The GIRDER-SLAB® system is a structural steel and precast hybrid, the first to use precast hollow core slabs with an integral steel girder to form a monolithic slab assembly. This proven technology has become the standard for achieving low floor-to-floor heights with structural steel in multi-story residential buildings.

**BACKGROUND**

Mid to high-rise residential structures have typically used a cast-in-place reinforced concrete structural system which offers such benefits as low floor-to-floor height and fireproof construction. With similar benefits, low to mid-rise residential buildings often utilize bearing wall systems supporting precast hollow core slabs. These structural systems are time consuming, weather sensitive and labor intensive.

Girder-Slab Technologies, LLC set out to develop an efficient structural steel based framing system that would meet the precise requirements associated with residential superstructures. Utilizing proven materials that have long been used by the construction industry, the GIRDER-SLAB® system was invented to bring the advantages of structural steel to multi-story residential buildings, offering a low floor-to-floor height alternative to cast-in-place reinforced concrete.

The GIRDER-SLAB® system is designed by the owner’s architect and structural engineer in combination with a structural steel frame. The components of the system, structural steel (including the unique D-BEAM® girder) and precast prestressed hollow core slabs, can be manufactured and supplied by the builder’s customary subcontractors, guaranteeing the owner competitive procurement of the building’s superstructure.
THE GIRDER-SLAB® SYSTEM

The GIRDER-SLAB® system consists of an interior steel girder known as an open-web dissymmetric beam (or D-BEAM® girder), and precast prestressed hollow core slabs connected by cementitious grout. This lightweight assembly develops composite action enabling the system to carry significant loads. An eight-inch or ten-inch thick precast hollow core slab provides for low floor-to-floor heights, is non-combustible, and the underside of the slab with its smooth form finish is ready-made for ceiling finish. The D-BEAM® girder is a fabricated inverted tee assembly contained within the plane of the floor that eliminates issues associated with a standard wide flange beam sitting below the slab.

The GIRDER-SLAB® system is ideal for use in mid to high-rise residential structures such as apartments, condominiums, hotels, student housing and senior living developments. The system is fire rated for use in residential buildings when constructed in accordance with Underwriters Laboratories, Inc. Floor Ceiling Design No. K912, also Certified for Canada.

Unlike cast-in-place concrete structures, the GIRDER-SLAB® system uses off site prefabricated components that are quickly erected on site by one trade, ironworkers. The system is low cost, lightweight and offers rapid assembly and construction.
DB8 indicates 8” D-BEAM® girder section

— indicates 8” precast hollow core slab
In order to solve the floor-to-floor and interference problems, Girder-Slab Technologies, LLC implemented a research and development program. We wanted an interior structural steel girder to be placed within the plane of the precast slab units, thereby producing a thin floor construction (akin to flat-plate) with a minimum floor to ceiling height.

The GIRDER-SLAB® system and the open web D-BEAM® girder technology are the result of more than fifteen years of research and development. Early testing produced an ASD approach for a rational design of the GIRDER-SLAB® system.

In order to develop a rational analysis that would maximize the use of the technology, extensive laboratory testing and analysis was undertaken. This included both small-scale specimens and full-scale assemblies in order to simulate actual bays. Each assembly was load tested well above code required residential live loads. The D-BEAM® girder performed without failure even at these higher loads.

Recent, more sophisticated testing enabled us to develop an LRFD approach to the GIRDER-SLAB® system, improving upon the system’s previously established structural and economic benefits.

Buildings constructed using the GIRDER-SLAB® system can be built as high as any other structural steel building. The D-BEAM® girder and the precast hollow core slab support gravity loads. The GIRDER-SLAB® system is easily integrated with lateral resisting steel braced frames and concrete or masonry shear walls.

The GIRDER-SLAB® system is available for use by industry professionals. Application and use of the information published by Girder-Slab Technologies, LLC requires design by a registered professional structural engineer. Fabrication, construction and assembly of the GIRDER-SLAB® system and D-BEAM® girder shall be in conformance with the GIRDER-SLAB® system Design Guide v3.3.
COMPETITIVE BIDDING
THE D-BEAM® GIRDER

WITH PRACTICALLY AN UNLIMITED SOURCE OF SUPPLY, THE D-BEAM® GIRDER IS MANUFACTURED BY YOUR LOCAL STEEL FABRICATORS AS PART OF A COMPLETE STRUCTURAL STEEL PACKAGE.

