A SYSTEM FOR RAPID PRECAST DECK CONSTRUCTION

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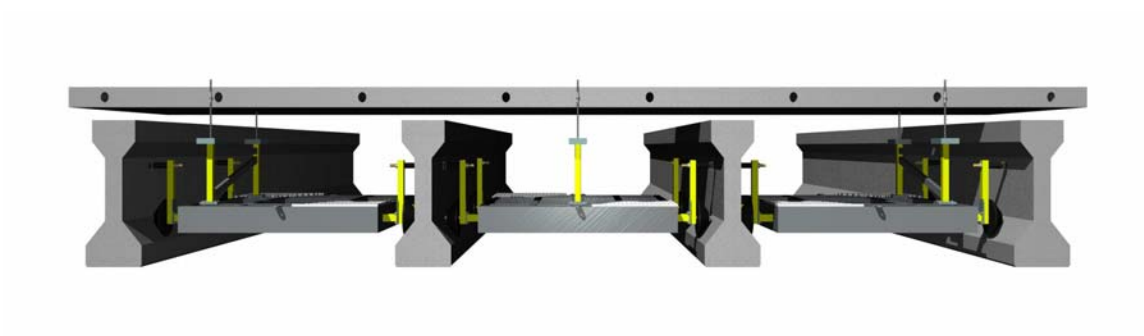
ABSTRACT

This paper describes a new system for construction of bridge decks using longitudinally post-tensioned precast deck panels. Deck panels, either full or partial depth units, are rolled into position, leveled and post-tensioned while suspended on wheeled forming bogies which ride on the bottom flanges of precast girders. After post-tensioning, final adjustments to the profile grade are made using leveling bolts, grout is pumped into the void between girders and panels to yield a composite structural system.

Keywords

Forming Bogie
Leveling System
Full Depth Panels
Partial Depth Panels
Long Bed Casting
Battery Molds
Longitudinal Post-Tensioning
Composite Shear Transfer



INTRODUCTION

The need for a reliable precast decking system stems from a host of project constraints: Construction in remote areas where access is limited, batch concrete is difficult to procure, and/or labor resources are scarce; the need to quickly construct or replace a deck for Maintenance of Traffic, or emergency repair of a damaged facility; and/or the need to work during periods of wet, freezing or otherwise adverse climatic conditions.

At the heart of the system are wheeled bogies, shown in Figure 1 below. They ride on the bottom flanges of standard AASHTO or Bulb Tee girders. These carts are provided with either jacking plates (for use with leveling bolts set in the precast panels) or screw jacks for automatic/remote control level adjustment. Leveling bolts provide a means of manual adjustment that is relatively fool-proof. A cart is positioned in each bay (between a pair of girders) the full width of the bridge, for support of a single full width precast deck panel. As each panel is rolled into position, the next set of bogies is wheeled out, a panel set in place, and the operation continues until the entire span is filled. Prototype bogies have been fabricated by both Hamilton Forms in Texas, and Southern Forms in Tennessee.

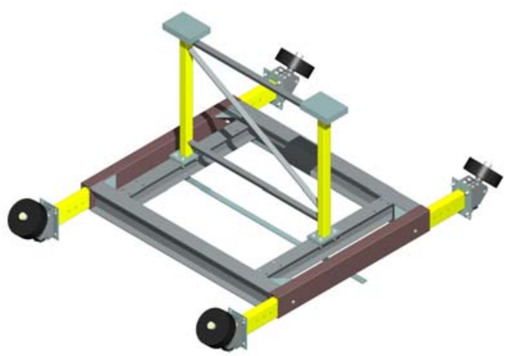


Figure 1

After an entire span (or unit) is filled with panels, the panels are adjusted/leveled so that all lie in a single plane above the girders. The operation is relatively simple, accomplished using a survey rod (or rods) and leveling bolts. See Figure 2 below.

Once leveled, strand is pushed through longitudinal tendon ducts for post tensioning. Immediately prior to post-tensioning the panel joints are buttered with epoxy, in a manner very similar to the post-tensioning process employed for segmental box or cylinder pile fabrication. Tendons are stressed, resulting in a long continuous unit with precisely calculated residual compression across the transverse deck joints. The level of prestress is calculated to result in a minimum residual compression of 250 psi – or as required by finite element analysis of the flat slab system based on the magnitude and size of the wheel loads.

