

REVIEW AND STRUCTURAL  
INVESTIGATION OF  
CRACKED BRIDGE DECKS

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## REVIEW AND STRUCTURAL INVESTIGATION OF CRACKED BRIDGE DECK

### Problem Statement:

Cast-in-place reinforced concrete slab supported by precast deck units offer an attractive method of bridge construction due to the speed of erection and the elimination of deck supporting forms. However, past experience indicates excessive deck cracking which represents a constant maintenance problem. It is therefore important to conduct a detailed investigation into the cause of this cracking and whether good reinforcement detailing and other design consideration could improve the performance.

Review of existing information indicates that, unfortunately, neither the current AASHTO (LFD) nor the new LRFD Specifications provide clear design guidelines for precast concrete decks with slab overlay. Also, the FDOT design guidelines do not offer any information for these types of structures. Therefore, there is an immediate need for clear design guidelines for these types of bridge decks.

### Objectives of Investigation

The main objectives of this preliminary investigation are:

1. Review of the design and construction plans for three bridges. Two of these bridges, Reedy Creek -ABAM design in Disney and Cow Creek in Dist. 2, were determined to perform satisfactorily while the remaining bridge has shown extensive cracking (Turkey Creek).
2. Investigate whether there is a missing common link that is not addressed in the cracked bridge. All design assumptions and their significance will be investigated with relation to the Standard AASHTO Specification and the LRFD Code.
3. Perform a parameterc study to evaluate the effects of relative shrinkage between the cast in place and precast decks and any other parameters identified under task 2.

4. Compare the results from the above study with those of elastic analysis where the effects of creep and shrinkage of concrete and stress relaxation of prestressed steel are ignored.

## I. REVIEW OF EXISTING BRIDGES:

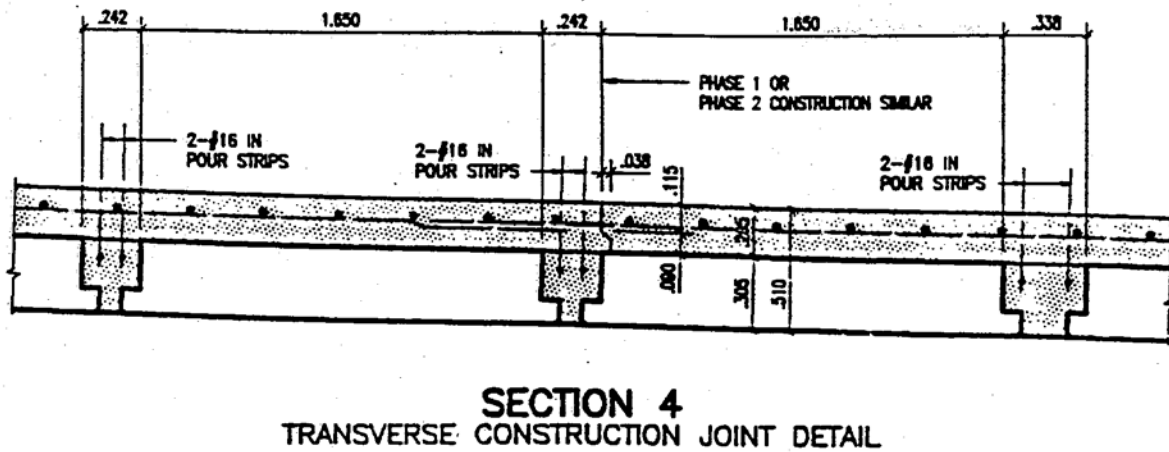
The designs of three slab bridges were reviewed and evaluated. These bridges represent two different designs that have been used by the FDOT. Following is a summary of the design of each of these bridges and their current conditions.

### I.1 SR5 (US1) OVER TURKEY CREEK BRIDGE

#### Condition Assessment:

The bridge, located in Melbourne, FL, is the new State Road 5 over Turkey Creek, and is a 6 span continuous structure. The superstructure is composed primarily of 12" deep precast prestressed solid concrete slab units with an 8" cast in place structural deck as shown in Figure 1. The reinforcement in the cast in place slab consisted of No. 5 bars spaced at 12 inches on center in both the longitudinal and transverse direction. The location of reinforcement was specified to be 4 inches from the top deck surface (mid depth).

Evaluation of the current conditions of the bridge revealed extensive surface cracking and signs of patching of concrete spalling at different locations. The size, width and location of cracks vary across the bridge deck. These cracks have been developing in the deck surface since the first phase of construction. Generally, the cracking is concentrated in two areas: tension cracks in the deck surface across the support and longitudinal "map" cracks in the midspan areas. The tension zone cracks across the support are common in continuous span concrete bridges. Providing sufficient reinforcement in the negative moment region helps in distributing and controlling the width of these cracks. The remaining "map" cracks as seen in Figure 2 are generally caused by temperature and shrinkage movements in the cast-in-place concrete and environmental conditions during the casting process as will be discussed later.



**Figure 1 Bridge Deck Details**

Visual inspection of the cracked region yields an observation into the degree of quality control employed during construction. Figure two shows that the longitudinal cracks occurred at increments corresponding to the spacing of the deck reinforcement. Additionally, shadows are observed in the same location showing signs of improper placement of the reinforcement within the thickness of the deck. In this case, it is likely that the longitudinal reinforcement was placed such that adequate concrete cover was not provided. There is strong indication that the steel reinforcement was not placed according to the design plans.

The apparent poor placement of the reinforcement represents a significant problem that will result in future deterioration throughout the life of the bridge due to the expected cracking and spalling of the concrete in the areas with shallow reinforcement. At the age of only five years there is a significant level of deterioration which will continually require maintenance and repair.

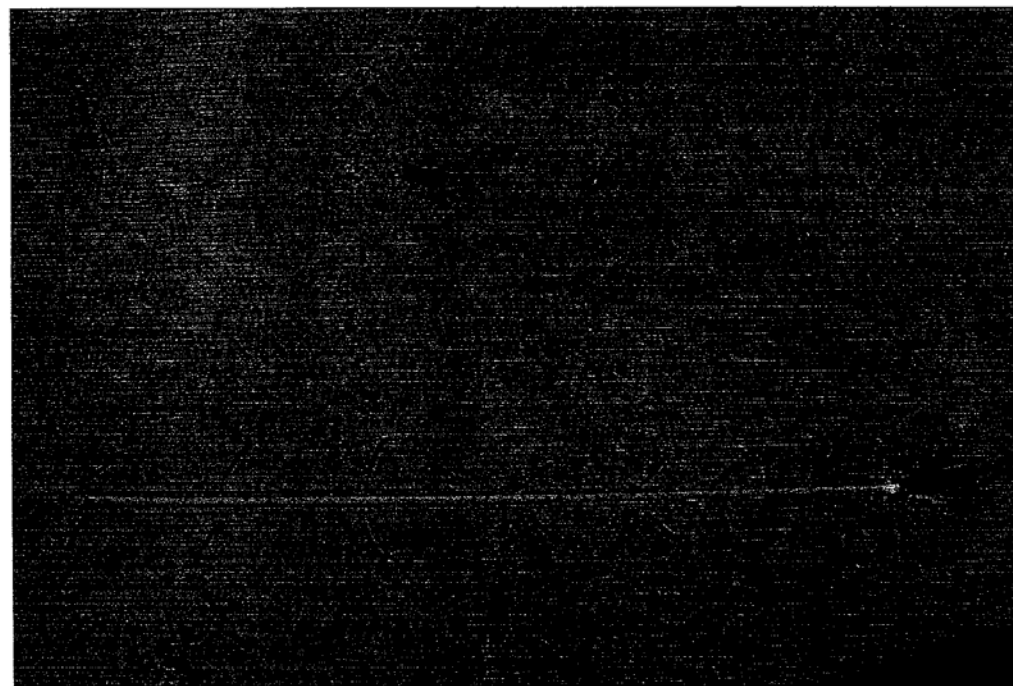


Figure 2 Bridge Deck Cracking - Turkey Creek

## I.2 CR 340 Over COW Creek Bridge

### Condition Assessment:

The bridge, located near Gainesville, FL, is on CR 340 over Turkey Creek. The bridge was completed in the summer of 2000. The bridge consists of five 9.4 m (30.8 ft) continuous spans. The superstructure is composed primarily of 1200 or 1500 mm (48" to 60") wide by 300 or 400 mm (12" to 16") deep precast prestressed solid concrete slab units, respectively. The thickness of the cast in place slab was 150 mm (6"). The reinforcement of the cast in place slab consisted of number 5 bars spaced at 6 inches on center. The specified depth of transverse reinforcement was 2 inches below the top surface of the deck in order to minimize expected longitudinal shrinkage cracks. Figures 3 to 6 show the different details of the bridge. Figure 7 shows the bridge under construction.

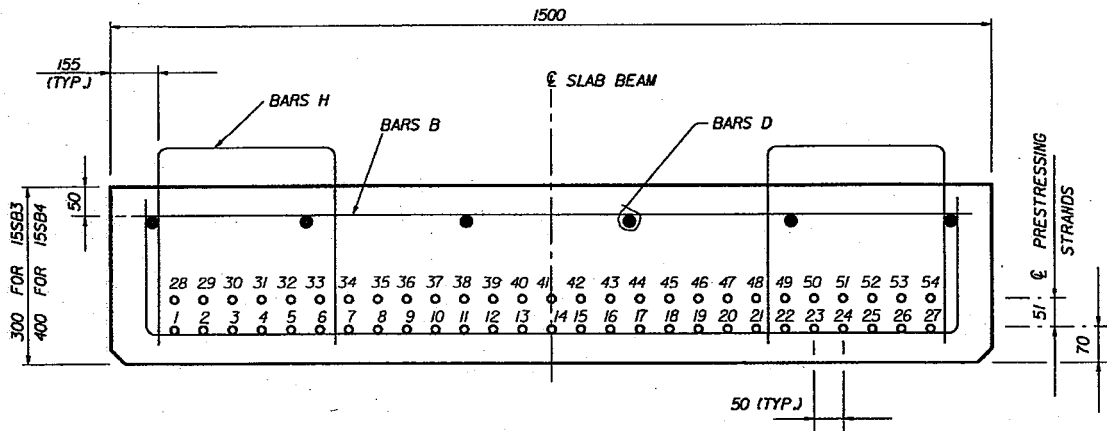


Figure 3 Precast Slab Cross Section – Cow Creek

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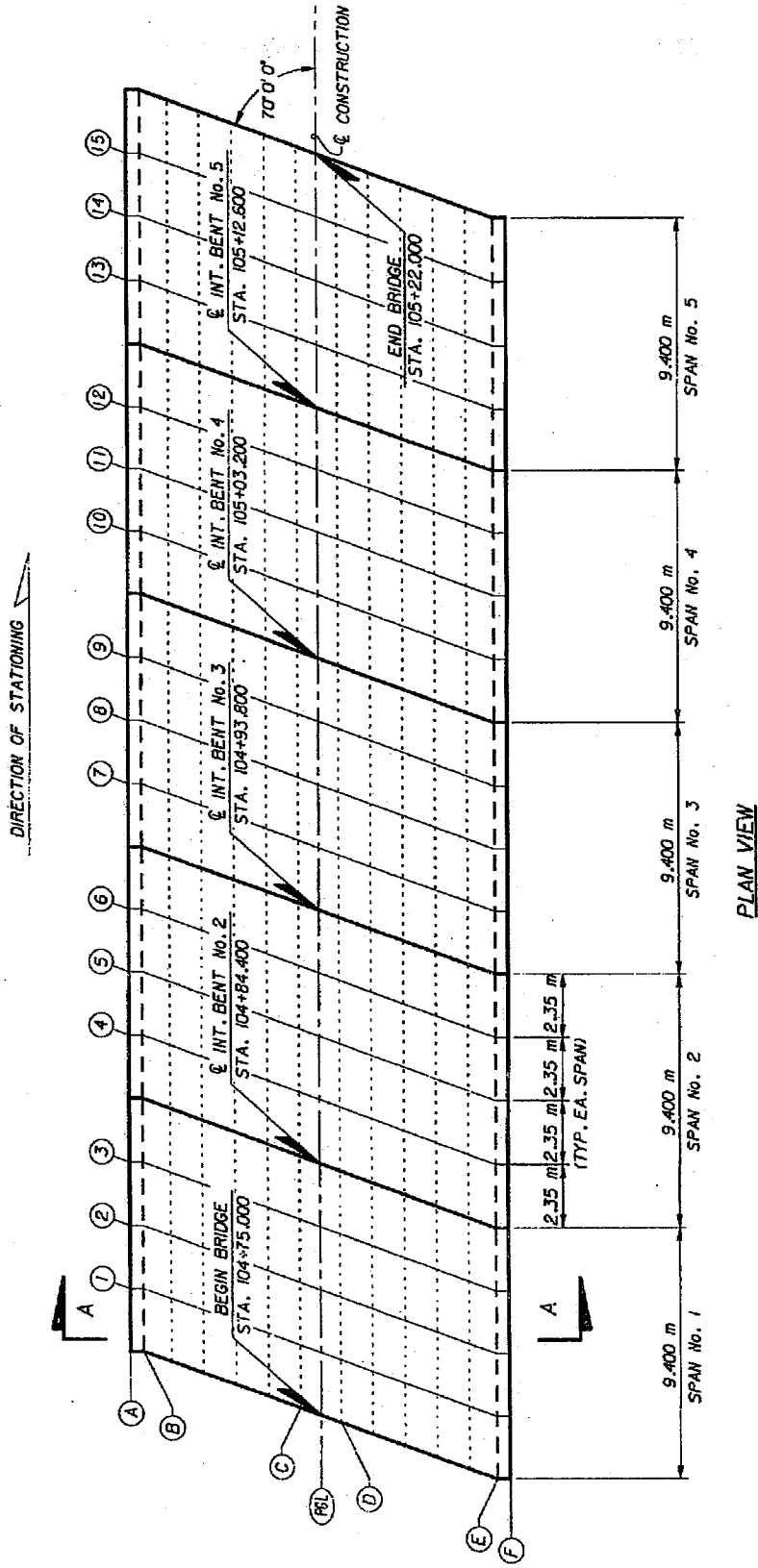


Figure 4 Plan View – Cow Creek

REVIEW AND STRUCTURAL INVESTIGATION OF CRACKED BRIDGE DECK

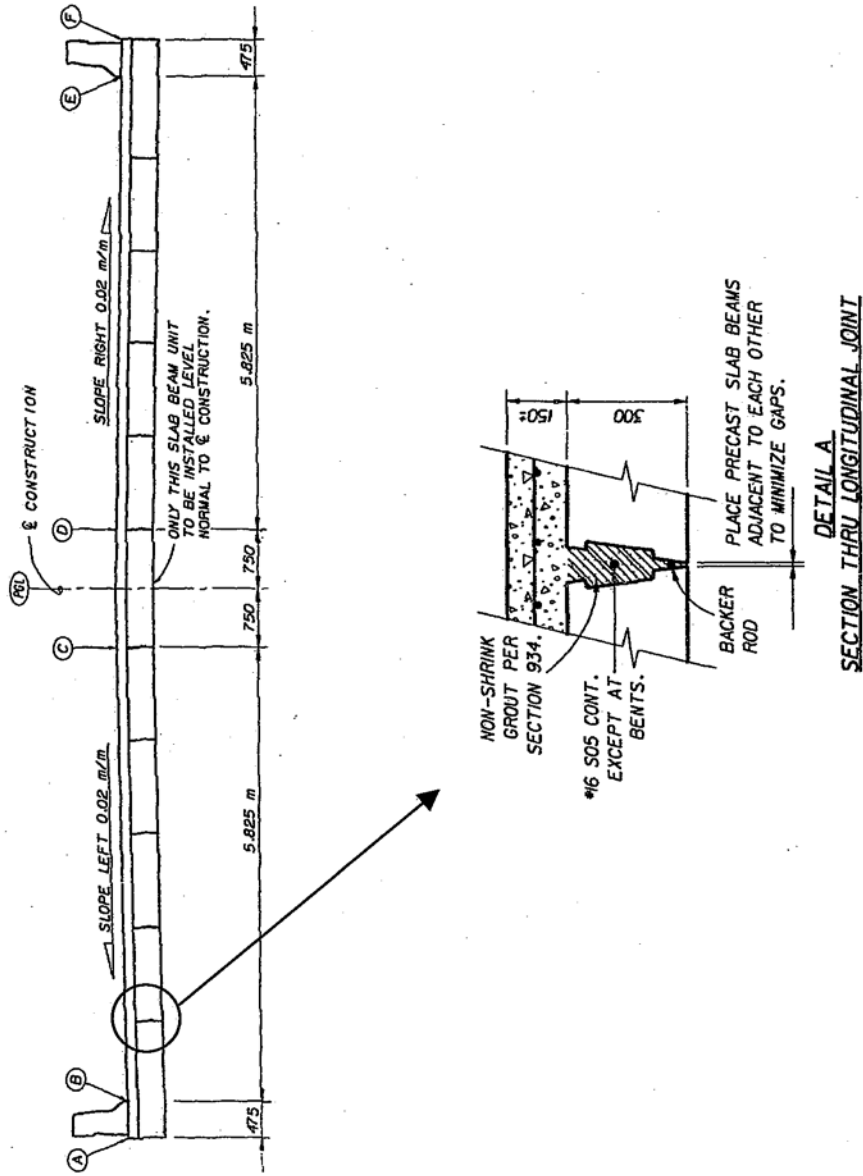


Figure 5 Section Through Bridge Deck



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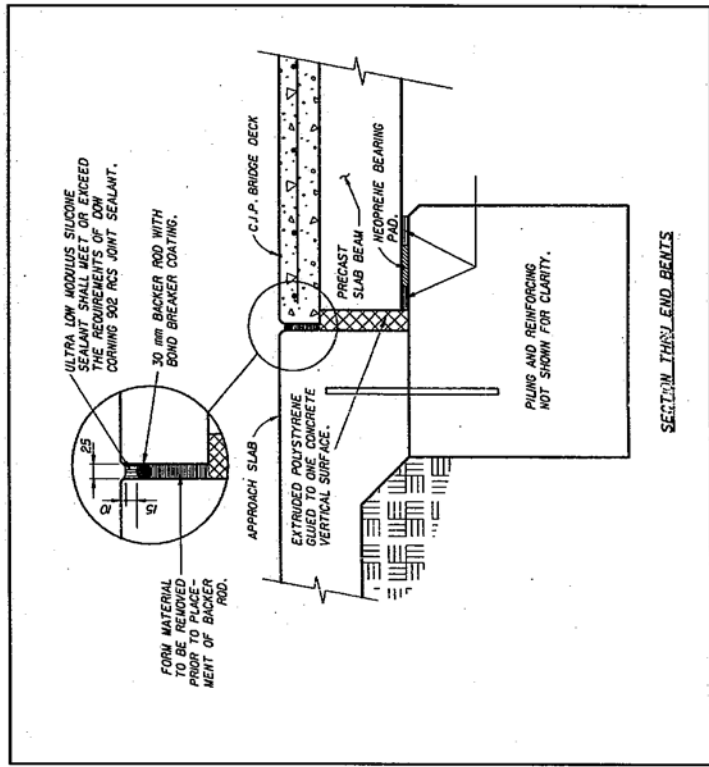
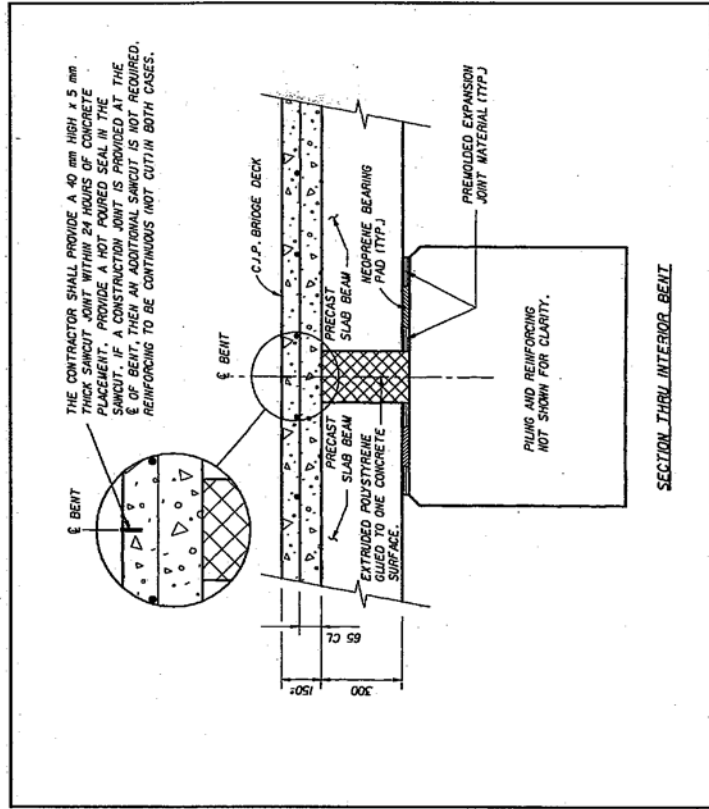


Figure 6 Joint Details

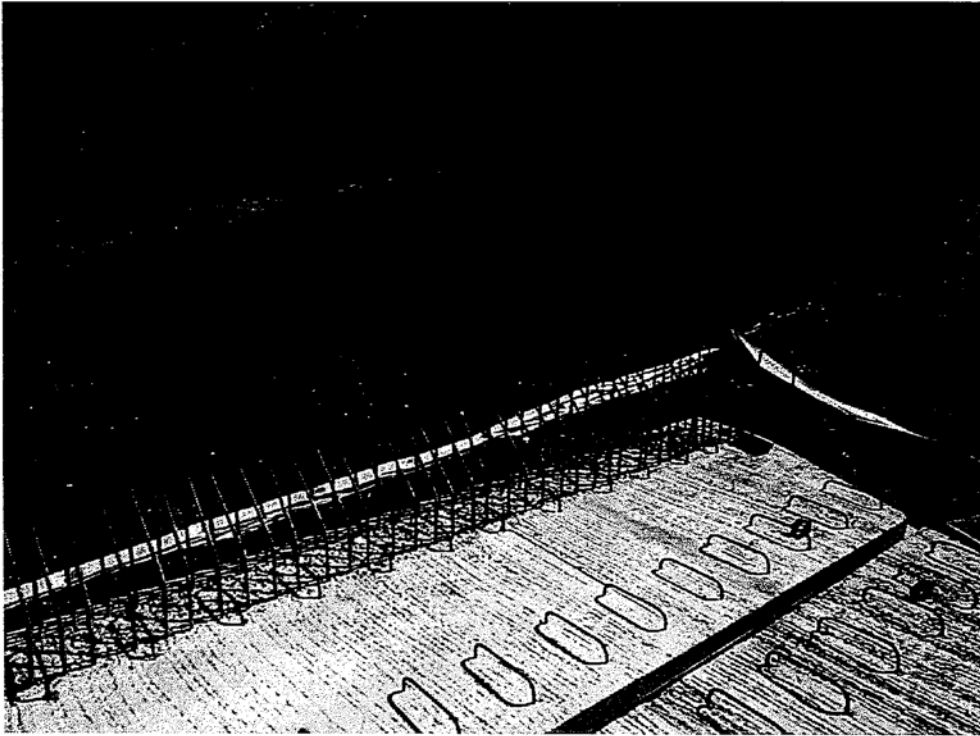


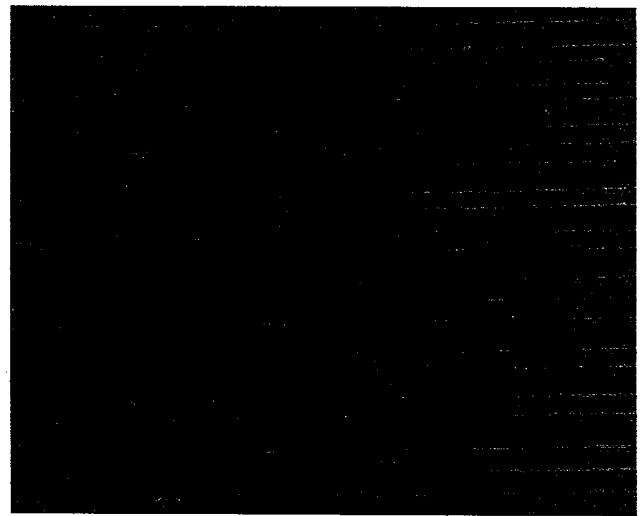
Figure 7 Bridge Under Construction

Evaluation of the current conditions of the bridge revealed minor longitudinal surface cracking and transverse cracking of the supports. This type of cracking is not specific to this bridge type and is also common in slab on girders bridges. Prior investigation by the Structures Design Office concluded that these cracks have no differential movement and showed little or no increase in size. It was also stated that the quality control during the placement of the cast in place slab was less than ideal resulting in a wet mix and placement of the transverse reinforcement at four inches or more below the surface of the deck. Figure 8 shows the observed cracking. Figure 8(a) shows cracking at the expansion joint which is due to improper joint installation.