THE D-BEAM® GIRDER FABRICATION PROCESS BEGINS WITH A STANDARD WIDE FLANGE SECTION THAT WHEN UNIQUELY CUT THROUGH THE WEB PRODUCES TWO IDENTICAL TEE SECTIONS.

THE FABRICATOR THEN WELDS A FLAT BAR TO THE TOP OF THE REMAINING WEB CREATING THE NARROW TOP FLANGE OF THE D-BEAM® GIRDER.

TWO D-BEAM® GIRDERS ARE FABRICATED FROM ONE PARENT BEAM WITHOUT WASTE.
## D-BEAM® GIRDER DIMENSIONS

<table>
<thead>
<tr>
<th>Designation</th>
<th>Web Included Weight (lb/ft)</th>
<th>Average Area (in²)</th>
<th>Depth (d) (in)</th>
<th>Parent Beam Size</th>
<th>Web Thickness (t_w) (in)</th>
<th>Flange Thickness (t_f) (in)</th>
<th>Flange Width (b_f) (in)</th>
<th>a (in)</th>
<th>b (in)</th>
<th>w (in)</th>
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<td>14 x 61</td>
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<td>14 x 68</td>
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<td>14 x 74</td>
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## D-BEAM® GIRDER PROPERTIES

<table>
<thead>
<tr>
<th>Designation</th>
<th>$I_x$ (in$^4$)</th>
<th>$N_{A_{hot,DB}}$ (in)</th>
<th>$S_{hot,DB}$ (in$^3$)</th>
<th>$S_{sup,DB}$ (in$^3$)</th>
<th>$Q_{sup,bar,DB}$ (in$^3$)</th>
<th>$P_{N_{A_{hot,DB}}}$ (kip)</th>
<th>$Z$ (kip-ft)</th>
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<td>68.1</td>
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</tbody>
</table>

**Notes:**
- **F_y = 50 ksi**
- **ASD 9TH EDITION**
- **ASD 14TH EDITION**
- **LRFD 14TH EDITION**
8" D-BEAM® GIRDER CUTTING PATTERNS

DB 8 x 37

DB 8 x 39

DB 8 x 42

DB 8 x 45

DB 8 x 57

DB 8 x 61
9" D-BEAM® GIRDER CUTTING PATTERNS

DB 9 x 41

DB 9 x 45

DB 9 x 46

DB 9 x 48

DB 9 x 49

DB 9 x 52

DB 9 x 57

DB 9 x 65
8" D-BEAM® GIRDER WITH 8" HOLLOW CORE
LRFD

Design Checks - Noncomposite

Noncomposite Moment

\[ M_{nc} = 180.5 \text{ kip-ft} \]
\[ \delta_{M} = 190.3 \text{ kip-ft} \]

Horizontal Shear

\[ V_{H} = 28.9 \text{ kips} \]
\[ \delta_{V} = 33.5 \text{ kips} \]

Design Checks - Full Composite

Floor LL Deflection

Allow. \[ \Delta_{ll} = \frac{l}{360} \]
\[ \Delta_{ll} = 0.53 \text{ in} \]

Full Composite Moment

\[ M_{fc} = 298.4 \text{ kip-ft} \]
\[ \delta_{M} = 299.7 \text{ kip-ft} \]

Flexural Ductility Check

\[ v_{fd} = \frac{f_{y}}{f_{y,lc}} \]
\[ n = 0.009698 \]
\[ 2n = 0.003448 \]

Shear

\[ V_{S} = 47.7 \text{ kips} \]
\[ \delta_{V} = 75.9 \text{ kips} \]

**Elastic and plastic section moduli (S and Z, respectively) are based on entire cross section being transformed into the parent beam (D-BEAM® girder bottom tee) material.**