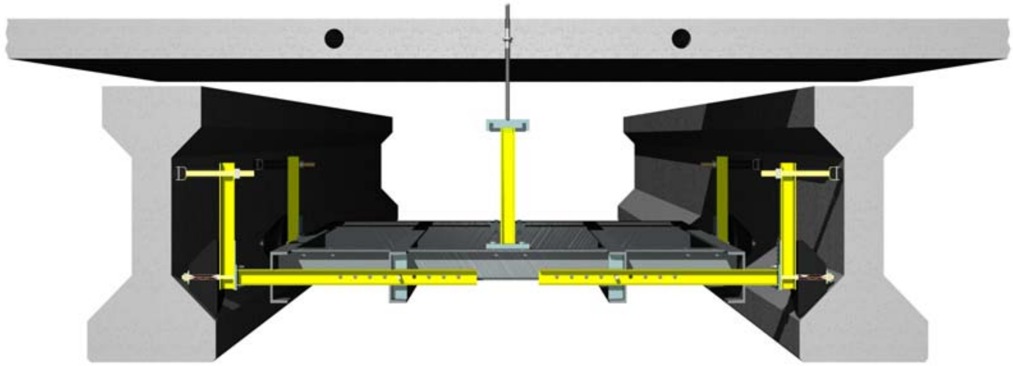
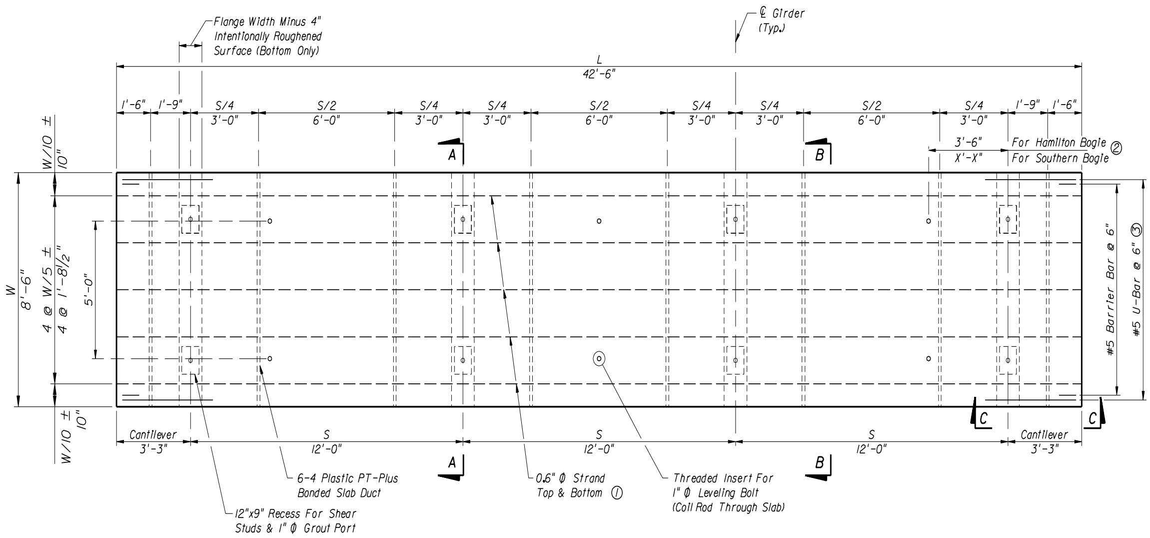


Figure 2

Panels employed can be either full depth or partial depth. In either case pockets are formed into the panels for placement of shear studs, to ensure composite action in the finished product. Each pocket can be fitted with a grout port, as inlet and outlet ports for placement of the composite build-up. Slab details are shown in Figure 3. There will be cases where partial depth slabs may be preferred, to yield final quality control for the riding surface to the field contractor, or conversely where full depth slabs are needed, to minimize filed operations. Either practice can be accommodated. It is anticipated that precast panels can either be cast in long beds, so that a single set of strand can form all panels in a span, or using battery molds, where the slabs are cast upright, on their sides, to conserve space and yield finished/formed surfaces both top and bottom without screeds.