The performance of this bridge can be termed acceptable. Better quality control during the construction coupled with 4 to 7 days of wet curing could result in even better performance. This type of bridge is attractive and simple to construct, however, tight quality control is important. Figure 9 shows the bridge after construction.



a) Cracking at Joints



b) Longitudinal Cracking

Figure 8 Observed Cracking

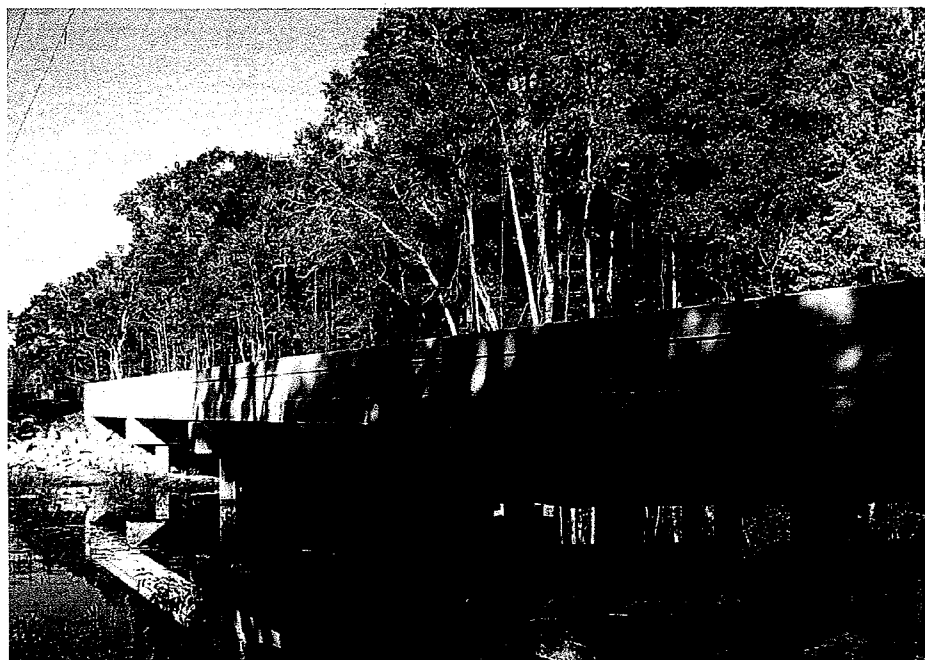


Figure 9 Bridge After Construction

### I.3 Reedy Creek Bridge:

#### Condition Assessment:

The bridge, located in Orlando, FL, is owned by Disney. The twin bridges shown in Figure 10 were built across Reedy Creek using "top-down" construction.

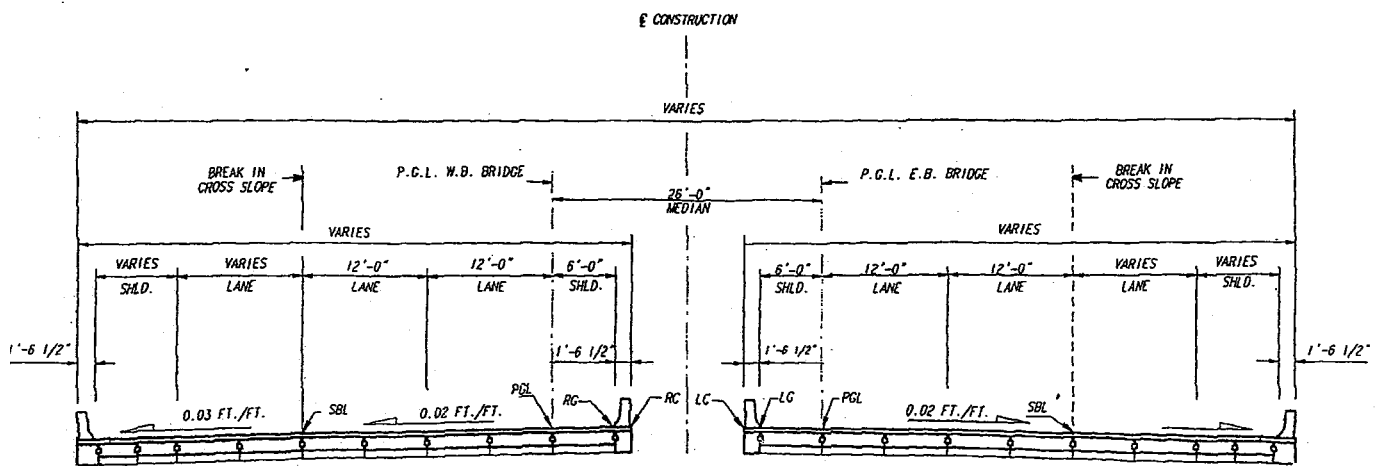


Figure 10 Cross Section of Reedy Creek Bridge

The bridge consists of twenty-five 40 ft. continuous spans. The superstructure is composed primarily of 6 ft. wide by 15 inches deep precast prestressed solid concrete slab units as shown in Figure 11.

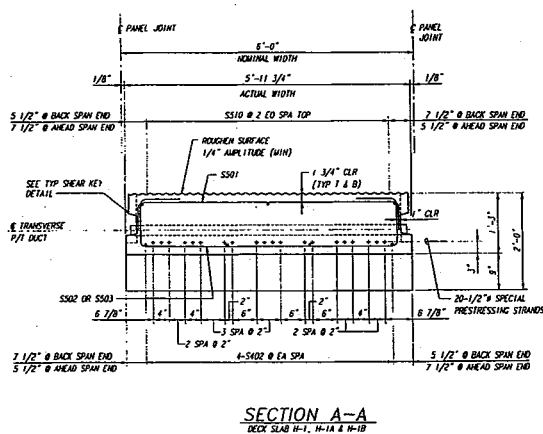


Figure 11 Details of Precast Slab Unit

The thickness of the cast in place slab was 6 inches. The reinforcement of the cast in place slab consisted of number 4 and 6 bars spaced at 12 inches on center for the transverse and longitudinal reinforcement, respectively. The depth of reinforcement was specified at 2 inches below the top surface of the deck. Figure 12 shows views of the bridge during construction.

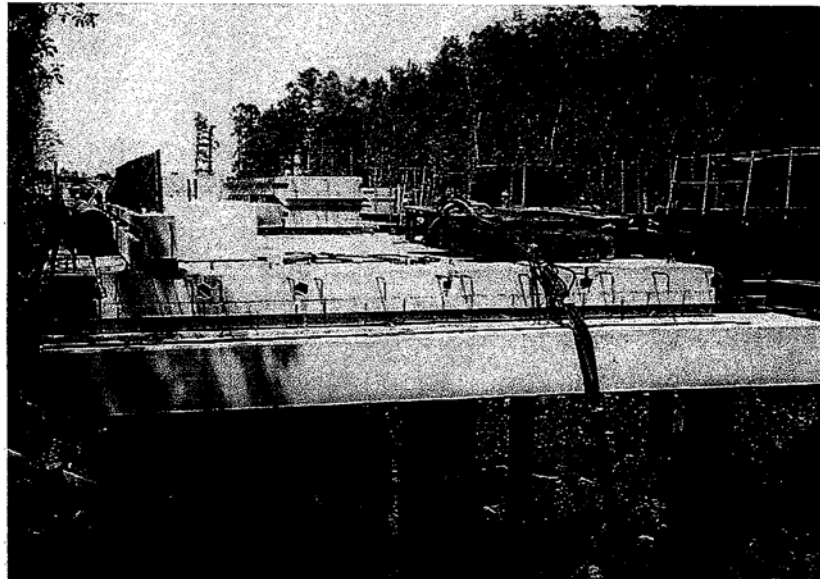


Figure 12 Bridge During Construction

The precast units were transversely post tensioned to form a monolithic slab prior to casting of the 6" thick slab. The cast in place slab units contained four 2 1/2" diameter rigid galvanized steel ducts spaced at 8 feet as shown in Figure 13.

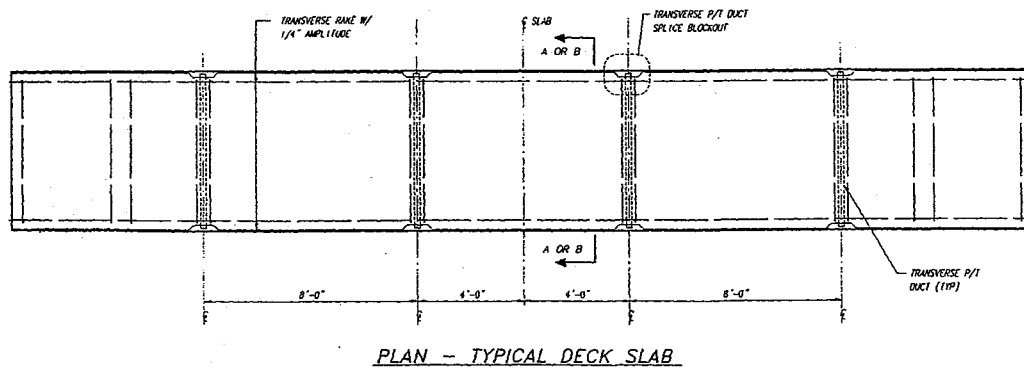


Figure 13 Precast Deck Unit

Once the precast units were installed, the ducts were spliced at the panel joints with female coupler and taped to form a mortar tight seal as shown in Figure 14.

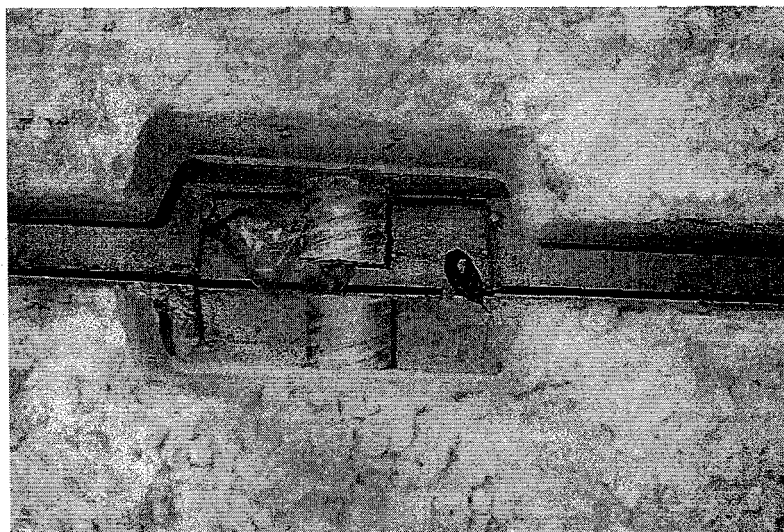


Figure 14. Panels Alignment

Five (5) 0.6" diameter low-relaxation strands were then pulled through each duct. The five strands were stressed up to a jacking force of 234 kips. Allowing for a 20% prestress loss, the average final . prestress across the joints was approximately 100 psi. Construction details of the grout pocket are shown in Figure 15.

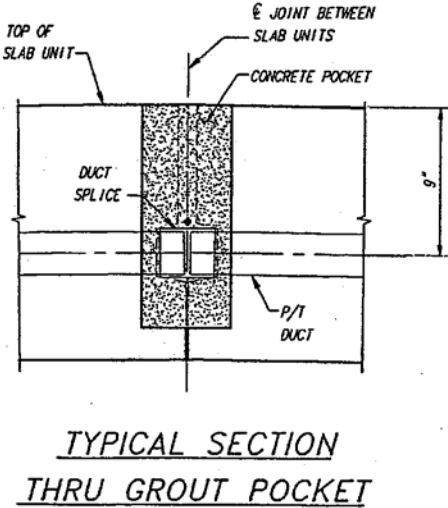
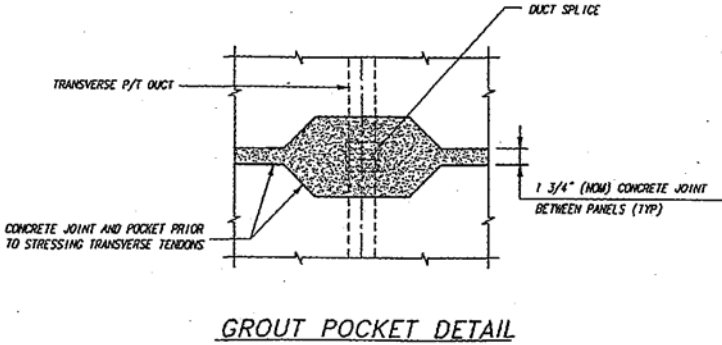


Figure 15 Grout Pocket Details



Figure 16 shows the details of the shear key between the prestressed panels. Reinforcement consisting of welded wire mesh was inserted in the shear keys just before concreting the cast-in-place slab. The shear keys and grout pockets were filled with ready mix grout prior to casting the slab to insure proper filling of all voids.

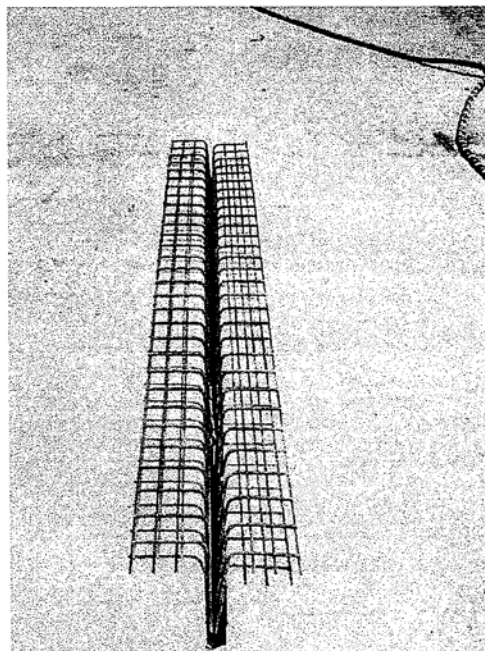
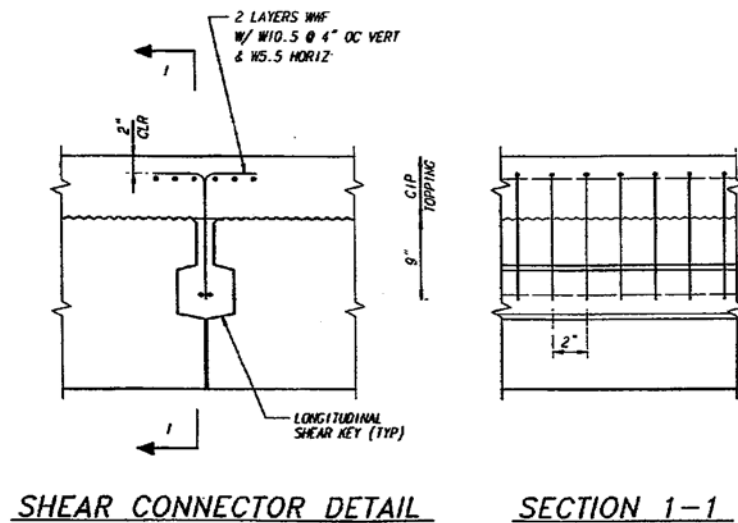


Figure 16 Shear Key Details

Visual observation indicates no signs of cracking. The transverse post tensioning and proper details of the shear keys practically eliminated any possibility of deck cracking.

#### I.4 Summary of Conditions Evaluation

One of the main objectives of the MOT is to find a bridge system that does not require transverse post tensioning. Experience shows that, generally, contractors are not eager to use or promote such systems due to perceived difficulty and the lack of necessary experience. Without a doubt, the Reedy Creek Bridge offers the best performance of the three bridges. The bridge is very attractive and will require very little maintenance over its life span. However, it does not meet the MOT objectives with regard to transverse post tensioning.

The other two bridges had similar designs. However, their performance was markedly different. The behavior of the Turkey Creek Bridge can be termed poor with the bridge requiring continuing maintenance. The behavior of the Cow Creek Bridge can be termed good despite the observed longitudinal and transverse cracking.

There are two major differences that can attribute to the vastly different behavior, the type of longitudinal joints and the reinforcement in the cast in place slab. The Cow Creek Bridge contained twice the amount of reinforcement in the cast in place slab compared to the Turkey Creek Bridge. This additional reinforcement helped in controlling the shrinkage stresses, resulting in fewer and smaller width cracks.

The following section explores the design deficiencies in the Turkey Creek Bridge and explains how to avoid them in the future.

## II STRUCTURAL EVALUATION

### II.1 Detailing:

Of primary concern is the detail of the construction joint shown in Figure 1. This figure shows that the precast deck joint is directly in line with the construction joint in the CIP slab creating an undesirable structural discontinuity. This type of structural discontinuity serves as a crack initiator and resulted cracks propagating from the bottom to the top of the bridge deck.

Regardless of the location of the construction joint, the primary resisting element at the section is the cast in place concrete slab. Checking a simplified model, however, results in a maximum shear stress of 40 psi. AASHTO code states that when minimum steel tie requirements are met, a shear capacity of 75 psi can be assumed at the contact surface (AASHTO 9.20.4.3). Since the calculated 40-psi may be high, it demonstrates that this may be a significant effect.

### II.2 Transverse Flexural Capacity

The LRFD Specifications do not require transverse design of a full depth cast in place deck slab. However, it states that performance and cracking problems are associated with the cases of CIP slab supported by precast deck panels and close attention is needed. Transverse moments due to live loads result in tensile stresses that should be accounted for in the design.

The transverse flexural capacity of the deck is checked using assumptions from AASHTO LRFD Specifications as to the width of deck, which is attributable to a wheel load. In the positive moment region, this width is 65", while in the negative moment region the width is 66". A computer model was then generated to determine the maximum transverse moments distributed through the deck. In all cases, the maximum stresses transmitted are well below the cracking stress of the attributed deck width.

## II.3 Differential Shrinkage

Another possibility for the observed cracking is differential shrinkage and temperature effects. The following calculations show the effect of these elements.

### 1. Minimum Requirements for Shrinkage and Temperature Reinforcement AASHTO Standard Specifications (Sec. 8.20.1)

The AASHTO Standard Specifications state that the total area of reinforcement provided shall be at least 0.125 in<sup>2</sup> per foot in each direction. The LRFD Specifications (Sec.5.10.8.2) require minimum reinforcement area:

$$A_{s\min} \geq 0.11A_g / F_y \quad (\text{LRFD Eq. 5.10.8.2-1})$$

Assume a 12" width for the calculation of the minimum transverse reinforcement required for resisting shrinkage and temperature in the CIP concrete slab:

Required minimum reinforcement area,

$$A_s(\min) = \frac{0.11 \times 8 \times 12}{60} = 0.18 \text{ in}^2/\text{ft}$$

The provided transverse reinforcement is #5 @ 12" ( $A_s = 0.3 \text{ in}^2$ )  $\geq A_s(\min)$

Unfortunately, neither of the two Specifications provides any clear guidance for precast decks with slab overlay. The AASHTO Standard Specifications do not offer any guidance for placing the reinforcement. However, the LRFD Specifications require that the steel reinforcement should be equally distributed on both faces of the slab except that for members 6.0 in. or less in thickness, the steel may be placed in a single layer. In the Turkey Creek Bridge, only a single layer of reinforcement placed at 2 inches from the top surface of the slab was used.

### 2. Stress Due to Differential Shrinkage

The differential shrinkage between the precast and CEP concrete results in tensile stresses that

should be accounted for in the design. In the following calculations it was assumed that the precast deck is 30 days older than CEP concrete slab. The following calculations check the stress for 12" width of slab at 90 days. The calculations for up to 720 days are given in the attached tables.

$$\varepsilon_{sh,t} = A \frac{t}{t + 35}$$

Concrete shrinkage can be approximated at a time, t, by the following equation:

Where A is a factor      =  $0.51 \times 10^{-3}$       for moist cured concrete  
                                        $0.80 \times 10^{-3}$       for sections which are not properly cured

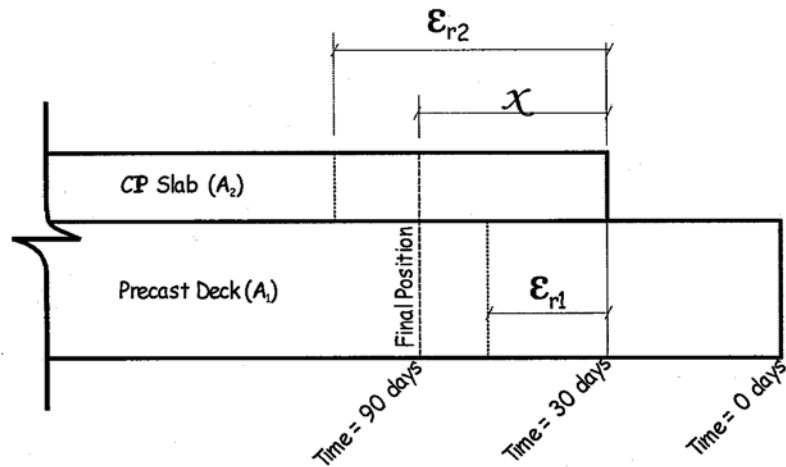
Assuming  $A = 0.51 \times 10^{-3}$ , the free shrinkage strain after composite action for the precast deck can be calculated as follows:

$$\varepsilon_{r1} = \varepsilon_{t=90} - \varepsilon_{t=30} = \left[ \frac{t_{90}}{t_{90} + 35} - \frac{t_{30}}{t_{30} + 35} \right] \times 0.51 \times 10^{-3} = 1.32 \times 10^{-4}$$

Similarly, the free shrinkage strain after composite action for the CIP slab is:

$$\varepsilon_{r2} = \varepsilon_{t=60} = \frac{t_{60}}{t_{60} + 35} \times 0.51 \times 10^{-3}$$

The above values are for the free shrinkage of the precast deck and cast in place slab. However, in actual conditions the precast deck restrains the free shrinkage strain of CIP slab. The actual strains of the deck and slab can be determined with equilibrium and compatibility condition as shown in the figure below.



$\epsilon_{r1}$  = free shrinkage of precast deck  
 $\epsilon_{r2}$  = free shrinkage of slab  
 $X$  = actual shrinkage of composite action

From equilibrium:

$$A_2(\epsilon_{r2} - X)E = A_1(X - \epsilon_{r1})E$$

$$X = \frac{A_1\epsilon_{r1} + A_2\epsilon_{r2}}{A_1 + A_2}$$

Where  $A_1$  and  $A_2$  are the areas of the precast slab and the CIP slab, respectively. For one-ft. width of the CIP slab the stress due to differential shrinkage is:

$$\sigma = E(\epsilon_{r2} - X) = E \times \frac{(\epsilon_{r2} - \epsilon_{r1})A_1}{A_1 + A_2}$$

The above stress value is based on moist cured condition at the age of 90 days. Table 1 shows the stresses that can be developed using a curing factor,  $A = 0.51 \times 10^{-3}$  along with the required amount of reinforcement to resist this stress. It can be seen that this stress can reach 423 psi after one year, which is equal to the cracking strength of 424 psi assuming a 5000-psi compressive strength.

If a curing factor,  $A = 0.8 \times 10^{-3}$ , is assumed the calculated differential shrinkage stress after one year will be 663 psi which exceeds the tensile strength of concrete (424 psi) as shown in Table 2. Inadequate reinforcement of the CIP slab will result in excessive cracking such as observed in the Turkey Creek Bridge.

It should be also noted that the above calculations are based on conservative assumptions, since in many cases the precast panels are much older than the assumed 30 days when the CIP concrete is placed. This will result in much higher value for the stresses due to differential shrinkage. In addition the quality of curing is an important parameter that is most often ignored. In actual construction the value of the curing factor,  $A$ , is somewhere between  $0.51 \times 10^{-3}$  and  $0.80 \times 10^{-3}$ ; and in the majority of cases is closer to the higher value. It is clear from the above calculation that the provided reinforcement was insufficient to resist these shrinkage stresses resulting in the observed cracking.

The above calculations show that the differential shrinkage stress alone can easily result in the observed cracking. The actual transverse reinforcement ( $0.3 \text{ in}^2 / \text{ft}$ ) is far below what should be required by proper design. Note that Cow Creek Bridge with similar dimensions did not show signs of excessive cracking, which can be attributed to higher transverse reinforcement ( $0.6 \text{ in}^2 / \text{ft}$ ).

Appendix A shows the results of a parametric study for varying values of the curing coefficients and CIP depth. It can be seen from the results that the method of curing and the depth of the CIP slab are major parameters that should be closely monitored during construction.

