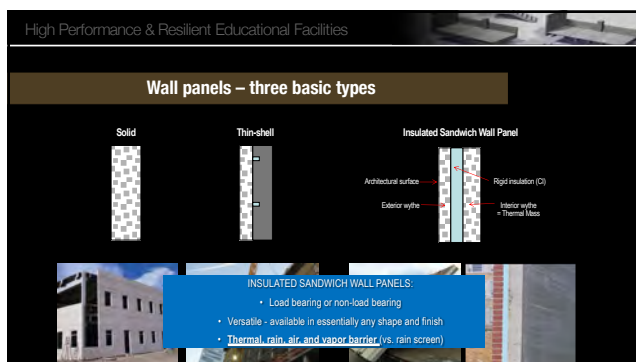
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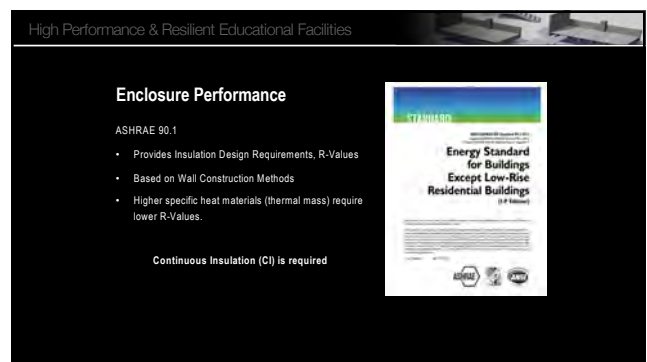
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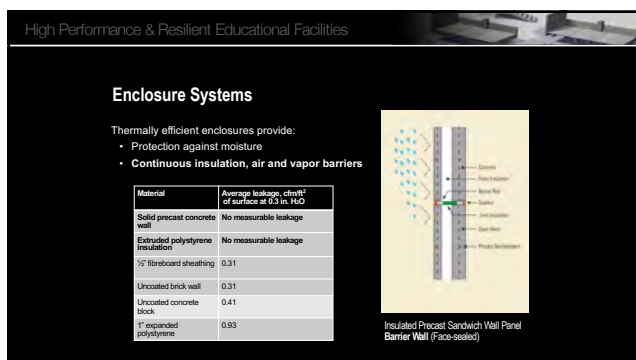
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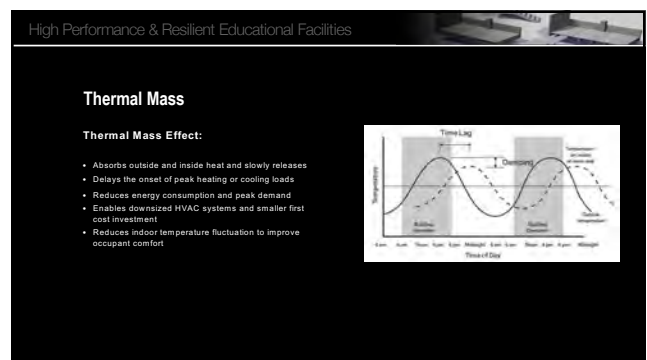
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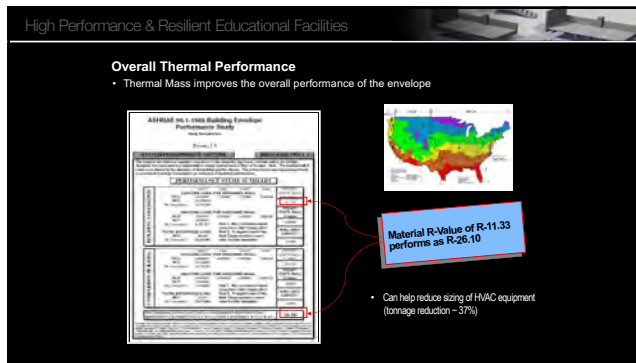
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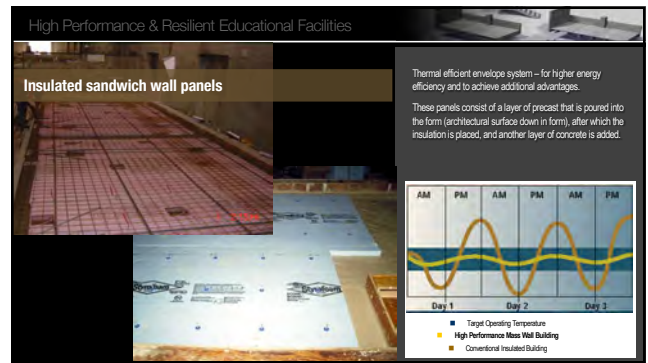
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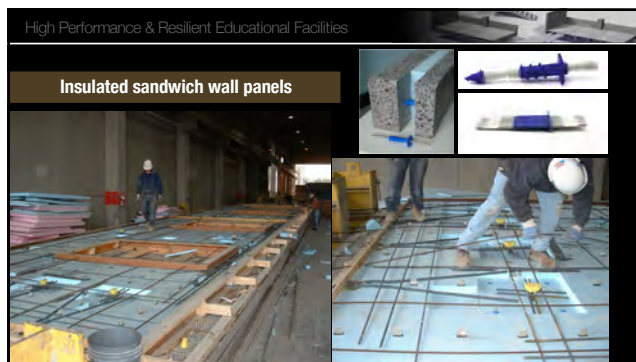
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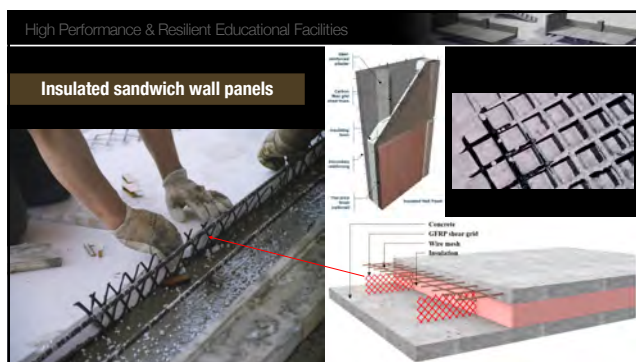
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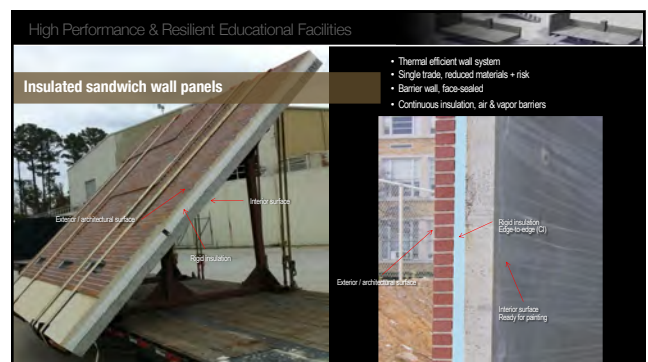
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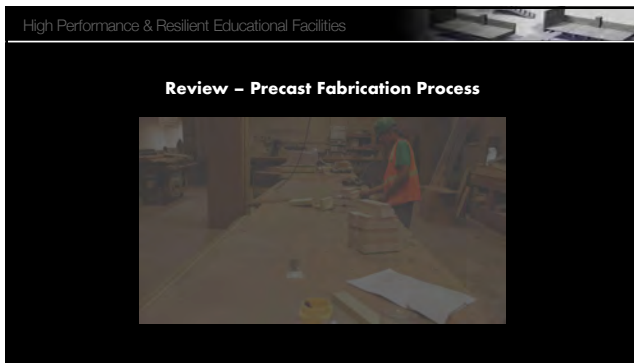
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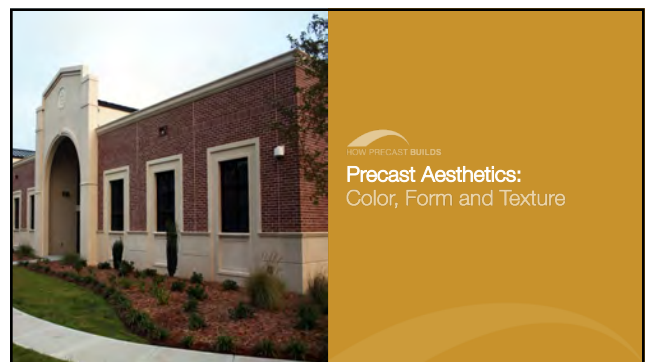
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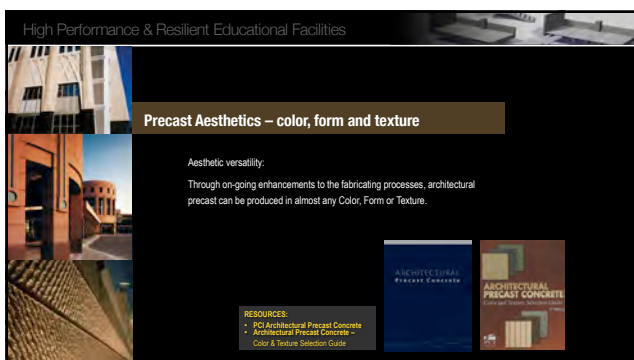
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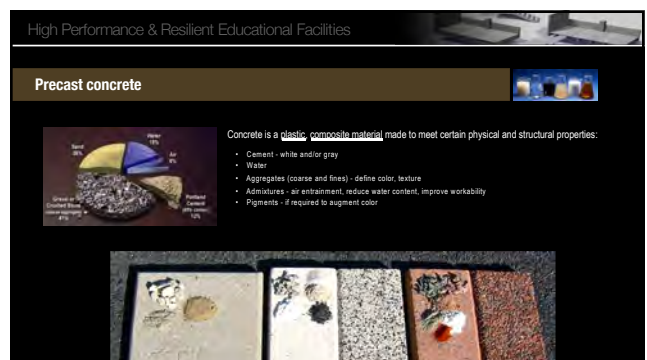
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High Performance & Resilient Educational Facilities