NOTE: GRAPHICAL REPRESENTATION ONLY
The online D-BEAM® girder Calculator Reference Tool v3.3 is intended for use only with assemblies identical to S1, S2 & S3 in the GIRDER-SLAB® system Design Guide v3.3.
9" D-BEAM® GIRDER WITH 10" HOLLOW CORE LRFD

D-BEAM® girder

- D-BEAM® girder + D9.9x65
- Parent Beam Yield Stress [f_p] = 50 ksi
- Top Bar Yield Stress [f_t] = 50 ksi

Span Information

- D-BEAM® girder Span = 21 ft
- Composite Section Effective Width = 5.25 ft
- Total Tributary Width for Load = 34 ft

Precast Slab

- Nominal Slab Thickness = 10 in.
- Precast Slab Weight = 68 psf

Grout

- Unit Weight of Grout = 140 lb/ft³

Unfactored Loads

- Basic Dead Load (D-BEAM® girder + Slab + Grout) = 20.8 psf
- Add'l Composite Dead Load [i.e. topping] = 0 psf
- Partition Live Load = 15 psf
- Basic Floor Live Load = 40 psf
- Consider Floor Live Load Reduction [IBC 2009/2012] = Yes

Floor Live Load Reduction = 35.3%  
Reduced Floor Live Load = 25.9 psf

Factored Moments

- Basic Dead Load Moment = 185.76 kip-ft
- Add'l Composite Dead Load Moment = 0.00 kip-ft
- Partition Live Load Moment = 0.00 kip-ft
- Floor Live Load Moment = 0.00 kip-ft
- Total Factored Moment = 185.76 kip-ft

Factored Shears

- Basic Dead Load Shear = 35.38 kips
- Add'l Composite Dead Load Shear = 0.00 kips
- Partition Live Load Shear = 0.00 kips
- Floor Live Load Shear = 0.00 kips
- Total Factored Shear = 35.38 kips

Deflections (negative values indicate downward deflection)

- (optional) D-BEAM® girder Camber = 0.75 in
- Basic Dead Load Deflection = -1.16 in
- Add'l Composite Dead Load Deflection = 0.00 in
- Partition Live Load Deflection = -0.11 in
- Floor Live Load Deflection = -0.20 in
- Total (Net) Deflection due to all loads = -0.72 in

Design Checks - Noncomposite

- Noncomposite Moment
  - M = 185.8 kip-ft
  - M_D = 255.5 kip-ft

Design Checks - Full Composite

- Floor LL Deflection
  - Allow. M = L/360
  - Δ_D = 0.20 in
  - L/360 = 0.70 in

- Full Composite Moment
  - M = 281.8 kip-ft
  - M_D = 370.6 kip-ft

- Flexural Ductility Check
  - f_D (yield/limit state) = 0.010889
  - 2ν_D = 0.003448

- Shear
  - V = 53.7 kips
  - V_D = 55.7 kips

Section Properties

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<tr>
<td>D</td>
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Elastic (Crooked) Section Properties

| NA                        | in | ---         | 6.42 |
| I_p                      | in^4 | 314         | ---   |
| S_p                       | in^3 | ---         | 88.1  |
| Z                          | in^3 | ---         | 168.9 |

Effective Moment of Inertia (for deflection calculations)

| I_D                        | in^4 | 314         | 674   |

Effective Plastic Section Properties

| PM                        | in | 0.84         | 8.59  |
| Z                          | in 86.13 | 98.82       |

Load Resisted by Each Cross Section

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<thead>
<tr>
<th>Basic DL (B+5+C)</th>
<th>Add'l Comp. DL</th>
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<tbody>
<tr>
<td>Partition LL</td>
<td>Floor LL</td>
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TYPICAL GIRDER-SLAB® SYSTEM SECTION
@ REINFORCED CORE

NOTE:
VERIFY REINFORCING FOR ACTUAL LATERAL LOADS

TYPICAL GIRDER-SLAB® SYSTEM SECTION
@ NON-REINFORCED CORE

NOTE:
DB9 TOP FLANGE WILL BE ABOVE THE SLAB AND WITHIN DEPTH OF TOPPING

TYPICAL SECTION: 8" GIRDER-SLAB® SYSTEM
BEARING ON WF BEAM

NOTE:
REVIEW UNBRACED LENGTH OF BEAM
CHECK WEB FOR SHEAR REINFORCEMENT

TYPICAL SECTION: 8" GIRDER-SLAB® SYSTEM
WITHOUT WF SPANDREL BEAM

NOTE:
TO BE USED WHEN NO SPANDREL BEAM AND SLAB DIAPHRAGM SPAN ≥ 30'-0"
SPECIAL PLANK ACTING AS DIAPHRAGM CHORD
CAST SOLID END OR FILLED CORES MAY BE REQUIRED FOR EXTERIOR WALL ASSEMBLY (VAPOR BARRIER, CONNECTIONS ETC.)

