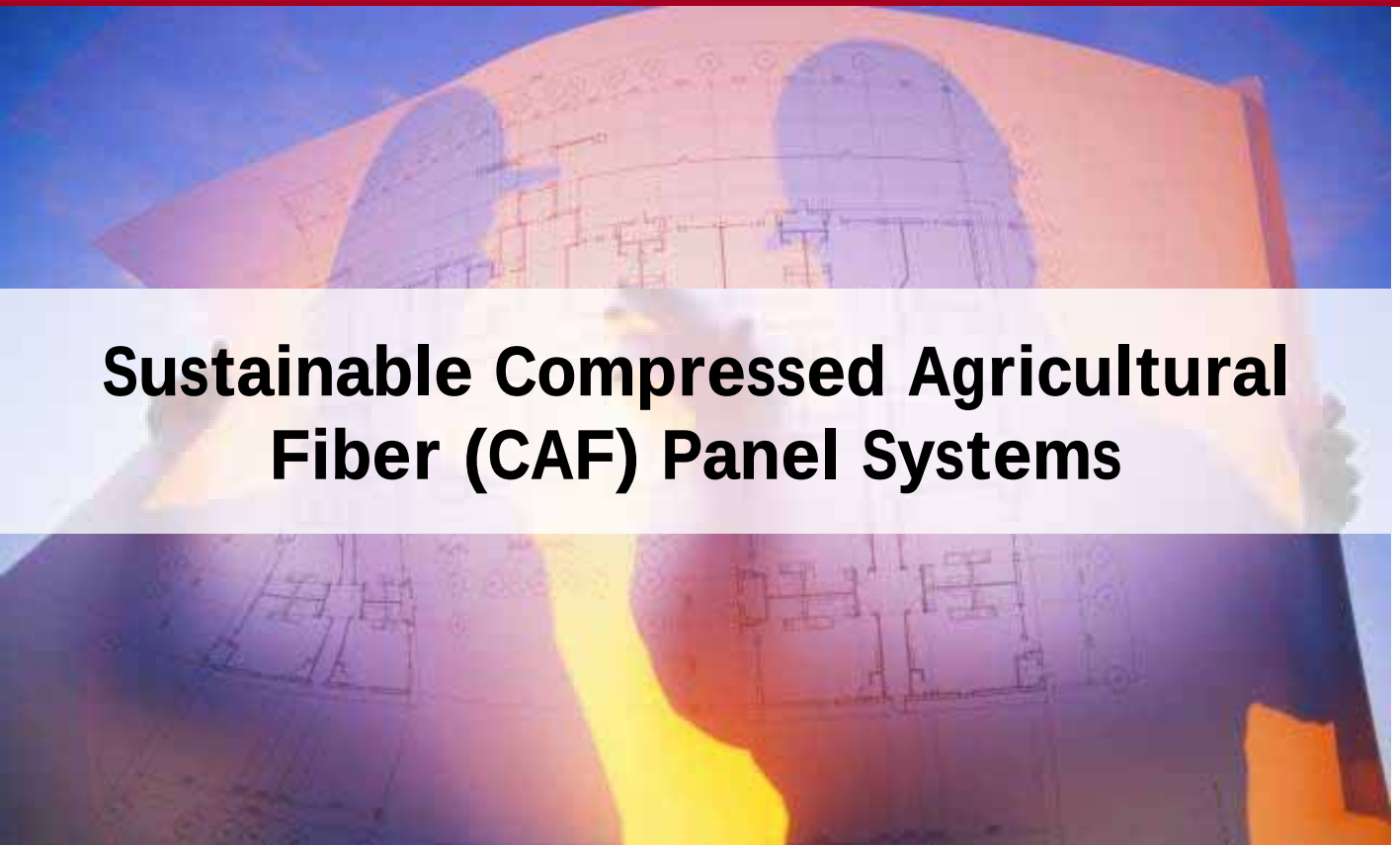

Sustainable Compressed Agricultural Fiber (CAF) Panel Systems

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Sustainable Compressed Agricultural Fiber (CAF) Panel Systems

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Description: Provides an overview of the features, manufacturing process, and economical and environmental benefits of Compressed Agricultural Fiber (CAF) panel systems.

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Learning Objectives

Upon completing this course, you will be able to:

- define CAF panel construction and its applications
- discuss the sustainable manufacturing process of CAF panels
- contrast traditional building methods vs. building with CAF panels in terms of time/cost savings and environmental considerations, and
- state the performance characteristics and green benefits of designing with CAF panel systems.

Table of Contents

Click on title to view

What are Compressed Agricultural Fiber Panels?

Introduction

In the wake of the green movement, today's designers/architects are looking for sustainable building solutions that are not only environmentally responsible, but also suit the needs and budget of the client.

Advances in technology have resulted in the ability to transform renewable agricultural resources, such as wheat and rice straw, into environmentally engineered Structural Insulated Panels (SIPs).

Sold as a waste product, agricultural fiber is readily available in abundance across the United States, adding a second cash crop for farmers and further contributing to the domestic economy.

Straw Bales

A Green and Sustainable Construction Alternative

Offering superior performance and lower costs, CAF panel structural systems easily substitute for traditional construction, including blocks, tilt wall, ICFs, poured in place concrete walls, steel and wood construction.

All Green SIPs Prototype: Wachovia Corp. Branch Project, Dallas, Texas

Applications of CAF Panel Systems

Compressed Agricultural Fiber (CAF) panels are used for structural walls, curtain walls, floors, and flat roofs in a variety of residential, multi-family, and commercial buildings.

Construction of Post Office: Raleigh, N.C.

Architect's Home in NJ built with CAF Panels

Panel Sizes

CAF panels are available in two thicknesses: 4-3/8" (9 lbs./sq. ft.) and 7-7/8”(14 lbs./sq. ft.). They are pre-engineered to specific building requirements (including all openings) up to 9'x24'.

Four-Plex, Electra, Texas: Constructed with Environmentally-Friendly CAF Panels

Load Bearing Panels

SIPs are structural up to 24' in height and can span 22' as a roof or floor application. Subsequent slides present load tables, including transverse, axial compression, and shearwall racking for 4-3/8” and 7-7/8” panels.

Example of CAF Panel Construction: United States Post Office, Fort Worth, Texas

Example of Transverse Loads for Wall Panels: 4” and 8” Panel

TRANSVERSE LOAD TABLE FOR WALL PANELS[3,4]

4-3/8" thick panel

8' PANEL HEIGHT

MID-HEIGHT DEFLECTION	PROFILE BOARD SPACING[1]		
	4'-1 3/4"	8'-1 3/4"	Exceeds 8'-1 3/4"[2]
H/120	59 psf	44 psf	28 psf
H/240	34 psf	27 psf	19 psf
H/360	24 psf	19 psf	14 psf
H/600	14 psf	11 psf	9 psf
H/720	11 psf	9 psf	7 psf

[1] The Agriboard core is fabricated in sections that are 4'-0" wide. Intermediate profile boards are 1-3/4" wide x 3-1/2" deep. This results in intermediate profile board spacings of 4'-1 3/4" and 8'-1 3/4" for 8' high panels.

[2] Pertains to panels longer than the noted dimension, constructed without intermediate profile boards.

[3] All heights shown are simple span conditions.

[4] No increase is permitted to the tabulated values for wind or seismic loading conditions.

TRANSVERSE LOAD TABLE FOR WALL PANELS[4,5]

7-7/8" thick panel

8' PANEL HEIGHT

MID-HEIGHT DEFLECTION	PROFILE BOARD SPACING[1]		
	4'-3 1/2"	8'-3 1/2"	Exceeds 8'-3 1/2"[2]
H/120	165 psf	115 psf	60 psf
H/240	152 psf	96 psf	35 psf
H/360	98 psf	62 psf	24 psf
H/600	53 psf	35 psf	16 psf
H/720	42 psf	29 psf	14 psf

[1] The Agriboard core is fabricated in sections that are 4'-0" wide. For 8' high panels, the core is oriented with the 4'-0" dimension horizontal. The intermediate profile boards are 3-1/2" wide x 7" deep. This results in intermediate profile board spacings of 4'-3 1/2" and 8'-3 1/2" for 8' high panels. Refer to footnote 3 for panel heights exceeding 8'.