Color

col-or – noun
[kuhl-er]

1. the quality of an object or substance with respect to light reflected by the object, usually determined visually by measurement of hue, saturation, and brightness of the reflected light; saturation or chroma; hue.


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High Performance & Resilient Educational Facilities

Color

Color in concrete is achieved by:

- **Cement** – can be gray, white or buff (exerts primary influence on smooth finish and has effect on general tone of the panel)
- **Coarse Aggregates** (stone) – become more dominate as surface of the concrete is removed to obtain medium or deep exposure profile
- **Fine Aggregates** (sand) – can have major effect on color of white and light colored concrete
- **Pigments** – and pigmented admixtures can be added to the matrix to achieve colors not achievable by the combination of cement and fine aggregates alone
- **Coatings** – paint, stains, sealers...applied after casting




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High Performance & Resilient Educational Facilities

Color

We can break these into two groups:

- **Paste or cement dominant color** - When the paste is the primary contributor to color, typically zero (smooth) to light exposure finishes
- **Aggregate dominant color** - When the aggregate is the primary contributor to color, typically medium to deep exposure finishes



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High Performance & Resilient Educational Facilities

Matrix color: Cement + Pigment* (gray – 1/3 gray / 1/2 white – white)

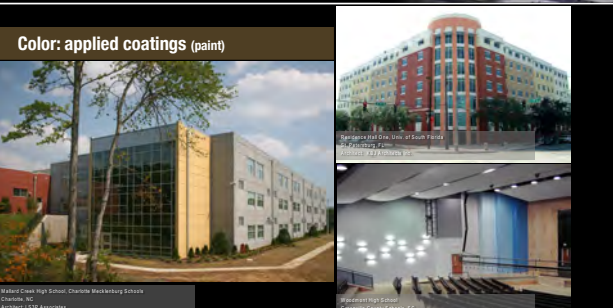
Color Name	Gray	1/3 Gray	1/2 White	White
Black	101	102	103	104
Dark Gray	105	106	107	108
Gray	109	110	111	112
Light Gray	113	114	115	116
White	117	118	119	120
Dark Brown	201	202	203	204
Brown	205	206	207	208
Light Brown	209	210	211	212
Dark Red	301	302	303	304
Red	305	306	307	308
Light Red	309	310	311	312
Dark Yellow	401	402	403	404
Yellow	405	406	407	408
Light Yellow	409	410	411	412

* Iron oxide pigments – natural & synthetic

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High Performance & Resilient Educational Facilities

Color: applied coatings (paint)



Sheldon Creek High School, Charlotte-Mecklenburg Schools, Charlotte, NC
Southwest LSP Associates

Sheldon Creek High School, Charlotte-Mecklenburg Schools, Charlotte, NC
Southwest LSP Associates

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High Performance & Resilient Educational Facilities

Form

Form - noun
[fawrm]

1. external appearance of a clearly defined area, as distinguished from color or material; configuration.
2. the shape of a thing
3. something that gives or determines shape; a mold.
4. the manner or style of arranging and coordinating parts for a pleasing or effective result ...
5. the organization, placement, or relationship of basic elements...
6. the structure, pattern, organization, or essential nature of anything

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High Performance & Resilient Educational Facilities

Steel forms ... standard cross sections

Double Tee Hollowcore Inverted T beam
Wall panel / Edge beam Stadium cover

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High Performance & Resilient Educational Facilities

Form - custom column and radial wall panel molds

Column cover form Radial wall panel form and product

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High Performance & Resilient Educational Facilities

Resists High quality plywood
Back and custom formfitters and shapes Bendable "Wacky Wood"

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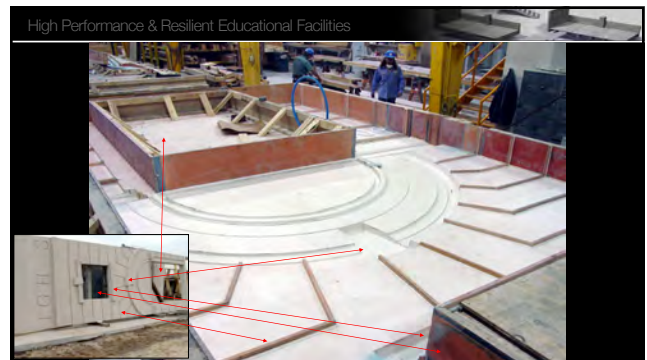
High Performance & Resilient Educational Facilities

SCAD Museum of Art - most being constructed using existing historic structure
Eastman, GA
Architect: Smith & Shettle, LLP; Architects: STP (David A. Smith)