NOTE:
STABILIZE BEAMS AND SLABS UNTIL ALL GROUTING AND WELDING IS COMPLETE

TYPICAL SECTION: 8” PRECAST SLAB END BEARING ON WF SPANDREL BEAM

TYPICAL SECTION: 8” PRECAST SLAB AT ELEVATOR DOOR SILL

TYPICAL SECTION: 8” PRECAST SLAB SUPPORT DETAIL

PRECAST SLAB SUPPORT DETAIL
EXAMPLES OF D-BEAM® GIRDER CONNECTIONS TO WF COLUMNS

NOTE: CHECK WEBSITE FAQS ON CONNECTION DESIGN

TYPICAL SECTION THRU WF COLUMN AT GROUT POUR STOP

TYPICAL BRACE CONNECTION CLEAR OF PLANK

TYPICAL "TREE" COLUMN ELEVATION
NOTE: STABILIZE BEAMS AND SLAB UNTIL ALL GROUTING AND WELDING IS COMPLETE

TYPICAL PLAN/ELEVATION: 8" D-BEAM® GIRDER CONNECTION TO HSS COLUMN
NOTE: USED AT EXPOSED COLUMNS WITH CONCEALED CONNECTIONS
MUST NOTE TO STABILIZE ALL D-BEAM® GIRDERSD
MODIFY WITH BOLTS "OUTSIDE" OF D-BEAM® GIRDER FOR NORMAL CONNECTION
TYPICAL SECTION: GIRDER-SLAB® SYSTEM WITH RATED DRYWALL SOFFIT ENCLOSURE (OPTIONAL DRYWALL PARTITION) DETAILS ARE SIMILAR FOR DB9 WITH 2” CONCRETE TOPPING

TYPICAL SECTION: GIRDER-SLAB® SYSTEM WITH RATED SPRAY FIREPROOFING (OPTIONAL DRYWALL PARTITION) DETAILS ARE SIMILAR FOR DB9 WITH 2” CONCRETE TOPPING

TYPICAL SECTION: GIRDER-SLAB® SYSTEM WITH DRYWALL SOFFIT / PARTITION ENCLOSURE DETAILS ARE SIMILAR FOR DB9 WITH 2” CONCRETE TOPPING

TYPICAL SECTION: GIRDER-SLAB® SYSTEM WITH DRYWALL CHASE PARTITION ENCLOSURE DETAILS ARE SIMILAR FOR DB9 WITH 2” CONCRETE TOPPING

THE PARTITION AND RATED PROTECTION DETAILS ARE PROVIDED FOR ILLUSTRATIVE PURPOSES ONLY AND NOT INTENDED FOR ACTUAL USE. GIRDER-SLAB TECHNOLOGIES, LLC IS NOT RESPONSIBLE FOR DESIGN, MEANS, OR METHODS ASSOCIATED WITH THIS DETAIL.
The GIRDER-SLAB® system Design Guide v3.3 and technology is available for use by industry professionals. Application and use of this information requires design by a registered professional structural engineer.

Structural Engineers are asked to add the following GIRDER-SLAB® system Specification Guide to the General Notes section of their construction documents. The Specification Guide and the Typical System Structural and Architectural Details are available in both CAD and PDF formats on the Design Team Resources page of the GIRDER-SLAB® system website www.girder-slab.com.

The GIRDER-SLAB® system and the D-BEAM® girder are available from your customary steel fabricators. Fabrication, construction and assembly shall be in conformance with the GIRDER-SLAB® system Design Guide v3.3 specifications and details.

