FOLDED STEEL PLATE GIRDER SYSTEM

APPLICATIONS IN ACCELERATED BRIDGE CONSTRUCTION
AASHTO SCOBS
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WHAT IS THE FOLDED STEEL PLATE GIRDER (FSPG) SYSTEM?

Typical Exterior Panel Unit

Typical Interior Panel Unit
FSPG RANGE OF APPLICABILITY:

• Simply supported structures
• Girder lengths between 20’ & 60’
• Skews between 0° & 45°
• Max. C/C girder spacing for shipping: 11’-4”
• Max. deck panel width: 10’-8” interior & 11’-4” exterior
• Precast deck, barriers, & end diaphragms
• 8” Closure pours
• Any substructure type
• Proprietary but not sole source
FSPG BASIS OF DESIGN:

- FEM & laboratory testing at UN-Lincoln & FIU
- Distribution factors per FEM & AASHTO approximate method
- HL-93 or permit vehicle
- $LL \Delta \leq L/800$
- 100 year (min.) fatigue life
- A 709 Grade 50 steel
- Variable depth haunch accounts for DL deflection & cross slope
- Section properties conservatively ignore haunch, closure pour, & barrier
- Design considers both simply supported & continuously supported uncured deck panels
- Serviceability or Fatigue typically controls the design
GIRDERS:

- Non-composite girder is non-compact and designed as a box element
- Composite girder is compact and designed as a steel stringer
- Composite NA located in top flange or deck
- Flange separators are used for bracing the bottom flanges and transmitting lateral loads
- Additional 10 KSI stress in bottom flanges per AASHTO accounts for lateral loads
- Low fatigue detail categories
- Torsionally stiff: intermediate stiffeners, cross frames, & diaphragms are not required
FSPG SIZES:

- Eleven standard FSPG sizes are available
- 0.375” or 0.5” plate thickness
- Girder depth between 16.75” and 35”
- Design tables are available for preliminary girder sizing
### Sample FSPG Design Table:

#### Non-Composite Section Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_y</td>
<td>1672 ln^4</td>
</tr>
<tr>
<td>S_y TOP</td>
<td>236.9 ln^3</td>
</tr>
<tr>
<td>S_y BOT.</td>
<td>177.0 ln^3</td>
</tr>
<tr>
<td>r_y</td>
<td>6.66 ln</td>
</tr>
</tbody>
</table>

#### N=8 Composite Section Properties

<table>
<thead>
<tr>
<th>Effective Slab Width</th>
<th>I_y</th>
<th>S_y TOP SLAB</th>
<th>S_y TOP STEEL</th>
<th>S_y BOT. STEEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>6'-0&quot;</td>
<td>4806 ln^4</td>
<td>626.8 ln^3</td>
<td>3372.4 ln^3</td>
<td>293.8 ln^3</td>
</tr>
<tr>
<td>7'-0&quot;</td>
<td>5011 ln^4</td>
<td>689.5 ln^3</td>
<td>-2154.5 ln^3</td>
<td>295.5 ln^3</td>
</tr>
<tr>
<td>8'-0&quot;</td>
<td>5190 ln^4</td>
<td>745.8 ln^3</td>
<td>-9575.6 ln^3</td>
<td>304.5 ln^3</td>
</tr>
<tr>
<td>9'-0&quot;</td>
<td>5348 ln^4</td>
<td>798.3 ln^3</td>
<td>-6676.8 ln^3</td>
<td>309.1 ln^3</td>
</tr>
<tr>
<td>10'-0&quot;</td>
<td>5490 ln^4</td>
<td>847.4 ln^3</td>
<td>-5375.0 ln^3</td>
<td>313.3 ln^3</td>
</tr>
</tbody>
</table>

Note: Negative S_y TOP STEEL indicates top flange is below neutral axis.

#### 3N=24 Composite Section Properties

<table>
<thead>
<tr>
<th>Effective Slab Width</th>
<th>I_y</th>
<th>S_y TOP SLAB</th>
<th>S_y TOP STEEL</th>
<th>S_y BOT. STEEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>6'-0&quot;</td>
<td>3416 ln^4</td>
<td>324.1 ln^3</td>
<td>1124.3 ln^3</td>
<td>253.7 ln^3</td>
</tr>
<tr>
<td>7'-0&quot;</td>
<td>3595 ln^4</td>
<td>354.4 ln^3</td>
<td>1360.7 ln^3</td>
<td>259.4 ln^3</td>
</tr>
<tr>
<td>8'-0&quot;</td>
<td>3756 ln^4</td>
<td>383.7 ln^3</td>
<td>1640.7 ln^3</td>
<td>264.3 ln^3</td>
</tr>
<tr>
<td>9'-0&quot;</td>
<td>3902 ln^4</td>
<td>411.9 ln^3</td>
<td>1977.2 ln^3</td>
<td>268.6 ln^3</td>
</tr>
<tr>
<td>10'-0&quot;</td>
<td>4035 ln^4</td>
<td>433.1 ln^3</td>
<td>2388.9 ln^3</td>
<td>272.5 ln^3</td>
</tr>
</tbody>
</table>