**Table 1 CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A =0.00051)**

t (day)	Free Shrinkage Strain		Strain (ε <sub>t</sub> )	Strain Slop (tan θ)	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck							
30	2.35E-04	0.00E+00	3.91E-05	1.07E-05	1.90E+02	-3.23E+02	2.71E+02	-7.14E+01	1.60E-01
60	3.22E-04	2.35E-04	7.09E-05	1.37E-05	2.44E+02	-4.14E+02	3.47E+02	-9.13E+01	2.05E-01
90	3.67E-04	3.22E-04	9.30E-05	1.50E-05	2.66E+02	-4.52E+02	3.79E+02	-9.97E+01	2.23E-01
120	3.95E-04	3.67E-04	1.09E-04	1.56E-05	2.77E+02	-4.72E+02	3.95E+02	-1.04E+02	2.33E-01
150	4.14E-04	3.95E-04	1.21E-04	1.60E-05	2.84E+02	-4.83E+02	4.05E+02	-1.07E+02	2.39E-01
180	4.27E-04	4.14E-04	1.30E-04	1.62E-05	2.88E+02	-4.90E+02	4.11E+02	-1.08E+02	2.42E-01
210	4.37E-04	4.27E-04	1.37E-04	1.64E-05	2.91E+02	-4.95E+02	4.15E+02	-1.09E+02	2.45E-01
240	4.45E-04	4.37E-04	1.43E-04	1.65E-05	2.93E+02	-4.98E+02	4.18E+02	-1.10E+02	2.46E-01
270	4.51E-04	4.45E-04	1.48E-04	1.66E-05	2.95E+02	-5.01E+02	4.20E+02	-1.10E+02	2.47E-01
300	4.57E-04	4.51E-04	1.52E-04	1.66E-05	2.96E+02	-5.03E+02	4.21E+02	-1.11E+02	2.48E-01
330	4.61E-04	4.57E-04	1.55E-04	1.67E-05	2.97E+02	-5.04E+02	4.23E+02	-1.11E+02	2.49E-01
360	4.65E-04	4.61E-04	1.58E-04	1.67E-05	2.97E+02	-5.05E+02	4.24E+02	-1.11E+02	2.50E-01
390	4.68E-04	4.65E-04	1.61E-04	1.67E-05	2.98E+02	-5.06E+02	4.24E+02	-1.12E+02	2.50E-01
420	4.71E-04	4.68E-04	1.63E-04	1.68E-05	2.98E+02	-5.07E+02	4.25E+02	-1.12E+02	2.50E-01
450	4.73E-04	4.71E-04	1.65E-04	1.68E-05	2.99E+02	-5.08E+02	4.25E+02	-1.12E+02	2.51E-01
480	4.75E-04	4.73E-04	1.66E-04	1.68E-05	2.99E+02	-5.08E+02	4.26E+02	-1.12E+02	2.51E-01
510	4.77E-04	4.75E-04	1.67E-04	1.68E-05	2.99E+02	-5.09E+02	4.26E+02	-1.12E+02	2.51E-01
540	4.79E-04	4.77E-04	1.69E-04	1.68E-05	2.99E+02	-5.09E+02	4.26E+02	-1.12E+02	2.51E-01
570	4.80E-04	4.79E-04	1.70E-04	1.68E-05	2.99E+02	-5.09E+02	4.27E+02	-1.12E+02	2.51E-01
600	4.82E-04	4.80E-04	1.72E-04	1.69E-05	3.00E+02	-5.09E+02	4.27E+02	-1.12E+02	2.52E-01
630	4.83E-04	4.82E-04	1.73E-04	1.69E-05	3.00E+02	-5.09E+02	4.27E+02	-1.12E+02	2.52E-01
660	4.84E-04	4.83E-04	1.74E-04	1.69E-05	3.00E+02	-5.10E+02	4.27E+02	-1.12E+02	2.52E-01
690	4.85E-04	4.84E-04	1.75E-04	1.69E-05	3.00E+02	-5.10E+02	4.27E+02	-1.12E+02	2.52E-01
720	4.86E-04	4.85E-04	1.76E-04	1.69E-05	3.00E+02	-5.10E+02	4.28E+02	-1.13E+02	2.52E-01

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 8.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

Shrinkage strain = t/(t+35)\*A  
 Slab was cast B days before CIP deck  
 A = 5.10E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Free Shrinkage Strain  
 After Composite (t1-t)  
 Pre-slab  
 CIP-deck



**Table 2 CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A =0.0008)**

Shrinkage strain =  $t/(t+35)^A$   
 Slab was cast B days before CIP deck  
 A = 8.00E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Free Shrinkage Strain  
 From 0 days (0 - t)  
 Pre-slab  
 CIP-deck  
 After Composite (t1-t)  
 CIP-deck

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 8.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain		Strain ( $\epsilon_1$ )	Strain Slope (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (0 - t)	CIP-deck	Pre-slab	After Composite (t1-t)			slab_bot	slab_Top	CIP_bot		CIP_Top
30	3.69E-04	0.00E+00	1.36E-04	3.69E-04	6.14E-05	1.68E-05	2.98E+02	-5.07E+02	4.25E+02	-1.12E+02	2.51E-01
60	5.05E-04	3.69E-04	2.07E-04	5.05E-04	1.11E-04	2.15E-05	3.82E+02	-6.50E+02	5.44E+02	-1.43E+02	3.21E-01
90	5.76E-04	5.05E-04	2.50E-04	5.76E-04	1.46E-04	2.35E-05	4.17E+02	-7.09E+02	5.94E+02	-1.56E+02	3.50E-01
120	6.19E-04	5.76E-04	2.79E-04	6.19E-04	1.71E-04	2.45E-05	4.35E+02	-7.40E+02	6.20E+02	-1.63E+02	3.66E-01
150	6.49E-04	6.19E-04	3.01E-04	6.49E-04	1.89E-04	2.51E-05	4.46E+02	-7.57E+02	6.35E+02	-1.67E+02	3.74E-01
180	6.70E-04	6.49E-04	3.16E-04	6.70E-04	2.03E-04	2.54E-05	4.52E+02	-7.69E+02	6.44E+02	-1.70E+02	3.80E-01
210	6.86E-04	6.70E-04	3.29E-04	6.86E-04	2.15E-04	2.57E-05	4.57E+02	-7.76E+02	6.51E+02	-1.71E+02	3.84E-01
240	6.98E-04	6.86E-04	3.39E-04	6.98E-04	2.24E-04	2.59E-05	4.60E+02	-7.82E+02	6.55E+02	-1.72E+02	3.86E-01
270	7.08E-04	6.98E-04	3.47E-04	7.08E-04	2.32E-04	2.60E-05	4.62E+02	-7.86E+02	6.58E+02	-1.73E+02	3.88E-01
300	7.16E-04	7.08E-04	3.54E-04	7.16E-04	2.38E-04	2.61E-05	4.64E+02	-7.89E+02	6.61E+02	-1.74E+02	3.90E-01
330	7.23E-04	7.16E-04	3.60E-04	7.23E-04	2.44E-04	2.62E-05	4.65E+02	-7.91E+02	6.63E+02	-1.74E+02	3.91E-01
360	7.29E-04	7.23E-04	3.65E-04	7.29E-04	2.48E-04	2.62E-05	4.66E+02	-7.93E+02	6.64E+02	-1.75E+02	3.92E-01
390	7.34E-04	7.29E-04	3.69E-04	7.34E-04	2.52E-04	2.63E-05	4.67E+02	-7.94E+02	6.66E+02	-1.75E+02	3.92E-01
420	7.38E-04	7.34E-04	3.73E-04	7.38E-04	2.56E-04	2.63E-05	4.68E+02	-7.95E+02	6.67E+02	-1.75E+02	3.93E-01
450	7.42E-04	7.38E-04	3.76E-04	7.42E-04	2.59E-04	2.63E-05	4.68E+02	-7.96E+02	6.67E+02	-1.75E+02	3.93E-01
480	7.46E-04	7.42E-04	3.78E-04	7.46E-04	2.62E-04	2.64E-05	4.69E+02	-7.97E+02	6.68E+02	-1.76E+02	3.94E-01
510	7.49E-04	7.46E-04	3.82E-04	7.49E-04	2.65E-04	2.64E-05	4.69E+02	-7.98E+02	6.69E+02	-1.76E+02	3.94E-01
540	7.51E-04	7.49E-04	3.84E-04	7.51E-04	2.67E-04	2.64E-05	4.70E+02	-7.98E+02	6.69E+02	-1.76E+02	3.94E-01
570	7.54E-04	7.51E-04	3.87E-04	7.54E-04	2.69E-04	2.64E-05	4.70E+02	-7.99E+02	6.70E+02	-1.76E+02	3.95E-01
600	7.56E-04	7.54E-04	3.89E-04	7.56E-04	2.71E-04	2.64E-05	4.70E+02	-7.99E+02	6.70E+02	-1.76E+02	3.95E-01
630	7.58E-04	7.56E-04	3.90E-04	7.58E-04	2.73E-04	2.65E-05	4.70E+02	-8.00E+02	6.70E+02	-1.76E+02	3.95E-01
660	7.60E-04	7.58E-04	3.92E-04	7.60E-04	2.75E-04	2.65E-05	4.71E+02	-8.00E+02	6.71E+02	-1.76E+02	3.95E-01
690	7.61E-04	7.60E-04	3.94E-04	7.61E-04	2.76E-04	2.65E-05	4.71E+02	-8.00E+02	6.71E+02	-1.76E+02	3.95E-01
720	7.63E-04	7.61E-04	3.94E-04	7.61E-04	2.76E-04	2.65E-05	4.71E+02	-8.00E+02	6.71E+02	-1.76E+02	3.95E-01

## II.4 Construction Quality

Construction quality is a subject that cannot be over emphasized. The type of construction is dependent on very simple, but yet important parameters that can significantly influence the final product.

### 1. Curing:

The key to a successful system is by limiting and controlling shrinkage stresses. Wet curing of the concrete deck for seven days will most likely achieve the desired results. This fact should be clear in the construction specifications and should be enforced. The construction inspectors should be made aware of the importance of this simple task which is most often ignored.

### 2. Concrete Placement:

Low shrinkage translates to low water / cement ratio. Again, most often this fact is ignored. Placing concrete on Saturday in the absence of FDOT inspectors, as is the case with Cow Creek Bridge, will most often lead to undesirable results. Concrete with low water/cement ratios should be specified for this type of construction. Construction additives and admixtures should be considered providing that the rate, of concrete shrinkage is not impacted.

### 3. Steel Placement:

Poor placement of the reinforcement represents a significant problem that will result in future deterioration throughout the life of the bridge, due to the expected cracking and spalling of the concrete in the areas with shallow reinforcement. In both of the Turkey Creek and Cow Creek Bridges the reinforcement was improperly placed which is an indication of the lack of quality control. The purpose of the reinforcement is cracking control and variations in placement could negate its effectiveness. Tight construction tolerances should be specified and enforced.

#### 4. Surface Cleaning:

The quality of concrete bonding between the CIP concrete and the prestressed concrete panels is very important. Avoiding surface contaminations due to oil or fuel spills from construction equipment is an important step towards better bond quality. This issue is most often overlooked in the construction specifications. Clear guidance to the inspectors for locating and cleaning oil contaminations should be addressed.

#### 11.4 Transverse Differential Displacement

The final structural evaluation deals with the possibility that the CIP slab is not fully capable of transmitting loads transversely to the precast slab units. This can result in independent action, or differential displacement, of the precast units. A computer model is used to determine the amount of stress in the CIP slab due to the independent movement of the precast units. In the program, the deck between adjacent precast units is modeled as a beam element. The support conditions for the elements fixes rotation at the ends, but provides for some resistance to vertical displacement. Both ends of the model are then subjected to a forced displacement, with one end receiving a slightly greater amount, thus simulating a differential displacement. The following procedure demonstrates the calculation of the stress induced in the slab for a differential displacement of 0.05".

$$\text{Stiffness Matrix for CIP slab: } K = \begin{bmatrix} \frac{k_1 \cdot L^3}{EI} + 12 & 6L & -12 & 6L \\ 6L & 4L^2 & -6L & 2L^2 \\ -12 & -6L & \frac{k_2 \cdot L^3}{EI} + 12 & -6L \\ 6L & 2L^2 & -6L & 4L^2 \end{bmatrix} \cdot \frac{EI}{L^3}$$

Where:

$k_1$  and  $k_2$  = additional stiffness provided by precast unit at ends 1 and 2

$E$  = modulus of elasticity of CIP slab

$I$  = moment of inertia per unit width of slab

$L$  = length of element (spacing between adjacent precast units)

Next, the matrix representing the induced differential deflection is created:

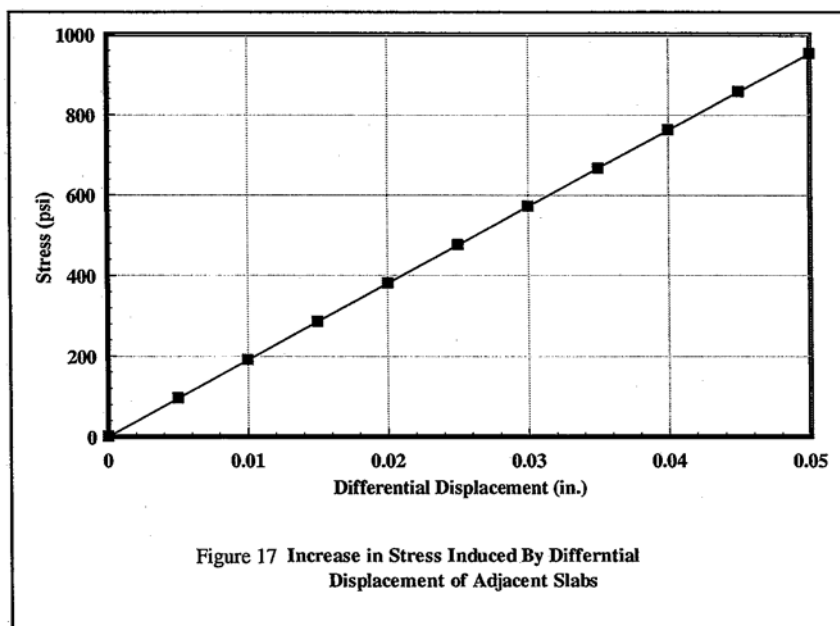
$$Q = \begin{bmatrix} 0.15 \\ 0 \\ 0.1 \\ 0 \end{bmatrix} \quad \text{Here, a difference in vertical deflection of 0.05" is used.}$$

Forces are then calculated by the relation:

$$F = K \times Q$$

Producing a bending stress within the element of over 950 psi per unit width.

Various runs of the simulation can be seen in the graph below where a relative displacement between units of as little as 0.03" (0.75 mm) can cause a tensile stress (590 psi) which exceed the concrete modulus of rupture.



The above analysis represents another possibility for cracking. Proper design, reinforcement and grout of the longitudinal shear keys should provide the necessary continuity across these joints. Proper reinforcement and detailing could transform individual slabs to a monolithic system with superior performance. The reinforcement and grout quality are addressed below:

## II.5 Grout Materials:

Non-shrink grout is the most common material used in filling shear keys. Generally research showed that these types of material do not meet the requirements for maximum shrinkage limits or minimum bond strength, which are critical for effective load transfer.

In a research study by Gulyas et al the performance of two different grouting materials, non-shrink grouts and magnesium ammonium phosphate mortars, were investigated. Shear keys made of both materials were tested in vertical shear; longitudinal shear, and direct tension. It was concluded that the grout materials strength, alone, does not provide an accurate picture of their field performance. The effects of grouting materials, the shapes of the keyway, curing, substrate exposure, and texture are important parameters that contribute to the overall performance of the grouted joints.

In the study, shear keys made with Mg-NG4-P04 mortars performed significantly better than those made with non-shrink grout. The direct tensile bond strength, vertical shear strength, and longitudinal shear strength of the Mg-NG4-P04 mortars were much higher than those for non-shrink grout despite slight difference in compressive strength of both materials.

It is important to consider grout materials with inherent bond strength high enough to fail in the substrate of properly prepared high strength concretes. Materials that produce failure in the substrate concrete in direct tension, per ACI 503 Appendix Testing, and exceed the ASTM C 882 slant shear test for epoxy requirements may be initially considered.

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1 Gulyas R.J., Wirthlin, G.J., and Champa, J.T, "Evaluation of Keyway Grout Test Methods for Precast Concrete Bridges" PCI Journal , V. 40, No. 1, Jan.- Feb. 1995.

The bond between the precast concrete and the grout material is important. Sandblasting the top and the shear key areas of the precast panels prior to transportation to the job site is an effective way of improving the bond quality. The sand blasting will remove surface laitance and form release agents, both of which produce a substrate with poor bonding qualities.

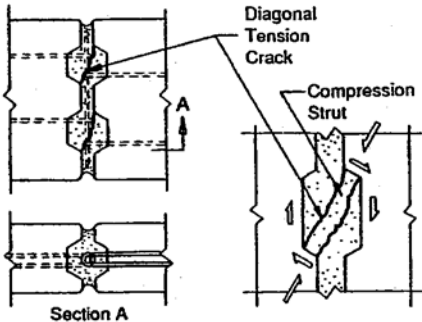
The use of non-shrink grouts should be discouraged for keyway grouting or any bond critical applications.

The issue of grout material should be properly addressed in construction specifications. The lack of guidance in this area is unacceptable in light of the array of newly developed construction materials. Proper evaluation of suitable grout materials that meet a specific need should be carried out. Limited testing or using the material on an experimental basis until more data is available should be encouraged.

II.6 Shear Key Reinforcement

The best type of shear key reinforcement is transverse post-tensioning. However, due to the lack of interest, other types of connections should be considered. The shear key detail utilized in the Reedy Creek Bridge (Figure 16) is simple and effective. It provides reinforcement of the shear key where it is needed. Research shows that reinforced joints are stronger and possess higher ductility. Generally, as shown in Figure 18, the resistance of a keyed joint can be limited by:

- (a) Cracking of grout parallel to joint,
- (b) Diagonal cracks across joints,
- (c) Crushing of key edges or joint concrete, or
- (d) Slippage along contact area.



(a) Diagonal Tension

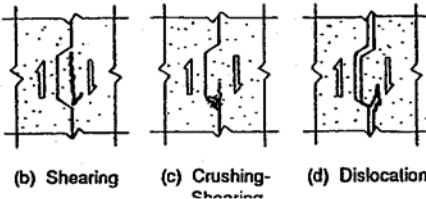
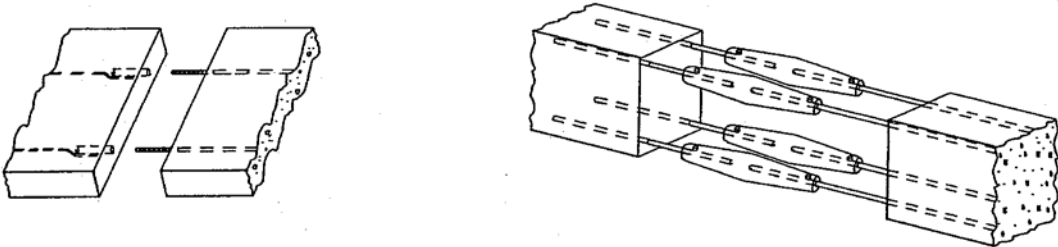
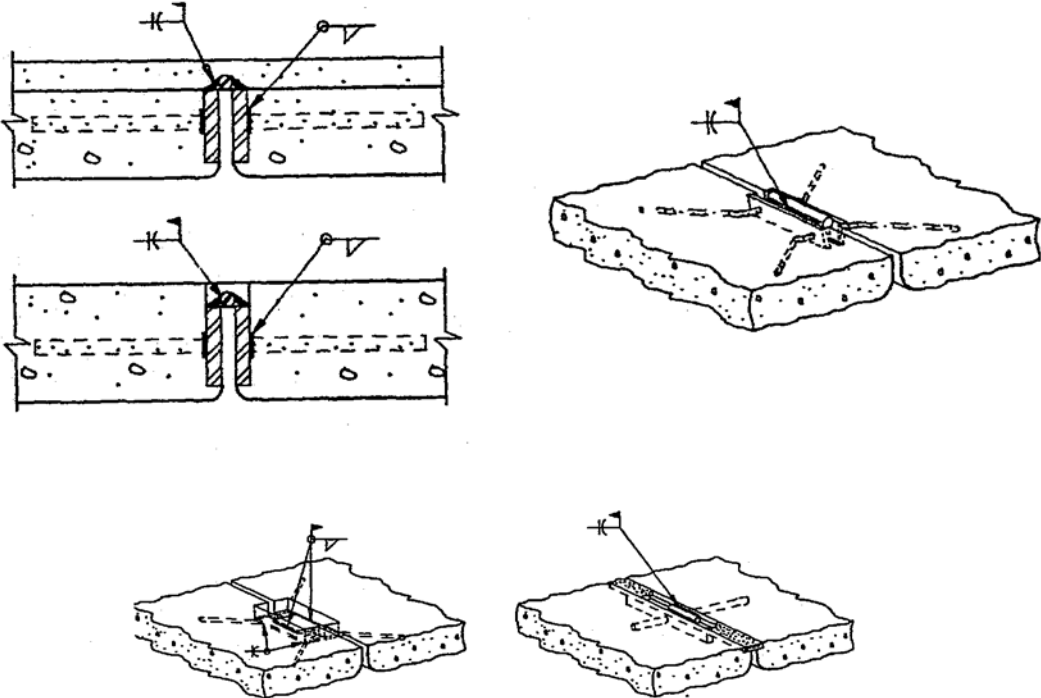


Figure 18 Possible Failures of Keyed joints

Figure 19 shows different possibilities for connections between the precast Pannels.



(a) Special Splice Sleeves



(b) Angles or flat plates with deformed bar anchors embedded in concrete

Figure 19 Panel to Panel Connections

Properly spaced connections help distribute vertical loading and even out differential camber. However, these connections must be carefully located and detailed to allow easy installation. Easy, simple, and effective connections capable of transferring the loads and resisting shear action should be developed.

#### CONCLUSIONS:

1. Stresses due to differential shrinkage represent one major reason for cracking of CIP slab over precast panels. Uncontrolled, These stresses could exceed the concrete cracking strength and should be accounted for in the design.
2. The design plans show a single layer of steel reinforcement placed at 50 mm from the top of the CIP slab, which might have a significant effect on the performance, since the LRFD Specifications clearly require that the steel reinforcement should be equally distributed on both faces of the slab with thickness exceeding 6 inches.
3. Slight independent vertical movement of the precast deck (less than 1 mm) could result in high tensile stresses exceeding the concrete cracking strength. Properly spaced connections help distribute vertical loading and even out differential camber. Design specifications for easy, simple, and effective connections capable of transferring the loads and resisting shear action need to be established for these types of bridge systems.
4. Curing of the CIP slab is a major parameter that has a significant impact on the performance. Tight construction quality control are essential in the successful implementation of these bridge systems.
5. Differential shrinkage strain, combined with other factors, such as temperature changes, creep, and live load effect, can easily result in the observed cracking and were not accounted



for in the design.

6. The use of non-shrink grouts should be discouraged for keyway grouting or any bond critical applications. The issue of grout material should be properly addressed in construction specifications. Proper evaluation of suitable grout materials that meet a specific need should be carried out. Limited testing or using the material on experimental basis until more data is available should be encouraged.
7. Poor placement of the reinforcement represents a significant problem that will result in future deterioration throughout the life of the bridge due to the expected cracking and spalling of the concrete in the areas with shallow reinforcement. Tight Construction tolerances should be specified and enforced.
8. The quality of concrete bonding between the CIP concrete and the prestressed concrete panels is very important. Avoiding surface contaminations due to oil or fuel spills from construction equipment is an important step towards better bond quality. Clear guidance to the inspectors for locating and cleaning oil contaminations should be addressed.
9. Concrete with low water/cement ratios should be specified for this type of construction. Construction additives and admixture should be considered providing that the rate of concrete shrinkage is not impacted.

#### Recommendations:

Developing guide design and construction specifications addressing the issues highlighted in this report are recommended.

Appendix A  
Parametric Study

Curing Coefficient A = 0.00051

CIP depth 6 to 12 inches



## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A =0.00051)

Shrinkage strain =  $t/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = 5.10E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 7.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	2.35E-04	0.00E+00	8.67E-05	2.35E-04	3.77E-05	1.09E-05	1.96E+02	-3.28E+02	2.66E+02	-8.32E+01	1.28E-01
60	3.22E-04	2.35E-04	1.32E-04	3.22E-04	6.91E-05	1.40E-05	2.51E+02	-4.20E+02	3.41E+02	-1.07E+02	1.64E-01
90	3.67E-04	3.22E-04	1.59E-04	3.67E-04	9.10E-05	1.59E-05	2.74E+02	-4.59E+02	3.72E+02	-1.16E+02	1.79E-01
120	3.95E-04	3.67E-04	1.78E-04	3.95E-04	1.07E-04	1.59E-05	2.86E+02	-4.79E+02	3.88E+02	-1.21E+02	1.87E-01
150	4.14E-04	3.95E-04	1.92E-04	4.14E-04	1.18E-04	1.63E-05	2.93E+02	-4.90E+02	3.98E+02	-1.24E+02	1.91E-01
180	4.27E-04	4.14E-04	2.02E-04	4.27E-04	1.28E-04	1.65E-05	2.97E+02	-4.97E+02	4.03E+02	-1.26E+02	1.94E-01
210	4.37E-04	4.27E-04	2.10E-04	4.37E-04	1.35E-04	1.67E-05	3.00E+02	-5.02E+02	4.07E+02	-1.27E+02	1.96E-01
240	4.45E-04	4.37E-04	2.16E-04	4.45E-04	1.41E-04	1.68E-05	3.02E+02	-5.06E+02	4.10E+02	-1.28E+02	1.97E-01
270	4.51E-04	4.45E-04	2.21E-04	4.51E-04	1.45E-04	1.69E-05	3.03E+02	-5.08E+02	4.12E+02	-1.29E+02	1.98E-01
300	4.61E-04	4.51E-04	2.26E-04	4.57E-04	1.50E-04	1.70E-05	3.05E+02	-5.10E+02	4.14E+02	-1.29E+02	1.99E-01
330	4.65E-04	4.61E-04	2.29E-04	4.61E-04	1.53E-04	1.70E-05	3.05E+02	-5.12E+02	4.15E+02	-1.30E+02	2.00E-01
360	4.68E-04	4.65E-04	2.33E-04	4.65E-04	1.56E-04	1.71E-05	3.06E+02	-5.13E+02	4.16E+02	-1.30E+02	2.00E-01
390	4.71E-04	4.68E-04	2.35E-04	4.68E-04	1.59E-04	1.71E-05	3.07E+02	-5.14E+02	4.17E+02	-1.30E+02	2.01E-01
420	4.73E-04	4.71E-04	2.38E-04	4.71E-04	1.61E-04	1.71E-05	3.07E+02	-5.14E+02	4.17E+02	-1.30E+02	2.01E-01
450	4.75E-04	4.73E-04	2.40E-04	4.73E-04	1.63E-04	1.71E-05	3.08E+02	-5.15E+02	4.18E+02	-1.31E+02	2.01E-01
480	4.77E-04	4.75E-04	2.42E-04	4.75E-04	1.66E-04	1.72E-05	3.08E+02	-5.16E+02	4.18E+02	-1.31E+02	2.01E-01
510	4.79E-04	4.77E-04	2.44E-04	4.77E-04	1.67E-04	1.72E-05	3.08E+02	-5.16E+02	4.18E+02	-1.31E+02	2.01E-01
540	4.80E-04	4.79E-04	2.45E-04	4.79E-04	1.68E-04	1.72E-05	3.08E+02	-5.16E+02	4.19E+02	-1.31E+02	2.02E-01
570	4.80E-04	4.80E-04	2.47E-04	4.80E-04	1.69E-04	1.72E-05	3.09E+02	-5.17E+02	4.19E+02	-1.31E+02	2.02E-01
600	4.82E-04	4.82E-04	2.48E-04	4.82E-04	1.71E-04	1.72E-05	3.09E+02	-5.17E+02	4.19E+02	-1.31E+02	2.02E-01
630	4.83E-04	4.83E-04	2.49E-04	4.83E-04	1.72E-04	1.72E-05	3.09E+02	-5.17E+02	4.20E+02	-1.31E+02	2.02E-01
660	4.84E-04	4.84E-04	2.50E-04	4.84E-04	1.73E-04	1.72E-05	3.09E+02	-5.17E+02	4.20E+02	-1.31E+02	2.02E-01
690	4.85E-04	4.85E-04	2.51E-04	4.85E-04	1.74E-04	1.72E-05	3.09E+02	-5.18E+02	4.20E+02	-1.31E+02	2.02E-01
720	4.86E-04	4.86E-04	2.51E-04	4.85E-04	1.74E-04	1.72E-05	3.09E+02	-5.18E+02	4.20E+02	-1.31E+02	2.02E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00051)