[2] Pertains to panels longer than the noted dimension, constructed without intermediate profile boards.

[3] For panels exceeding 8' in height, the standard panel width is 8'-0". The Agriboard core is oriented with the 4'-0" dimension vertical.

[4] All heights shown are simple span conditions.

[5] No increase is permitted to the tabulated values for wind or seismic loading conditions.

PANEL HEIGHTS EXCEEDING 8' (PANEL WIDTH = 8'-0")[3]

PANEL HEIGHT	MID-HEIGHT DEFLECTION	1 Intermediate Profile Board per Panel	No Intermediate Profile Boards
10'	H/120	150 psf	105 psf
	H/240	136 psf	87 psf
	H/360	88 psf	57 psf
	H/600	48 psf	32 psf
	H/720	38 psf	26 psf
12'	H/120	134 psf	96 psf
	H/240	120 psf	78 psf
	H/360	78 psf	51 psf
	H/600	42 psf	29 psf
	H/720	34 psf	24 psf
14'	H/120	119 psf	87 psf
	H/240	104 psf	69 psf
	H/360	67 psf	45 psf
	H/600	37 psf	26 psf
	H/720	30 psf	21 psf
16'	H/120	104 psf	78 psf
	H/240	88 psf	60 psf
	H/360	57 psf	39 psf
	H/600	32 psf	23 psf
	H/720	25 psf	18 psf
18'	H/120	88 psf	69 psf
	H/240	73 psf	51 psf
	H/360	47 psf	33 psf
	H/600	26 psf	19 psf
	H/720	21 psf	16 psf
20'	H/120	73 psf	60 psf
	H/240	57 psf	43 psf
	H/360	37 psf	28 psf
	H/600	21 psf	16 psf
	H/720	17 psf	13 psf
22'	H/120	57 psf	51 psf
	H/240	41 psf	34 psf
	H/360	26 psf	22 psf
	H/600	15 psf	13 psf
	H/720	12 psf	11 psf
24'	H/120	42 psf	42 psf
	H/240	25 psf	25 psf
	H/360	16 psf	16 psf
	H/600	10 psf	10 psf
	H/720	8 psf	8 psf

Example of Transverse Loads for Floor and Roof Panels: 8” Panel

TRANSVERSE LOAD TABLE FOR FLOOR AND ROOF PANELS

7-7/8" thick panel

PANEL SPAN	ALLOWABLE LIVE LOAD		ALLOWABLE ADDITIONAL DEAD PLUS LIVE LOAD	
	No Intermediate Profile Boards	1 Intermediate Profile Board every 4'-3 1/2"	No Intermediate Profile Boards	1 Intermediate Profile Board every 4'-3 1/2"
8'	62 psf	98 psf	82 psf	138 psf
10'	57 psf	88 psf	73 psf	124 psf
12'	51 psf	78 psf	64 psf	106 psf
14'	67 psf	67 psf	55 psf	90 psf
16'	39 psf	57 psf	46 psf	74 psf
18'	33 psf	47 psf	37 psf	59 psf
20'	28 psf	37 psf	29 psf	43 psf
22'	20 psf	26 psf	20 psf	27 psf
24'	11 psf	11 psf	11 psf	11 psf

1 All spans shown are simple span conditions.
2 Allowable mid-span deflection is considered L/360 for the live load and L/240 for the dead plus live load.
3 The Agri-Core™ is fabricated in sections that are 4' wide. For 8' span length panels, the core is oriented with the 4' dimension horizontal. For panels exceeding 8' span, the Agri-Core™ is oriented with the 4' dimension vertical.

Example of Combined Transverse / Axial Compression Loads: 4” Panel

8' PANEL HEIGHT

PROFILE BOARD SPACING[5]	TRANSVERSE WIND LOAD									
	5 psf	10 psf	15 psf	20 psf	25 psf	30 psf	35 psf	40 psf	45 psf	50 psf
4'-1 3/4"	1,712	1,565	1,418	1,272	1,125	978	831	684	537	391
8'-1 3/4"	1,514	1,314	1,113	913	713	513	312	112		
EXCEEDS 8'-1 3/4"	1,287	1,009	732	455	177					
	H/600	H/360	H/240	H/120						

[1] Axial load may be applied by roof or floor joists spaced at 2'-0" on center maximum. Bearing area of framing members must be equal to or greater than 6.5 in.[2]

[2] All heights shown are simple span.

[3] No increase is permitted to the tabulated values for wind or seismic loading conditions.

[4] Loading shown is for panels with no openings. Openings in panels must be engineered.

[5] Profile boards are 1-3/4 wide x 3-1/2" deep Timberstrand PSL oriented vertically.

Example of Combined Transverse / Axial Compression Loads: 8” Panel

TABLES FOR COMBINED TRANSVERSE AND AXIAL LOADS[1,2,3,4]

ALLOWABLE UNIFORM AXIAL LOADS (PLF) FROM FLOOR OR ROOF FRAMING MEMBERS AT 12" O.C.

7-7/8" thick wall panels

8' PANEL HEIGHT

PROFILE BOARD SPACING[5]	TRANSVERSE WIND LOAD									
	5 psf	10 psf	15 psf	20 psf	25 psf	30 psf	35 psf	40 psf	45 psf	50 psf
4'-3 1/2"	3,760	3,643	3,527	3,410	3,293	3,176	3,060	2,943	2,826	2,709
8'-3 1/2"	2,956	2,823	2,690	2,556	2,423	2,290	2,157	2,024	1,891	1,758
EXCEEDS 8'-3 1/2"	2,065	1,884	1,704	1,523	1,343	1,162	982	801	621	440
	H/720		H/600	H/360	H/240			H/120		

PANEL HEIGHTS EXCEEDING 8' (PANEL WIDTH 8'-0") WITH NO INTERMEDIATE PROFILE BOARDS

HEIGHT	TRANSVERSE WIND LOAD									
	5 psf	10 psf	15 psf	20 psf	25 psf	30 psf	35 psf	40 psf	45 psf	50 psf
10'	3,692	3,551	3,411	3,271	3,130	2,990	2,850	2,709	2,569	2,429
12'	3,501	3,335	3,170	3,004	2,838	2,672	2,506	2,340	2,175	2,009
14'	3,311	3,119	2,928	2,737	2,546	2,354	2,163	1,972	1,780	1,589
16'	3,120	2,903	2,687	2,470	2,253	2,036	1,820	1,603	1,386	1,169
18'	2,930	2,687	2,445	2,203	1,961	1,718	1,476	1,234	992	749
20'	2,739	2,472	2,204	1,936	1,668	1,401	1,133	865	597	330
22'	2,549	2,256	1,962	1,669	1,376	1,083	790	498	203	
24'	2,358	2,040	1,721	1,402	1,084	765	446	127		
	H/720	H/600	H/360	H/240		H/120				

PANEL HEIGHTS EXCEEDING 8' (PANEL WIDTH 8'-0") WITH INTERMEDIATE PROFILE BOARD[5]

HEIGHT	TRANSVERSE WIND LOAD									
	5 psf	10 psf	15 psf	20 psf	25 psf	30 psf	35 psf	40 psf	45 psf	50 psf
10'	4,466	4,333	4,201	4,068	3,936	3,803	3,671	3,538	3,406	3,273
12'	4,165	4,006	3,847	3,688	3,528	3,369	3,210	3,051	2,892	2,733
14'	3,864	3,678	3,492	3,307	3,121	2,935	2,749	2,564	2,378	2,192
16'	3,563	3,350	3,138	2,926	2,713	2,501	2,289	2,076	1,864	1,652
18'	3,262	3,023	2,784	2,545	2,306	2,067	1,828	1,589	1,350	1,111
20'	2,960	2,695	2,429	2,164	1,898	1,633	1,367	1,102	836	571
22'	2,659	2,367	2,075	1,783	1,491	1,199	907	615	323	31
24'	2,358	2,040	1,721	1,402	1,084	765	446	127		
	H/720	H/600	H/360	H/240		H/120				

[1] Bearing area of framing members must be equal to or greater than 11.8 in^2.