1. The open web Dissymmetric Beam shall be fabricated from (ASTM A992/A572 Grade 50) standard steel wide flange sections with flat bar at top-flange and shall meet AISC standards (except for depth, tolerance ± 1/8”), unpainted unless specified. The open web Dissymmetric Beam can be specified to include camber. Cambering can be built in during assembly of the girder.

2. If the structural engineer of record determines that shoring of the pre-composite assembly is needed, leave in place until grout attains required strength.

3. Precast prestressed concrete hollow-core slab units (min. 5,000 PSI) shall be in 4 or 8 foot widths and shall meet PCI standards and tolerances, 2” min. bearing unless specified otherwise.

4. Reinforcing steel (ASTM A615 Grade 60) shall be placed through the Dissymmetric Beam web openings and into slab cores.

5. Cementitious grout (min. 4,000 PSI) shall be placed monolithically around and through the Dissymmetric Beam web openings and into slab cores. When concrete topping is used, attain specified strength of grout prior to placement.

6. The GIRDER-SLAB® system shall be constructed in accordance with Underwriters Laboratories Inc., Floor-Ceiling Assembly Design No. K912 in order to meet fire classification standards and ratings set forth by BOCA and ICC codes.


8. The supplier of the GIRDER-SLAB® system shall provide to the Project Owner (or its representative) a GIRDER-SLAB® system Compliance Certificate for each project upon completion of system assembly and construction.

9. Comply with all applicable provisions of the following standards and codes:
   - Girder-Slab Technologies LLC Design-Guide
   - American Institute of Steel Construction (AISC)
   - American Welding Society (AWS)
   - Precast Concrete Institute (PCI)
   - American Concrete Institute (ACI)
   - American Society of Testing and Materials (ASTM)
   - Underwriters Laboratories Inc. (UL) - Fire Resistance Directory UL K912
   - Building Officials & Code Administrators International Inc. (BOCA) - National Building Code
   - International Code Council Inc. (ICC) - International Building Code
   - Other applicable codes and standards
1. **Steel Beam** — Composite dissymmetric steel beam fabricated from structural steel members in accordance with the Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, published by the American Institute of Steel Construction. The castellated steel beam, with a partially open web consists of the bottom flange and partial web with a bar welded to the web that serves as the top flange and conforms to the following requirements on pages 12, 14 and 15 of this Design Guide.

2. **Concrete Topping** — (Optional for unrestrained rating) - 3000 psi compressive strength, 150 (+ or -) 3 pcf unit weight. Normal weight concrete. Min 1-1/8 in. thickness required for 3 hr Restrained Assembly Rating.

3. **Precast Concrete Units** — Carbonate, siliceous or lightweight aggregate. Min 8 in. thick by 4 or 8 ft wide units with cross section similar to that shown for Design No. J952. Openings may be provided through the units for piping, ducts or similar services and should be suitably enclosed with constructions having at least equal resistance, acceptable to authorities having jurisdiction. Units have a min 1-1/2 in. bearing on the bottom flange of Item 1.


5. **Runner Channel** — Fabricated from 25 MSG galv steel, min 1/2 in. deep, with 1 in. legs, fastened to steel beam with XZF powder actuated pins spaced 12 in. OC.

6. **Gypsum Board** — 1/2 or 5/8 in. thick gypsum board fastened to runner channels with 1 in. long, 0.150 in. diam steel screws spaced 16 in. OC.

7. **Corner Bead** — Fabricated from min 28 MSG galv steel to form an angle with 1-1/4 in. legs. Legs perforated with 1/4 in. diam holes approximately 1 in. OC. Attached to runner channel through gypsum board with 1 in. long, 0.150 in. diam steel screws spaced 16 in. OC.

8. **Joint Compound** — (Not shown) 1/32 in. thick on bottom and sides of wallboard from corner beads and feathered out. Paper tape embedded in joint compound over joints with edges of compound feathered out.