Shrinkage strain =  $\frac{t}{t+(35)^A}$  Distance from Bottom  
 Slab was cast B days before CIP deck Bottom of slab (in.) = 0.00E+00  
 A = 5.10E-04 Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01 Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 8.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Strain		Strain Slip (tan θ)	Calculated Stress (psi)			Relief Req. (sq. in. per ft.)	
	From 0 days (t0-t)		Strain (ε <sub>s</sub> )	Slab			CIP_bot	CIP_Top		
	Pre-slab	CIP-deck		slab_bot		slab_Top				CIP_Top
30	3.25E-04	0.00E+00	3.91E-05	2.35E-04	1.07E-05	1.90E+02	-3.23E+02	2.71E+02	-7.14E+01	1.60E-01
60	3.22E-04	2.35E-04	7.09E-05	3.22E-04	1.37E-05	2.44E+02	-4.14E+02	3.47E+02	-9.13E+01	2.05E-01
90	3.67E-04	3.22E-04	9.30E-05	3.67E-04	1.50E-05	2.66E+02	-4.52E+02	3.79E+02	-9.97E+01	2.23E-01
120	3.95E-04	3.67E-04	1.09E-04	3.95E-04	1.56E-05	2.77E+02	-4.72E+02	3.95E+02	-1.04E+02	2.33E-01
150	4.14E-04	3.95E-04	1.21E-04	4.14E-04	1.60E-05	2.84E+02	-4.83E+02	4.05E+02	-1.07E+02	2.39E-01
180	4.27E-04	4.14E-04	1.30E-04	4.27E-04	1.62E-05	2.88E+02	-4.90E+02	4.11E+02	-1.08E+02	2.42E-01
210	4.37E-04	4.27E-04	1.37E-04	4.37E-04	1.64E-05	2.91E+02	-4.95E+02	4.15E+02	-1.09E+02	2.45E-01
240	4.45E-04	4.37E-04	1.43E-04	4.45E-04	1.65E-05	2.93E+02	-4.98E+02	4.18E+02	-1.10E+02	2.46E-01
270	4.51E-04	4.45E-04	1.48E-04	4.51E-04	1.66E-05	2.95E+02	-5.01E+02	4.20E+02	-1.10E+02	2.47E-01
300	4.57E-04	4.51E-04	1.52E-04	4.57E-04	1.66E-05	2.96E+02	-5.03E+02	4.21E+02	-1.11E+02	2.48E-01
330	4.61E-04	4.57E-04	1.55E-04	4.61E-04	1.67E-05	2.97E+02	-5.04E+02	4.23E+02	-1.11E+02	2.49E-01
360	4.65E-04	4.61E-04	1.58E-04	4.65E-04	1.67E-05	2.97E+02	-5.05E+02	4.24E+02	-1.11E+02	2.50E-01
390	4.68E-04	4.65E-04	1.61E-04	4.68E-04	1.67E-05	2.98E+02	-5.06E+02	4.24E+02	-1.12E+02	2.50E-01
420	4.71E-04	4.68E-04	1.63E-04	4.71E-04	1.68E-05	2.98E+02	-5.07E+02	4.25E+02	-1.12E+02	2.50E-01
450	4.73E-04	4.71E-04	1.65E-04	4.73E-04	1.68E-05	2.99E+02	-5.08E+02	4.25E+02	-1.12E+02	2.50E-01
480	4.75E-04	4.73E-04	1.67E-04	4.75E-04	1.68E-05	2.99E+02	-5.08E+02	4.26E+02	-1.12E+02	2.51E-01
510	4.77E-04	4.75E-04	1.69E-04	4.77E-04	1.68E-05	2.99E+02	-5.09E+02	4.26E+02	-1.12E+02	2.51E-01
540	4.79E-04	4.77E-04	1.70E-04	4.79E-04	1.68E-05	2.99E+02	-5.09E+02	4.27E+02	-1.12E+02	2.51E-01
570	4.80E-04	4.79E-04	1.72E-04	4.80E-04	1.68E-05	3.00E+02	-5.09E+02	4.27E+02	-1.12E+02	2.52E-01
600	4.82E-04	4.80E-04	1.73E-04	4.82E-04	1.69E-05	3.00E+02	-5.09E+02	4.27E+02	-1.12E+02	2.52E-01
630	4.83E-04	4.82E-04	1.74E-04	4.83E-04	1.69E-05	3.00E+02	-5.10E+02	4.27E+02	-1.12E+02	2.52E-01
660	4.84E-04	4.83E-04	1.75E-04	4.84E-04	1.69E-05	3.00E+02	-5.10E+02	4.27E+02	-1.12E+02	2.52E-01
690	4.85E-04	4.84E-04	1.76E-04	4.85E-04	1.69E-05	3.00E+02	-5.10E+02	4.28E+02	-1.13E+02	2.52E-01
720	4.86E-04	4.85E-04	1.76E-04	4.86E-04	1.69E-05	3.00E+02	-5.10E+02	4.28E+02	-1.13E+02	2.52E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00051)

Shrinkage strain =  $t/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = 5.10E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 9.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 $\epsilon_y$  (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_r$ )	Strain Slip (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.35E-04	0.00E+00	8.67E-05	2.35E-04	4.12E-05	1.04E-05	1.82E+02	-3.17E+02	2.77E+02	-5.55E+01	2.00E-01
60	3.22E-04	2.35E-04	1.32E-04	3.22E-04	7.36E-05	1.33E-05	2.33E+02	-4.06E+02	3.59E+02	-7.10E+01	2.56E-01
90	3.67E-04	3.22E-04	1.59E-04	3.67E-04	9.59E-05	1.45E-05	2.54E+02	-4.43E+02	3.88E+02	-7.75E+01	2.79E-01
120	3.95E-04	3.67E-04	1.78E-04	3.95E-04	1.12E-04	1.52E-05	2.68E+02	-4.62E+02	4.04E+02	-8.09E+01	2.91E-01
150	4.14E-04	3.95E-04	1.92E-04	4.14E-04	1.24E-04	1.55E-05	2.72E+02	-4.74E+02	4.14E+02	-8.28E+01	2.98E-01
180	4.27E-04	4.14E-04	2.02E-04	4.27E-04	1.33E-04	1.58E-05	2.76E+02	-4.81E+02	4.20E+02	-8.40E+01	3.03E-01
210	4.37E-04	4.27E-04	2.10E-04	4.37E-04	1.40E-04	1.59E-05	2.78E+02	-4.89E+02	4.24E+02	-8.49E+01	3.06E-01
240	4.45E-04	4.37E-04	2.16E-04	4.45E-04	1.46E-04	1.60E-05	2.80E+02	-4.91E+02	4.27E+02	-8.55E+01	3.08E-01
270	4.51E-04	4.45E-04	2.21E-04	4.51E-04	1.51E-04	1.61E-05	2.82E+02	-4.93E+02	4.29E+02	-8.59E+01	3.09E-01
300	4.57E-04	4.51E-04	2.26E-04	4.57E-04	1.55E-04	1.62E-05	2.83E+02	-4.94E+02	4.31E+02	-8.62E+01	3.10E-01
330	4.61E-04	4.57E-04	2.29E-04	4.61E-04	1.59E-04	1.62E-05	2.84E+02	-4.94E+02	4.32E+02	-8.65E+01	3.10E-01
360	4.65E-04	4.61E-04	2.33E-04	4.65E-04	1.62E-04	1.62E-05	2.84E+02	-4.96E+02	4.33E+02	-8.66E+01	3.12E-01
390	4.68E-04	4.65E-04	2.35E-04	4.68E-04	1.64E-04	1.63E-05	2.85E+02	-4.96E+02	4.34E+02	-8.68E+01	3.13E-01
420	4.71E-04	4.68E-04	2.38E-04	4.71E-04	1.66E-04	1.63E-05	2.85E+02	-4.97E+02	4.35E+02	-8.69E+01	3.13E-01
450	4.73E-04	4.71E-04	2.40E-04	4.73E-04	1.69E-04	1.63E-05	2.86E+02	-4.98E+02	4.35E+02	-8.70E+01	3.13E-01
480	4.75E-04	4.73E-04	2.42E-04	4.75E-04	1.70E-04	1.63E-05	2.86E+02	-4.98E+02	4.36E+02	-8.71E+01	3.14E-01
510	4.77E-04	4.75E-04	2.44E-04	4.77E-04	1.72E-04	1.64E-05	2.86E+02	-4.99E+02	4.36E+02	-8.72E+01	3.14E-01
540	4.79E-04	4.77E-04	2.45E-04	4.79E-04	1.74E-04	1.64E-05	2.87E+02	-4.99E+02	4.36E+02	-8.73E+01	3.14E-01
570	4.80E-04	4.79E-04	2.47E-04	4.80E-04	1.75E-04	1.64E-05	2.87E+02	-5.00E+02	4.37E+02	-8.73E+01	3.14E-01
600	4.82E-04	4.80E-04	2.48E-04	4.82E-04	1.76E-04	1.64E-05	2.87E+02	-5.00E+02	4.37E+02	-8.74E+01	3.15E-01
630	4.83E-04	4.82E-04	2.49E-04	4.83E-04	1.77E-04	1.64E-05	2.87E+02	-5.00E+02	4.37E+02	-8.74E+01	3.15E-01
660	4.84E-04	4.83E-04	2.50E-04	4.84E-04	1.78E-04	1.64E-05	2.87E+02	-5.00E+02	4.37E+02	-8.74E+01	3.15E-01
690	4.85E-04	4.84E-04	2.51E-04	4.85E-04	1.79E-04	1.64E-05	2.87E+02	-5.00E+02	4.37E+02	-8.75E+01	3.15E-01
720	4.86E-04	4.85E-04	2.51E-04	4.85E-04	1.79E-04	1.64E-05	2.87E+02	-5.00E+02	4.37E+02	-8.75E+01	3.15E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00051)

Shrinkage strain =  $t/(t+35)^*A$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 5.10E-04      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain (ε <sub>t</sub> )	Strain Slop (tan θ)	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	Pre-slab	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top	CIP_bot		CIP_Top
30	3.35E-04	0.00E+00	8.67E-05	2.35E-04	4.37E-05	1.01E-05	1.72E+02	-3.11E+02	2.84E+02	-3.75E+01	2.47E-01
60	3.22E-04	2.35E-04	1.32E-04	3.22E-04	7.68E-05	1.29E-05	2.20E+02	-3.97E+02	3.64E+02	-4.80E+01	3.16E-01
90	3.67E-04	3.67E-04	1.59E-04	3.67E-04	9.94E-05	1.40E-05	2.40E+02	-4.34E+02	3.97E+02	-5.24E+01	3.45E-01
120	3.95E-04	3.95E-04	1.78E-04	3.95E-04	1.15E-04	1.47E-05	2.51E+02	-4.53E+02	4.14E+02	-5.47E+01	3.60E-01
150	4.14E-04	4.14E-04	1.92E-04	4.14E-04	1.27E-04	1.50E-05	2.57E+02	-4.64E+02	4.24E+02	-5.60E+01	3.68E-01
180	4.27E-04	4.27E-04	2.02E-04	4.27E-04	1.37E-04	1.52E-05	2.61E+02	-4.70E+02	4.30E+02	-5.69E+01	3.74E-01
210	4.37E-04	4.37E-04	2.10E-04	4.37E-04	1.44E-04	1.54E-05	2.63E+02	-4.75E+02	4.35E+02	-5.74E+01	3.77E-01
240	4.45E-04	4.45E-04	2.16E-04	4.45E-04	1.49E-04	1.56E-05	2.65E+02	-4.78E+02	4.38E+02	-5.78E+01	3.80E-01
270	4.51E-04	4.51E-04	2.21E-04	4.51E-04	1.55E-04	1.56E-05	2.66E+02	-4.81E+02	4.40E+02	-5.81E+01	3.82E-01
300	4.57E-04	4.57E-04	2.26E-04	4.57E-04	1.59E-04	1.56E-05	2.67E+02	-4.82E+02	4.42E+02	-5.83E+01	3.83E-01
330	4.61E-04	4.61E-04	2.29E-04	4.61E-04	1.62E-04	1.57E-05	2.68E+02	-4.84E+02	4.43E+02	-5.85E+01	3.84E-01
360	4.65E-04	4.65E-04	2.33E-04	4.65E-04	1.65E-04	1.57E-05	2.69E+02	-4.85E+02	4.44E+02	-5.86E+01	3.85E-01
390	4.68E-04	4.68E-04	2.35E-04	4.68E-04	1.68E-04	1.57E-05	2.69E+02	-4.86E+02	4.45E+02	-5.87E+01	3.85E-01
420	4.71E-04	4.71E-04	2.38E-04	4.71E-04	1.70E-04	1.58E-05	2.70E+02	-4.87E+02	4.45E+02	-5.87E+01	3.86E-01
450	4.73E-04	4.73E-04	2.40E-04	4.73E-04	1.72E-04	1.58E-05	2.70E+02	-4.87E+02	4.46E+02	-5.88E+01	3.86E-01
480	4.75E-04	4.75E-04	2.42E-04	4.75E-04	1.74E-04	1.58E-05	2.70E+02	-4.88E+02	4.46E+02	-5.88E+01	3.87E-01
510	4.77E-04	4.77E-04	2.44E-04	4.77E-04	1.76E-04	1.58E-05	2.70E+02	-4.88E+02	4.47E+02	-5.89E+01	3.87E-01
540	4.79E-04	4.79E-04	2.45E-04	4.79E-04	1.77E-04	1.58E-05	2.71E+02	-4.88E+02	4.47E+02	-5.90E+01	3.88E-01
570	4.80E-04	4.80E-04	2.47E-04	4.80E-04	1.79E-04	1.58E-05	2.71E+02	-4.89E+02	4.47E+02	-5.90E+01	3.88E-01
600	4.82E-04	4.82E-04	2.48E-04	4.82E-04	1.80E-04	1.58E-05	2.71E+02	-4.89E+02	4.47E+02	-5.91E+01	3.88E-01
630	4.83E-04	4.83E-04	2.49E-04	4.83E-04	1.81E-04	1.58E-05	2.71E+02	-4.89E+02	4.48E+02	-5.91E+01	3.88E-01
660	4.84E-04	4.84E-04	2.50E-04	4.84E-04	1.82E-04	1.58E-05	2.71E+02	-4.89E+02	4.48E+02	-5.92E+01	3.89E-01
690	4.85E-04	4.85E-04	2.51E-04	4.85E-04	1.83E-04	1.59E-05	2.71E+02	-4.90E+02	4.48E+02	-5.92E+01	3.89E-01
720	4.86E-04	4.86E-04	2.51E-04	4.86E-04	1.83E-04	1.59E-05	2.71E+02	-4.90E+02	4.48E+02	-5.92E+01	3.89E-01



## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00051)

Shrinkage strain =  $v/(t+35)^A$  Distance from Bottom  
 Slab was cast B days before CIP deck Bottom of slab (in.) = 0.00E+00  
 A = 5.10E-04 h\_CIP (in.) = 1.10E+01 Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01 E (psi) = 4.00E+06 Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab fy (psi) = 6.00E+04 Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1+t)		Strain ( $\epsilon_t$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)		
	From 0 days (10-t)		Pre-slab				CIP-deck	slab_bot	slab_Top		CIP_bot	CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck								
30	2.35E-04	0.00E+00	8.67E-05	2.35E-04	4.65E-05	9.68E-06	1.61E+02	-3.04E+02	2.91E+02	-1.88E+01	2.99E-01	
60	3.22E-04	2.35E-04	1.32E-04	3.22E-04	8.04E-05	1.24E-05	2.06E+02	-3.89E+02	3.72E+02	-2.40E+01	3.83E-01	
90	3.67E-04	3.22E-04	1.59E-04	3.67E-04	1.03E-04	1.35E-05	2.25E+02	-4.24E+02	4.07E+02	-2.62E+01	4.18E-01	
120	3.95E-04	3.67E-04	1.78E-04	3.95E-04	1.20E-04	1.41E-05	2.34E+02	-4.43E+02	4.24E+02	-2.74E+01	4.36E-01	
150	4.14E-04	3.95E-04	1.92E-04	4.14E-04	1.32E-04	1.44E-05	2.40E+02	-4.53E+02	4.34E+02	-2.80E+01	4.47E-01	
180	4.27E-04	4.14E-04	2.02E-04	4.27E-04	1.41E-04	1.47E-05	2.44E+02	-4.60E+02	4.41E+02	-2.84E+01	4.53E-01	
210	4.37E-04	4.27E-04	2.10E-04	4.37E-04	1.48E-04	1.48E-05	2.46E+02	-4.66E+02	4.45E+02	-2.87E+01	4.58E-01	
240	4.45E-04	4.37E-04	2.16E-04	4.45E-04	1.54E-04	1.49E-05	2.48E+02	-4.69E+02	4.48E+02	-2.89E+01	4.61E-01	
270	4.51E-04	4.45E-04	2.21E-04	4.51E-04	1.59E-04	1.50E-05	2.49E+02	-4.70E+02	4.50E+02	-2.91E+01	4.63E-01	
300	4.57E-04	4.51E-04	2.26E-04	4.57E-04	1.63E-04	1.50E-05	2.50E+02	-4.72E+02	4.52E+02	-2.92E+01	4.65E-01	
330	4.61E-04	4.57E-04	2.29E-04	4.61E-04	1.67E-04	1.51E-05	2.51E+02	-4.73E+02	4.53E+02	-2.92E+01	4.66E-01	
360	4.65E-04	4.61E-04	2.33E-04	4.65E-04	1.70E-04	1.51E-05	2.51E+02	-4.74E+02	4.54E+02	-2.93E+01	4.68E-01	
390	4.68E-04	4.65E-04	2.35E-04	4.68E-04	1.73E-04	1.51E-05	2.52E+02	-4.75E+02	4.55E+02	-2.94E+01	4.68E-01	
420	4.71E-04	4.68E-04	2.38E-04	4.71E-04	1.75E-04	1.52E-05	2.52E+02	-4.76E+02	4.56E+02	-2.94E+01	4.69E-01	
450	4.73E-04	4.71E-04	2.40E-04	4.73E-04	1.77E-04	1.52E-05	2.52E+02	-4.77E+02	4.56E+02	-2.94E+01	4.70E-01	
480	4.75E-04	4.73E-04	2.42E-04	4.75E-04	1.79E-04	1.52E-05	2.52E+02	-4.77E+02	4.57E+02	-2.95E+01	4.70E-01	
510	4.77E-04	4.75E-04	2.44E-04	4.77E-04	1.80E-04	1.52E-05	2.53E+02	-4.77E+02	4.57E+02	-2.95E+01	4.71E-01	
540	4.79E-04	4.77E-04	2.45E-04	4.79E-04	1.82E-04	1.52E-05	2.53E+02	-4.78E+02	4.58E+02	-2.95E+01	4.71E-01	
570	4.80E-04	4.79E-04	2.47E-04	4.80E-04	1.83E-04	1.52E-05	2.53E+02	-4.78E+02	4.58E+02	-2.95E+01	4.71E-01	
600	4.82E-04	4.80E-04	2.48E-04	4.82E-04	1.84E-04	1.52E-05	2.53E+02	-4.78E+02	4.58E+02	-2.96E+01	4.71E-01	
630	4.83E-04	4.82E-04	2.49E-04	4.83E-04	1.86E-04	1.52E-05	2.53E+02	-4.79E+02	4.58E+02	-2.96E+01	4.72E-01	
660	4.84E-04	4.83E-04	2.49E-04	4.84E-04	1.87E-04	1.53E-05	2.53E+02	-4.79E+02	4.59E+02	-2.96E+01	4.72E-01	
690	4.85E-04	4.84E-04	2.50E-04	4.85E-04	1.87E-04	1.53E-05	2.53E+02	-4.79E+02	4.59E+02	-2.96E+01	4.72E-01	
720	4.86E-04	4.85E-04	2.51E-04	4.86E-04	1.88E-04	1.53E-05	2.53E+02	-4.79E+02	4.59E+02	-2.96E+01	4.72E-01	

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00051)

Shrinkage strain =  $v/(t+35)^A$   
 Slab was cast B days before CIP deck  
 A = 5.10E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 1.20E+01  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	2.35E-04	0.00E+00	8.67E-05	2.35E-04	4.96E-05	9.29E-06	1.49E+02	-2.97E+02	2.97E+02	-1.08E-13	3.57E-01
60	3.22E-04	2.35E-04	1.32E-04	3.22E-04	8.42E-05	1.19E-05	1.90E+02	-3.81E+02	3.81E+02	0.00E+00	4.57E-01
90	3.67E-04	3.22E-04	1.59E-04	3.67E-04	1.08E-04	1.30E-05	2.08E+02	-4.15E+02	4.15E+02	0.00E+00	4.99E-01
120	3.95E-04	3.67E-04	1.78E-04	3.95E-04	1.24E-04	1.39E-05	2.17E+02	-4.33E+02	4.33E+02	0.00E+00	5.20E-01
150	4.14E-04	3.95E-04	1.92E-04	4.14E-04	1.36E-04	1.39E-05	2.22E+02	-4.44E+02	4.44E+02	-2.17E-13	5.33E-01
180	4.27E-04	4.14E-04	2.02E-04	4.27E-04	1.45E-04	1.41E-05	2.25E+02	-4.50E+02	4.50E+02	2.17E-13	5.41E-01
210	4.37E-04	4.27E-04	2.10E-04	4.37E-04	1.53E-04	1.42E-05	2.27E+02	-4.55E+02	4.55E+02	0.00E+00	5.46E-01
240	4.45E-04	4.37E-04	2.16E-04	4.45E-04	1.59E-04	1.43E-05	2.29E+02	-4.58E+02	4.58E+02	0.00E+00	5.50E-01
270	4.51E-04	4.45E-04	2.21E-04	4.51E-04	1.64E-04	1.44E-05	2.30E+02	-4.60E+02	4.60E+02	0.00E+00	5.52E-01
300	4.57E-04	4.51E-04	2.26E-04	4.57E-04	1.68E-04	1.44E-05	2.31E+02	-4.62E+02	4.62E+02	0.00E+00	5.54E-01
330	4.61E-04	4.57E-04	2.28E-04	4.61E-04	1.72E-04	1.45E-05	2.32E+02	-4.63E+02	4.63E+02	2.17E-13	5.56E-01
360	4.65E-04	4.61E-04	2.29E-04	4.65E-04	1.75E-04	1.45E-05	2.32E+02	-4.64E+02	4.64E+02	0.00E+00	5.57E-01
390	4.68E-04	4.65E-04	2.33E-04	4.68E-04	1.77E-04	1.45E-05	2.33E+02	-4.65E+02	4.65E+02	0.00E+00	5.58E-01
420	4.71E-04	4.68E-04	2.35E-04	4.71E-04	1.80E-04	1.46E-05	2.33E+02	-4.66E+02	4.66E+02	2.17E-13	5.59E-01
450	4.73E-04	4.71E-04	2.38E-04	4.73E-04	1.82E-04	1.46E-05	2.33E+02	-4.66E+02	4.66E+02	2.17E-13	5.60E-01
480	4.75E-04	4.73E-04	2.40E-04	4.75E-04	1.83E-04	1.46E-05	2.33E+02	-4.67E+02	4.67E+02	0.00E+00	5.60E-01
510	4.77E-04	4.75E-04	2.42E-04	4.77E-04	1.85E-04	1.46E-05	2.34E+02	-4.67E+02	4.67E+02	0.00E+00	5.61E-01
540	4.79E-04	4.77E-04	2.44E-04	4.79E-04	1.87E-04	1.46E-05	2.34E+02	-4.68E+02	4.68E+02	2.17E-13	5.61E-01
570	4.80E-04	4.79E-04	2.45E-04	4.80E-04	1.88E-04	1.46E-05	2.34E+02	-4.68E+02	4.68E+02	0.00E+00	5.62E-01
600	4.82E-04	4.80E-04	2.47E-04	4.82E-04	1.89E-04	1.46E-05	2.34E+02	-4.68E+02	4.68E+02	0.00E+00	5.62E-01
630	4.83E-04	4.82E-04	2.48E-04	4.83E-04	1.89E-04	1.46E-05	2.34E+02	-4.68E+02	4.68E+02	-2.17E-13	5.62E-01
660	4.84E-04	4.83E-04	2.49E-04	4.84E-04	1.90E-04	1.46E-05	2.34E+02	-4.69E+02	4.69E+02	-2.17E-13	5.62E-01
690	4.85E-04	4.84E-04	2.50E-04	4.85E-04	1.91E-04	1.47E-05	2.34E+02	-4.69E+02	4.69E+02	2.17E-13	5.63E-01
720	4.86E-04	4.85E-04	2.51E-04	4.86E-04	1.92E-04	1.47E-05	2.34E+02	-4.69E+02	4.69E+02	2.17E-13	5.63E-01

Curing Coefficient A = 0.00055

CIP depth 6 to 12 inches

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00055)