[2] All heights shown are simple span.

[3] No increase is permitted to the tabulated values for wind or seismic loading conditions.

[4] Loading shown is for panels with no openings. Openings in panels must be engineered.

[5] Profile boards are 3-1/2" wide x 7" deep Timberstrand PSL oriented vertically. For panel heights greater than 8', intermediate profile board is centered between panel edges.

Example of Shearwall Racking Loads

Allowable shearwall racking loads are listed below for 4-3/8” and 7-7/8” panels.

Allowable Shearwall Racking Loads[1, 2] (pif)	
Panel Thickness (inches)	Allowable Racking Load (pif)
4-3/8”	575
7-7/8”	1115

For SI: 1 inch = 25.5 mm, 1 foot = 304.8 mm, 1 pif = 14.6 N/m.

[1] Maximum panel height-to-width ratio is 1:1.

[2] The orientation of the oriented strand board (OSB) facing material is with the strength axis of the OSB parallel to the 4-foot panel side.

Non-Load Bearing Panels

Non-load bearing panels can replace structural steel, reducing the overall building costs. As well, a no-bearing cladding or curtain wall can reduce X bracing, girts, and construction time. With this type of construction, the carriage head bolts through the CAF panel to the steel frame.

The Production Process

Introduction

In this section of the course, a review of the manufacturing process of CAF structural insulated panels is presented.

With all the manufacturing completed in a controlled setting, and all panel openings cut out by computer to the exact specifications of the client, building with CAF structural insulated panels translates into zero job site waste.

This fact minimizes land fill contribution, as well as produces a safer job site.

Storage of Raw Material

To begin, the raw material is stored in a moisture controlled environment until ready for the milling process. Next, the 1000 lb. bales of straw are conveyed to the cleaning station where the straw is conditioned for milling.

Straw Bale Feed Conveyor

Cleaning Station

After the raw material is cleaned to remove dirt, debris, and insects, it is then separated for proper lengths and condition. An all-natural pest and mold resistant borate is blended into the straw, then heat and compression is added to begin the bonding process.

Straw Enters De-flaker and Straw Walker

Electrical Chase

For conduit installation, the ram face die produces the electrical chase that runs the entire length of the panel in the straw core.

Note that the chases are 1” in diameter and are spaced 8” – 8” – 16” – 8” – 8”.

Control Center

Throughout the CAF production process, the control center is responsible for the following:

- the monitoring of the moisture content for density control
- the borate addition for pest/mold resistance
- the temperature for sterilization and bonding
- the ram pressure for panel strength
- the panel thickness for dimensional accuracy

Compactor Control Center

Panel Cutter

Next, the CAF is covered in heat activated 69 lb. craft paper, cooled, and cut to the proper length as dictated by the application.

Panel Cutter and Density Checkpoint

Profile Material

The subsequent step in the construction of the panel is adding the CAF core to the profile material. Laminated beam is the profile material that surrounds the panel, providing tremendous strength, as indicated in the table below that contrasts the properties of #2 Spruce Pine Fir and 1.5E Laminated Beam.

	Bending Stress psi	Shear Stress psi	Compressive Stress	Mod of Elasticity
#2 Spruce Pine Fir	875	135	1,150	1,400,000
1.5E Laminated Beam	2,275	400	1,950	1,500,000
Laminated Beam vs. Spruce Pine Fir	257%	296%	169%	107%

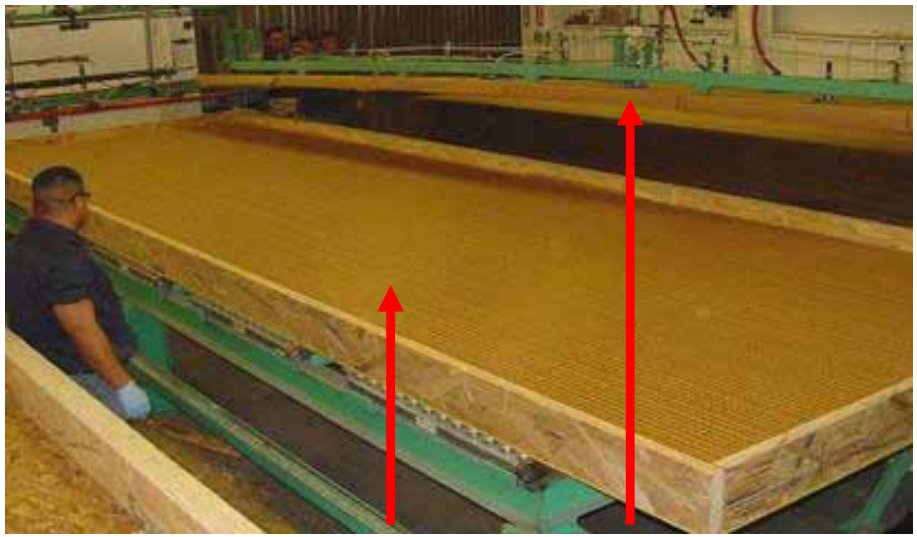
First Adhesive Application

The "pan" of the SIP is created and the glue is applied in preparation to receive the CAF.

8” Thick Panel Production

When producing a 8" thick panel, two CAF slabs are required. The first is laid in-place, then a second layer of glue is applied for the bonding of the second slab of CAF.

1st CAF Layer Set Into Pan



2nd Adhesive Layer Applied

2nd CAF Layer

Oriented Strand Board Layer

A third layer of adhesive is applied before the cover, or top, of the SIP is installed. The cover of the SIP is made from Oriented Strand Board (OSB). Adhesive is also applied to the profile edges for strength and waterproofing.

3rd Adhesive Layer Applied Between the CAF Core and the Top OSB Layer

Panel Assembly and Curing

The layer of OSB is glued, squared, and then nailed into place and made ready for the press (left image). Two panels at a time are loaded into the pod press and cured for 45 minutes under 6,500 psi (right image). Once cured, the panels are a complete composite material.

Final Panel Assembly

Panel Adhesive Layers Cure in Pod Press

Panel Penetrations

Cured panels are then sent to the Computer Numeric Control (CNC) Router Machine which cuts out all the panel penetrations, such as windows, doors, electrical boxes, roof drains, etc. Note that these cuts are made to within 1/8" tolerance. Prior to shipping, the SIPs are inspected, numbered, and certified squared.

Summary of Production Process

Given the manufacturing process and the attributes of the CAF, laminated beam, and OSB, a CAF panel system has superior properties.

A review of the performance characteristics, as well as the features and benefits of CAF panel systems, is presented in the next section of the course.

Panels Staged for Shipping

Speed of Construction

Introduction

CAF panel structural systems offer the fastest known construction method, averaging one day to erect residential walls.

Note that it takes typically two to four days to put up a 5,000 sq. ft. structure, which reduces the time it takes to open a building of this size by roughly four weeks.

The installation of a CAF system uses laborers, not framers, further reducing labor costs. CAF systems are pre-engineered to eliminate jobsite waste, meaning no costly disposal.

50K Sq. Ft. Project

Using CAF panels engineered to meet exact design requirements, this 50,000 sq. ft. project was clad in five days.