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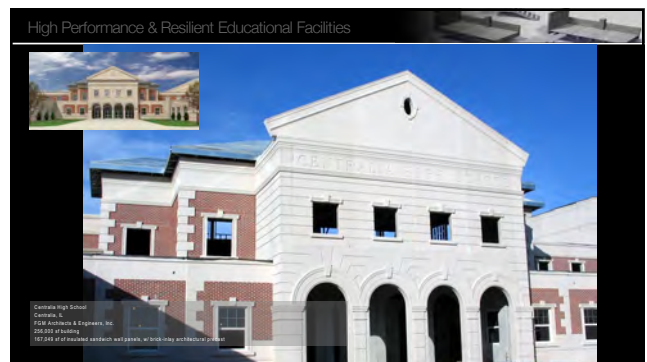
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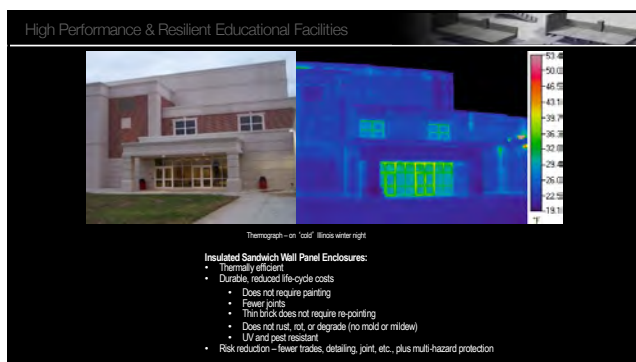
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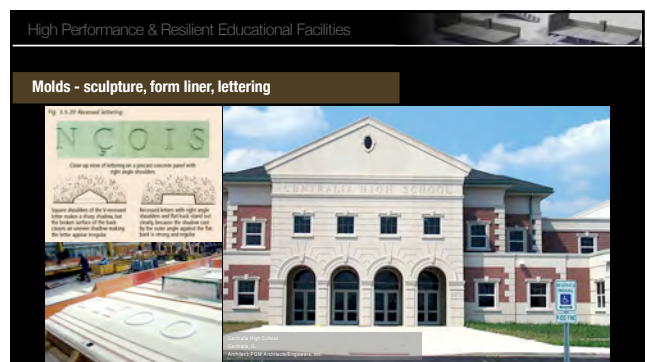
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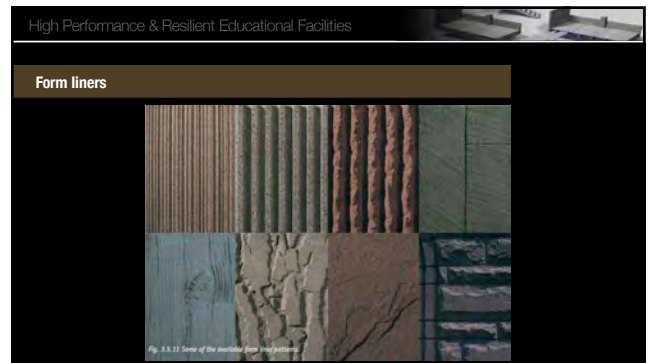
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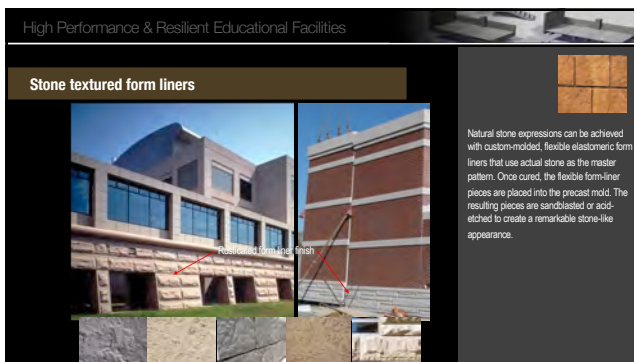
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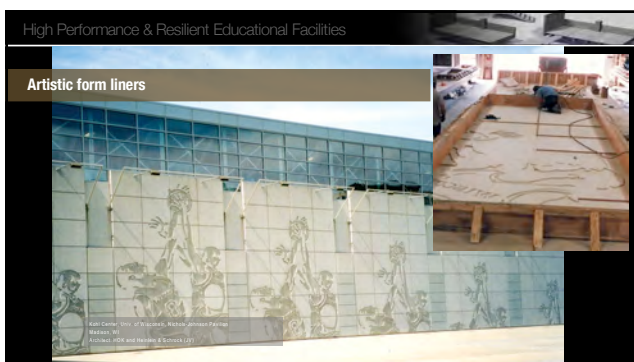
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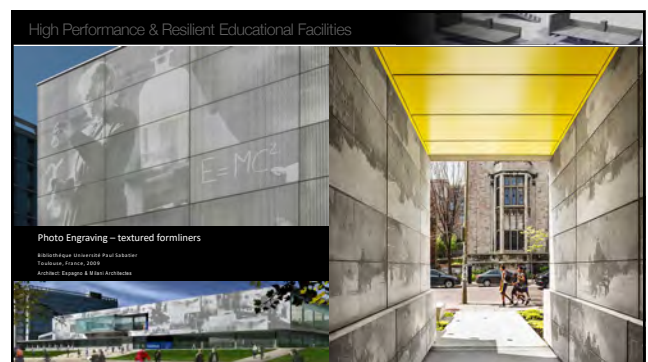
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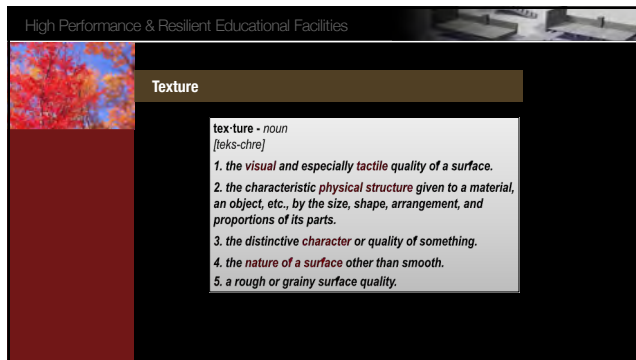
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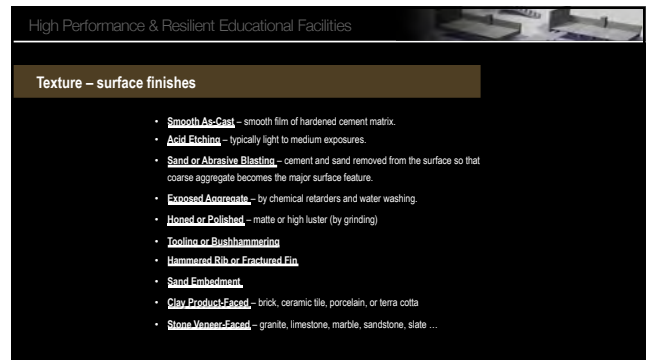
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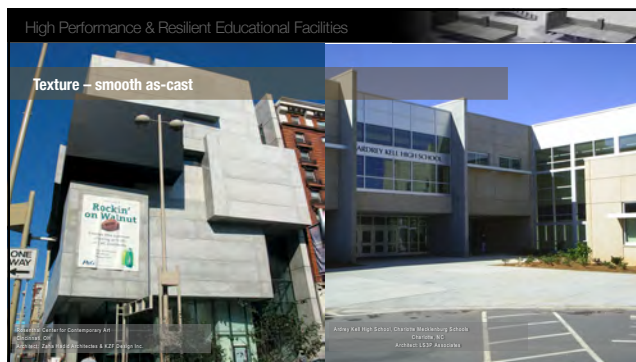
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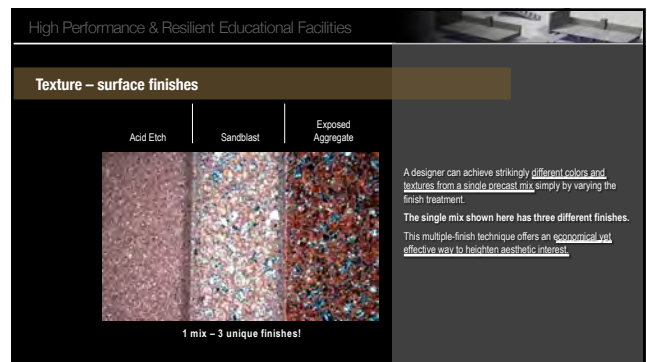
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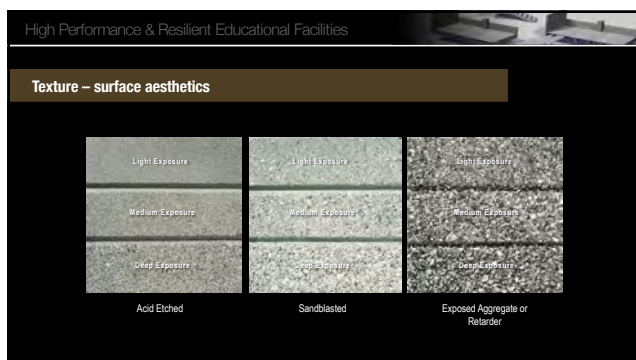
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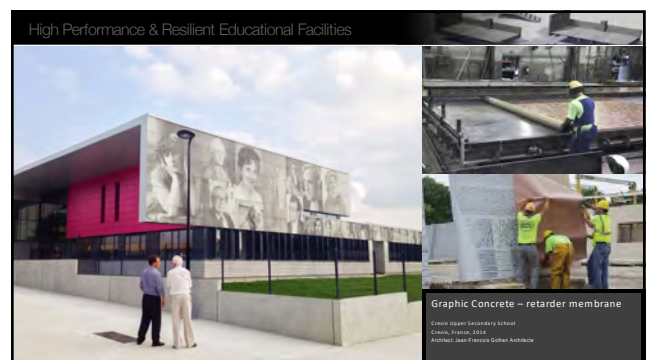
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Thin Brick in Precast
Using actual clay masonry products cast directly into concrete panel; allows these traditional building materials to be more versatile



