

Illinois Girder Shapes Offer Design Flexibility

by Kevin Riechers, Illinois Department of Transportation

Earlier this year the Illinois Department of Transportation (IDOT) introduced a series of new precast, prestressed concrete (PPC) girder profiles to supplement their current PPC girder profiles. The goals were to create

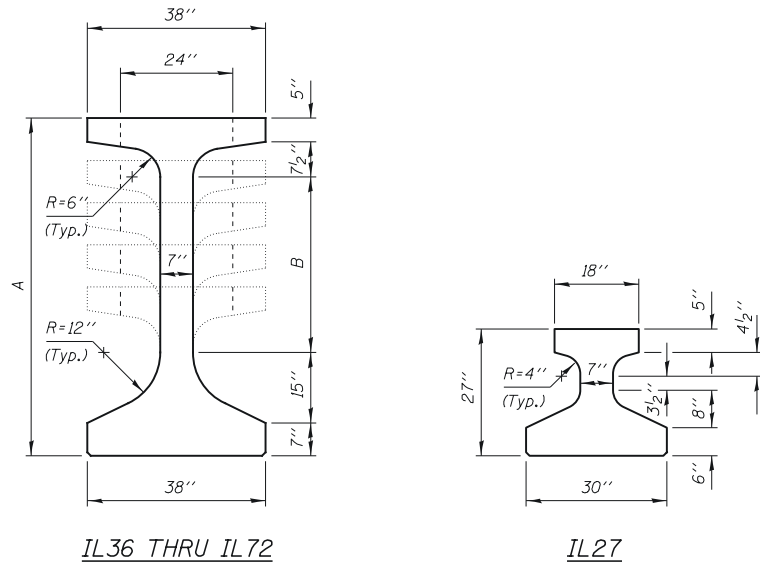
- sections that are capable of spanning further to compete with other materials,
- robust top flanges to better resist damage during future deck replacements,
- improved durability,
- sections with sufficient lateral stiffness to accommodate use for longer spans,
- a variety of functional bridge configurations, and
- sections with future growth potential by utilizing higher concrete strengths.

Before selecting the new beam sections, IDOT reviewed numerous beam configurations and designs from surrounding states and other leading concrete beam states throughout the country. The development process also included close coordination with the Precast/Prestressed Concrete Institute (PCI), concrete researchers, Illinois fabricators, and potential users/owners. All available design options and fabrication techniques were reviewed and revisited to help IDOT achieve its goals.

A total of 11 new beam sections were created. The following are some highlights of their characteristics:

- Six beam depths: 27, 36, 45, 54, 63, and 72 in.
- Narrow, thick top-flanges with two width options
- Large bottom flanges
- Curved flange-to-web transitions
- Concrete compressive strength of 8.5 ksi at 28 days—increased from 7 ksi
- 0.6-in.-diameter, Grade 270 strands
- Epoxy-coated, welded-wire shear reinforcement with standardized spacing

Compared to the new Illinois (IL) shapes, IDOT's current PPC I-beam and bulb-tee



SECTION PROPERTIES

Beam	Area (in ²)	I _x (in ⁴)	I _y (in ⁴)	S _b (in ³)	S _t (in ³)
IL27-1830	457.9	33879	20442	3060.4	2126.7
IL36-2438	728.0	100433	50889	6832.1	4715.1
IL36-3838	805.4	124639	69530	7563.0	6385.1
IL45-2438	791.0	182623	51146	10045.2	6809.2
IL45-3838	868.4	223604	69787	11004.1	9060.1
IL54-2438	854.0	295427	51403	13551.6	9174.7
IL54-3838	931.4	357078	70044	14730.9	11998.5
IL63-2438	917.0	441689	51661	17294.0	11790.9
IL63-3838	994.4	527741	70302	18687.7	15182.4
IL72-2438	980.0	624180	51918	21237.8	14648.6
IL72-3838	1057.4	738236	70559	22855.6	18595.3

Beam nomenclature: ILXX-YYZZ
 XX=Beam depth
 YY=Top flange width
 ZZ=Bottom flange width

DIMENSIONS

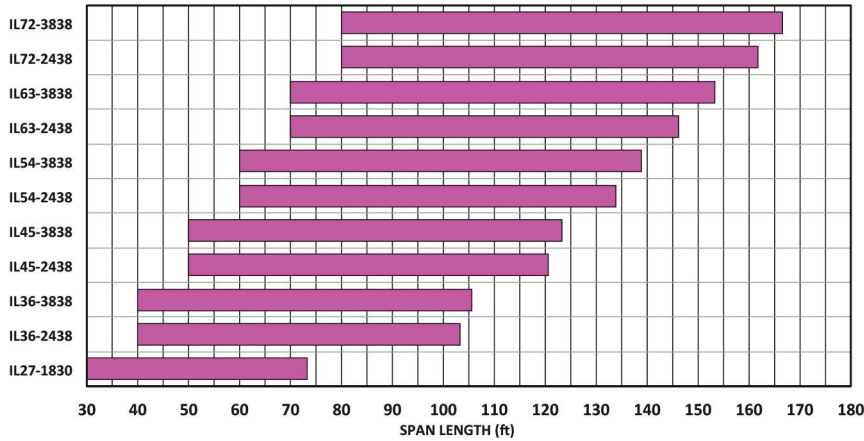
Beam	A (in)	B (in)
IL36	36	1 ¹ / ₂
IL45	45	10 ¹ / ₂
IL54	54	19 ¹ / ₂
IL63	63	28 ¹ / ₂
IL72	72	37 ¹ / ₂

Geometric configurations and section properties for the new Illinois (IL-beam) shapes. All Figures: Illinois Department of Transportation.