Man-hour Comparison

	National Construction Estimator	R.S. Means
Precast tiltwall 8"	146	216
2" Rigid Insulation (2 layers)	105	105
Total	**251**	**321**
Concrete Block 8" X 8" X 16"	576	532
2" Rigid Insulation (2 layers)	105	105
Total	**681**	**637**
Metal Framing 4"	134	146
Metal Framing 6"	168	150
Insulation	29	29
1/2" Sheathing (exterior)	76	67
1/2" Drywall (unfinished)	33	38
1" Extruded Insulation (2X6 only)	48	52
Total 4"	**272**	**280**
Total 6"	**354**	**336**
Wood Framing Total 4"	101	96
Wood Framing Total 6"	149	106
Insulation	29	29
1/2" Sheeting (exterior)	76	67
1/2" Drywall (unfinished)	33	38
1" Rigid Extruded Insulation (2X6 only)	48	52
Total 4"	**239**	**230**
Total 6"	**335**	**292**

CAF Panels: 80 man-hours based on actual job performance

This table compares the man-hours needed for various construction methods based on a 50'x100' building, 16' tall, 4,800 sq. ft. of wall area, with no windows or doors. Note that no supervisory hours are included.

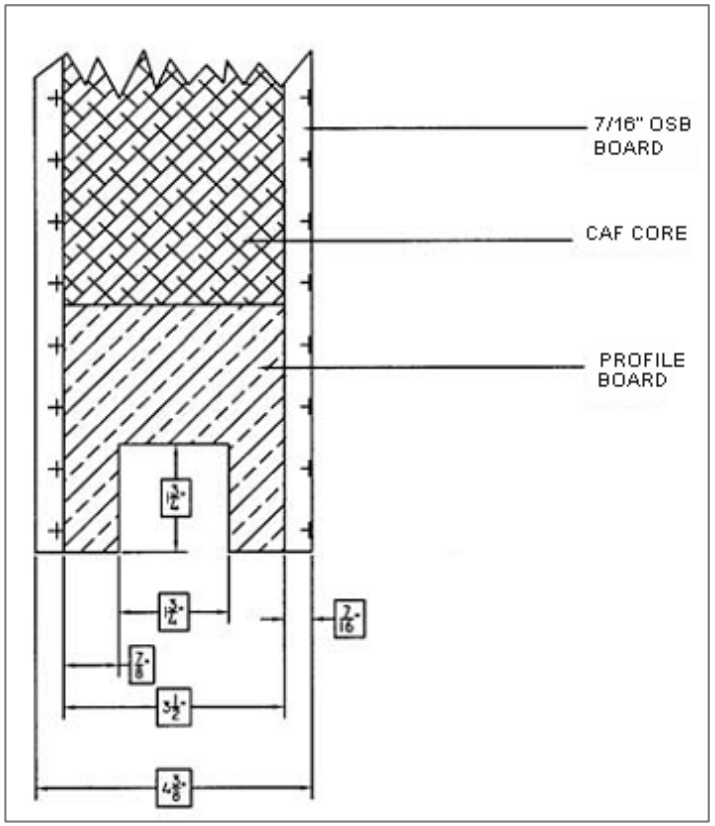
Man-hour Comparison cont'd...

Results of the man-hour comparison clearly indicate that building with CAF panels saves substantial labor time.

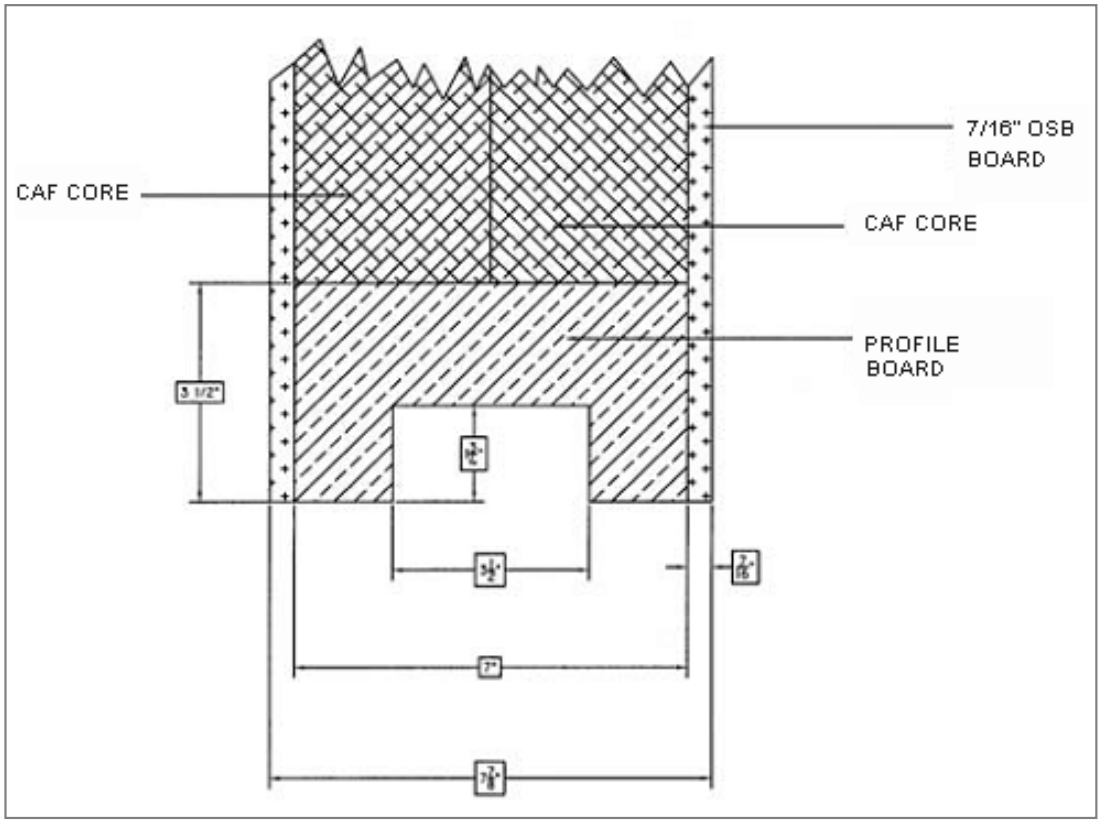
Traditional Construction Materials	CAF Panels
Metal Framing 4"	3.5 times faster
Precast Tiltwall Wood Framing 4"	3 times faster
Wood Framing 6" Metal Framing 6"	4 times faster
Concrete Block	8 times faster

Panel Keyway Geometry

Below are 4” and 8” panel keyway illustrations showing the OSB, CAF core, and profile board. Pictured on the next slide is an illustration of a wall-to-wall keyway connection.