Benefits and Advantages

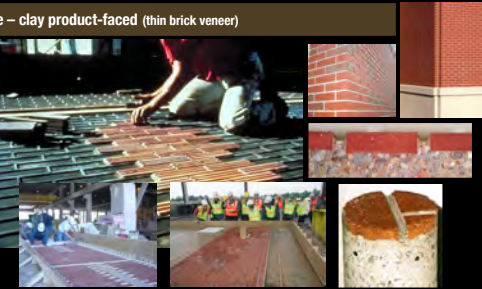
- Controlled conditions, high quality control
- Year-round production, no weather delays or additional costs
- No scaffolding or material storage
- No anchors, flashing and weeps
- No repointing needed; raked joints possible



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High Performance & Resilient Educational Facilities

Texture – clay product-faced (thin brick veneer)




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High Performance & Resilient Educational Facilities

BUILDING ENVELOPE SYSTEM - FINISHES
BRICK FACADE TREATMENTS

BRICK – For owners seeking brick finishes, precast producers offer cost-effective ways of producing wall panels and related building facade products whereby thin brick is integrally cast into concrete panels. Thin brick are manufactured by the nation's leaders in masonry production and are offered in standard brick sizes.

CORE SAMPLE



TWIN BRICK SIZES

Roman - 3-5/8 x 11-5/8
Modular - 2-1/4 x 7-5/8
Norman - 2-1/4 x 11-5/8
2-1/4" Maryland (6 x 8) - 2-1/4 x 15-5/8
Kingston - 2-5/8 x 7-5/8
Closure - 3-5/8 x 7-5/8
Utility - 3-5/8 x 11-5/8
3-5/8" Maryland - 3-5/8 x 15-5/8
Triple Brick - 7-5/8 x 7-5/8

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High Performance & Resilient Educational Facilities

BUILDING ENVELOPE SYSTEM - FINISHES
BRICK FACADE TREATMENTS


BRICK – A wide range of brick options including smooth, wire cut, and sand-molded textures, iron spot finished bricks, numerous color choices, as well as various shapes and sizes to create corners, arches, soldier courses and other brick patterns.

COURSING OPTIONS


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High Performance & Resilient Educational Facilities

Textures




Colors



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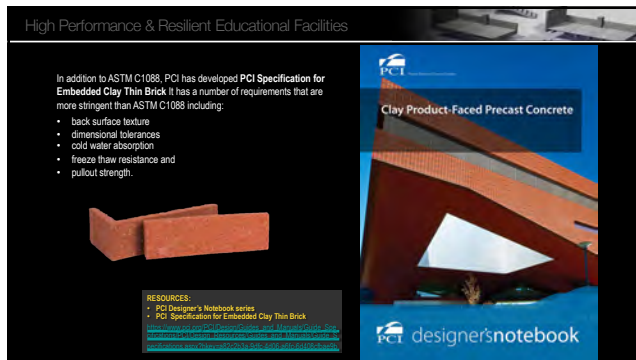
High Performance & Resilient Educational Facilities



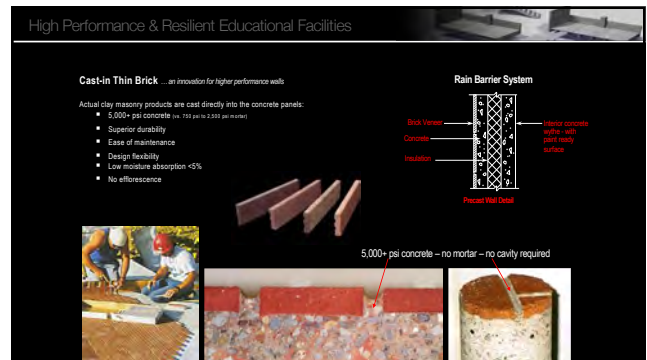
Like other clay brick, thin brick are manufactured to ASTM International standards. ASTM C1088 is the standard that applies to thin brick and includes criteria intended to ensure durability as well as acceptable appearance.

These criteria are usually sufficient for typical adhered veneer applications - but may not be adequate for precast projects.