Prototype testing is being conducted at Gulf Coast Pre-Stress' facility in Pass Christian, Mississippi. Results of full scale mock-up tests will be presented at the October PCI Conference.



INTERIOR PANEL

NOTES:

S= Girder Spacing

L = Deck Panel Length (Bridge Width)

W = Deck Panel Width

Full Depth Slab (8" Thick)

WWWF (4x4 W4xW4) Not Shown. WWF Covers Entire Panel Area In Mat Below Duct.

DIMENSIONAL TOLERANCES:

Length: L (42'-6") ± 1/16"

Width: W (8'-6") ± 1/16"

Thickness: T (8") ± 1/16"

Level: All Points On Top Or Bottom Surface Shall Lie In The Same Plane To ±1/16"

MATERIALS:

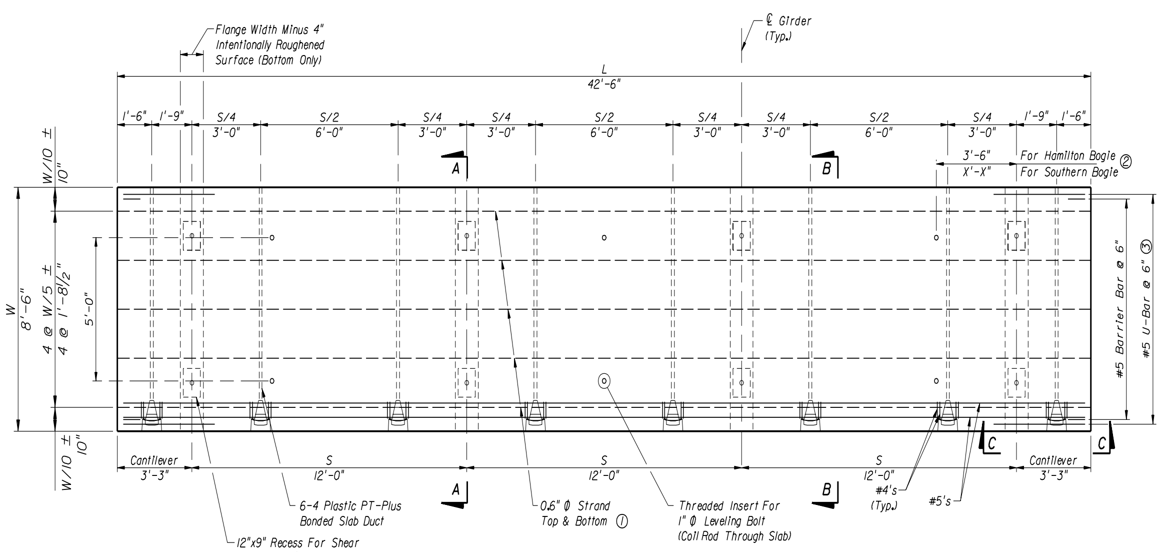
Concrete:	f'c = 6000 psi	Normal Weight Concrete 28-Day Compressive Strength
Reinforcing Steel:	Fy = 60000 psi	ASTM A615 GR60
Prestress Strand:	Fpu=270000 psi	ASTM A416
WWF:	Fy=65000 psi	ASTM A185
PT-Plus:	6-4 Bonded Slab System	Type SA Anchorages

①

GIRDER SPACING S	STRAND DIA.
9' - 10'	1/2" Ø Lo Lax
10' - 11'	1/2" Ø Special
11' - 12'	0.6" Ø Lo Lax

② Based On Prototype Dimensions

③ Barrier Reinforcement (For Vehicular Impact)