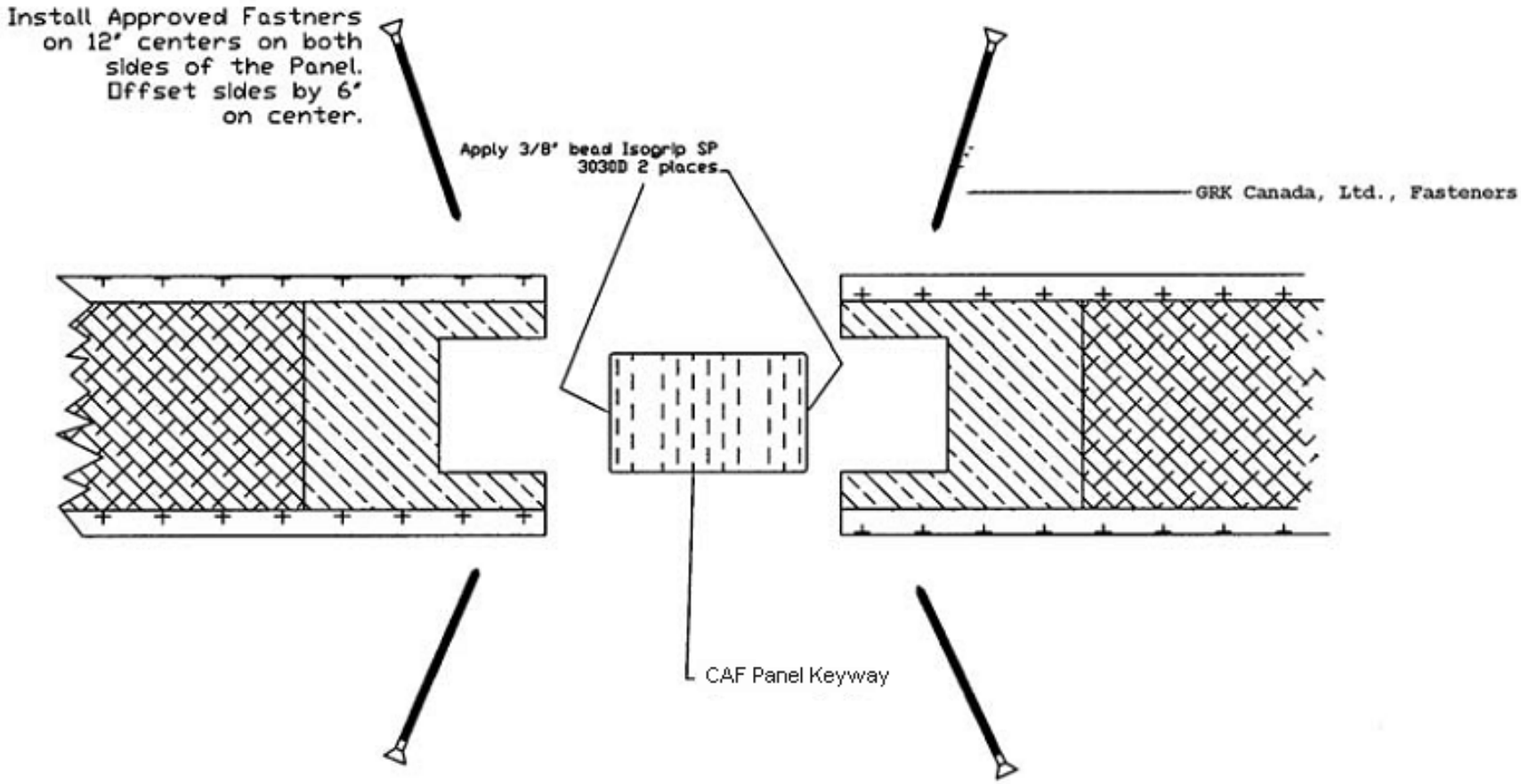


4” Panel Keyway Geometry



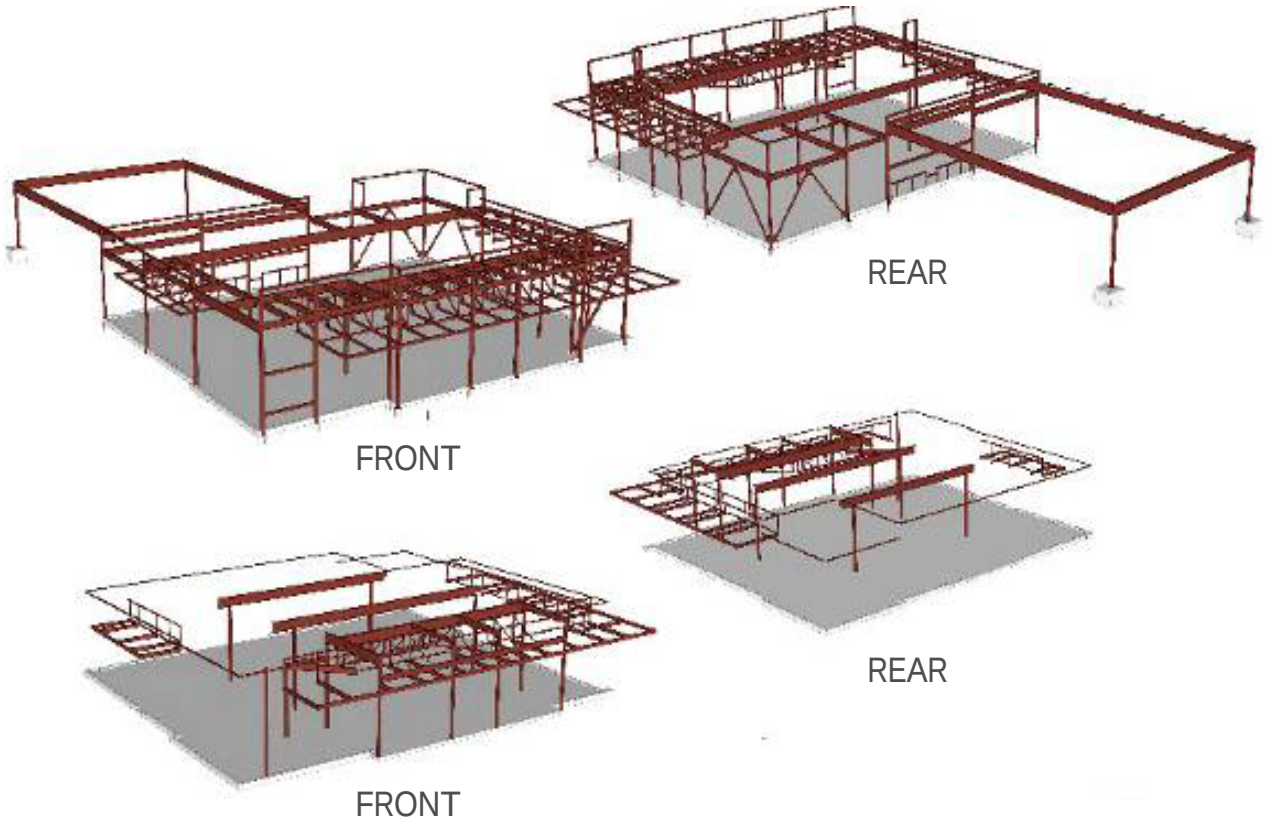
8” Panel Keyway Geometry

Wall-to-Wall Keyway Connection



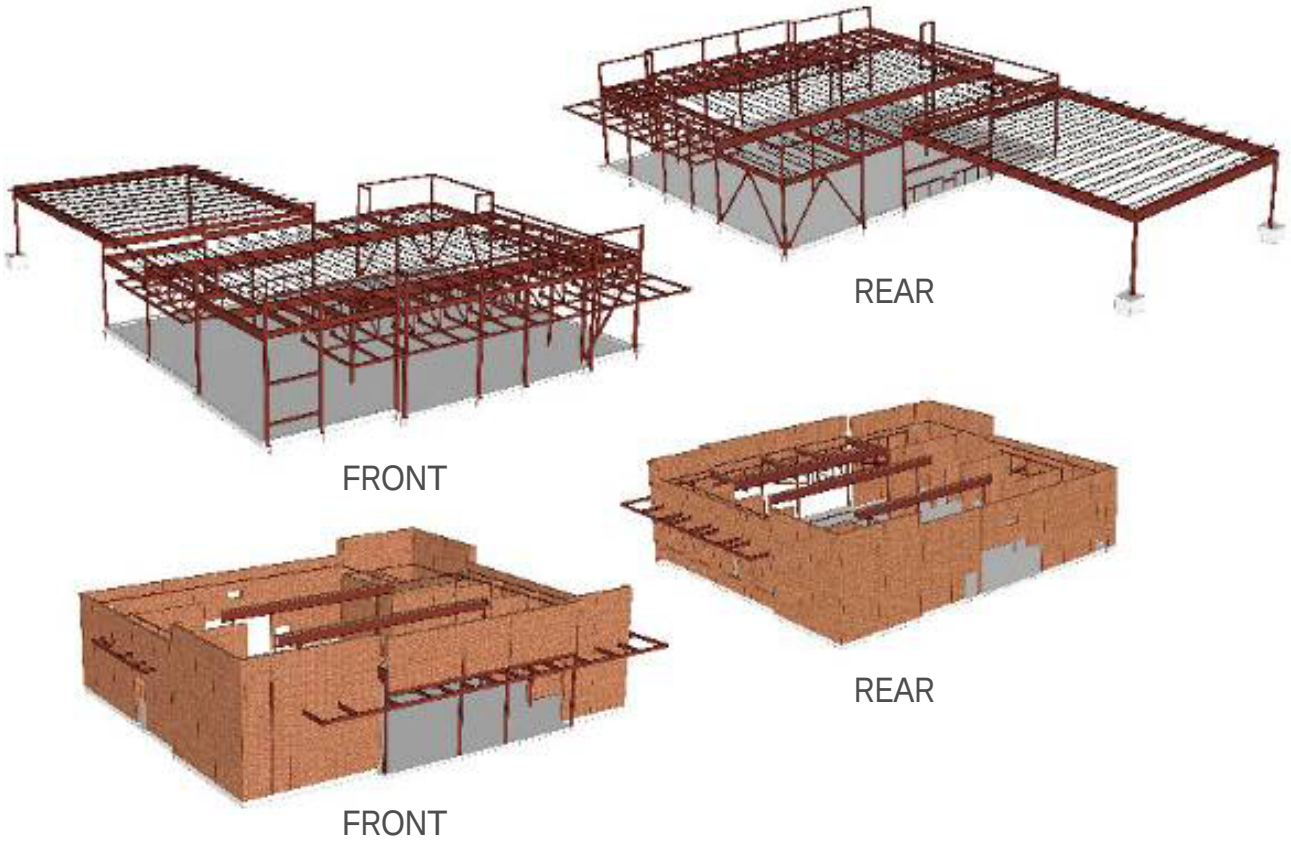
Conventional Steel Frame vs. CAF Panel Construction