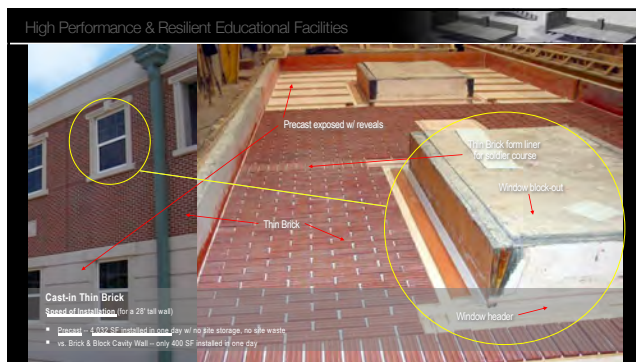
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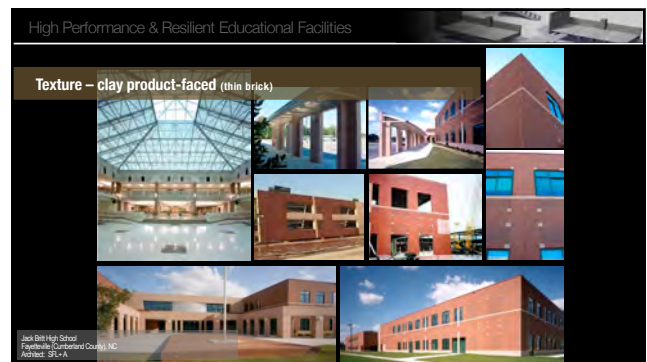
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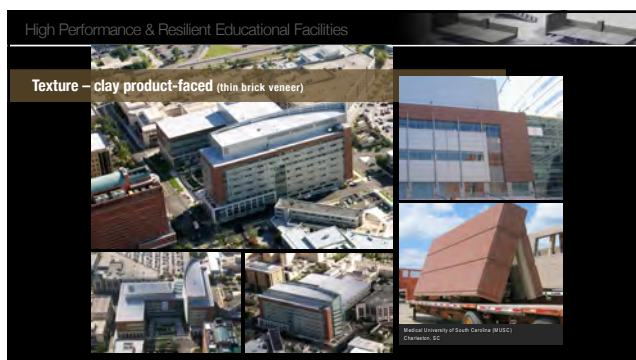
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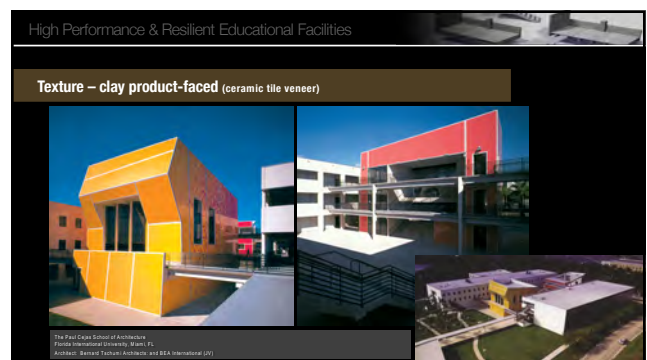
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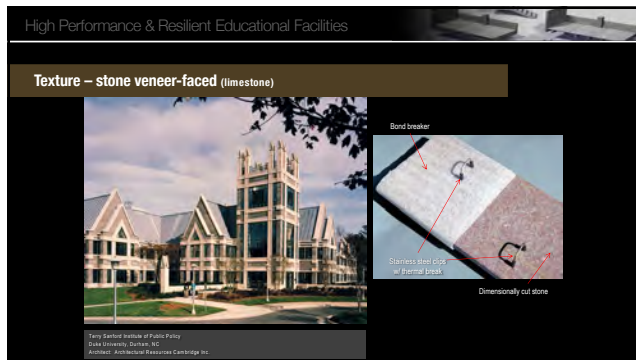
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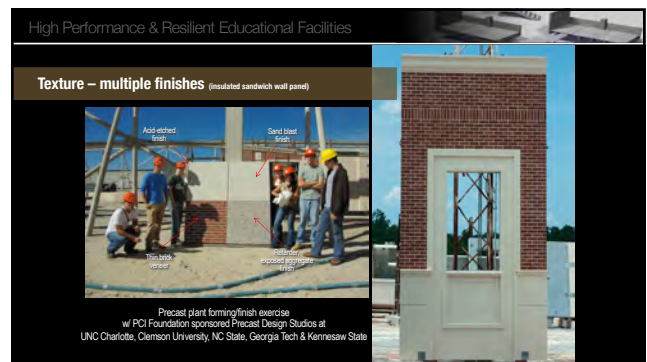
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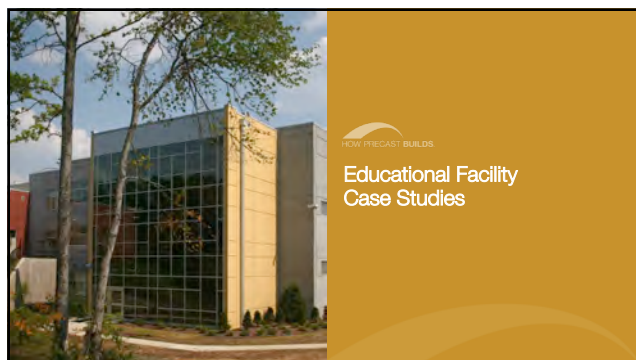
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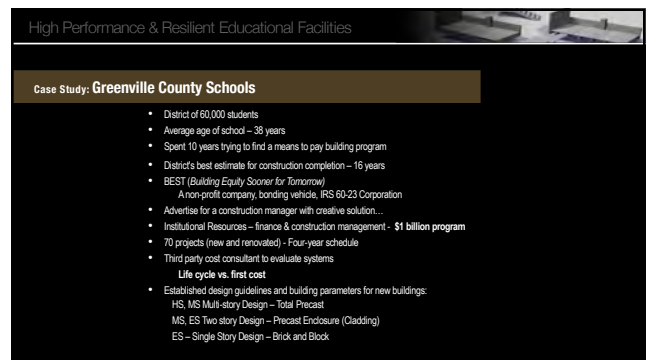
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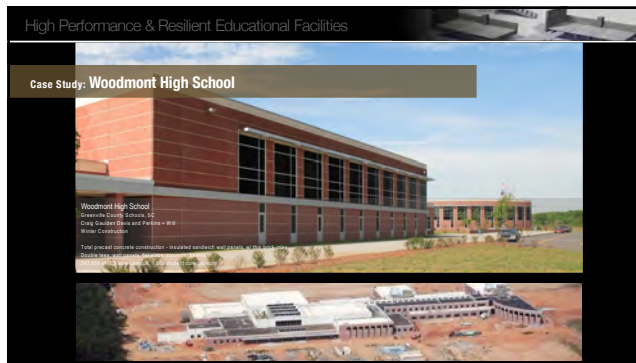
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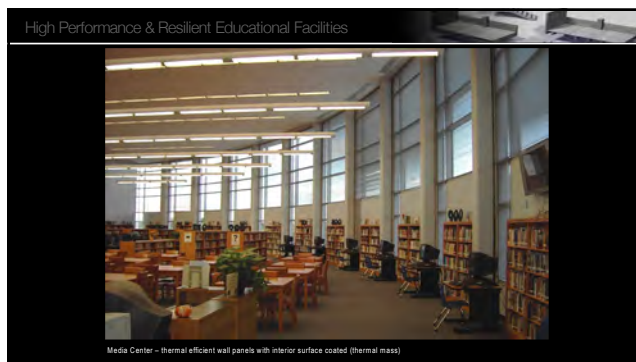
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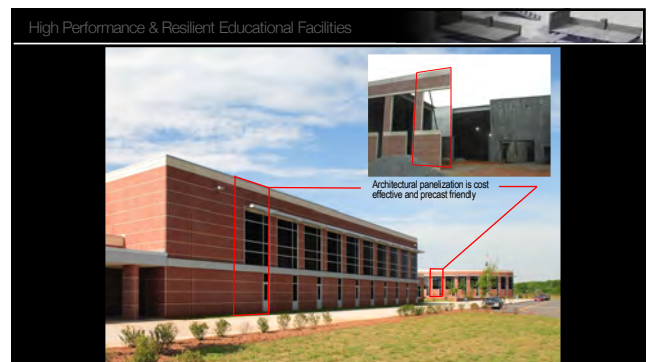
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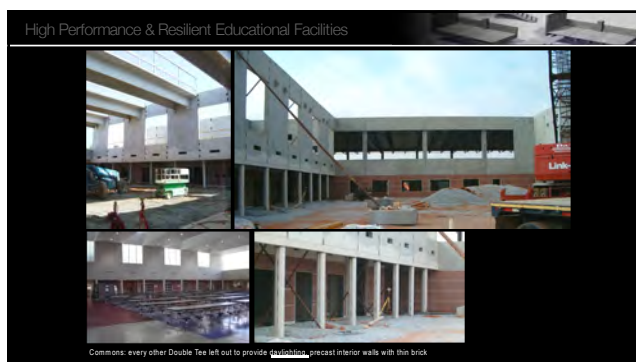
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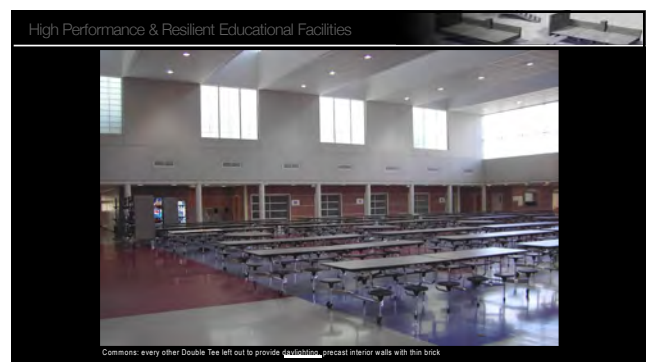
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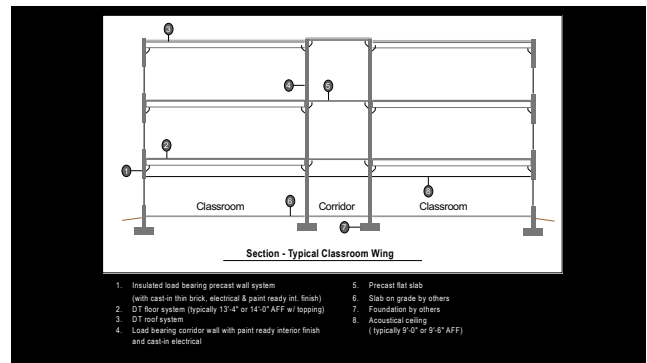
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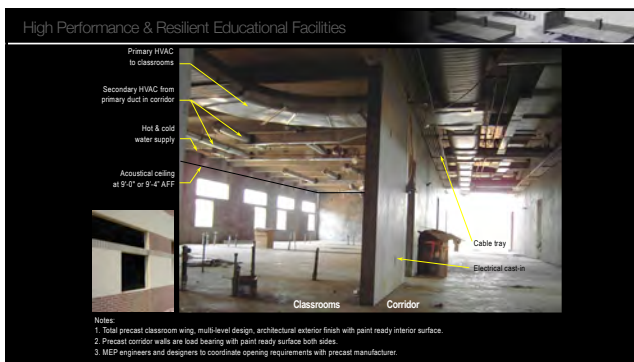
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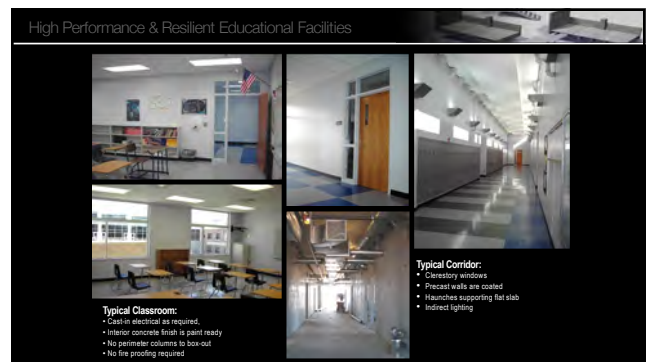
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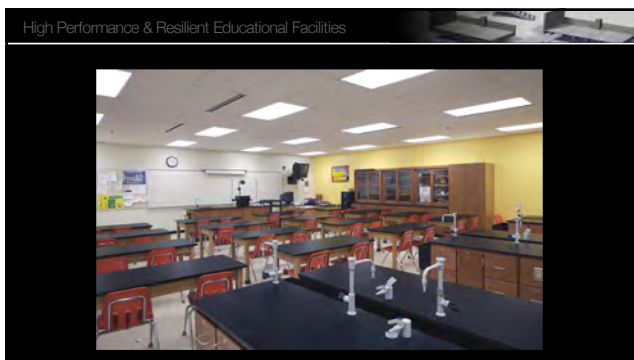
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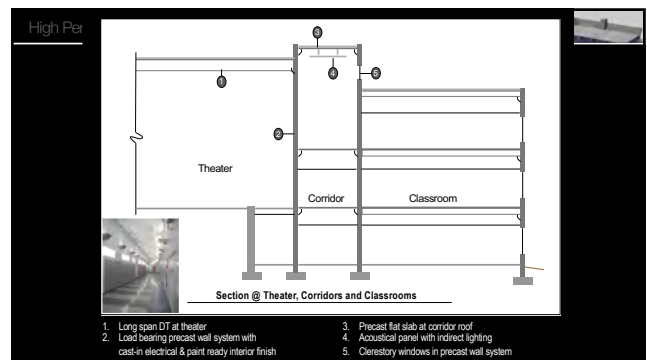
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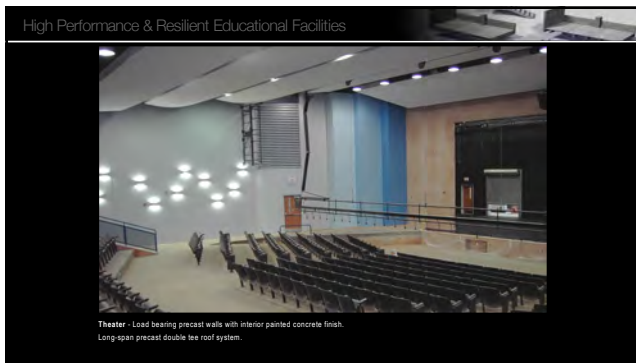
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High Performance & Resilient Educational Facilities