#### Equivalent Plate Girder Dimensions

- Top Flange: 27.5" x 0.5"
- Web: 15.5" x 1.035"
- Bottom Flange: 16.0" x 0.5"

#### Moment Capacity

<table>
<thead>
<tr>
<th>Effective Slab Width</th>
<th>Plastic, M_y</th>
<th>Nominal, M_y</th>
</tr>
</thead>
<tbody>
<tr>
<td>6'-0&quot;</td>
<td>1691 KIP-FT</td>
<td>1439 KIP-FT</td>
</tr>
<tr>
<td>7'-0&quot;</td>
<td>1776 KIP-FT</td>
<td>1560 KIP-FT</td>
</tr>
<tr>
<td>8'-0&quot;</td>
<td>1840 KIP-FT</td>
<td>1650 KIP-FT</td>
</tr>
<tr>
<td>9'-0&quot;</td>
<td>1890 KIP-FT</td>
<td>1740 KIP-FT</td>
</tr>
<tr>
<td>10'-0&quot;</td>
<td>1930 KIP-FT</td>
<td>1805 KIP-FT</td>
</tr>
</tbody>
</table>

#### Plate Information

- Plate Width Along Plate: 75.70 in
- Area: 37.89 in^2
- Weight: 128.92 plf
BEARINGS:

Bearing assemblies consist of:

- Bearing stiffeners
- Shim plates
- Sole plates
- Elastomeric bearing pads
- Fixed/expansion anchor bolts
END DIAPHRAGMS:

- Backwalls are not required
- Concrete end diaphragms accommodate thermal movement and end rotation
- End diaphragm details vary based on girder depth and skew
- Can be used with or without approach slabs
FABRICATION IS PERFORMED IN FIVE SIMPLE STEPS:

1. Bending the steel plates
2. Installation of miscellaneous hardware
3. Installation of shear studs
4. Corrosion protection of the girders
5. Precasting the deck, end diaphragms, and barriers
BENDING THE STEEL PLATES:
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Girders are cold bent in approximately 2-3 hours
INSTALLATION OF MISCELLANEOUS HARDWARE:
Bearing stiffeners, flange separators, & sole plates installed in approx. 1-2 days
INSTALLATION OF SHEAR STUDS:

Shear studs are attached in approximately 1 day
CORROSION PROTECTION AS APPLICABLE:

- Galvanizing
- Metallizing
- Painting
- Weathering steel
PRECASTING THE DECK, END DIAPHRAGMS & BARRIERS:
Precasting completed in approximately 1 week
COMPLETED UNIT:

- Fabrication in as little as 4-6 weeks from NTP
- The composite unit is easy to ship to the construction site
THE COMPOSITE UNIT CAN BE LIFTED WITH A RELATIVELY SMALL CRANE:
THE COMPOSITE UNITS CAN BE ERECTED IN AS LITTLE AS ONE HOUR:
CLOSURE POURS:
Approximately 2 hours per joint
BENEFITS:

CONTRACTORS:
• Accelerated schedule
• Lighter & more stable
• Competitive construction costs

OWNERS:
• Versatility
• Reduced maintenance
• Sustainable design
• Reduced life-cycle cost
• Proven technology
ACCELERATED SCHEDULE:

- Accelerated superstructure fabrication
- Composite units arrive to site fully assembled
- Blockouts are provided for lifting tabs near centerline of bearings
- No field welding or bolting required
- SIP forms can be attached prior to erection
- Open to traffic within 24 hours of erection
LIGHTER & MORE STABLE:

• 1/3 the weight of concrete beams
• Less steel by weight than typical ABC steel stringer construction
• No intermediate stiffeners or cross frames
• Shipping weight & length reduce hauling permits
• Stable shape during fabrication, shipping, & erection
• Wide top flange is stable during future redecking
COMPETITIVE CONSTRUCTION COSTS:

- Lower material cost
- Shop labor versus field labor
- Smaller work force required
- Uses smaller capacity cranes
- Cost competitive with other ABC construction types
VERSATILITY:

- Installed on any substructure type
- Installed with or without approach slabs
- ABC or conventional construction
REDUCED MAINTENANCE:

- Jointless design
- Cold bend radius = 5t
- Minimized fatigue prone details
- Bottom flanges sloped for drainage
- Galvanizing, metallizing, or weathering steel provides corrosion protection
- Minimized miscellaneous hardware
- Fully inspectable
SUSTAINABLE DESIGN:

- Developed by an expert in sustainable design
- Workmanship in a controlled environment at QC’d facilities
- Girder corrosion protection
- Various deck overlay options
- Jointless design
- 100 year service life
REDUCED LIFE-CYCLE COST:

- Less steel = lower material cost
- Reduced field labor
- Reduced equipment costs
- Reduced maintenance
- Long service life
PROVEN TECHNOLOGY:

- Designed in accordance with AASHTO LRFD 5th Edition, 2010
- Design based on FEM and laboratory testing
- Approved for use by FHWA
- Endorsed by AISC, NSBA, & SSSBA
- Two bridges constructed- MA (2011) & NE (2014)
- Twenty months of monitoring by UMass – Amherst
  - No signs of distress
  - Readings within expected ranges
  - Effective system for ABC of short span bridges
THANK YOU!

QUESTIONS?