The remaining slides in this section compare two methods of constructing a low rise commercial building. Traditional framing is illustrated in the top images (front and rear) while the lower images represent the same building built with CAF panels. At this stage, both buildings have the steel columns and beams erected, but note how much more steel is required with the traditional method.



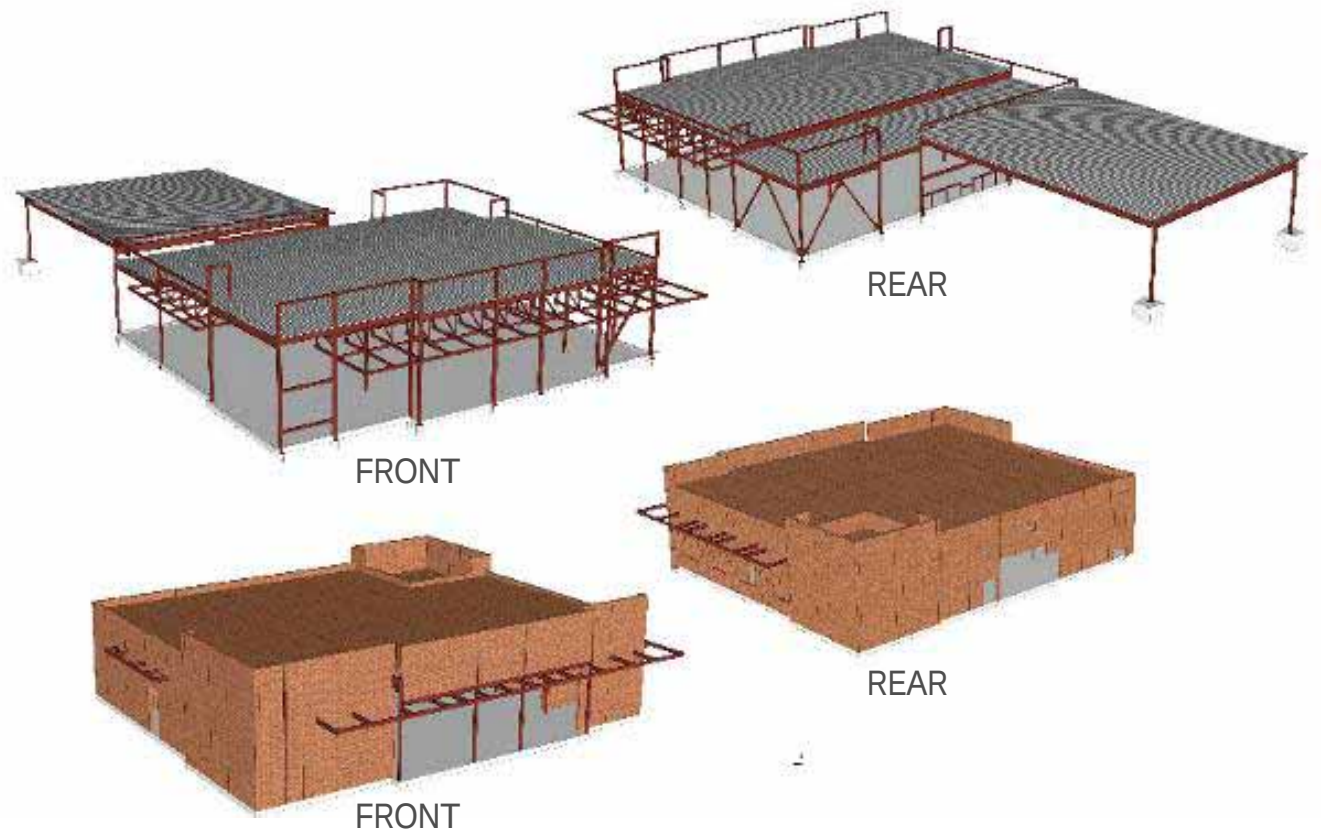
Conventional Steel Frame vs. CAF Panel Construction cont'd…

At the same time that the CAF panel building has moved on to installing wall panels (which includes structure and sheathing) the traditionally-built structure is still being framed.



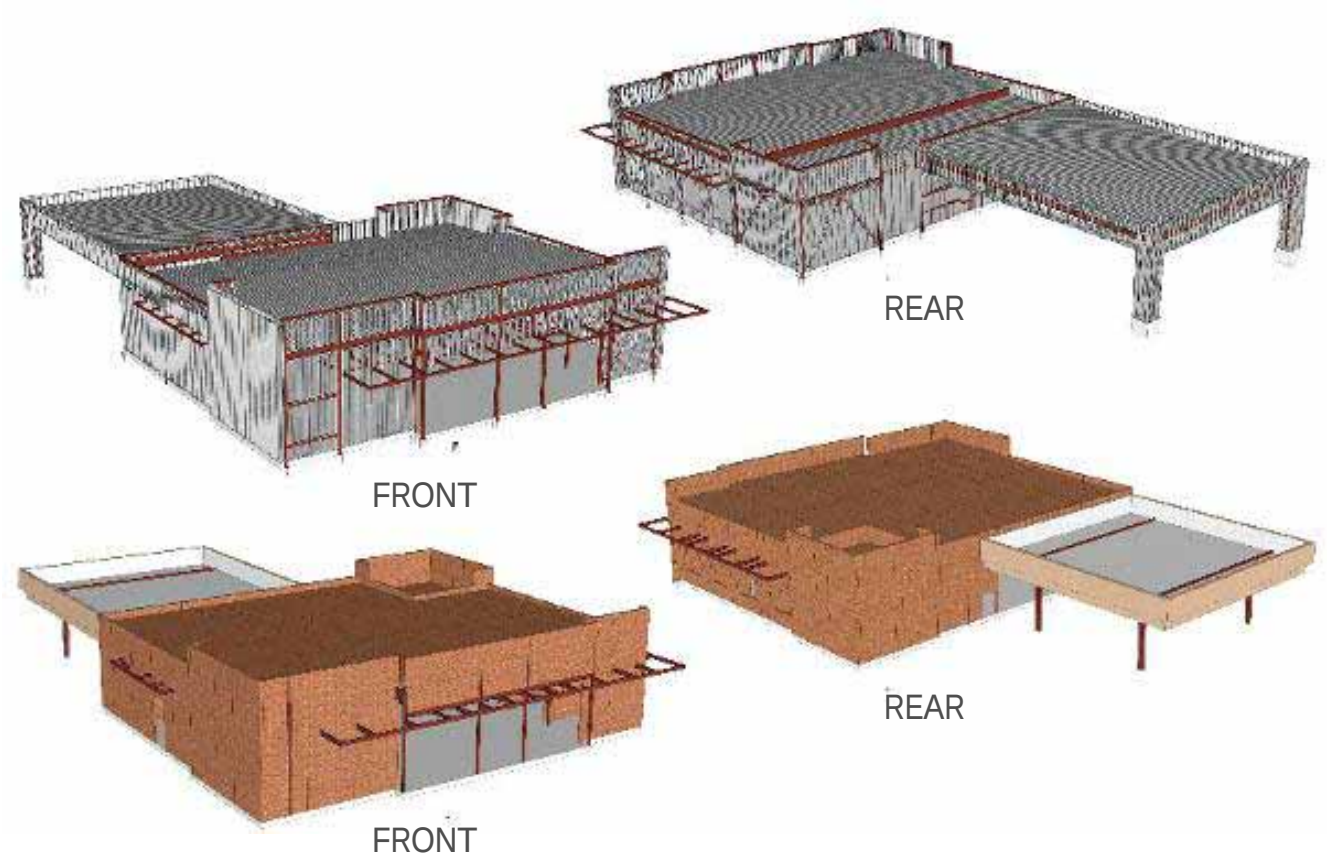
Conventional Steel Frame vs. CAF Panel Construction cont'd…

The traditional building is still framing steel and is also doing the roof deck while the roof and wall panels are being installed on the CAF panel building.