Precast Systems and Sound

Sound Transmission Class: STC Rating
Commonly designated as the ability of a barrier to reduce the intensity of airborne sound. Adding mass to a wall or floor ceiling system is a major factor in reducing sound.

Precast System	STC
• 6" Precast concrete wall	55
• 8" Precast concrete wall	58
• Double Tee with 2" topping	54
• 4" Flat slab	49
• 6" Flat slab	55

Figure 9.2.4.1 Sound transmission class as a function of weight of floor or wall

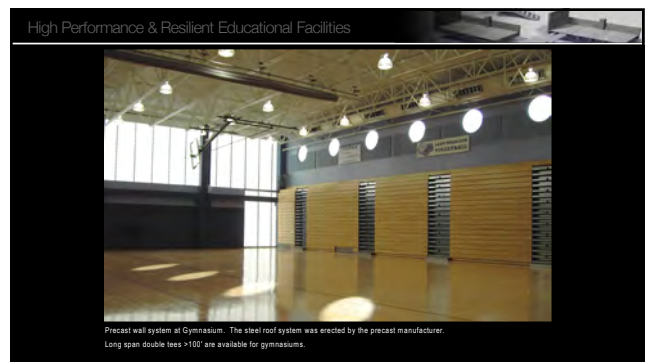
Note: When adding a sound absorbing material or air cavity the STC rating can typically be increased by 4-6.