Shrinkage strain =  $t/(t+35)^2 \times A$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 5.50E-04      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain (ε)	Strain Slop (tan θ)	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_top	CIP_bot		CIP_top
30	2.54E-04	0.00E+00	9.35E-05	2.54E-04	4.01E-05	1.19E-05	2.14E+02	-3.56E+02	2.85E+02	-9.50E+01	1.14E-01
60	3.47E-04	2.54E-04	1.42E-04	3.47E-04	7.37E-05	1.52E-05	2.74E+02	-4.56E+02	3.65E+02	-1.22E+02	1.46E-01
90	3.96E-04	3.47E-04	1.72E-04	3.96E-04	9.73E-05	1.66E-05	2.98E+02	-4.98E+02	3.98E+02	-1.33E+02	1.59E-01
120	4.26E-04	3.96E-04	1.92E-04	4.26E-04	1.14E-04	1.73E-05	3.12E+02	-5.19E+02	4.15E+02	-1.38E+02	1.66E-01
150	4.46E-04	4.26E-04	2.07E-04	4.46E-04	1.27E-04	1.77E-05	3.19E+02	-5.32E+02	4.25E+02	-1.42E+02	1.70E-01
180	4.60E-04	4.46E-04	2.18E-04	4.60E-04	1.37E-04	1.80E-05	3.24E+02	-5.40E+02	4.32E+02	-1.44E+02	1.73E-01
210	4.71E-04	4.60E-04	2.26E-04	4.71E-04	1.44E-04	1.82E-05	3.27E+02	-5.45E+02	4.36E+02	-1.45E+02	1.74E-01
240	4.80E-04	4.71E-04	2.33E-04	4.80E-04	1.51E-04	1.83E-05	3.29E+02	-5.49E+02	4.39E+02	-1.46E+02	1.76E-01
270	4.87E-04	4.80E-04	2.39E-04	4.87E-04	1.56E-04	1.84E-05	3.31E+02	-5.52E+02	4.41E+02	-1.47E+02	1.76E-01
300	4.93E-04	4.87E-04	2.43E-04	4.93E-04	1.60E-04	1.85E-05	3.32E+02	-5.54E+02	4.43E+02	-1.48E+02	1.77E-01
330	4.97E-04	4.93E-04	2.47E-04	4.97E-04	1.64E-04	1.85E-05	3.33E+02	-5.55E+02	4.44E+02	-1.48E+02	1.78E-01
360	5.01E-04	4.97E-04	2.51E-04	5.01E-04	1.67E-04	1.85E-05	3.34E+02	-5.56E+02	4.45E+02	-1.48E+02	1.78E-01
390	5.05E-04	5.01E-04	2.54E-04	5.05E-04	1.70E-04	1.86E-05	3.34E+02	-5.57E+02	4.46E+02	-1.49E+02	1.78E-01
420	5.08E-04	5.05E-04	2.56E-04	5.08E-04	1.73E-04	1.86E-05	3.35E+02	-5.58E+02	4.47E+02	-1.49E+02	1.79E-01
450	5.10E-04	5.08E-04	2.59E-04	5.10E-04	1.75E-04	1.86E-05	3.35E+02	-5.59E+02	4.47E+02	-1.49E+02	1.79E-01
480	5.13E-04	5.10E-04	2.61E-04	5.13E-04	1.77E-04	1.87E-05	3.36E+02	-5.60E+02	4.48E+02	-1.49E+02	1.79E-01
510	5.15E-04	5.13E-04	2.63E-04	5.15E-04	1.79E-04	1.87E-05	3.36E+02	-5.60E+02	4.48E+02	-1.49E+02	1.79E-01
540	5.17E-04	5.15E-04	2.64E-04	5.17E-04	1.80E-04	1.87E-05	3.36E+02	-5.61E+02	4.48E+02	-1.49E+02	1.79E-01
570	5.18E-04	5.17E-04	2.66E-04	5.18E-04	1.82E-04	1.87E-05	3.36E+02	-5.61E+02	4.48E+02	-1.49E+02	1.79E-01
600	5.20E-04	5.18E-04	2.67E-04	5.20E-04	1.83E-04	1.87E-05	3.37E+02	-5.61E+02	4.49E+02	-1.50E+02	1.80E-01
630	5.21E-04	5.20E-04	2.68E-04	5.21E-04	1.84E-04	1.87E-05	3.37E+02	-5.61E+02	4.49E+02	-1.50E+02	1.80E-01
660	5.22E-04	5.21E-04	2.70E-04	5.22E-04	1.85E-04	1.87E-05	3.37E+02	-5.62E+02	4.49E+02	-1.50E+02	1.80E-01
690	5.23E-04	5.22E-04	2.71E-04	5.23E-04	1.86E-04	1.87E-05	3.37E+02	-5.62E+02	4.49E+02	-1.50E+02	1.80E-01
720	5.25E-04	5.23E-04	2.71E-04	5.23E-04	1.86E-04	1.87E-05	3.37E+02	-5.62E+02	4.49E+02	-1.50E+02	1.80E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00055)

Shrinkage strain =  $t/(t+35)*A$       Distance from Bottom      0.00E+00  
 Slab was cast B days before CIP deck      Bottom of slab (in.) =      1.20E+01  
 A = 5.50E-04      Top of slab (in.) =      1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) =      1.20E+01  
 t start from casting of slab      Top of CIP (in.) =      2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	2.54E-04	0.00E+00	9.35E-05	2.54E-04	4.07E-05	1.18E-05	2.11E+02	-3.54E+02	2.87E+02	-8.98E+01	1.38E-01
60	3.47E-04	2.54E-04	1.42E-04	3.47E-04	7.45E-05	1.51E-05	2.71E+02	-4.53E+02	3.68E+02	-1.15E+02	1.77E-01
90	3.96E-04	3.47E-04	1.72E-04	3.96E-04	9.81E-05	1.65E-05	2.95E+02	-4.95E+02	4.01E+02	-1.25E+02	1.93E-01
120	4.26E-04	4.26E-04	1.92E-04	4.26E-04	1.15E-04	1.72E-05	3.08E+02	-5.16E+02	4.19E+02	-1.31E+02	2.01E-01
150	4.46E-04	4.46E-04	2.07E-04	4.46E-04	1.28E-04	1.76E-05	3.16E+02	-5.29E+02	4.29E+02	-1.34E+02	2.06E-01
180	4.60E-04	4.60E-04	2.18E-04	4.60E-04	1.38E-04	1.78E-05	3.20E+02	-5.36E+02	4.35E+02	-1.36E+02	2.09E-01
210	4.71E-04	4.71E-04	2.26E-04	4.71E-04	1.45E-04	1.80E-05	3.23E+02	-5.42E+02	4.39E+02	-1.37E+02	2.11E-01
240	4.80E-04	4.80E-04	2.33E-04	4.80E-04	1.52E-04	1.81E-05	3.26E+02	-5.45E+02	4.42E+02	-1.38E+02	2.13E-01
270	4.87E-04	4.87E-04	2.39E-04	4.87E-04	1.57E-04	1.82E-05	3.27E+02	-5.48E+02	4.45E+02	-1.39E+02	2.14E-01
300	4.93E-04	4.93E-04	2.43E-04	4.93E-04	1.61E-04	1.83E-05	3.28E+02	-5.50E+02	4.46E+02	-1.39E+02	2.15E-01
330	4.97E-04	4.97E-04	2.47E-04	4.97E-04	1.65E-04	1.84E-05	3.29E+02	-5.52E+02	4.48E+02	-1.40E+02	2.15E-01
360	5.01E-04	5.01E-04	2.51E-04	5.01E-04	1.68E-04	1.84E-05	3.30E+02	-5.53E+02	4.49E+02	-1.40E+02	2.16E-01
390	5.05E-04	5.05E-04	2.54E-04	5.05E-04	1.71E-04	1.84E-05	3.31E+02	-5.54E+02	4.49E+02	-1.40E+02	2.16E-01
420	5.08E-04	5.08E-04	2.56E-04	5.08E-04	1.74E-04	1.85E-05	3.31E+02	-5.55E+02	4.50E+02	-1.41E+02	2.17E-01
450	5.10E-04	5.10E-04	2.59E-04	5.10E-04	1.76E-04	1.85E-05	3.32E+02	-5.56E+02	4.51E+02	-1.41E+02	2.17E-01
480	5.13E-04	5.13E-04	2.61E-04	5.13E-04	1.78E-04	1.85E-05	3.32E+02	-5.56E+02	4.51E+02	-1.41E+02	2.17E-01
510	5.15E-04	5.15E-04	2.63E-04	5.15E-04	1.80E-04	1.85E-05	3.32E+02	-5.57E+02	4.52E+02	-1.41E+02	2.17E-01
540	5.17E-04	5.17E-04	2.64E-04	5.17E-04	1.81E-04	1.85E-05	3.33E+02	-5.57E+02	4.52E+02	-1.41E+02	2.17E-01
570	5.18E-04	5.18E-04	2.66E-04	5.18E-04	1.83E-04	1.85E-05	3.33E+02	-5.57E+02	4.52E+02	-1.41E+02	2.18E-01
600	5.20E-04	5.20E-04	2.67E-04	5.20E-04	1.84E-04	1.86E-05	3.33E+02	-5.58E+02	4.52E+02	-1.41E+02	2.18E-01
630	5.21E-04	5.21E-04	2.68E-04	5.21E-04	1.85E-04	1.86E-05	3.33E+02	-5.58E+02	4.53E+02	-1.41E+02	2.18E-01
660	5.22E-04	5.22E-04	2.70E-04	5.22E-04	1.86E-04	1.86E-05	3.33E+02	-5.58E+02	4.53E+02	-1.41E+02	2.18E-01
690	5.23E-04	5.23E-04	2.71E-04	5.23E-04	1.87E-04	1.86E-05	3.33E+02	-5.58E+02	4.53E+02	-1.42E+02	2.18E-01
720	5.25E-04	5.25E-04	2.71E-04	5.25E-04	1.87E-04	1.86E-05	3.33E+02	-5.58E+02	4.53E+02	-1.42E+02	2.18E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00055)

Shrinkage strain =  $V/(t+35)^A$       Distance from Bottom      0.00E+00  
 Slab was cast B days before CIP deck      Bottom of slab (in.) =      1.20E+01  
 A = 5.50E-04      Top of slab (in.) =      1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) =      2.00E+01  
 t start from casting of slab      Top of CIP (in.) =      2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_t$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.47E-04	0.00E+00	9.35E-05	2.54E-04	4.22E-05	1.15E-05	2.09E+02	-3.49E+02	2.92E+02	-7.70E+01	1.72E-01
60	3.96E-04	2.54E-04	1.42E-04	3.47E-04	7.65E-05	1.48E-05	2.63E+02	-4.47E+02	3.74E+02	-9.85E+01	2.21E-01
90	4.26E-04	3.47E-04	1.72E-04	3.96E-04	1.00E-04	1.61E-05	2.87E+02	-4.88E+02	4.09E+02	-1.08E+02	2.41E-01
120	4.46E-04	3.96E-04	1.92E-04	4.26E-04	1.17E-04	1.68E-05	2.99E+02	-5.09E+02	4.26E+02	-1.12E+02	2.51E-01
150	4.60E-04	4.26E-04	2.07E-04	4.46E-04	1.30E-04	1.72E-05	3.06E+02	-5.21E+02	4.37E+02	-1.15E+02	2.57E-01
180	4.71E-04	4.46E-04	2.18E-04	4.60E-04	1.40E-04	1.75E-05	3.11E+02	-5.29E+02	4.43E+02	-1.17E+02	2.61E-01
210	4.77E-04	4.60E-04	2.26E-04	4.71E-04	1.48E-04	1.77E-05	3.14E+02	-5.34E+02	4.47E+02	-1.18E+02	2.64E-01
240	4.80E-04	4.71E-04	2.33E-04	4.80E-04	1.54E-04	1.78E-05	3.16E+02	-5.37E+02	4.50E+02	-1.19E+02	2.66E-01
270	4.87E-04	4.80E-04	2.39E-04	4.87E-04	1.59E-04	1.79E-05	3.18E+02	-5.40E+02	4.53E+02	-1.19E+02	2.68E-01
300	4.93E-04	4.87E-04	2.43E-04	4.93E-04	1.64E-04	1.79E-05	3.19E+02	-5.42E+02	4.54E+02	-1.20E+02	2.68E-01
330	4.97E-04	4.93E-04	2.47E-04	4.97E-04	1.67E-04	1.80E-05	3.20E+02	-5.44E+02	4.56E+02	-1.20E+02	2.69E-01
360	5.01E-04	4.97E-04	2.51E-04	5.01E-04	1.71E-04	1.80E-05	3.21E+02	-5.45E+02	4.57E+02	-1.20E+02	2.69E-01
390	5.05E-04	5.01E-04	2.54E-04	5.05E-04	1.74E-04	1.81E-05	3.21E+02	-5.46E+02	4.58E+02	-1.20E+02	2.70E-01
420	5.08E-04	5.05E-04	2.56E-04	5.08E-04	1.76E-04	1.81E-05	3.22E+02	-5.47E+02	4.58E+02	-1.21E+02	2.70E-01
450	5.10E-04	5.08E-04	2.59E-04	5.10E-04	1.78E-04	1.81E-05	3.22E+02	-5.47E+02	4.59E+02	-1.21E+02	2.70E-01
480	5.13E-04	5.10E-04	2.61E-04	5.13E-04	1.80E-04	1.81E-05	3.22E+02	-5.48E+02	4.59E+02	-1.21E+02	2.71E-01
510	5.15E-04	5.13E-04	2.63E-04	5.15E-04	1.82E-04	1.81E-05	3.23E+02	-5.48E+02	4.60E+02	-1.21E+02	2.71E-01
540	5.17E-04	5.15E-04	2.64E-04	5.17E-04	1.84E-04	1.82E-05	3.23E+02	-5.49E+02	4.60E+02	-1.21E+02	2.71E-01
570	5.18E-04	5.17E-04	2.66E-04	5.18E-04	1.85E-04	1.82E-05	3.23E+02	-5.49E+02	4.60E+02	-1.21E+02	2.71E-01
600	5.20E-04	5.18E-04	2.67E-04	5.20E-04	1.86E-04	1.82E-05	3.23E+02	-5.49E+02	4.61E+02	-1.21E+02	2.71E-01
630	5.21E-04	5.20E-04	2.68E-04	5.21E-04	1.88E-04	1.82E-05	3.23E+02	-5.50E+02	4.61E+02	-1.21E+02	2.72E-01
660	5.22E-04	5.21E-04	2.70E-04	5.22E-04	1.89E-04	1.82E-05	3.23E+02	-5.50E+02	4.61E+02	-1.21E+02	2.72E-01
690	5.23E-04	5.22E-04	2.71E-04	5.23E-04	1.90E-04	1.82E-05	3.24E+02	-5.50E+02	4.61E+02	-1.21E+02	2.72E-01
720	5.25E-04	5.23E-04	2.71E-04	5.23E-04	1.90E-04	1.82E-05	3.24E+02	-5.50E+02	4.61E+02	-1.21E+02	2.72E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00055)

Shrinkage strain =  $t/(t+35)*A$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 5.50E-04      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain From 0 days (10 <sup>-4</sup> )		Free Shrinkage Strain After Composite (10 <sup>-4</sup> )		Strain (ε <sub>t</sub> )	Strain Slop (tan θ)	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	Pre-slab	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top	CIP_bot		CIP_Top
30	2.54E-04	0.00E+00	9.35E-05	2.54E-04	4.44E-05	1.12E-05	1.96E+02	-3.42E+02	2.99E+02	-5.98E+01	2.15E-01
60	3.47E-04	3.47E-04	1.42E-04	3.47E-04	7.93E-05	1.44E-05	2.51E+02	-4.36E+02	3.83E+02	-7.66E+01	2.76E-01
90	3.96E-04	3.96E-04	1.72E-04	3.96E-04	1.03E-04	1.57E-05	2.74E+02	-4.78E+02	4.18E+02	-8.36E+01	3.01E-01
120	4.26E-04	4.26E-04	1.92E-04	4.26E-04	1.21E-04	1.64E-05	2.86E+02	-4.99E+02	4.36E+02	-8.72E+01	3.14E-01
150	4.46E-04	4.46E-04	2.07E-04	4.46E-04	1.38E-04	1.67E-05	2.93E+02	-5.11E+02	4.47E+02	-8.93E+01	3.22E-01
180	4.60E-04	4.60E-04	2.18E-04	4.60E-04	1.43E-04	1.70E-05	2.97E+02	-5.19E+02	4.53E+02	-9.06E+01	3.26E-01
210	4.71E-04	4.71E-04	2.26E-04	4.71E-04	1.51E-04	1.72E-05	3.00E+02	-5.23E+02	4.58E+02	-9.15E+01	3.30E-01
240	4.80E-04	4.80E-04	2.33E-04	4.80E-04	1.57E-04	1.73E-05	3.02E+02	-5.27E+02	4.61E+02	-9.22E+01	3.32E-01
270	4.87E-04	4.87E-04	2.39E-04	4.87E-04	1.63E-04	1.74E-05	3.04E+02	-5.30E+02	4.63E+02	-9.26E+01	3.33E-01
300	4.93E-04	4.93E-04	2.43E-04	4.93E-04	1.67E-04	1.74E-05	3.05E+02	-5.32E+02	4.65E+02	-9.30E+01	3.35E-01
330	4.97E-04	4.97E-04	2.47E-04	4.97E-04	1.71E-04	1.75E-05	3.06E+02	-5.33E+02	4.66E+02	-9.32E+01	3.36E-01
360	5.01E-04	5.01E-04	2.51E-04	5.01E-04	1.74E-04	1.75E-05	3.07E+02	-5.34E+02	4.67E+02	-9.34E+01	3.36E-01
390	5.05E-04	5.05E-04	2.54E-04	5.05E-04	1.77E-04	1.76E-05	3.07E+02	-5.35E+02	4.68E+02	-9.36E+01	3.37E-01
420	5.08E-04	5.08E-04	2.56E-04	5.08E-04	1.80E-04	1.76E-05	3.08E+02	-5.36E+02	4.69E+02	-9.38E+01	3.38E-01
450	5.10E-04	5.10E-04	2.59E-04	5.10E-04	1.82E-04	1.76E-05	3.08E+02	-5.37E+02	4.69E+02	-9.39E+01	3.38E-01
480	5.13E-04	5.13E-04	2.61E-04	5.13E-04	1.84E-04	1.76E-05	3.08E+02	-5.37E+02	4.70E+02	-9.40E+01	3.38E-01
510	5.15E-04	5.15E-04	2.63E-04	5.15E-04	1.86E-04	1.76E-05	3.09E+02	-5.38E+02	4.70E+02	-9.40E+01	3.39E-01
540	5.17E-04	5.17E-04	2.64E-04	5.17E-04	1.87E-04	1.76E-05	3.09E+02	-5.38E+02	4.71E+02	-9.41E+01	3.39E-01
570	5.18E-04	5.18E-04	2.66E-04	5.18E-04	1.89E-04	1.77E-05	3.09E+02	-5.39E+02	4.71E+02	-9.42E+01	3.39E-01
600	5.20E-04	5.20E-04	2.67E-04	5.20E-04	1.90E-04	1.77E-05	3.09E+02	-5.39E+02	4.71E+02	-9.42E+01	3.39E-01
630	5.21E-04	5.21E-04	2.68E-04	5.21E-04	1.91E-04	1.77E-05	3.09E+02	-5.39E+02	4.71E+02	-9.43E+01	3.39E-01
660	5.22E-04	5.22E-04	2.70E-04	5.22E-04	1.92E-04	1.77E-05	3.09E+02	-5.39E+02	4.72E+02	-9.43E+01	3.39E-01
690	5.23E-04	5.23E-04	2.71E-04	5.23E-04	1.93E-04	1.77E-05	3.10E+02	-5.39E+02	4.72E+02	-9.43E+01	3.40E-01
720	5.25E-04	5.25E-04	2.71E-04	5.25E-04	1.93E-04	1.77E-05	3.10E+02	-5.39E+02	4.72E+02	-9.43E+01	3.40E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00055)

Shrinkage strain =  $t/(t+35)*A$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 5.50E-04      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_r$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	2.54E-04	0.00E+00	9.35E-05	2.54E-04	4.71E-05	1.08E-05	1.85E+02	-3.35E+02	3.06E+02	-4.05E+01	2.66E-01
60	3.47E-04	2.54E-04	1.42E-04	3.47E-04	8.28E-05	1.39E-05	2.37E+02	-4.29E+02	3.92E+02	-5.18E+01	3.40E-01
90	3.96E-04	3.47E-04	1.72E-04	3.96E-04	1.07E-04	1.51E-05	2.59E+02	-4.68E+02	4.28E+02	-5.66E+01	3.72E-01
120	4.26E-04	3.96E-04	1.92E-04	4.26E-04	1.24E-04	1.59E-05	2.70E+02	-4.88E+02	4.47E+02	-5.90E+01	3.88E-01
150	4.46E-04	4.26E-04	2.07E-04	4.46E-04	1.37E-04	1.62E-05	2.77E+02	-5.00E+02	4.57E+02	-6.04E+01	3.97E-01
180	4.60E-04	4.46E-04	2.18E-04	4.60E-04	1.47E-04	1.64E-05	2.81E+02	-5.07E+02	4.64E+02	-6.13E+01	4.03E-01
210	4.71E-04	4.60E-04	2.26E-04	4.71E-04	1.55E-04	1.66E-05	2.84E+02	-5.12E+02	4.69E+02	-6.19E+01	4.07E-01
240	4.80E-04	4.71E-04	2.33E-04	4.80E-04	1.62E-04	1.67E-05	2.86E+02	-5.16E+02	4.72E+02	-6.23E+01	4.10E-01
270	4.87E-04	4.80E-04	2.39E-04	4.87E-04	1.67E-04	1.68E-05	2.87E+02	-5.18E+02	4.74E+02	-6.27E+01	4.12E-01
300	4.93E-04	4.87E-04	2.43E-04	4.93E-04	1.71E-04	1.68E-05	2.88E+02	-5.20E+02	4.76E+02	-6.29E+01	4.13E-01
330	4.97E-04	4.93E-04	2.47E-04	4.97E-04	1.75E-04	1.69E-05	2.89E+02	-5.22E+02	4.78E+02	-6.31E+01	4.14E-01
360	5.01E-04	4.97E-04	2.51E-04	5.01E-04	1.78E-04	1.69E-05	2.90E+02	-5.23E+02	4.79E+02	-6.32E+01	4.15E-01
390	5.05E-04	5.01E-04	2.54E-04	5.05E-04	1.81E-04	1.70E-05	2.90E+02	-5.24E+02	4.79E+02	-6.33E+01	4.16E-01
420	5.08E-04	5.05E-04	2.56E-04	5.08E-04	1.84E-04	1.70E-05	2.91E+02	-5.25E+02	4.80E+02	-6.34E+01	4.17E-01
450	5.10E-04	5.08E-04	2.59E-04	5.10E-04	1.86E-04	1.70E-05	2.91E+02	-5.25E+02	4.81E+02	-6.35E+01	4.17E-01
480	5.13E-04	5.10E-04	2.61E-04	5.13E-04	1.88E-04	1.70E-05	2.91E+02	-5.26E+02	4.81E+02	-6.36E+01	4.18E-01
510	5.15E-04	5.13E-04	2.63E-04	5.15E-04	1.90E-04	1.70E-05	2.92E+02	-5.26E+02	4.82E+02	-6.37E+01	4.18E-01
540	5.17E-04	5.15E-04	2.64E-04	5.17E-04	1.91E-04	1.71E-05	2.92E+02	-5.27E+02	4.82E+02	-6.37E+01	4.18E-01
570	5.18E-04	5.17E-04	2.66E-04	5.18E-04	1.93E-04	1.71E-05	2.92E+02	-5.27E+02	4.82E+02	-6.37E+01	4.19E-01
600	5.20E-04	5.18E-04	2.67E-04	5.20E-04	1.94E-04	1.71E-05	2.92E+02	-5.27E+02	4.83E+02	-6.37E+01	4.19E-01
630	5.21E-04	5.20E-04	2.68E-04	5.21E-04	1.95E-04	1.71E-05	2.92E+02	-5.28E+02	4.83E+02	-6.38E+01	4.19E-01
660	5.22E-04	5.21E-04	2.70E-04	5.22E-04	1.97E-04	1.71E-05	2.92E+02	-5.28E+02	4.83E+02	-6.38E+01	4.19E-01
690	5.23E-04	5.22E-04	2.71E-04	5.23E-04	1.98E-04	1.71E-05	2.92E+02	-5.28E+02	4.83E+02	-6.38E+01	4.19E-01
720	5.25E-04	5.23E-04	2.71E-04	5.23E-04	1.98E-04	1.71E-05	2.92E+02	-5.28E+02	4.83E+02	-6.38E+01	4.19E-01



## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00055)