9. **Spray-Applied Fire Resistive Material** — As an alternate to Items 5 through 8, the bottom flange of the steel beam may be protected with a spray applied fire resistive material. Applied in one coat to a final untamped thickness of 3/8 in. to steel surfaces which are free of dirt, oil or scale. Min avg untamped density of 13 pcf with min ind untamped density of 11 pcf for Types II and D-C/F. Min avg and min ind untamped densities of 22 and 19 pcf, respectively, for Type HP. For Type I, min avg density of 15 pcf with min ind value of 12 pcf. ISOLATEK INTERNATIONAL — Type D-C/F, HP, I or II, Type EBS or Type X Adhesive/Sealer optional.

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.
GIRDER-SLAB® SYSTEM FEATURES & BENEFITS

THE GIRDER-SLAB® SYSTEM COMBINES THE ADVANTAGES OF STRUCTURAL STEEL AND FLAT-PLATE CONCRETE.

THE GIRDER-SLAB® SYSTEM IS LOW COST, LIGHTWEIGHT AND OFFERS RAPID CONSTRUCTION AND ASSEMBLY.

YOUR DESIGN

The GIRDER-SLAB® system is designed by you, the owner’s preferred architect and structural engineer.

"JUMP THE CORRIDOR"

D-BEAM® girders spanning the length of the building between one interior column line.

MULTIPLE INTERIOR COLUMN LINES

D-BEAM® girders spanning the width of the building between multiple interior column lines.
After grouting, the composite slab is complete and ready for use.

Finish floor leveling material is normally completed after the building is closed and interior studs are installed.

The underside of the precast hollow core slab is often left unfinished, or a wall board ceiling can be used to conceal the bottom flange of the D-BEAM® girder.
The GIRDER-SLAB® system has been carefully developed to meet the precise needs associated with residential superstructures. An eight-inch or ten-inch thick precast hollow-core core slab provides for low floor-to-floor heights, is non-combustible, and the underside of the slab with its smooth form finish is readymade for ceiling finish. The D-Beam® girder is an inverted tee assembly contained within the plane of the floor.

Girder-Slab Technologies, LLC is a marketing company. We inform design and construction professionals, supply design tools and details and assist the engineer of record on an as needed basis. Girder-Slab Technologies, LLC can help you determine whether or not the GIRDER-SLAB® system will add value to your project.

After slabs are set, grout is easily placed flowing around the D-Beam® girder, through its web openings and 12” into a reinforced cell. Allows faster access for the work of other trades. Coring of slabs for utilities is easier and permits final adjustment.

The innovative D-Beam® girder was designed to allow the precast slab to sit on the top of its bottom flange concealing the top flange and web. No formwork or shoring is needed.

### GIRDER-SLAB® SYSTEM BENEFITS

- Low floor-to-floor heights, minimize building height
- Super-fast structure and building completion
- Reduced building structure weight
- Floor plan design flexibility
- Limited weather impact (including cold climates)
- Structure assembly is one process, one source
- Integrates well with mixed use spaces below
- Meets AISC tolerance standards
- Meets 2-3 hour fire ratings using UL K912
- Meets required sound (STC) ratings
- Limited on-site labor
- Reduced on-site overhead costs
- Eliminates / reduces soffits
- Factory made quality components
YOUR PROJECTS

THE GIRDER-SLAB® SYSTEM

Designed, fabricated and built by you.

SEE MORE OF YOUR PROJECTS AT www.GIRDER-SLAB.com

THE ENVOY HOTEL - BOSTON, MA

CITY POINT TOWER 1 - BROOKLYN, NY

THE YARD AT COLLEGE AVENUE - RUTGERS UNIVERSITY - NEW BRUNSWICK, NJ
<table>
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<tr>
<td>220 Rowan Boulevard</td>
<td>Glassboro, NJ</td>
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TIME IS MONEY

Assembly of the GIRDER-SLAB® system is extremely fast with limited weather impact including cold climates. The prefabricated components are assembled in place by the steel erector as part of the entire structural steel and precast superstructure. The GIRDER-SLAB® system provides faster access to the work of other trades helping your project stay on or ahead of schedule.

12 Stories
161,653 Square Feet

August 1, 2011
August 17, 2011
September 30, 2011

The GIRDER-SLAB® system can reduce your construction schedule leading to faster pre-sales and early revenue generation.
The Combined Advantages of Structural Steel and Flat Plate Concrete