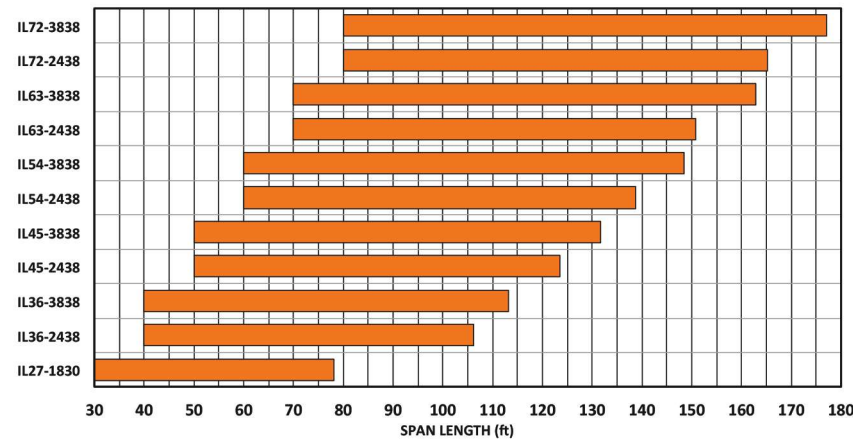
beams have smaller cross sections, but the same range in depths is available for both the new and current shapes—36 to 72 in. A new shallower IL-beam with a depth of 27 in. was created to expand the span range for new and replacement structures.

Typically, wide and thin top-flange beams provide an efficient prestressed beam design. It's not uncommon to see a top-flange width of 48 in. that's less than 3 in. thick at the outside edges. However, wide and thin top flanges make future deck removal difficult, provide less space for deck drainage options, and offer less flexibility for locating stage lines and concrete closure placements for staged construction.

The new IDOT sections have a maximum top-flange width of 38 in., with a minimum thickness of 5 in. The top flange can be reduced to 24 in. with a simple form block-out. These flange configurations help meet IDOT's goals of providing more flexibility and easier removal and replacement of existing decks. This was in line with IDOT's choice of durability and functionality as its top priorities when creating the new sections.



Simple-span ranges for the new Illinois (IL-beam) shapes.



Multi-span ranges for the new Illinois (IL-beam) shapes.

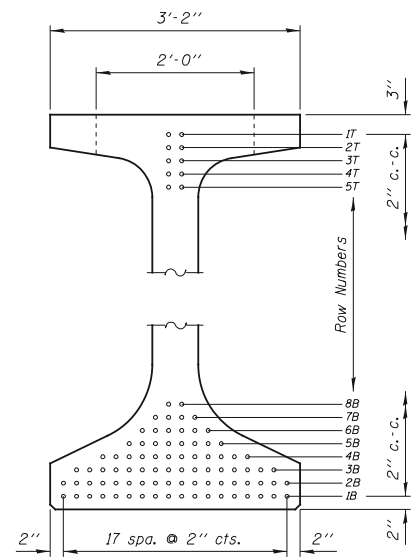
The bottom-flange bulb was sized to accommodate more strands and to improve lateral stability. The 28-day concrete compressive strength of 8.5 ksi with a compressive strength of 7 ksi at transfer enables the use of fifty-eight 0.6-in.-diameter strands in the largest new section, but there is a capacity for 84 strands. This allows room for growth as Illinois becomes more comfortable with greater concrete strengths.

The majority of the sections (IL 36 through IL 72), were created with the same top and bottom flange for fabrication and design efficiency, and the beam depths are in uniform 9-in. increments. The flange-to-web transitions were curved to improve aesthetics and to aid with form removal.

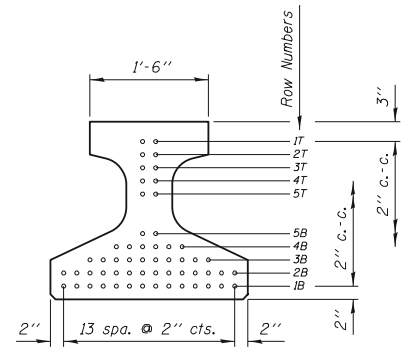
Significant Benefits

The new shapes offer significant benefits for designing with precast concrete girders. The longer spans can eliminate substructure units and move piers out of waterways, creating a more environmentally friendly design. These longer, same-depth sections can also save on overall structure length, embankment work, profile grades, and the need to purchase additional right of way. When shorter spans are needed, the new profiles allow wider beam spacings that can eliminate beam lines, which saves material and construction costs.

IDOT also worked closely with local fabricators and PCI to ensure the new shapes could be transported safely and effectively. The new shapes satisfy the shipping and handling requirements of PCI, and the fabricators will ensure (through evaluation by a structural engineer) that their trucks can satisfy the required roll stiffness for the beam size, length, and delivery route chosen. Additional costs for permits and routing analysis for longer and heavier girders will be included in the bid costs for the girders.



IL36 THRU IL72



IL27

Permissible strand locations in the new Illinois (IL-beam) shapes.

The new shapes provide many improvements over IDOT's current sections, but they are tailored for longer spans and are considerably heavier and therefore may not always be the best economic solution for shorter spans. Situations such as narrow structures with staged construction where beam lines can't be eliminated, or delivery sites with load and geometry restrictions, are typically not suited for the new shapes. For these reasons, the original shapes will remain available for use in unique situations.

Overall, the new girder shapes offer additional robustness, longer service life, more versatility, improved durability during deck replacements, and more functionality to meet the bridge needs in Illinois. IDOT anticipates seeing precast concrete girders being specified in cost-effective designs more often in Illinois thanks to these new girder shapes.

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