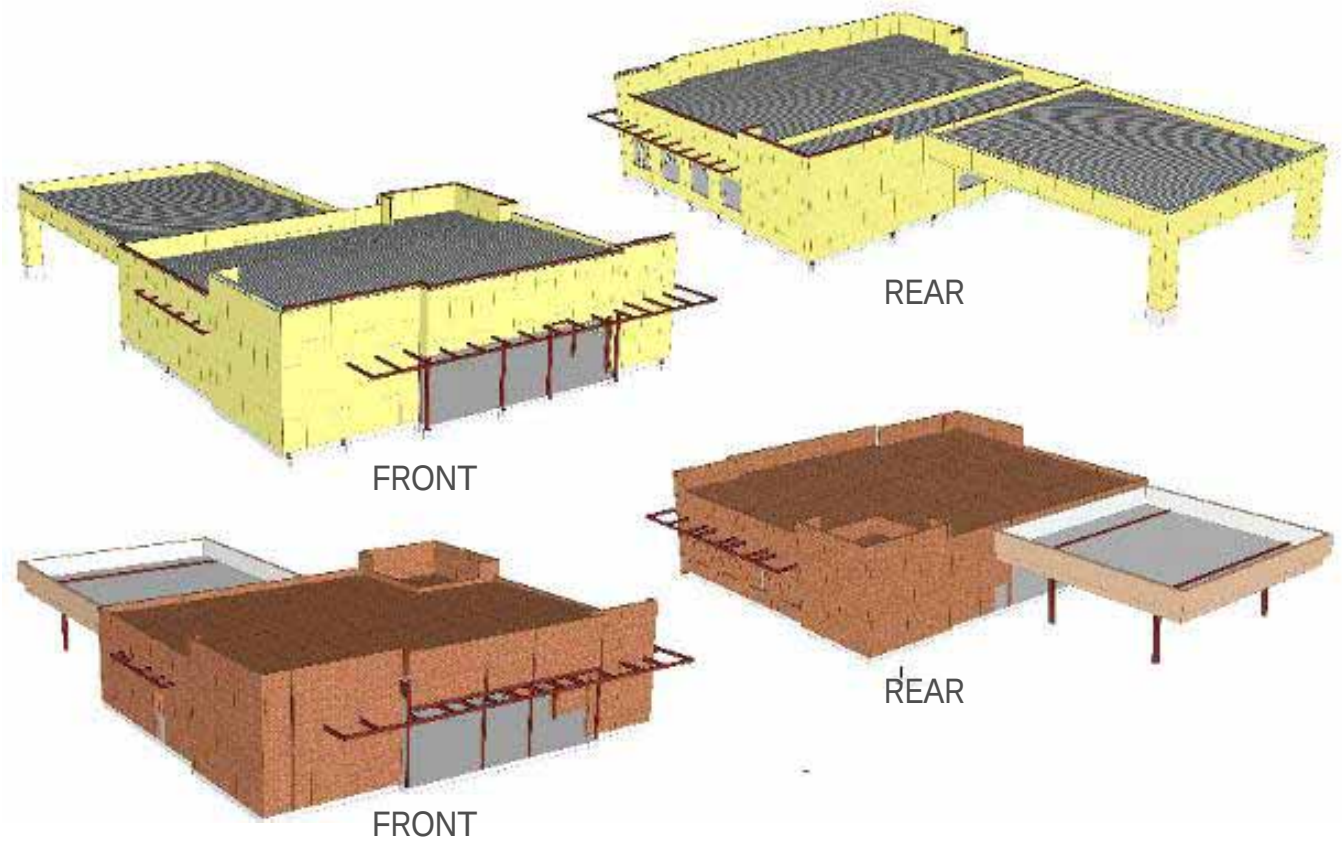
Conventional Steel Frame vs. CAF Panel Construction cont'd…

While framing is still ongoing with the traditional building, the CAF panel structure is at the complete dry-in stage.



Conventional Steel Frame vs. CAF Panel Construction cont'd…

At the same time that the traditional building is reaching dry-in stage, the structure built with CAF panels is fully constructed, resulting in a four week savings in total construction time and approximately 40% structural steel reduction.



Features and Benefits

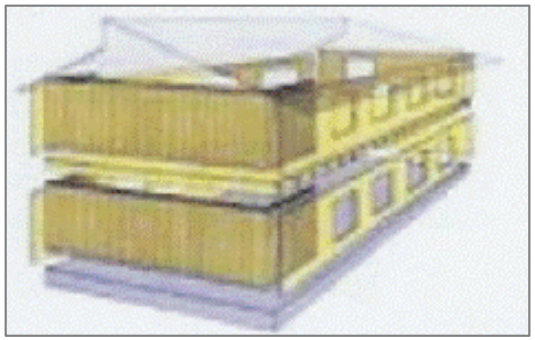
Introduction

As well as speed of construction, CAF panels offer many advantages over traditional materials.

In this section of the course, a review of the features and benefits of CAF panels is presented, beginning with thermal performance.

Thermal Performance

This illustration shows that if all the wall studs were placed together in a traditional wood or steel framed structure, they would represent 20% of the total wall area, meaning 20% of the wall area is poorly insulated.



Wood or Steel Framing has 20% Thermal Short Circuit.

Conversely, a CAF panel structural system eliminates studs for structural support. The entire center of the panel is insulated with a compressed straw insulation panel, resulting in the elimination of hot and cold spots. The system also creates greater thermal mass, which helps regulate morning-to-night temperature changes.

Note that dynamic R-Values are 13.4 for 4-3/8” panels, and 25.4 for 7-7/8” panels.

Thermal Performance cont'd…

Because the compressed agricultural fiber is such an effective insulator, CAF panels can reduce energy use by 20%-40% in a typical structure. Furthermore, since there are no thermal leaks between connection points, a much tighter building envelope is created.

When tested by Oak Ridge National Laboratory, results indicate that a building envelope built with CAF panels is approximately seven times more effective at controlling air loss than stick built construction.

Therefore, the structure requires less energy and maintains a more uniform temperature from room to room.

Traditional Construction

Stick Built Room Leaks Air at 126 cfm.

Compressed Agricultural Fiber Panels

CAF Panel Room Allowed Only 18 cfm

Case Study – Wachovia Corporation

The following case study compares utility cost data of CAF panel construction vs. conventional building construction.

Two branch offices in Austin, Texas, shared identical floor plans and were located on similar lots just six miles apart with the same orientation to the sun.

Wachovia Corp. designed the Escarpment Village branch (top image) utilizing sustainable design and construction practices, using CAF panel construction.

The other building, Southpark Meadows, was built with stud and fiberglass bat insulation.

Escarpment Village – CAF Panel Construction

Southpark Meadows – Conventional Construction

Case Study – Wachovia Corporation cont'd…

Data supplied by Austin Energy clearly indicates that the Escarpment Village branch built with CAF panels is a much more energy efficient building with a 52% average cost savings monthly.