END PANEL

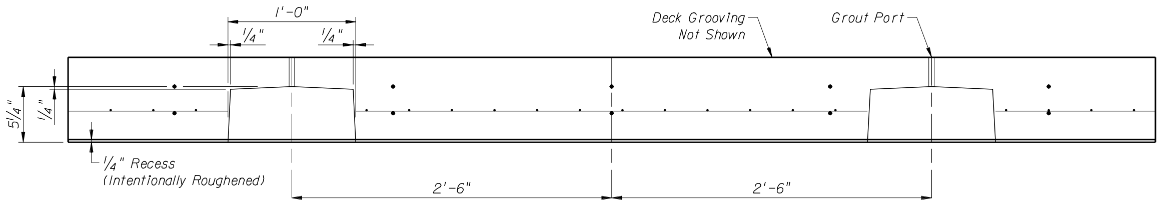
Figure 3

Design and Construction Considerations

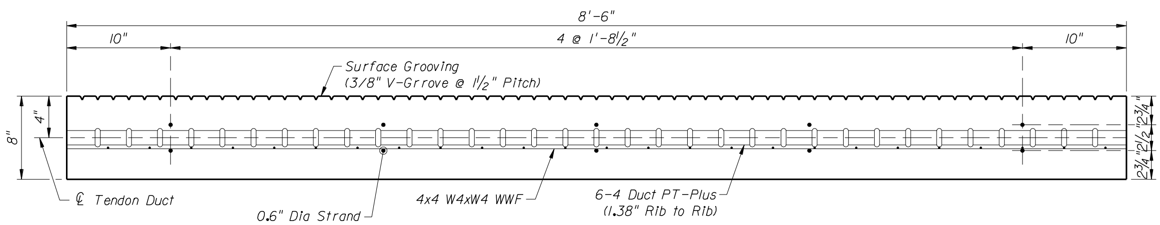
A number of design parameters must be satisfied each time the system is employed. Several of these parameters are listed and discussed below:

- Transverse Prestress: Depending on the girder spacing, the level of transverse prestress must be varied. Using the same strand pattern, we can adjust the size of the strand to accommodate a wide range of girder spacing. For example, Figure 3 shows that by increasing strand size from ½" dia. lo-lax, to ½" dia. special, to 0.6" dia. strand, an increase in girder spacing from 9 to 12 feet is readily accommodated. Note that the centroid of the prestress force is centered in the panel, avoiding camber, and minimizing detrimental creep deformation. Transverse prestress must be checked for loads developed during handling, setting and leveling operations – in addition to service loads.
- Longitudinal Prestress: Longitudinal post-tensioning ensures adequate shear transfer across panel joints. Using Finite Element Analysis the tendons can be sized to prevent tension in the joints under the design wheel loads. Because the tendons are stressed while panels are suspended on bogies, and panels are leveled to lie in the same plane prior to stressing, prestress losses are minimized and the panel stresses can be calculated with a high degree of precision. Note that some deck (vertical) curvature can be tolerated in the assembly of panels after tensioning, due to the inherent flexibility of the thin panel.
- Horizontal Shear: The current AASHTO equations for shear transfer between deck and girders indicate that if the surfaces of the girders and panels are intentionally roughened, a considerable amount of cohesion will develop along the interface. In bulb tees, where the width of the top flange is 4 to 5 feet, this cohesive force is sufficient to preclude the use of shear studs except at the ends of the girders, where a nominal amount of headed studs can be used to supplement the shear transfer. The provision of the Code specifying 2 foot spacing of stud groups can be accommodated, but should be carefully reviewed. Two foot spacing of stud blockouts can increase costs unnecessarily.
- Bracing: Bracing is necessary to stabilize girders. A simple system for bracing the girders over piers has been developed that will allow bogies to roll freely from one span to another. Thrust due to wheel loads on the bottom flanges of long girders is resisted through friction between polyurethane treads on the concrete surface, but supplemented using a system of bracing initially clamped to the girders preventing the exterior girders from lateral displacement.
- Grouting: The grouting operation is critical to the development of composite action. Each shear pocket can be fitted with a grout port , and grouting proceeds at relatively low pressures from one end of the girders to the other (pier to pier), using rigid foam 'backer rod' along the outside faces of the girder, clamped to the girders when the fully tensioned slab is lowered to final grade, to channel the grout.

Several key details for slab construction are shown in Figure 4 below.



SECTION B-B



SECTION A-A

Figure 4