Shrinkage strain =  $v/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = 5.50E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 1.10E+01  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 $\gamma$  (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	2.54E-04	0.00E+00	9.35E-05	2.54E-04	5.02E-05	1.04E-05	1.73E+02	-3.28E+02	3.14E+02	-2.02E+01	3.23E-01
60	3.47E-04	2.54E-04	1.42E-04	3.47E-04	8.67E-05	1.34E-05	2.22E+02	-4.19E+02	4.02E+02	-2.59E+01	4.13E-01
90	3.96E-04	3.47E-04	1.72E-04	3.96E-04	1.11E-04	1.46E-05	2.42E+02	-4.58E+02	4.38E+02	-2.89E+01	4.51E-01
120	4.26E-04	3.96E-04	1.92E-04	4.26E-04	1.29E-04	1.52E-05	2.53E+02	-4.78E+02	4.57E+02	-2.96E+01	4.71E-01
150	4.46E-04	4.26E-04	2.07E-04	4.46E-04	1.42E-04	1.56E-05	2.59E+02	-4.89E+02	4.68E+02	-3.02E+01	4.82E-01
180	4.60E-04	4.46E-04	2.18E-04	4.60E-04	1.52E-04	1.58E-05	2.63E+02	-4.96E+02	4.75E+02	-3.07E+01	4.89E-01
210	4.71E-04	4.60E-04	2.28E-04	4.71E-04	1.60E-04	1.60E-05	2.65E+02	-5.01E+02	4.80E+02	-3.10E+01	4.94E-01
240	4.80E-04	4.71E-04	2.33E-04	4.80E-04	1.66E-04	1.61E-05	2.67E+02	-5.09E+02	4.83E+02	-3.12E+01	4.97E-01
270	4.87E-04	4.80E-04	2.39E-04	4.87E-04	1.72E-04	1.62E-05	2.68E+02	-5.07E+02	4.86E+02	-3.13E+01	5.00E-01
300	4.93E-04	4.87E-04	2.43E-04	4.93E-04	1.76E-04	1.62E-05	2.69E+02	-5.09E+02	4.87E+02	-3.15E+01	5.02E-01
330	4.97E-04	4.93E-04	2.47E-04	4.97E-04	1.80E-04	1.63E-05	2.70E+02	-5.10E+02	4.89E+02	-3.15E+01	5.03E-01
360	5.01E-04	4.97E-04	2.51E-04	5.01E-04	1.83E-04	1.63E-05	2.71E+02	-5.12E+02	4.90E+02	-3.16E+01	5.04E-01
390	5.05E-04	5.01E-04	2.54E-04	5.05E-04	1.86E-04	1.63E-05	2.72E+02	-5.13E+02	4.91E+02	-3.17E+01	5.05E-01
420	5.08E-04	5.05E-04	2.56E-04	5.08E-04	1.89E-04	1.64E-05	2.72E+02	-5.13E+02	4.92E+02	-3.17E+01	5.06E-01
450	5.10E-04	5.08E-04	2.59E-04	5.10E-04	1.89E-04	1.64E-05	2.72E+02	-5.14E+02	4.92E+02	-3.18E+01	5.06E-01
480	5.13E-04	5.10E-04	2.61E-04	5.13E-04	1.91E-04	1.64E-05	2.72E+02	-5.14E+02	4.93E+02	-3.18E+01	5.07E-01
510	5.15E-04	5.13E-04	2.63E-04	5.15E-04	1.93E-04	1.64E-05	2.73E+02	-5.15E+02	4.93E+02	-3.18E+01	5.07E-01
540	5.17E-04	5.15E-04	2.64E-04	5.17E-04	1.95E-04	1.64E-05	2.73E+02	-5.15E+02	4.93E+02	-3.18E+01	5.08E-01
570	5.18E-04	5.17E-04	2.66E-04	5.18E-04	1.96E-04	1.64E-05	2.73E+02	-5.16E+02	4.94E+02	-3.19E+01	5.08E-01
600	5.20E-04	5.18E-04	2.67E-04	5.20E-04	1.98E-04	1.64E-05	2.73E+02	-5.16E+02	4.94E+02	-3.19E+01	5.08E-01
630	5.21E-04	5.20E-04	2.68E-04	5.21E-04	2.00E-04	1.64E-05	2.73E+02	-5.16E+02	4.94E+02	-3.19E+01	5.09E-01
660	5.22E-04	5.21E-04	2.70E-04	5.22E-04	2.01E-04	1.64E-05	2.73E+02	-5.16E+02	4.94E+02	-3.19E+01	5.09E-01
690	5.23E-04	5.22E-04	2.71E-04	5.23E-04	2.02E-04	1.65E-05	2.73E+02	-5.17E+02	4.95E+02	-3.19E+01	5.09E-01
720	5.25E-04	5.23E-04	2.71E-04	5.23E-04	2.02E-04	1.65E-05	2.73E+02	-5.17E+02	4.95E+02	-3.19E+01	5.09E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00055)

Shrinkage strain =  $\frac{1}{t+(35)^A}$  Distance from Bottom  
 Slab was cast B days before CIP deck Bottom of slab (in.) = 0.00E+00  
 A = 5.50E-04 h\_CIP (in.) = 1.20E+01 Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01 E (psi) = 4.00E+06 Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab fy (psi) = 6.00E+04 Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain (ε)	Strain Slop (tan θ)	Calculated Stress (psi)			Relinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	2.54E-04	0.00E+00	9.35E-05	2.54E-04	5.34E-05	1.00E-05	1.60E+02	-3.21E+02	3.21E+02	-2.17E-13	3.85E-01
60	3.47E-04	2.54E-04	1.42E-04	3.47E-04	9.09E-05	1.28E-05	2.06E+02	-4.10E+02	4.10E+02	0.00E+00	4.93E-01
90	3.96E-04	3.47E-04	1.72E-04	3.96E-04	1.16E-04	1.40E-05	2.24E+02	-4.48E+02	4.48E+02	0.00E+00	5.38E-01
120	4.26E-04	3.96E-04	1.92E-04	4.26E-04	1.34E-04	1.46E-05	2.34E+02	-4.67E+02	4.67E+02	2.17E-13	5.61E-01
150	4.46E-04	4.26E-04	2.07E-04	4.46E-04	1.47E-04	1.50E-05	2.39E+02	-4.79E+02	4.79E+02	0.00E+00	5.74E-01
180	4.60E-04	4.46E-04	2.18E-04	4.60E-04	1.57E-04	1.52E-05	2.43E+02	-4.86E+02	4.86E+02	-2.17E-13	5.83E-01
210	4.71E-04	4.60E-04	2.26E-04	4.71E-04	1.65E-04	1.53E-05	2.45E+02	-4.91E+02	4.91E+02	0.00E+00	5.89E-01
240	4.80E-04	4.71E-04	2.33E-04	4.80E-04	1.71E-04	1.54E-05	2.47E+02	-4.94E+02	4.94E+02	-2.17E-13	5.93E-01
270	4.87E-04	4.80E-04	2.39E-04	4.87E-04	1.77E-04	1.55E-05	2.48E+02	-4.96E+02	4.96E+02	0.00E+00	5.96E-01
300	4.93E-04	4.87E-04	2.43E-04	4.93E-04	1.81E-04	1.56E-05	2.49E+02	-4.98E+02	4.98E+02	0.00E+00	5.98E-01
330	4.97E-04	4.93E-04	2.47E-04	4.97E-04	1.85E-04	1.56E-05	2.50E+02	-5.00E+02	5.00E+02	0.00E+00	6.00E-01
360	5.01E-04	4.97E-04	2.51E-04	5.01E-04	1.88E-04	1.57E-05	2.50E+02	-5.01E+02	5.01E+02	0.00E+00	6.01E-01
390	5.05E-04	5.01E-04	2.54E-04	5.05E-04	1.91E-04	1.57E-05	2.51E+02	-5.02E+02	5.02E+02	0.00E+00	6.02E-01
420	5.08E-04	5.05E-04	2.56E-04	5.08E-04	1.94E-04	1.57E-05	2.51E+02	-5.02E+02	5.02E+02	-4.34E-13	6.03E-01
450	5.10E-04	5.08E-04	2.59E-04	5.10E-04	1.96E-04	1.57E-05	2.52E+02	-5.03E+02	5.03E+02	0.00E+00	6.04E-01
480	5.13E-04	5.10E-04	2.61E-04	5.13E-04	1.98E-04	1.57E-05	2.52E+02	-5.04E+02	5.04E+02	0.00E+00	6.04E-01
510	5.15E-04	5.13E-04	2.63E-04	5.15E-04	2.00E-04	1.58E-05	2.52E+02	-5.04E+02	5.04E+02	0.00E+00	6.05E-01
540	5.17E-04	5.15E-04	2.64E-04	5.17E-04	2.01E-04	1.58E-05	2.52E+02	-5.04E+02	5.04E+02	0.00E+00	6.05E-01
570	5.18E-04	5.17E-04	2.66E-04	5.18E-04	2.03E-04	1.58E-05	2.52E+02	-5.05E+02	5.05E+02	0.00E+00	6.06E-01
600	5.20E-04	5.18E-04	2.67E-04	5.20E-04	2.04E-04	1.58E-05	2.52E+02	-5.05E+02	5.05E+02	0.00E+00	6.06E-01
630	5.21E-04	5.20E-04	2.68E-04	5.21E-04	2.05E-04	1.58E-05	2.53E+02	-5.05E+02	5.05E+02	0.00E+00	6.06E-01
660	5.22E-04	5.21E-04	2.70E-04	5.22E-04	2.06E-04	1.58E-05	2.53E+02	-5.05E+02	5.05E+02	0.00E+00	6.06E-01
690	5.23E-04	5.22E-04	2.71E-04	5.23E-04	2.06E-04	1.58E-05	2.53E+02	-5.06E+02	5.06E+02	0.00E+00	6.07E-01
720	5.25E-04	5.23E-04	2.71E-04	5.23E-04	2.07E-04	1.58E-05	2.53E+02	-5.06E+02	5.06E+02	0.00E+00	6.07E-01

Curing Coefficient A = 0.00060

CIP depth 6 to 12 inches

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00060)

Shrinkage strain =  $t/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = **6.00E-04**  
 B (days) = **3.00E+01**  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = **0.00E+00**  
 Top of slab (in.) = **1.20E+01**  
 Bottom of CIP (in.) = **1.20E+01**  
 Top of CIP (in.) = **2.00E+01**

h\_CIP (in.) = **6.00E+00**  
 h\_slab (in.) = **1.20E+01**  
 E (psi) = **4.00E+06**  
 fy (psi) = **6.00E+04**

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)	Strain (ε <sub>t</sub> )	Strain Slop (tan θ)	Calculated Stress (psi)		Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)	Pre-slab				slab_bot	slab_Top		CIP_bot
30	2.77E-04	0.00E+00	2.77E-04	4.37E-05	1.30E-05	-3.89E+02	3.11E+02	-1.04E+02	1.24E-01
60	3.79E-04	2.77E-04	1.02E-04	8.05E-05	1.66E-05	-4.97E+02	3.98E+02	-1.33E+02	1.59E-01
90	4.32E-04	3.79E-04	1.55E-04	1.06E-04	1.81E-05	-5.43E+02	4.35E+02	-1.45E+02	1.74E-01
120	4.66E-04	4.32E-04	1.88E-04	1.25E-04	1.89E-05	-5.67E+02	4.53E+02	-1.51E+02	1.81E-01
150	4.86E-04	4.66E-04	2.10E-04	1.38E-04	1.93E-05	-5.80E+02	4.64E+02	-1.55E+02	1.86E-01
180	5.02E-04	4.86E-04	2.25E-04	1.49E-04	1.96E-05	-5.89E+02	4.71E+02	-1.57E+02	1.88E-01
210	5.14E-04	5.02E-04	2.37E-04	1.58E-04	1.98E-05	-5.95E+02	4.76E+02	-1.59E+02	1.90E-01
240	5.24E-04	5.14E-04	2.47E-04	1.64E-04	2.00E-05	-5.99E+02	4.79E+02	-1.60E+02	1.92E-01
270	5.31E-04	5.24E-04	2.54E-04	1.70E-04	2.01E-05	-6.02E+02	4.81E+02	-1.60E+02	1.93E-01
300	5.37E-04	5.31E-04	2.60E-04	1.75E-04	2.01E-05	-6.04E+02	4.83E+02	-1.61E+02	1.93E-01
330	5.42E-04	5.37E-04	2.66E-04	1.79E-04	2.02E-05	-6.06E+02	4.85E+02	-1.62E+02	1.94E-01
360	5.47E-04	5.42E-04	2.70E-04	1.83E-04	2.02E-05	-6.07E+02	4.86E+02	-1.62E+02	1.94E-01
390	5.51E-04	5.47E-04	2.74E-04	1.86E-04	2.03E-05	-6.08E+02	4.87E+02	-1.62E+02	1.95E-01
420	5.54E-04	5.51E-04	2.77E-04	1.88E-04	2.03E-05	-6.09E+02	4.87E+02	-1.62E+02	1.95E-01
450	5.57E-04	5.54E-04	2.80E-04	1.91E-04	2.03E-05	-6.10E+02	4.88E+02	-1.63E+02	1.95E-01
480	5.59E-04	5.57E-04	2.82E-04	1.93E-04	2.03E-05	-6.10E+02	4.88E+02	-1.63E+02	1.95E-01
510	5.61E-04	5.59E-04	2.85E-04	1.95E-04	2.04E-05	-6.11E+02	4.89E+02	-1.63E+02	1.95E-01
540	5.63E-04	5.61E-04	2.87E-04	1.97E-04	2.04E-05	-6.12E+02	4.89E+02	-1.63E+02	1.96E-01
570	5.65E-04	5.63E-04	2.88E-04	1.98E-04	2.04E-05	-6.12E+02	4.89E+02	-1.63E+02	1.96E-01
600	5.67E-04	5.65E-04	2.90E-04	2.00E-04	2.04E-05	-6.12E+02	4.90E+02	-1.63E+02	1.96E-01
630	5.68E-04	5.67E-04	2.91E-04	2.01E-04	2.04E-05	-6.12E+02	4.90E+02	-1.63E+02	1.96E-01
660	5.70E-04	5.68E-04	2.93E-04	2.02E-04	2.04E-05	-6.13E+02	4.90E+02	-1.63E+02	1.96E-01
690	5.71E-04	5.70E-04	2.94E-04	2.03E-04	2.04E-05	-6.13E+02	4.90E+02	-1.63E+02	1.96E-01
720	5.72E-04	5.71E-04	2.95E-04	2.03E-04	2.04E-05	-6.13E+02	4.90E+02	-1.63E+02	1.96E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00060)

Shrinkage strain =  $t/(t+35)^A$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 6.00E-04      h\_CIP (in.) = 7.00E+00      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      E (psi) = 4.00E+06      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      fy (psi) = 6.00E+04      Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain (ε <sub>t</sub> )	Strain Slop (tan θ)	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	2.77E-04	0.00E+00	1.02E-04	2.77E-04	4.44E-05	1.29E-05	2.31E+02	-3.86E+02	3.13E+02	-9.79E+01	1.51E-01
60	3.79E-04	2.77E-04	1.55E-04	3.79E-04	8.13E-05	1.68E-05	2.95E+02	-4.94E+02	4.01E+02	-1.25E+02	1.93E-01
90	4.32E-04	3.79E-04	1.88E-04	4.32E-04	1.07E-04	1.80E-05	3.22E+02	-5.40E+02	4.38E+02	-1.37E+02	2.11E-01
120	4.65E-04	4.32E-04	2.10E-04	4.65E-04	1.26E-04	1.87E-05	3.36E+02	-5.63E+02	4.57E+02	-1.43E+02	2.20E-01
150	4.86E-04	4.65E-04	2.25E-04	4.86E-04	1.39E-04	1.92E-05	3.44E+02	-5.77E+02	4.68E+02	-1.46E+02	2.25E-01
180	5.02E-04	4.86E-04	2.37E-04	5.02E-04	1.50E-04	1.95E-05	3.49E+02	-5.85E+02	4.75E+02	-1.48E+02	2.28E-01
210	5.14E-04	5.02E-04	2.47E-04	5.14E-04	1.59E-04	1.97E-05	3.53E+02	-5.91E+02	4.79E+02	-1.50E+02	2.31E-01
240	5.24E-04	5.14E-04	2.54E-04	5.24E-04	1.65E-04	1.98E-05	3.55E+02	-5.95E+02	4.83E+02	-1.51E+02	2.32E-01
270	5.31E-04	5.24E-04	2.60E-04	5.31E-04	1.71E-04	1.99E-05	3.57E+02	-5.98E+02	4.85E+02	-1.52E+02	2.33E-01
300	5.37E-04	5.31E-04	2.66E-04	5.37E-04	1.76E-04	2.00E-05	3.58E+02	-6.00E+02	4.87E+02	-1.52E+02	2.34E-01
330	5.42E-04	5.37E-04	2.70E-04	5.42E-04	1.80E-04	2.00E-05	3.59E+02	-6.02E+02	4.88E+02	-1.53E+02	2.35E-01
360	5.47E-04	5.42E-04	2.74E-04	5.47E-04	1.84E-04	2.01E-05	3.60E+02	-6.03E+02	4.89E+02	-1.53E+02	2.36E-01
390	5.51E-04	5.47E-04	2.77E-04	5.51E-04	1.87E-04	2.01E-05	3.61E+02	-6.04E+02	4.90E+02	-1.53E+02	2.36E-01
420	5.54E-04	5.51E-04	2.80E-04	5.54E-04	1.89E-04	2.01E-05	3.61E+02	-6.05E+02	4.91E+02	-1.53E+02	2.36E-01
450	5.57E-04	5.54E-04	2.82E-04	5.57E-04	1.92E-04	2.02E-05	3.62E+02	-6.06E+02	4.92E+02	-1.54E+02	2.37E-01
480	5.59E-04	5.57E-04	2.85E-04	5.59E-04	1.94E-04	2.02E-05	3.62E+02	-6.07E+02	4.92E+02	-1.54E+02	2.37E-01
510	5.61E-04	5.59E-04	2.87E-04	5.61E-04	1.96E-04	2.02E-05	3.62E+02	-6.07E+02	4.93E+02	-1.54E+02	2.37E-01
540	5.63E-04	5.61E-04	2.88E-04	5.63E-04	1.98E-04	2.02E-05	3.63E+02	-6.08E+02	4.93E+02	-1.54E+02	2.37E-01
570	5.65E-04	5.63E-04	2.90E-04	5.65E-04	1.99E-04	2.02E-05	3.63E+02	-6.08E+02	4.93E+02	-1.54E+02	2.37E-01
600	5.67E-04	5.65E-04	2.91E-04	5.67E-04	2.01E-04	2.02E-05	3.63E+02	-6.08E+02	4.93E+02	-1.54E+02	2.37E-01
630	5.68E-04	5.67E-04	2.93E-04	5.68E-04	2.02E-04	2.02E-05	3.63E+02	-6.09E+02	4.94E+02	-1.54E+02	2.38E-01
660	5.70E-04	5.68E-04	2.94E-04	5.70E-04	2.03E-04	2.03E-05	3.63E+02	-6.09E+02	4.94E+02	-1.54E+02	2.38E-01
690	5.71E-04	5.70E-04	2.94E-04	5.71E-04	2.04E-04	2.03E-05	3.64E+02	-6.09E+02	4.94E+02	-1.54E+02	2.38E-01
720	5.72E-04	5.71E-04	2.95E-04	5.72E-04	2.04E-04	2.03E-05	3.64E+02	-6.09E+02	4.94E+02	-1.54E+02	2.38E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00060)

Shrinkage strain =  $\frac{1}{t+(35)^A}$   
 Slab was cast B days before CIP deck  
 A = 6.00E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

$h\_CIP$  (in.) = 8.00E+00  
 $h\_slab$  (in.) = 1.20E+01  
 $E$  (psi) = 4.00E+06  
 $f_y$  (psi) = 6.00E+04

t (day)	Free Shrinkage Strain			Free Shrinkage Strain		Strain ( $\epsilon_t$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Relinf. Req. (sq. in. per ft.)		
	From 0 days (t0-t)		CIP-deck	After Composite (t1-t)				CIP-deck	slab_bot	slab_Top		CIP_bot	CIP_Top
	Pre-slab	CIP-deck		Pre-slab	CIP-deck								
30	2.77E-04	0.00E+00	2.77E-04	2.77E-04	4.61E-05	1.26E-05	2.24E+02	-3.81E+02	3.19E+02	-8.40E+01	1.88E-01		
60	3.79E-04	2.77E-04	3.79E-04	3.79E-04	8.34E-05	1.61E-05	2.87E+02	-4.87E+02	4.08E+02	-1.07E+02	2.41E-01		
90	4.32E-04	3.79E-04	4.32E-04	4.32E-04	1.09E-04	1.76E-05	3.13E+02	-5.32E+02	4.46E+02	-1.17E+02	2.68E-01		
120	4.68E-04	4.32E-04	4.68E-04	4.65E-04	1.28E-04	1.84E-05	3.26E+02	-5.55E+02	4.66E+02	-1.22E+02	2.74E-01		
150	4.86E-04	4.68E-04	4.86E-04	4.86E-04	1.42E-04	1.88E-05	3.34E+02	-5.68E+02	4.76E+02	-1.25E+02	2.81E-01		
180	5.14E-04	5.02E-04	5.02E-04	5.02E-04	1.53E-04	1.91E-05	3.39E+02	-5.77E+02	4.83E+02	-1.27E+02	2.85E-01		
210	5.14E-04	5.02E-04	5.14E-04	5.14E-04	1.61E-04	1.93E-05	3.42E+02	-5.82E+02	4.88E+02	-1.28E+02	2.88E-01		
240	5.31E-04	5.24E-04	5.24E-04	5.24E-04	1.68E-04	1.94E-05	3.45E+02	-5.86E+02	4.91E+02	-1.29E+02	2.90E-01		
270	5.37E-04	5.31E-04	5.31E-04	5.31E-04	1.74E-04	1.95E-05	3.47E+02	-5.89E+02	4.94E+02	-1.30E+02	2.91E-01		
300	5.42E-04	5.37E-04	5.37E-04	5.37E-04	1.79E-04	1.96E-05	3.48E+02	-5.91E+02	4.96E+02	-1.30E+02	2.92E-01		
330	5.47E-04	5.42E-04	5.42E-04	5.42E-04	1.83E-04	1.96E-05	3.49E+02	-5.93E+02	4.97E+02	-1.31E+02	2.93E-01		
360	5.51E-04	5.47E-04	5.47E-04	5.47E-04	1.86E-04	1.97E-05	3.50E+02	-5.94E+02	4.98E+02	-1.31E+02	2.94E-01		
390	5.54E-04	5.51E-04	5.51E-04	5.51E-04	1.89E-04	1.97E-05	3.50E+02	-5.95E+02	4.99E+02	-1.31E+02	2.94E-01		
420	5.57E-04	5.54E-04	5.54E-04	5.57E-04	1.92E-04	1.97E-05	3.51E+02	-5.96E+02	5.00E+02	-1.32E+02	2.95E-01		
450	5.59E-04	5.57E-04	5.57E-04	5.59E-04	1.94E-04	1.98E-05	3.51E+02	-5.97E+02	5.01E+02	-1.32E+02	2.95E-01		
480	5.61E-04	5.59E-04	5.59E-04	5.61E-04	1.97E-04	1.98E-05	3.52E+02	-5.98E+02	5.01E+02	-1.32E+02	2.95E-01		
510	5.63E-04	5.61E-04	5.61E-04	5.63E-04	1.99E-04	1.98E-05	3.52E+02	-5.98E+02	5.01E+02	-1.32E+02	2.96E-01		
540	5.67E-04	5.63E-04	5.63E-04	5.65E-04	2.00E-04	1.98E-05	3.52E+02	-5.99E+02	5.02E+02	-1.32E+02	2.96E-01		
570	5.68E-04	5.67E-04	5.67E-04	5.68E-04	2.02E-04	1.98E-05	3.52E+02	-5.99E+02	5.02E+02	-1.32E+02	2.96E-01		
600	5.68E-04	5.67E-04	5.68E-04	5.67E-04	2.03E-04	1.98E-05	3.53E+02	-5.99E+02	5.02E+02	-1.32E+02	2.96E-01		
630	5.70E-04	5.68E-04	5.68E-04	5.68E-04	2.05E-04	1.98E-05	3.53E+02	-6.00E+02	5.03E+02	-1.32E+02	2.96E-01		
660	5.71E-04	5.70E-04	5.70E-04	5.70E-04	2.06E-04	1.98E-05	3.53E+02	-6.00E+02	5.03E+02	-1.32E+02	2.96E-01		
690	5.72E-04	5.71E-04	5.71E-04	5.71E-04	2.07E-04	1.99E-05	3.53E+02	-6.00E+02	5.03E+02	-1.32E+02	2.97E-01		
720	5.72E-04	5.71E-04	5.71E-04	5.71E-04	2.07E-04	1.99E-05	3.53E+02	-6.00E+02	5.03E+02	-1.32E+02	2.97E-01		

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00060)

Shrinkage strain =  $v/(t+35)^A$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 6.00E-04      h\_CIP (in.) = 9.00E+00      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      E (psi) = 4.00E+06      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      fy (psi) = 6.00E+04      Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain (ε <sub>t</sub> )	Strain Slop (tan θ)	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	2.77E-04	0.00E+00	1.02E-04	2.77E-04	4.85E-05	1.22E-05	2.14E+02	-3.73E+02	3.26E+02	-6.53E+01	2.36E-01
60	3.79E-04	3.79E-04	1.55E-04	3.79E-04	8.65E-05	1.57E-05	2.74E+02	-4.78E+02	4.18E+02	-8.35E+01	3.01E-01
90	4.32E-04	4.32E-04	1.88E-04	4.32E-04	1.13E-04	1.71E-05	2.99E+02	-5.22E+02	4.56E+02	-9.12E+01	3.28E-01
120	4.65E-04	4.65E-04	2.10E-04	4.65E-04	1.32E-04	1.78E-05	3.12E+02	-5.44E+02	4.76E+02	-9.51E+01	3.43E-01
150	4.86E-04	4.86E-04	2.25E-04	4.86E-04	1.45E-04	1.83E-05	3.20E+02	-5.57E+02	4.87E+02	-9.74E+01	3.51E-01
180	5.14E-04	5.02E-04	2.37E-04	4.86E-04	1.56E-04	1.85E-05	3.24E+02	-5.65E+02	4.94E+02	-9.89E+01	3.56E-01
210	5.24E-04	5.14E-04	2.47E-04	5.14E-04	1.65E-04	1.87E-05	3.28E+02	-5.71E+02	4.99E+02	-9.99E+01	3.59E-01
240	5.31E-04	5.24E-04	2.54E-04	5.24E-04	1.72E-04	1.89E-05	3.30E+02	-5.75E+02	5.03E+02	-1.01E+02	3.62E-01
270	5.37E-04	5.31E-04	2.60E-04	5.31E-04	1.78E-04	1.89E-05	3.32E+02	-5.78E+02	5.05E+02	-1.01E+02	3.64E-01
300	5.42E-04	5.37E-04	2.66E-04	5.37E-04	1.82E-04	1.90E-05	3.33E+02	-5.80E+02	5.07E+02	-1.01E+02	3.66E-01
330	5.47E-04	5.42E-04	2.70E-04	5.42E-04	1.86E-04	1.91E-05	3.34E+02	-5.82E+02	5.09E+02	-1.02E+02	3.66E-01
360	5.51E-04	5.47E-04	2.74E-04	5.47E-04	1.89E-04	1.91E-05	3.34E+02	-5.83E+02	5.10E+02	-1.02E+02	3.67E-01
390	5.54E-04	5.51E-04	2.77E-04	5.51E-04	1.93E-04	1.92E-05	3.35E+02	-5.84E+02	5.11E+02	-1.02E+02	3.68E-01
420	5.57E-04	5.54E-04	2.79E-04	5.57E-04	1.96E-04	1.92E-05	3.36E+02	-5.85E+02	5.12E+02	-1.02E+02	3.68E-01
450	5.59E-04	5.57E-04	2.80E-04	5.59E-04	1.98E-04	1.92E-05	3.36E+02	-5.86E+02	5.12E+02	-1.02E+02	3.69E-01
480	5.61E-04	5.59E-04	2.82E-04	5.59E-04	2.00E-04	1.92E-05	3.36E+02	-5.86E+02	5.13E+02	-1.03E+02	3.69E-01
510	5.63E-04	5.61E-04	2.85E-04	5.61E-04	2.02E-04	1.92E-05	3.37E+02	-5.87E+02	5.13E+02	-1.03E+02	3.70E-01
540	5.65E-04	5.63E-04	2.87E-04	5.63E-04	2.04E-04	1.93E-05	3.37E+02	-5.87E+02	5.13E+02	-1.03E+02	3.70E-01
570	5.67E-04	5.65E-04	2.88E-04	5.65E-04	2.06E-04	1.93E-05	3.37E+02	-5.87E+02	5.14E+02	-1.03E+02	3.70E-01
600	5.68E-04	5.67E-04	2.91E-04	5.67E-04	2.07E-04	1.93E-05	3.37E+02	-5.88E+02	5.14E+02	-1.03E+02	3.70E-01
630	5.70E-04	5.68E-04	2.93E-04	5.68E-04	2.09E-04	1.93E-05	3.38E+02	-5.88E+02	5.14E+02	-1.03E+02	3.70E-01
660	5.71E-04	5.70E-04	2.94E-04	5.70E-04	2.10E-04	1.93E-05	3.38E+02	-5.88E+02	5.14E+02	-1.03E+02	3.70E-01
690	5.72E-04	5.71E-04	2.95E-04	5.71E-04	2.11E-04	1.93E-05	3.38E+02	-5.89E+02	5.15E+02	-1.03E+02	3.70E-01
720	5.72E-04	5.71E-04	2.95E-04	5.71E-04	2.11E-04	1.93E-05	3.38E+02	-5.89E+02	5.15E+02	-1.03E+02	3.70E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00060)