Monthly Utilities		
$838	July 2006	$1,779
$900	August 2006	$1,958
$933	September 2006	$1,836

Savings achieved by using CAF panels, energy efficient glass, and upgraded HVAC systems.

Fire Rating

ASTM E119 tests show CAF panels have superior fire protection compared to foam insulations.

- straw core - 2+hour rating
- 4-3/8” panel load bearing – 1-1/2 hour rating
- 7-7/8” panel load bearing – 2-1/2 hour rating

Because the fiber is so tightly packed, there is no oxygen in the CAF to fuel a fire.

ASTM E-119 Fire Test After 2-1/2 Hr. Exposure

Green Features

Renewable Supply: Straw is grown and harvested in multiple annual crops, ensuring a continuously renewable supply. Plus, CAF panels eliminate over 80% of the dimensional lumber used in traditional construction by substituting straw and OSB.

Low-Emission Materials: Manufacturers of quality CAF systems use no adhesive binders in the straw core. The panel forming process is based on proven high pressure and high temperature technologies. Safe and effective borax compounds are added to eliminate mold and insects.

Reuse and Recycle: Over 80% of CAF panels consist of straw left over after the grain has been harvested. Much of this straw was burned in the past, adding to air pollution. Straw waste from the manufacturing process can be reused as landscape mulch or animal bedding.

Negative Carbon Footprint

The carbon footprint is a measurement of the amount of carbon dioxide emitted during the production of the product(s) in the analysis time frame. CAF panels have a negative carbon footprint as the growth of the wheat (and the unattributed removal of waste from disposal) counteracts the requirements for transport to the manufacturing facility.

CAF Panel Thickness	Size	Embodied Energy (GJ)	Embodied Water (L)	CO_2 Emitted (metric tons)
4-3/8”	24x9	58.82	19702.01	-0.42
7-7/8”	24x9	90.26	39404.01	-0.87

LEED®

As an environmentally-friendly and sustainable construction system, CAF panels can help a project earn LEED accreditation.

LEED is a voluntary, consensus-based national standard for developing high performance, sustainable buildings.

Under the supervision of the U.S Green Building Council (USGBC), the program is the premiere green building-rating program and stands for Leadership in Energy & Environmental Design.

LEED® cont'd...

Depending on the project, CAF products can contribute up to 13 LEED points.

Energy & Atmosphere (EA)		
Credit EA Prereq 2	Minimum Energy Performance	Required
Credit EA 1	Optimize Energy Performance	**3 to 7**
Materials & Resources (MR)		
Credit MR 5.1	10% harvested within 500 mile radius of jobsite	1
Credit MR 5.2	20% harvested with 500 mile radius of jobsite	1
Credit MR 6.0	Use **rapidly renewable** building products for 2.5% of the total value of all building materials	1
Indoor Environmental Quality (EQ)		
Credit EQ 4.4	Low-emitting Materials (Composite Wood and Agrifiber Products)	1
Innovation & Design (ID)		
Credit ID 1.1	Low Construction Waste	1
Credit ID 1.2	Exceed Regional Material Threshold	1

Sound Absorption / Mold Resistant

With an STC rating of 33, a CAF panel system produces a practically sound proof barrier to minimize environmental noise and enhance the occupants' privacy and comfort.

Borate, a natural chemical, is added to quality CAF systems for safe control of mold, which helps promote a healthy environment and good indoor air quality.

Please remember the **exam password** COMFORT. You will be required to enter it in order to proceed with the online examination.

Testing

Introduction

To ensure a quality product, CAF panel systems are subjected to extensive testing, including:

- structural tests - ASTM E72-98 and AC-04, includes axial, transverse, racking and concentrated point loading
- fire tests - ASTM E119 and ASTM C739 Section 14 - smoldering combustion
- mold, black mold and fungi resistance - ASTM C739 Section 11
- moisture vapor sorption - ASTM C739 Section 12
- odor emission - ASTM C739 Section 13
- corrosiveness - ASTM C739 Section 9
- blast resistance

Testing: Wind Conditions / Blast Resistance

Some CAF panels have been tested up to F5 Wind Conditions, meet FEMA 361, and are approved in Miami Dade County.

As well, some products are blast resistant and meet tough DoD and GSA standards for explosion and airborne contamination protection, which can be important requirements for certain projects, such as military applications.

Blast Panel 10 psi

Blast Resistance Testing: Commonly Specified Blast Loads

To evaluate blast resistance, panels were tested by an independent third party. Blast loads selected for testing and evaluation were based on the properties of the panels and not on specific threats. As a reference, some commonly specified blast loads for buildings are shown on the table below.

Commonly Specified Blast Loads

Load Range	Peak Applied Pressure (psi)	Maximum Applied Impulse (psi-msec)	Equivalent Linear Load Duration (msec)	Authority Specifying Similar Loadings
Low	4	30	15	GSA[1]
Low	5	40	16	DoD[2]
Low	6	30	10	DoD
Medium	10	90	18	GSA
Medium	12.5	80	13	DoD
Medium	14	50	7	DoD

[1] General Services Administration

[2] Department of Defense

A total of eight tests were conducted on 8" thick test samples and follows an initial test program where the panels were proven to be effective in resisting blast loads as high as 7.3 psi with an impulse of 84 psi-msec.

Blast Resistance Testing: Wall Response Categories

Although panel damage is important, it is also crucial to note that panels damaged by the blast may still have acceptable performance. The principal goal of blast resistant construction is to prevent injury to building occupants. Described in the table below are the four major response categories of wall performance.

Wall Response Categories

Response Category	Descriptive Category Name	Description
1	Reuse	The wall is undamaged or slightly damaged, and it can be reused with some form of repair.
2	Replace	The wall is damaged beyond repair, but it does not totally collapse.
3	Collapse	The wall collapses, but all debris remains within a distance equal to one wall height from the original location.
4	Blowout	The blast load overpowers the wall and wall debris is thrown farther than a distance equal to the wall height.

Results of each test are summarized on the following slide, indicating the response category of the test panel specimens.

Blast Resistance Testing Summary

Panel Test Summary

Test	Specimen Size	Applied Peak Blast Pressure (psi)	Maximum Applied Blast Impulse (psi-msec)	Panel[1] Resistance Based on Measured Reactions (psi)	Displacement[2] from High-Speed Video (inches)		Observed Performance Category
					Edge	Center	
AG3	8' x 8'	10.5	125	6.8	.9	1.1	2, Replace
AG4	8' x 8'	8.9	105	6.2	.9	1	2, Replace
AG8	8' x 8'	12.1	148	12.1	NA	1.5	2, Replace
AG5	8' x 12'	3.9	38	1.5	1.5	1.75	1, Reuse
AG5A	8' x 12'	5.9	58	2.7	2.0	3.0	1, Reuse
AG5B	8' x 12'	7.3	73	3.6	NA	NA	2, Replace
AG6	8' x 12'	9.7	95	4.9	3.2	3.5	2, Replace
AG7	8' x 12'	8.2	82	4.8	3.2	3.7	2, Replace

[1] Resistance was calculated by the equation $r_u = RL*2/(b*l)$.
RL = Reaction load at bottom support, b = panel width (96 inches), and l = panel length (96 inches or 144 inches)
[2] Displacement was determined at the time crack initiation occurred. For Tests AG5 and AG5A, the peak values are reported.

Summary

In Summary

- CAF panels were developed as a “green” and sustainable building system that offers the fastest known method of construction.
- Made from compressed wheat or rice straw, CAF panels can be configured as structural or curtain walls or used for fast and easy sub-floor decking. As well, they can accept most commercial roof finishes.
- With all the manufacturing completed in a controlled setting, and all panel openings cut out by computer to the exact specifications of the client, building with CAF structural insulated panels translates into zero job site waste.
- Not only do CAF panel structural systems offer many “green” benefits, such as optimizing energy performance and contributing to LEED accreditation, but they also provide fire protection, sound absorption, and mold resistance.

Conclusion of This Program

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