Source: PCI Design Handbook - 5th Edition

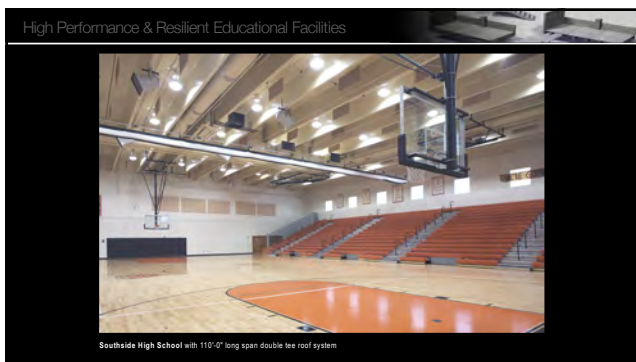
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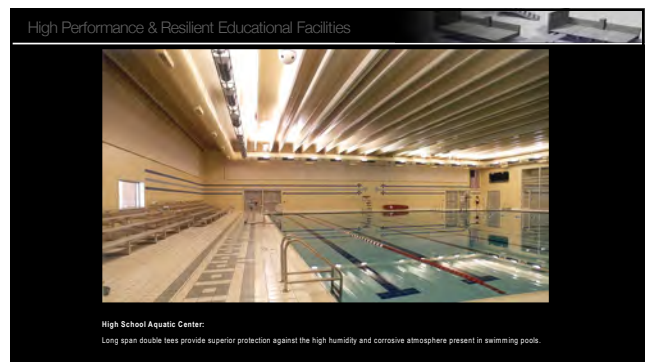
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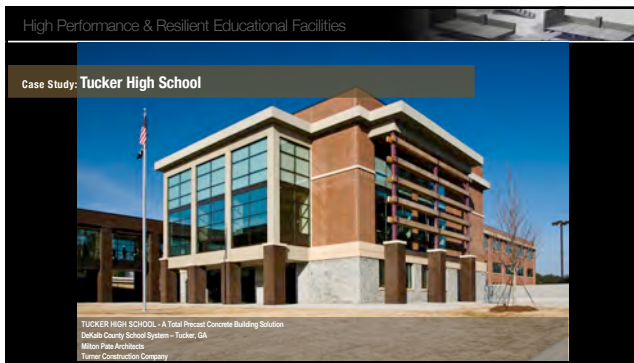
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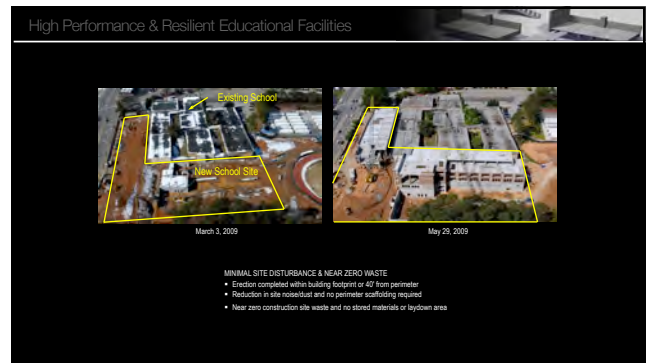
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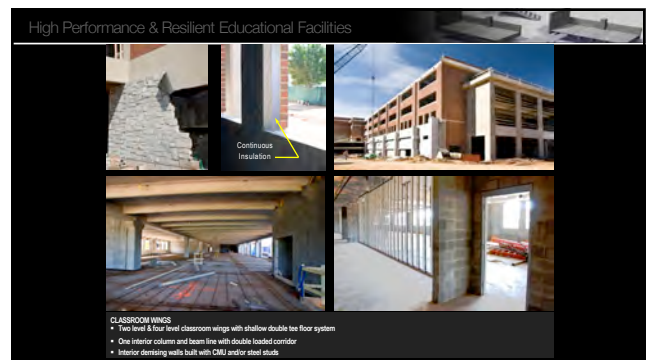
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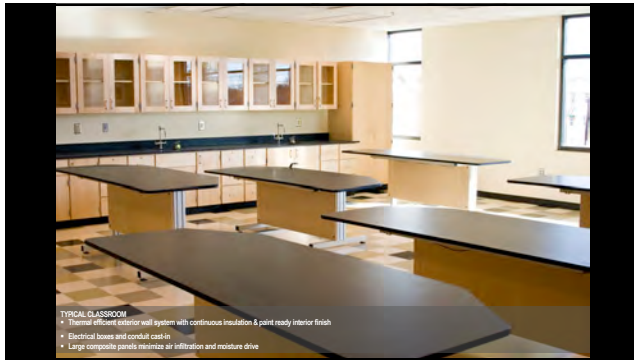
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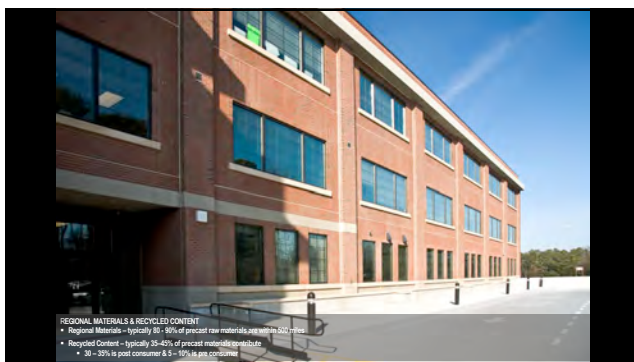
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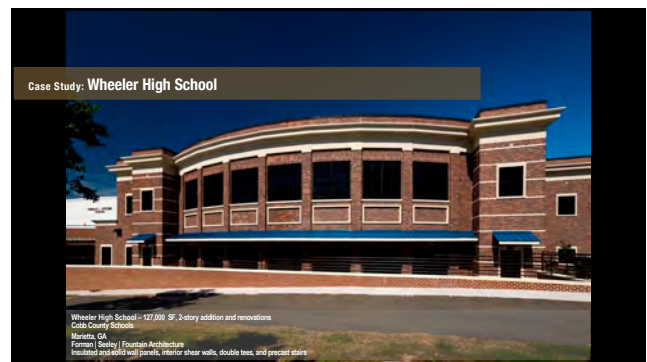
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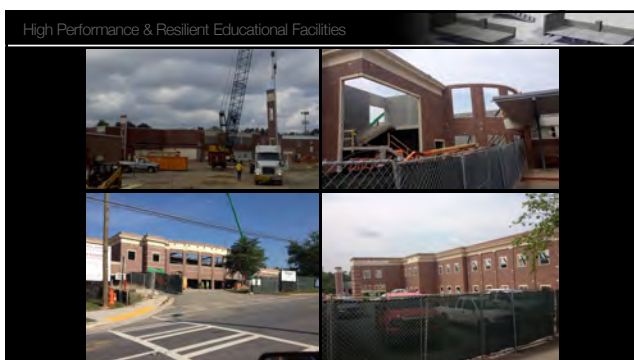
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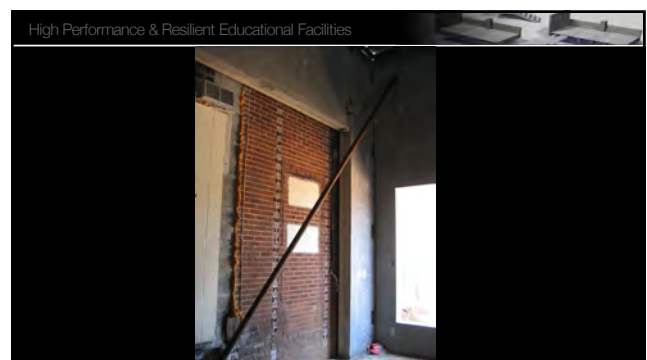
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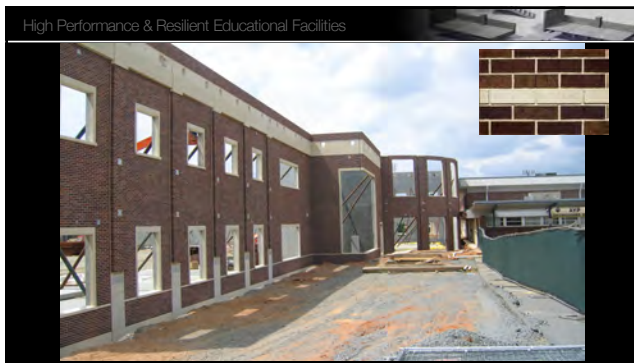
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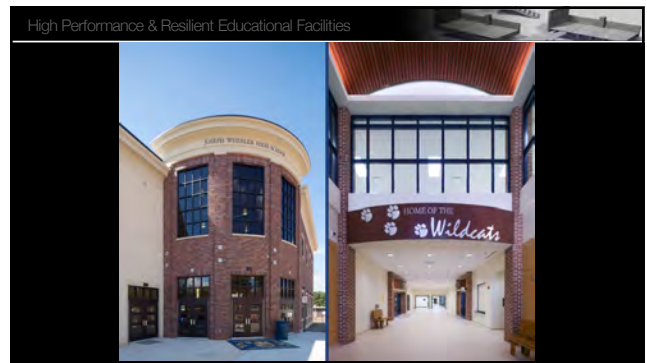
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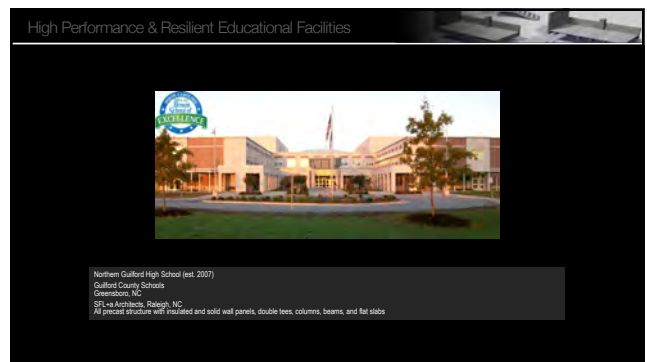
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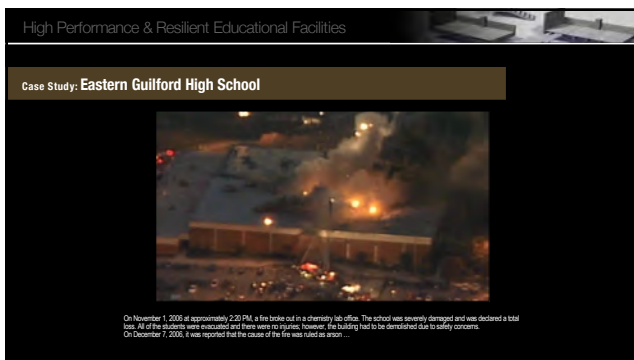
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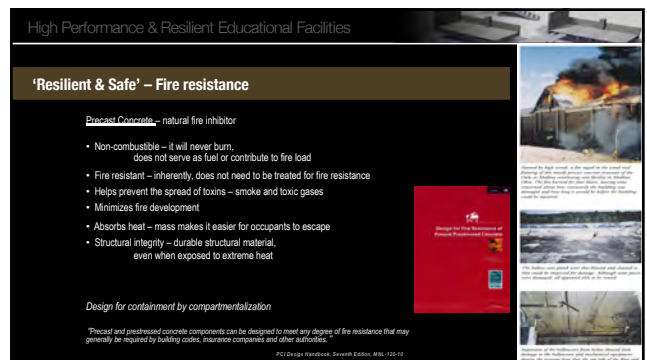
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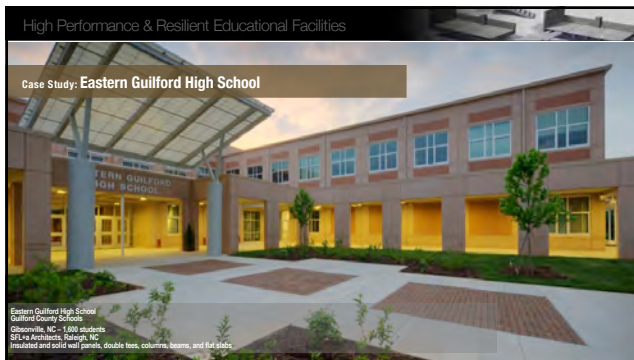
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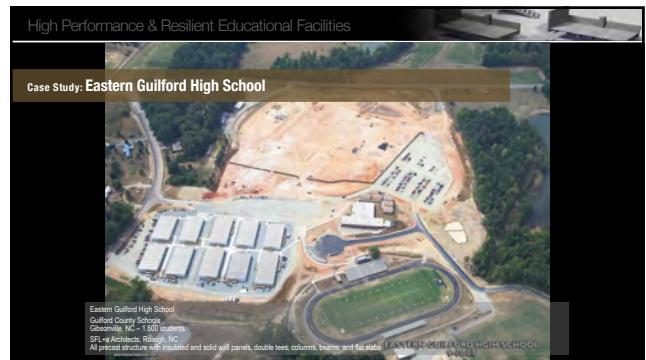
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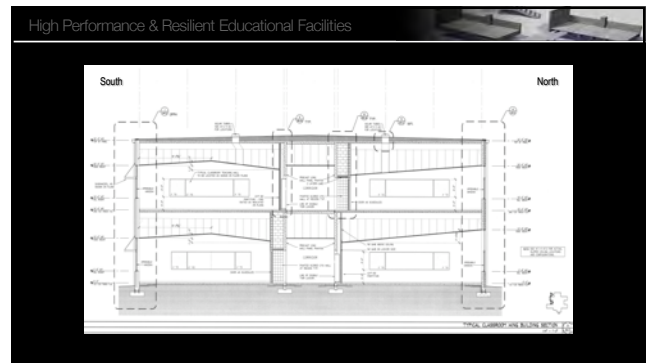
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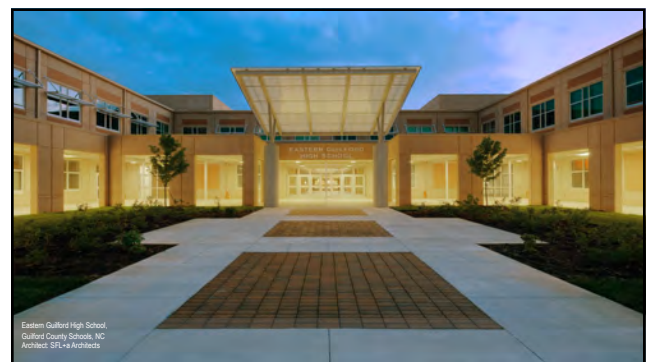
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High Performance & Resilient Educational Facilities