Shrinkage strain =  $t/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = 6.00E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 1.00E+01  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Stop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	2.77E-04	0.00E+00	1.02E-04	2.77E-04	5.14E-05	1.18E-05	2.02E+02	-3.65E+02	3.34E+02	-4.42E+01	2.90E-01
60	3.79E-04	2.77E-04	1.55E-04	3.79E-04	9.03E-05	1.51E-05	2.59E+02	-4.68E+02	4.28E+02	-5.65E+01	3.71E-01
90	4.32E-04	3.79E-04	1.88E-04	4.32E-04	1.17E-04	1.65E-05	2.83E+02	-5.10E+02	4.67E+02	-6.17E+01	4.05E-01
120	4.65E-04	4.32E-04	2.10E-04	4.65E-04	1.36E-04	1.72E-05	2.95E+02	-5.33E+02	4.87E+02	-6.44E+01	4.23E-01
150	4.86E-04	4.65E-04	2.25E-04	4.86E-04	1.50E-04	1.77E-05	3.02E+02	-5.45E+02	4.99E+02	-6.59E+01	4.33E-01
180	5.02E-04	4.86E-04	2.37E-04	5.02E-04	1.61E-04	1.79E-05	3.07E+02	-5.53E+02	5.06E+02	-6.69E+01	4.40E-01
210	5.14E-04	5.02E-04	2.47E-04	5.14E-04	1.69E-04	1.81E-05	3.10E+02	-5.59E+02	5.11E+02	-6.75E+01	4.44E-01
240	5.24E-04	5.14E-04	2.54E-04	5.24E-04	1.76E-04	1.82E-05	3.12E+02	-5.63E+02	5.15E+02	-6.80E+01	4.47E-01
270	5.31E-04	5.24E-04	2.60E-04	5.31E-04	1.82E-04	1.83E-05	3.13E+02	-5.66E+02	5.18E+02	-6.84E+01	4.49E-01
300	5.37E-04	5.31E-04	2.66E-04	5.37E-04	1.87E-04	1.84E-05	3.14E+02	-5.69E+02	5.19E+02	-6.86E+01	4.51E-01
330	5.42E-04	5.37E-04	2.70E-04	5.42E-04	1.91E-04	1.84E-05	3.15E+02	-5.69E+02	5.21E+02	-6.88E+01	4.52E-01
360	5.47E-04	5.42E-04	2.74E-04	5.47E-04	1.95E-04	1.85E-05	3.16E+02	-5.71E+02	5.22E+02	-6.90E+01	4.53E-01
390	5.51E-04	5.47E-04	2.77E-04	5.51E-04	1.98E-04	1.85E-05	3.17E+02	-5.72E+02	5.23E+02	-6.91E+01	4.54E-01
420	5.54E-04	5.51E-04	2.80E-04	5.54E-04	2.01E-04	1.86E-05	3.17E+02	-5.72E+02	5.24E+02	-6.92E+01	4.55E-01
450	5.57E-04	5.54E-04	2.82E-04	5.57E-04	2.03E-04	1.86E-05	3.17E+02	-5.73E+02	5.24E+02	-6.93E+01	4.55E-01
480	5.59E-04	5.57E-04	2.85E-04	5.59E-04	2.05E-04	1.86E-05	3.18E+02	-5.74E+02	5.25E+02	-6.93E+01	4.56E-01
510	5.61E-04	5.59E-04	2.87E-04	5.61E-04	2.07E-04	1.86E-05	3.18E+02	-5.74E+02	5.25E+02	-6.94E+01	4.56E-01
540	5.63E-04	5.61E-04	2.88E-04	5.63E-04	2.09E-04	1.86E-05	3.18E+02	-5.75E+02	5.26E+02	-6.94E+01	4.56E-01
570	5.65E-04	5.63E-04	2.90E-04	5.65E-04	2.10E-04	1.86E-05	3.19E+02	-5.75E+02	5.26E+02	-6.95E+01	4.57E-01
600	5.67E-04	5.65E-04	2.91E-04	5.67E-04	2.12E-04	1.86E-05	3.19E+02	-5.75E+02	5.26E+02	-6.95E+01	4.57E-01
630	5.68E-04	5.67E-04	2.93E-04	5.68E-04	2.13E-04	1.86E-05	3.19E+02	-5.76E+02	5.27E+02	-6.96E+01	4.57E-01
660	5.70E-04	5.68E-04	2.94E-04	5.70E-04	2.14E-04	1.86E-05	3.19E+02	-5.76E+02	5.27E+02	-6.96E+01	4.57E-01
690	5.71E-04	5.70E-04	2.94E-04	5.71E-04	2.15E-04	1.86E-05	3.19E+02	-5.76E+02	5.27E+02	-6.96E+01	4.57E-01
720	5.72E-04	5.71E-04	2.95E-04	5.72E-04	2.15E-04	1.86E-05	3.19E+02	-5.76E+02	5.27E+02	-6.96E+01	4.57E-01



## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00060)

Shrinkage strain =  $1/(t+35)^A$       Distance from Bottom      0.00E+00  
 Slab was cast B days before CIP deck      Bottom of slab (in.) =      1.20E+01  
 A = 6.00E-04      Top of slab (in.) =      1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) =      2.00E+01  
 t start from casting of slab      Top of CIP (in.) =      2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain (ε)	Strain Slop (tan θ)	Calculated Stress (psi)			Relief Req. (sq. in. per ft.)	
	Pre-slab	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top	CIP_bot		CIP_Top
30	2.77E-04	0.00E+00	1.02E-04	2.77E-04	5.47E-05	1.14E-05	1.89E+02	-3.57E+02	3.42E+02	-2.21E+01	3.52E-01
60	3.79E-04	2.77E-04	1.55E-04	3.79E-04	9.46E-05	1.46E-05	2.42E+02	-4.57E+02	4.38E+02	-2.83E+01	4.51E-01
90	4.32E-04	3.79E-04	1.88E-04	4.32E-04	1.22E-04	1.59E-05	2.64E+02	-4.99E+02	4.78E+02	-3.09E+01	4.92E-01
120	4.66E-04	4.32E-04	2.10E-04	4.66E-04	1.41E-04	1.66E-05	2.78E+02	-5.21E+02	4.99E+02	-3.22E+01	5.13E-01
150	4.86E-04	4.66E-04	2.25E-04	4.86E-04	1.55E-04	1.70E-05	2.82E+02	-5.33E+02	5.11E+02	-3.30E+01	5.26E-01
180	5.14E-04	4.86E-04	2.37E-04	5.02E-04	1.66E-04	1.72E-05	2.87E+02	-5.41E+02	5.18E+02	-3.34E+01	5.34E-01
210	5.24E-04	5.02E-04	2.47E-04	5.14E-04	1.74E-04	1.74E-05	2.89E+02	-5.47E+02	5.24E+02	-3.38E+01	5.39E-01
240	5.31E-04	5.14E-04	2.54E-04	5.24E-04	1.81E-04	1.75E-05	2.91E+02	-5.50E+02	5.27E+02	-3.40E+01	5.42E-01
270	5.37E-04	5.24E-04	2.60E-04	5.31E-04	1.87E-04	1.76E-05	2.93E+02	-5.53E+02	5.30E+02	-3.42E+01	5.45E-01
300	5.42E-04	5.37E-04	2.66E-04	5.37E-04	1.92E-04	1.77E-05	2.94E+02	-5.55E+02	5.32E+02	-3.43E+01	5.47E-01
330	5.47E-04	5.42E-04	2.70E-04	5.42E-04	1.96E-04	1.77E-05	2.95E+02	-5.57E+02	5.33E+02	-3.44E+01	5.49E-01
360	5.51E-04	5.47E-04	2.74E-04	5.47E-04	2.00E-04	1.78E-05	2.95E+02	-5.58E+02	5.35E+02	-3.45E+01	5.50E-01
390	5.54E-04	5.51E-04	2.77E-04	5.51E-04	2.03E-04	1.78E-05	2.96E+02	-5.59E+02	5.35E+02	-3.45E+01	5.51E-01
420	5.57E-04	5.54E-04	2.80E-04	5.57E-04	2.06E-04	1.79E-05	2.96E+02	-5.60E+02	5.36E+02	-3.46E+01	5.52E-01
450	5.59E-04	5.57E-04	2.82E-04	5.59E-04	2.08E-04	1.79E-05	2.97E+02	-5.61E+02	5.37E+02	-3.46E+01	5.53E-01
480	5.61E-04	5.59E-04	2.85E-04	5.61E-04	2.10E-04	1.79E-05	2.97E+02	-5.62E+02	5.37E+02	-3.47E+01	5.53E-01
510	5.63E-04	5.61E-04	2.87E-04	5.63E-04	2.12E-04	1.79E-05	2.97E+02	-5.62E+02	5.38E+02	-3.47E+01	5.54E-01
540	5.65E-04	5.63E-04	2.88E-04	5.65E-04	2.14E-04	1.79E-05	2.97E+02	-5.62E+02	5.38E+02	-3.47E+01	5.54E-01
570	5.67E-04	5.65E-04	2.90E-04	5.67E-04	2.16E-04	1.79E-05	2.98E+02	-5.63E+02	5.39E+02	-3.48E+01	5.55E-01
600	5.68E-04	5.67E-04	2.91E-04	5.67E-04	2.17E-04	1.79E-05	2.98E+02	-5.63E+02	5.39E+02	-3.48E+01	5.55E-01
630	5.70E-04	5.68E-04	2.93E-04	5.68E-04	2.18E-04	1.79E-05	2.98E+02	-5.63E+02	5.39E+02	-3.48E+01	5.55E-01
660	5.71E-04	5.70E-04	2.94E-04	5.70E-04	2.20E-04	1.79E-05	2.98E+02	-5.63E+02	5.39E+02	-3.48E+01	5.55E-01
690	5.71E-04	5.70E-04	2.94E-04	5.70E-04	2.20E-04	1.79E-05	2.98E+02	-5.63E+02	5.39E+02	-3.48E+01	5.55E-01
720	5.72E-04	5.71E-04	2.95E-04	5.71E-04	2.21E-04	1.80E-05	2.98E+02	-5.63E+02	5.40E+02	-3.48E+01	5.55E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A =0.00060)

Shrinkage strain =  $t/(t+35)*A$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 6.00E-04      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_t$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	2.77E-04	0.00E+00	1.02E-04	2.77E-04	5.83E-05	1.09E-05	1.75E+02	-3.50E+02	3.50E+02	2.17E-13	4.20E-01
60	3.79E-04	2.77E-04	1.55E-04	3.79E-04	9.91E-05	1.40E-05	2.24E+02	-4.48E+02	4.48E+02	0.00E+00	5.37E-01
90	4.32E-04	3.79E-04	1.88E-04	4.32E-04	1.26E-04	1.53E-05	2.44E+02	-4.89E+02	4.89E+02	0.00E+00	5.87E-01
120	4.65E-04	4.32E-04	2.10E-04	4.65E-04	1.46E-04	1.59E-05	2.55E+02	-5.10E+02	5.10E+02	-2.17E-13	6.12E-01
150	4.86E-04	4.65E-04	2.25E-04	4.86E-04	1.60E-04	1.63E-05	2.61E+02	-5.22E+02	5.22E+02	-2.17E-13	6.27E-01
180	5.02E-04	4.86E-04	2.37E-04	5.02E-04	1.71E-04	1.66E-05	2.65E+02	-5.30E+02	5.30E+02	0.00E+00	6.36E-01
210	5.14E-04	5.02E-04	2.47E-04	5.14E-04	1.80E-04	1.67E-05	2.68E+02	-5.36E+02	5.35E+02	0.00E+00	6.42E-01
240	5.24E-04	5.14E-04	2.54E-04	5.24E-04	1.87E-04	1.68E-05	2.69E+02	-5.39E+02	5.39E+02	0.00E+00	6.47E-01
270	5.31E-04	5.24E-04	2.60E-04	5.31E-04	1.93E-04	1.69E-05	2.71E+02	-5.42E+02	5.42E+02	0.00E+00	6.50E-01
300	5.37E-04	5.31E-04	2.66E-04	5.37E-04	1.98E-04	1.70E-05	2.72E+02	-5.44E+02	5.44E+02	0.00E+00	6.52E-01
330	5.42E-04	5.37E-04	2.70E-04	5.42E-04	2.02E-04	1.70E-05	2.73E+02	-5.46E+02	5.45E+02	0.00E+00	6.54E-01
360	5.47E-04	5.42E-04	2.74E-04	5.47E-04	2.05E-04	1.71E-05	2.73E+02	-5.48E+02	5.46E+02	0.00E+00	6.56E-01
390	5.51E-04	5.47E-04	2.77E-04	5.51E-04	2.09E-04	1.71E-05	2.74E+02	-5.47E+02	5.47E+02	0.00E+00	6.57E-01
420	5.54E-04	5.51E-04	2.80E-04	5.54E-04	2.11E-04	1.71E-05	2.74E+02	-5.48E+02	5.48E+02	0.00E+00	6.58E-01
450	5.57E-04	5.54E-04	2.82E-04	5.57E-04	2.14E-04	1.72E-05	2.74E+02	-5.49E+02	5.49E+02	0.00E+00	6.59E-01
480	5.59E-04	5.57E-04	2.85E-04	5.59E-04	2.16E-04	1.72E-05	2.75E+02	-5.49E+02	5.49E+02	0.00E+00	6.59E-01
510	5.61E-04	5.59E-04	2.87E-04	5.61E-04	2.18E-04	1.72E-05	2.75E+02	-5.50E+02	5.50E+02	0.00E+00	6.60E-01
540	5.63E-04	5.61E-04	2.88E-04	5.63E-04	2.20E-04	1.72E-05	2.75E+02	-5.50E+02	5.50E+02	0.00E+00	6.60E-01
570	5.65E-04	5.63E-04	2.90E-04	5.65E-04	2.21E-04	1.72E-05	2.75E+02	-5.51E+02	5.51E+02	0.00E+00	6.61E-01
600	5.67E-04	5.65E-04	2.91E-04	5.67E-04	2.23E-04	1.72E-05	2.75E+02	-5.51E+02	5.51E+02	0.00E+00	6.61E-01
630	5.68E-04	5.67E-04	2.93E-04	5.68E-04	2.24E-04	1.72E-05	2.76E+02	-5.51E+02	5.51E+02	0.00E+00	6.61E-01
660	5.70E-04	5.68E-04	2.94E-04	5.70E-04	2.25E-04	1.72E-05	2.76E+02	-5.51E+02	5.51E+02	-4.34E-13	6.62E-01
690	5.71E-04	5.70E-04	2.94E-04	5.70E-04	2.25E-04	1.72E-05	2.76E+02	-5.51E+02	5.51E+02	-4.34E-13	6.62E-01
720	5.72E-04	5.71E-04	2.95E-04	5.71E-04	2.26E-04	1.72E-05	2.78E+02	-5.52E+02	5.52E+02	0.00E+00	6.62E-01

Curing Coefficient  $A = 0.00065$

CIP depth 6 to 12 inches

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00065)

Shrinkage strain =  $t/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = 6.50E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 6.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_t$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.00E-04	0.00E+00	1.11E-04	3.00E-04	4.74E-05	1.40E-05	2.53E+02	-4.21E+02	3.37E+02	-1.12E+02	1.35E-01
60	4.11E-04	3.00E-04	1.68E-04	4.11E-04	8.72E-05	1.80E-05	3.23E+02	-5.39E+02	4.31E+02	-1.44E+02	1.72E-01
90	4.68E-04	4.11E-04	2.03E-04	4.68E-04	1.15E-04	1.98E-05	3.53E+02	-5.88E+02	4.71E+02	-1.57E+02	1.88E-01
120	5.03E-04	4.68E-04	2.27E-04	5.03E-04	1.35E-04	2.05E-05	3.68E+02	-6.14E+02	4.91E+02	-1.64E+02	1.96E-01
150	5.27E-04	5.03E-04	2.44E-04	5.27E-04	1.50E-04	2.10E-05	3.77E+02	-6.29E+02	5.03E+02	-1.68E+02	2.01E-01
180	5.44E-04	5.27E-04	2.57E-04	5.44E-04	1.61E-04	2.13E-05	3.83E+02	-6.38E+02	5.10E+02	-1.70E+02	2.04E-01
210	5.57E-04	5.44E-04	2.67E-04	5.57E-04	1.71E-04	2.15E-05	3.86E+02	-6.44E+02	5.15E+02	-1.72E+02	2.06E-01
240	5.67E-04	5.57E-04	2.75E-04	5.67E-04	1.78E-04	2.16E-05	3.89E+02	-6.49E+02	5.19E+02	-1.73E+02	2.08E-01
270	5.75E-04	5.67E-04	2.82E-04	5.75E-04	1.84E-04	2.17E-05	3.91E+02	-6.52E+02	5.21E+02	-1.74E+02	2.09E-01
300	5.82E-04	5.75E-04	2.88E-04	5.82E-04	1.90E-04	2.18E-05	3.93E+02	-6.54E+02	5.23E+02	-1.74E+02	2.09E-01
330	5.88E-04	5.82E-04	2.92E-04	5.88E-04	1.94E-04	2.19E-05	3.94E+02	-6.56E+02	5.25E+02	-1.75E+02	2.10E-01
360	5.92E-04	5.88E-04	2.96E-04	5.92E-04	1.98E-04	2.19E-05	3.95E+02	-6.58E+02	5.26E+02	-1.75E+02	2.10E-01
390	5.96E-04	5.92E-04	2.99E-04	5.96E-04	2.01E-04	2.20E-05	3.95E+02	-6.59E+02	5.27E+02	-1.76E+02	2.11E-01
420	6.00E-04	5.96E-04	3.00E-04	6.00E-04	2.04E-04	2.20E-05	3.96E+02	-6.60E+02	5.28E+02	-1.76E+02	2.11E-01
450	6.03E-04	6.00E-04	3.03E-04	6.03E-04	2.07E-04	2.20E-05	3.96E+02	-6.61E+02	5.28E+02	-1.76E+02	2.11E-01
480	6.06E-04	6.03E-04	3.06E-04	6.06E-04	2.09E-04	2.20E-05	3.97E+02	-6.61E+02	5.29E+02	-1.76E+02	2.12E-01
510	6.08E-04	6.06E-04	3.08E-04	6.08E-04	2.11E-04	2.21E-05	3.97E+02	-6.62E+02	5.29E+02	-1.76E+02	2.12E-01
540	6.10E-04	6.08E-04	3.10E-04	6.10E-04	2.13E-04	2.21E-05	3.97E+02	-6.62E+02	5.30E+02	-1.77E+02	2.12E-01
570	6.12E-04	6.10E-04	3.12E-04	6.12E-04	2.15E-04	2.21E-05	3.98E+02	-6.63E+02	5.30E+02	-1.77E+02	2.12E-01
600	6.14E-04	6.12E-04	3.14E-04	6.14E-04	2.16E-04	2.21E-05	3.98E+02	-6.63E+02	5.30E+02	-1.77E+02	2.12E-01
630	6.16E-04	6.14E-04	3.16E-04	6.16E-04	2.18E-04	2.21E-05	3.98E+02	-6.63E+02	5.31E+02	-1.77E+02	2.12E-01
660	6.17E-04	6.16E-04	3.17E-04	6.17E-04	2.18E-04	2.21E-05	3.98E+02	-6.64E+02	5.31E+02	-1.77E+02	2.12E-01
690	6.19E-04	6.17E-04	3.19E-04	6.19E-04	2.19E-04	2.21E-05	3.98E+02	-6.64E+02	5.31E+02	-1.77E+02	2.12E-01
720	6.20E-04	6.19E-04	3.20E-04	6.19E-04	2.20E-04	2.21E-05	3.98E+02	-6.64E+02	5.31E+02	-1.77E+02	2.12E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00065)

Shrinkage strain =  $t/(t+35)^2 \cdot A$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 6.50E-04      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 7.00E+00      Strain Slop (tan  $\theta$ )  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain From 0 days (10 <sup>-4</sup> )		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_r$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	Pre-slab	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top	CIP_bot		CIP_Top
30	3.00E-04	0.00E+00	1.11E-04	3.00E-04	4.81E-05	1.39E-05	2.50E+02	-4.18E+02	3.39E+02	-1.08E+02	1.63E-01
60	4.11E-04	3.00E-04	1.68E-04	4.11E-04	8.81E-05	1.78E-05	3.20E+02	-5.36E+02	4.34E+02	-1.36E+02	2.09E-01
90	4.68E-04	4.11E-04	2.03E-04	4.68E-04	1.16E-04	1.95E-05	3.49E+02	-5.85E+02	4.74E+02	-1.48E+02	2.28E-01
120	5.03E-04	4.68E-04	2.27E-04	5.03E-04	1.36E-04	2.03E-05	3.64E+02	-6.10E+02	4.95E+02	-1.55E+02	2.38E-01
150	5.27E-04	5.03E-04	2.44E-04	5.27E-04	1.51E-04	2.08E-05	3.73E+02	-6.25E+02	5.07E+02	-1.58E+02	2.44E-01
180	5.44E-04	5.27E-04	2.57E-04	5.44E-04	1.63E-04	2.11E-05	3.78E+02	-6.34E+02	5.14E+02	-1.61E+02	2.47E-01
210	5.57E-04	5.44E-04	2.67E-04	5.57E-04	1.72E-04	2.13E-05	3.82E+02	-6.40E+02	5.19E+02	-1.62E+02	2.50E-01
240	5.67E-04	5.57E-04	2.75E-04	5.67E-04	1.79E-04	2.14E-05	3.85E+02	-6.45E+02	5.23E+02	-1.63E+02	2.52E-01
270	5.75E-04	5.67E-04	2.82E-04	5.75E-04	1.85E-04	2.16E-05	3.87E+02	-6.48E+02	5.25E+02	-1.64E+02	2.53E-01
300	5.82E-04	5.75E-04	2.88E-04	5.82E-04	1.91E-04	2.16E-05	3.88E+02	-6.50E+02	5.27E+02	-1.65E+02	2.54E-01
330	5.88E-04	5.82E-04	2.92E-04	5.88E-04	1.95E-04	2.17E-05	3.89E+02	-6.52E+02	5.29E+02	-1.65E+02	2.55E-01
360	5.92E-04	5.88E-04	2.96E-04	5.92E-04	1.99E-04	2.17E-05	3.90E+02	-6.54E+02	5.30E+02	-1.66E+02	2.55E-01
390	5.96E-04	5.92E-04	2.99E-04	5.96E-04	2.02E-04	2.18E-05	3.91E+02	-6.55E+02	5.31E+02	-1.66E+02	2.56E-01
420	6.00E-04	5.96E-04	3.00E-04	6.00E-04	2.05E-04	2.18E-05	3.91E+02	-6.56E+02	5.32E+02	-1.66E+02	2.56E-01
450	6.03E-04	6.00E-04	3.03E-04	6.03E-04	2.08E-04	2.18E-05	3.92E+02	-6.57E+02	5.33E+02	-1.66E+02	2.56E-01
480	6.06E-04	6.03E-04	3.06E-04	6.06E-04	2.10E-04	2.19E-05	3.92E+02	-6.57E+02	5.33E+02	-1.67E+02	2.57E-01
510	6.08E-04	6.06E-04	3.08E-04	6.08E-04	2.12E-04	2.19E-05	3.93E+02	-6.58E+02	5.34E+02	-1.67E+02	2.57E-01
540	6.10E-04	6.08E-04	3.10E-04	6.10E-04	2.14E-04	2.19E-05	3.93E+02	-6.58E+02	5.34E+02	-1.67E+02	2.57E-01
570	6.12E-04	6.10E-04	3.12E-04	6.12E-04	2.16E-04	2.19E-05	3.93E+02	-6.59E+02	5.35E+02	-1.67E+02	2.57E-01
600	6.14E-04	6.12E-04	3.14E-04	6.14E-04	2.17E-04	2.19E-05	3.93E+02	-6.59E+02	5.35E+02	-1.67E+02	2.57E-01
630	6.16E-04	6.14E-04	3.16E-04	6.16E-04	2.19E-04	2.19E-05	3.94E+02	-6.60E+02	5.35E+02	-1.67E+02	2.57E-01
660	6.17E-04	6.16E-04	3.17E-04	6.17E-04	2.20E-04	2.19E-05	3.94E+02	-6.60E+02	5.35E+02	-1.67E+02	2.57E-01
690	6.19E-04	6.17E-04	3.19E-04	6.19E-04	2.21E-04	2.20E-05	3.94E+02	-6.60E+02	5.35E+02	-1.67E+02	2.58E-01
720	6.20E-04	6.19E-04	3.20E-04	6.20E-04	2.21E-04	2.20E-05	3.94E+02	-6.60E+02	5.35E+02	-1.67E+02	2.58E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00065)