High Performance Attributes and Benefits of Precast

VERSATILE	EFFICIENT	RESILIENT
Aesthetic Versatility	Site Efficiency	Structure Durability
Virtually any color, form, and texture	Minimal site disturbance	Long service life
Facade integration	Negligible waste	Barrier wall system
Historic compatibility	Accelerated construction	Functional resilience
Structural Versatility	Energy and Operational Efficiency	Multi-Hazard Protection
Load-bearing envelopes	Scalable performance	Storm resistance
Economical sections	Thermally efficient	Earthquake resistance
Long open spans	Low life-cycle costs	Blast resistance
Use Versatility	Risk Reduction	Life Safety and Health
Recyclable	Design assist	Indoor environmental quality
Deconstructive reuse	Reduced detailing and trades	Passive fire resistance
Adaptive reuse	Enhanced profitability	Meets FEMA 361

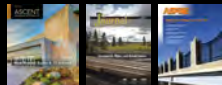
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High Performance & Resilient Educational Facilities

Resources

PCI and its regional affiliate Chapters offer - Ongoing industry support

- Publications – "Body of Knowledge" - *Most now FREE at PCI Publications/Bookstore*
 - Design handbooks
 - Technical literature
 - Guide Specifications
 - ASCENT – Free subscription www.ascenet.org
 - PCI JOURNAL
 - ASPIRE – Free subscription



Building Industry
Free subscription

Transportation Industry
Free subscription

- Websites - www.pci.org and www.pccci.org

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THANK YOU

info@gccpci.org




A Division of the Precast/Prestressed Concrete Institute

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