Shrinkage strain =  $t/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = 6.50E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 8.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.00E-04	0.00E+00	1.11E-04	3.00E-04	4.99E-05	1.36E-05	2.43E+02	-4.12E+02	3.46E+02	-9.09E+01	2.04E-01
60	4.11E-04	3.00E-04	1.68E-04	4.11E-04	9.04E-05	1.75E-05	3.10E+02	-5.28E+02	4.42E+02	-1.16E+02	2.61E-01
90	4.68E-04	4.11E-04	2.03E-04	4.68E-04	1.18E-04	1.91E-05	3.39E+02	-5.76E+02	4.83E+02	-1.27E+02	2.85E-01
120	5.03E-04	4.68E-04	2.27E-04	5.03E-04	1.39E-04	1.99E-05	3.54E+02	-6.01E+02	5.04E+02	-1.33E+02	2.97E-01
150	5.27E-04	5.03E-04	2.44E-04	5.27E-04	1.54E-04	2.04E-05	3.62E+02	-6.15E+02	5.16E+02	-1.36E+02	3.04E-01
180	5.44E-04	5.27E-04	2.57E-04	5.44E-04	1.65E-04	2.07E-05	3.67E+02	-6.25E+02	5.24E+02	-1.38E+02	3.09E-01
210	5.57E-04	5.44E-04	2.67E-04	5.57E-04	1.75E-04	2.09E-05	3.71E+02	-6.31E+02	5.29E+02	-1.39E+02	3.12E-01
240	5.67E-04	5.57E-04	2.75E-04	5.67E-04	1.82E-04	2.10E-05	3.74E+02	-6.36E+02	5.32E+02	-1.40E+02	3.14E-01
270	5.75E-04	5.67E-04	2.82E-04	5.75E-04	1.88E-04	2.11E-05	3.75E+02	-6.38E+02	5.35E+02	-1.41E+02	3.15E-01
300	5.82E-04	5.75E-04	2.88E-04	5.82E-04	1.93E-04	2.12E-05	3.77E+02	-6.41E+02	5.37E+02	-1.41E+02	3.17E-01
330	5.88E-04	5.82E-04	2.92E-04	5.88E-04	1.98E-04	2.13E-05	3.78E+02	-6.42E+02	5.39E+02	-1.42E+02	3.17E-01
360	5.92E-04	5.88E-04	2.96E-04	5.92E-04	2.02E-04	2.13E-05	3.79E+02	-6.44E+02	5.40E+02	-1.42E+02	3.18E-01
390	5.96E-04	5.92E-04	2.96E-04	5.92E-04	2.05E-04	2.13E-05	3.79E+02	-6.45E+02	5.41E+02	-1.42E+02	3.19E-01
420	6.00E-04	5.96E-04	3.00E-04	5.96E-04	2.08E-04	2.14E-05	3.80E+02	-6.46E+02	5.42E+02	-1.43E+02	3.19E-01
450	6.03E-04	6.00E-04	3.03E-04	6.00E-04	2.08E-04	2.14E-05	3.81E+02	-6.47E+02	5.42E+02	-1.43E+02	3.20E-01
480	6.06E-04	6.03E-04	3.06E-04	6.03E-04	2.11E-04	2.14E-05	3.81E+02	-6.48E+02	5.43E+02	-1.43E+02	3.20E-01
510	6.08E-04	6.06E-04	3.08E-04	6.06E-04	2.13E-04	2.15E-05	3.81E+02	-6.48E+02	5.43E+02	-1.43E+02	3.20E-01
540	6.10E-04	6.08E-04	3.10E-04	6.08E-04	2.15E-04	2.15E-05	3.81E+02	-6.49E+02	5.44E+02	-1.43E+02	3.20E-01
570	6.12E-04	6.10E-04	3.12E-04	6.10E-04	2.17E-04	2.15E-05	3.82E+02	-6.49E+02	5.44E+02	-1.43E+02	3.21E-01
600	6.14E-04	6.12E-04	3.14E-04	6.12E-04	2.19E-04	2.15E-05	3.82E+02	-6.49E+02	5.44E+02	-1.43E+02	3.21E-01
630	6.16E-04	6.14E-04	3.16E-04	6.14E-04	2.20E-04	2.15E-05	3.82E+02	-6.49E+02	5.44E+02	-1.43E+02	3.21E-01
660	6.17E-04	6.16E-04	3.17E-04	6.16E-04	2.22E-04	2.15E-05	3.82E+02	-6.50E+02	5.45E+02	-1.43E+02	3.21E-01
690	6.19E-04	6.17E-04	3.19E-04	6.17E-04	2.23E-04	2.15E-05	3.82E+02	-6.50E+02	5.45E+02	-1.43E+02	3.21E-01
720	6.20E-04	6.19E-04	3.20E-04	6.19E-04	2.24E-04	2.15E-05	3.82E+02	-6.50E+02	5.45E+02	-1.43E+02	3.21E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00065)

Shrinkage strain =  $t/(t+35)^2 \cdot A$       Distance from Bottom      0.00E+00  
 Slab was cast B days before CIP deck      Bottom of slab (in.) =      1.20E+01  
 A = 6.50E-04      Top of slab (in.) =      1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) =      2.00E+01  
 t start from casting of slab      Top of CIP (in.) =      2.00E+01

h\_CIP (in.) = 9.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain (ε <sub>r</sub> )	Strain Slop (tan θ)	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.00E-04	0.00E+00	1.11E-04	3.00E-04	5.25E-05	1.33E-05	2.32E+02	-4.04E+02	3.54E+02	-7.07E+01	2.55E-01
60	4.11E-04	3.00E-04	1.68E-04	4.11E-04	9.38E-05	1.70E-05	2.97E+02	-5.18E+02	4.53E+02	-9.05E+01	3.26E-01
90	4.68E-04	4.11E-04	2.03E-04	4.68E-04	1.22E-04	1.85E-05	3.24E+02	-5.85E+02	4.94E+02	-9.88E+01	3.56E-01
120	5.03E-04	4.68E-04	2.27E-04	5.03E-04	1.42E-04	1.93E-05	3.38E+02	-5.89E+02	5.15E+02	-1.03E+02	3.71E-01
150	5.27E-04	5.03E-04	2.44E-04	5.27E-04	1.58E-04	1.98E-05	3.46E+02	-6.04E+02	5.28E+02	-1.06E+02	3.80E-01
180	5.44E-04	5.27E-04	2.57E-04	5.44E-04	1.69E-04	2.01E-05	3.51E+02	-6.13E+02	5.36E+02	-1.07E+02	3.86E-01
210	5.57E-04	5.44E-04	2.67E-04	5.57E-04	1.79E-04	2.03E-05	3.55E+02	-6.19E+02	5.41E+02	-1.08E+02	3.89E-01
240	5.67E-04	5.57E-04	2.75E-04	5.67E-04	1.86E-04	2.04E-05	3.57E+02	-6.23E+02	5.45E+02	-1.09E+02	3.92E-01
270	5.75E-04	5.67E-04	2.82E-04	5.75E-04	1.92E-04	2.05E-05	3.59E+02	-6.26E+02	5.47E+02	-1.09E+02	3.94E-01
300	5.82E-04	5.75E-04	2.88E-04	5.82E-04	1.98E-04	2.06E-05	3.61E+02	-6.28E+02	5.49E+02	-1.10E+02	3.96E-01
330	5.88E-04	5.82E-04	2.92E-04	5.88E-04	2.02E-04	2.07E-05	3.62E+02	-6.30E+02	5.51E+02	-1.10E+02	3.97E-01
360	5.92E-04	5.88E-04	2.96E-04	5.92E-04	2.06E-04	2.07E-05	3.62E+02	-6.32E+02	5.52E+02	-1.10E+02	3.98E-01
390	5.96E-04	5.92E-04	3.00E-04	5.96E-04	2.09E-04	2.07E-05	3.63E+02	-6.33E+02	5.53E+02	-1.11E+02	3.98E-01
420	6.00E-04	5.96E-04	3.03E-04	6.00E-04	2.12E-04	2.08E-05	3.64E+02	-6.34E+02	5.54E+02	-1.11E+02	3.99E-01
450	6.03E-04	6.00E-04	3.06E-04	6.03E-04	2.15E-04	2.08E-05	3.64E+02	-6.34E+02	5.55E+02	-1.11E+02	3.99E-01
480	6.06E-04	6.03E-04	3.08E-04	6.06E-04	2.17E-04	2.08E-05	3.64E+02	-6.35E+02	5.55E+02	-1.11E+02	4.00E-01
510	6.08E-04	6.06E-04	3.10E-04	6.08E-04	2.19E-04	2.08E-05	3.65E+02	-6.36E+02	5.56E+02	-1.11E+02	4.00E-01
540	6.10E-04	6.08E-04	3.12E-04	6.10E-04	2.21E-04	2.09E-05	3.65E+02	-6.36E+02	5.56E+02	-1.11E+02	4.00E-01
570	6.12E-04	6.10E-04	3.14E-04	6.12E-04	2.23E-04	2.09E-05	3.65E+02	-6.37E+02	5.57E+02	-1.11E+02	4.01E-01
600	6.14E-04	6.12E-04	3.16E-04	6.14E-04	2.24E-04	2.09E-05	3.65E+02	-6.37E+02	5.57E+02	-1.11E+02	4.01E-01
630	6.16E-04	6.14E-04	3.17E-04	6.16E-04	2.26E-04	2.09E-05	3.66E+02	-6.37E+02	5.57E+02	-1.11E+02	4.01E-01
660	6.17E-04	6.16E-04	3.19E-04	6.17E-04	2.27E-04	2.09E-05	3.66E+02	-6.37E+02	5.57E+02	-1.11E+02	4.01E-01
690	6.19E-04	6.17E-04	3.20E-04	6.19E-04	2.28E-04	2.09E-05	3.66E+02	-6.38E+02	5.57E+02	-1.11E+02	4.01E-01
720	6.20E-04	6.19E-04	3.20E-04	6.19E-04	2.28E-04	2.09E-05	3.66E+02	-6.38E+02	5.57E+02	-1.11E+02	4.01E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A =0.00065)

Shrinkage strain =  $v/(t+35)*A$       Distance from Bottom      0.00E+00  
 Slab was cast B days before CIP deck      Bottom of slab (in.) =      1.20E+01  
 A = 6.50E-04      Top of slab (in.) =      1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) =      1.20E+01  
 t start from casting of slab      Top of CIP (in.) =      2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.00E-04	0.00E+00	1.11E-04	3.00E-04	5.57E-05	1.28E-05	2.19E+02	-3.96E+02	3.62E+02	-4.78E+01	3.14E-01
60	4.11E-04	3.00E-04	1.68E-04	4.11E-04	9.78E-05	1.64E-05	2.81E+02	-5.07E+02	4.64E+02	-6.12E+01	4.02E-01
90	4.68E-04	4.11E-04	2.03E-04	4.68E-04	1.27E-04	1.79E-05	3.06E+02	-5.53E+02	5.06E+02	-6.68E+01	4.38E-01
120	5.03E-04	4.68E-04	2.27E-04	5.03E-04	1.47E-04	1.87E-05	3.20E+02	-5.77E+02	5.28E+02	-6.97E+01	4.58E-01
150	5.27E-04	5.03E-04	2.44E-04	5.27E-04	1.62E-04	1.91E-05	3.27E+02	-5.91E+02	5.41E+02	-7.14E+01	4.69E-01
180	5.44E-04	5.27E-04	2.57E-04	5.44E-04	1.74E-04	1.94E-05	3.32E+02	-6.00E+02	5.49E+02	-7.25E+01	4.76E-01
210	5.57E-04	5.44E-04	2.67E-04	5.57E-04	1.83E-04	1.96E-05	3.35E+02	-6.05E+02	5.54E+02	-7.32E+01	4.81E-01
240	5.67E-04	5.57E-04	2.75E-04	5.67E-04	1.91E-04	1.97E-05	3.38E+02	-6.10E+02	5.58E+02	-7.37E+01	4.84E-01
270	5.75E-04	5.67E-04	2.82E-04	5.75E-04	1.97E-04	1.98E-05	3.39E+02	-6.13E+02	5.61E+02	-7.40E+01	4.87E-01
300	5.82E-04	5.75E-04	2.88E-04	5.82E-04	2.03E-04	1.99E-05	3.41E+02	-6.15E+02	5.63E+02	-7.43E+01	4.88E-01
330	5.88E-04	5.82E-04	2.92E-04	5.88E-04	2.07E-04	2.00E-05	3.42E+02	-6.17E+02	5.64E+02	-7.45E+01	4.90E-01
360	5.92E-04	5.88E-04	2.96E-04	5.92E-04	2.11E-04	2.00E-05	3.42E+02	-6.18E+02	5.66E+02	-7.47E+01	4.91E-01
390	5.96E-04	5.92E-04	2.99E-04	5.96E-04	2.14E-04	2.00E-05	3.43E+02	-6.19E+02	5.67E+02	-7.48E+01	4.92E-01
420	6.00E-04	5.96E-04	3.00E-04	6.00E-04	2.17E-04	2.00E-05	3.44E+02	-6.20E+02	5.67E+02	-7.50E+01	4.93E-01
450	6.03E-04	6.00E-04	3.03E-04	6.03E-04	2.20E-04	2.01E-05	3.44E+02	-6.21E+02	5.68E+02	-7.50E+01	4.93E-01
480	6.06E-04	6.03E-04	3.06E-04	6.06E-04	2.22E-04	2.01E-05	3.44E+02	-6.22E+02	5.69E+02	-7.51E+01	4.94E-01
510	6.08E-04	6.06E-04	3.08E-04	6.08E-04	2.24E-04	2.01E-05	3.45E+02	-6.22E+02	5.70E+02	-7.52E+01	4.94E-01
540	6.10E-04	6.08E-04	3.10E-04	6.10E-04	2.26E-04	2.02E-05	3.45E+02	-6.22E+02	5.70E+02	-7.52E+01	4.94E-01
570	6.12E-04	6.10E-04	3.12E-04	6.12E-04	2.28E-04	2.02E-05	3.45E+02	-6.23E+02	5.70E+02	-7.53E+01	4.94E-01
600	6.14E-04	6.12E-04	3.14E-04	6.14E-04	2.29E-04	2.02E-05	3.45E+02	-6.23E+02	5.70E+02	-7.53E+01	4.95E-01
630	6.16E-04	6.14E-04	3.16E-04	6.16E-04	2.31E-04	2.02E-05	3.45E+02	-6.24E+02	5.71E+02	-7.54E+01	4.95E-01
660	6.17E-04	6.16E-04	3.17E-04	6.17E-04	2.32E-04	2.02E-05	3.46E+02	-6.24E+02	5.71E+02	-7.54E+01	4.95E-01
690	6.19E-04	6.17E-04	3.19E-04	6.19E-04	2.32E-04	2.02E-05	3.46E+02	-6.24E+02	5.71E+02	-7.54E+01	4.96E-01
720	6.20E-04	6.19E-04	3.20E-04	6.19E-04	2.33E-04	2.02E-05	3.46E+02	-6.24E+02	5.71E+02	-7.54E+01	4.96E-01



## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00065)

Shrinkage strain =  $t / (t + 35) * A$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 6.50E-04      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      E (psi) = 4.00E+06      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      fy (psi) = 6.00E+04      Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain (ε <sub>t</sub> )	Strain Slop (tan θ)	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	Pre-slab	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top	CIP_bot		CIP_Top
	From 0 days (t0-t)	CIP-deck	After Composite (t1-t)	CIP-deck			slab_bot	slab_Top	CIP_bot		CIP_Top
30	3.00E-04	0.00E+00	1.11E-04	3.00E-04	5.93E-05	1.23E-05	-3.87E+02	2.05E+02	3.71E+02	-2.39E+01	3.82E-01
60	4.11E-04	3.00E-04	1.68E-04	4.11E-04	1.02E-04	1.58E-05	-4.96E+02	2.62E+02	4.75E+02	-3.06E+01	4.88E-01
90	4.68E-04	4.11E-04	2.03E-04	4.68E-04	1.32E-04	1.72E-05	-5.41E+02	2.86E+02	5.18E+02	-3.34E+01	5.33E-01
120	5.03E-04	4.68E-04	2.27E-04	5.03E-04	1.52E-04	1.80E-05	-5.64E+02	2.99E+02	5.40E+02	-3.49E+01	5.56E-01
150	5.27E-04	5.03E-04	2.44E-04	5.27E-04	1.68E-04	1.84E-05	-5.78E+02	3.06E+02	5.53E+02	-3.57E+01	5.70E-01
180	5.44E-04	5.27E-04	2.57E-04	5.44E-04	1.80E-04	1.87E-05	-5.86E+02	3.10E+02	5.62E+02	-3.62E+01	5.78E-01
210	5.57E-04	5.44E-04	2.67E-04	5.57E-04	1.89E-04	1.89E-05	-5.92E+02	3.13E+02	5.67E+02	-3.66E+01	5.84E-01
240	5.67E-04	5.57E-04	2.75E-04	5.67E-04	1.97E-04	1.90E-05	-5.96E+02	3.16E+02	5.71E+02	-3.68E+01	5.88E-01
270	5.75E-04	5.67E-04	2.82E-04	5.75E-04	2.03E-04	1.91E-05	-5.99E+02	3.17E+02	5.74E+02	-3.70E+01	5.91E-01
300	5.82E-04	5.75E-04	2.88E-04	5.82E-04	2.08E-04	1.92E-05	-6.02E+02	3.18E+02	5.76E+02	-3.72E+01	5.93E-01
330	5.88E-04	5.82E-04	2.92E-04	5.88E-04	2.13E-04	1.92E-05	-6.03E+02	3.19E+02	5.78E+02	-3.73E+01	5.95E-01
360	5.92E-04	5.88E-04	2.96E-04	5.92E-04	2.16E-04	1.93E-05	-6.05E+02	3.20E+02	5.79E+02	-3.74E+01	5.96E-01
390	5.96E-04	5.92E-04	3.00E-04	5.96E-04	2.20E-04	1.93E-05	-6.07E+02	3.21E+02	5.80E+02	-3.74E+01	5.97E-01
420	6.00E-04	5.96E-04	3.03E-04	6.00E-04	2.23E-04	1.93E-05	-6.07E+02	3.21E+02	5.81E+02	-3.75E+01	5.98E-01
450	6.03E-04	6.00E-04	3.06E-04	6.03E-04	2.25E-04	1.94E-05	-6.07E+02	3.21E+02	5.82E+02	-3.75E+01	5.98E-01
480	6.06E-04	6.03E-04	3.08E-04	6.06E-04	2.28E-04	1.94E-05	-6.08E+02	3.22E+02	5.82E+02	-3.76E+01	5.99E-01
510	6.08E-04	6.06E-04	3.10E-04	6.08E-04	2.30E-04	1.94E-05	-6.09E+02	3.22E+02	5.83E+02	-3.76E+01	6.00E-01
540	6.10E-04	6.08E-04	3.12E-04	6.10E-04	2.32E-04	1.94E-05	-6.09E+02	3.22E+02	5.83E+02	-3.76E+01	6.00E-01
570	6.12E-04	6.10E-04	3.14E-04	6.12E-04	2.34E-04	1.94E-05	-6.09E+02	3.22E+02	5.84E+02	-3.76E+01	6.00E-01
600	6.14E-04	6.12E-04	3.16E-04	6.14E-04	2.35E-04	1.94E-05	-6.10E+02	3.23E+02	5.84E+02	-3.77E+01	6.01E-01
630	6.16E-04	6.14E-04	3.17E-04	6.16E-04	2.37E-04	1.94E-05	-6.10E+02	3.23E+02	5.84E+02	-3.77E+01	6.01E-01
660	6.17E-04	6.16E-04	3.19E-04	6.17E-04	2.38E-04	1.94E-05	-6.10E+02	3.23E+02	5.84E+02	-3.77E+01	6.01E-01
690	6.19E-04	6.17E-04	3.20E-04	6.19E-04	2.39E-04	1.94E-05	-6.10E+02	3.23E+02	5.85E+02	-3.77E+01	6.02E-01
720	6.20E-04	6.19E-04	3.20E-04	6.19E-04	2.39E-04	1.94E-05	-6.10E+02	3.23E+02	5.85E+02	-3.77E+01	6.02E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00065)

Shrinkage strain =  $t/(t+35)*A$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 6.50E-04      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain From 0 days (10 <sup>-4</sup> )		Free Shrinkage Strain After Composite (t1-t)		Strain (ε <sub>t</sub> )	Strain Slop (tan θ)	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	Pre-slab	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top	CIP_bot		CIP_Top
30	3.00E-04	0.00E+00	1.11E-04	3.00E-04	6.32E-05	1.19E-05	1.89E+02	-3.79E+02	3.79E+02	0.00E+00	4.55E-01
60	4.11E-04	3.00E-04	1.68E-04	4.11E-04	1.07E-04	1.52E-05	2.43E+02	-4.85E+02	4.85E+02	-2.17E-13	5.82E-01
90	4.68E-04	4.11E-04	2.03E-04	4.68E-04	1.37E-04	1.65E-05	2.65E+02	-5.30E+02	5.30E+02	0.00E+00	6.35E-01
120	5.03E-04	5.03E-04	2.27E-04	5.03E-04	1.58E-04	1.73E-05	2.76E+02	-5.52E+02	5.52E+02	0.00E+00	6.63E-01
150	5.27E-04	5.27E-04	2.44E-04	5.27E-04	1.73E-04	1.77E-05	2.83E+02	-5.66E+02	5.66E+02	0.00E+00	6.79E-01
180	5.44E-04	5.44E-04	2.57E-04	5.44E-04	1.85E-04	1.79E-05	2.87E+02	-5.74E+02	5.74E+02	-4.34E-13	6.89E-01
210	5.57E-04	5.57E-04	2.67E-04	5.57E-04	1.95E-04	1.81E-05	2.90E+02	-5.80E+02	5.80E+02	0.00E+00	6.96E-01
240	5.75E-04	5.75E-04	2.75E-04	5.67E-04	2.02E-04	1.82E-05	2.92E+02	-5.84E+02	5.84E+02	0.00E+00	7.00E-01
300	5.82E-04	5.75E-04	2.82E-04	5.75E-04	2.09E-04	1.83E-05	2.93E+02	-5.87E+02	5.87E+02	4.34E-13	7.04E-01
330	5.88E-04	5.82E-04	2.88E-04	5.82E-04	2.14E-04	1.84E-05	2.94E+02	-5.89E+02	5.89E+02	0.00E+00	7.07E-01
360	5.92E-04	5.88E-04	2.92E-04	5.88E-04	2.19E-04	1.85E-05	2.95E+02	-5.91E+02	5.91E+02	-4.34E-13	7.09E-01
390	5.96E-04	5.92E-04	2.96E-04	5.92E-04	2.22E-04	1.85E-05	2.96E+02	-5.92E+02	5.92E+02	-4.34E-13	7.10E-01
420	6.00E-04	5.96E-04	3.00E-04	5.96E-04	2.26E-04	1.85E-05	2.96E+02	-5.93E+02	5.93E+02	0.00E+00	7.12E-01
450	6.03E-04	6.00E-04	3.03E-04	6.00E-04	2.29E-04	1.86E-05	2.97E+02	-5.94E+02	5.94E+02	0.00E+00	7.13E-01
480	6.06E-04	6.03E-04	3.06E-04	6.03E-04	2.32E-04	1.86E-05	2.97E+02	-5.95E+02	5.95E+02	0.00E+00	7.13E-01
510	6.08E-04	6.06E-04	3.08E-04	6.06E-04	2.34E-04	1.86E-05	2.98E+02	-5.95E+02	5.95E+02	0.00E+00	7.14E-01
540	6.10E-04	6.08E-04	3.10E-04	6.08E-04	2.36E-04	1.86E-05	2.98E+02	-5.96E+02	5.96E+02	0.00E+00	7.15E-01
570	6.12E-04	6.10E-04	3.12E-04	6.10E-04	2.38E-04	1.86E-05	2.98E+02	-5.96E+02	5.96E+02	4.34E-13	7.15E-01
600	6.14E-04	6.12E-04	3.14E-04	6.12E-04	2.40E-04	1.86E-05	2.98E+02	-5.96E+02	5.96E+02	0.00E+00	7.16E-01
630	6.16E-04	6.14E-04	3.16E-04	6.14E-04	2.41E-04	1.86E-05	2.98E+02	-5.97E+02	5.97E+02	0.00E+00	7.16E-01
660	6.17E-04	6.16E-04	3.17E-04	6.16E-04	2.43E-04	1.87E-05	2.99E+02	-5.97E+02	5.97E+02	0.00E+00	7.16E-01
690	6.19E-04	6.17E-04	3.19E-04	6.17E-04	2.44E-04	1.87E-05	2.99E+02	-5.97E+02	5.97E+02	-4.34E-13	7.17E-01
720	6.20E-04	6.19E-04	3.20E-04	6.19E-04	2.45E-04	1.87E-05	2.99E+02	-5.98E+02	5.98E+02	0.00E+00	7.17E-01

Curing Coefficient A = 0.00070  
CIP depth 6 to 12 inches

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00070)

Shrinkage strain =  $t/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = **7.00E-04**  
 B (days) = **3.00E+01**  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = **0.00E+00**  
 Top of slab (in.) = **1.20E+01**  
 Bottom of CIP (in.) = **1.20E+01**  
 Top of CIP (in.) = **2.00E+01**

h\_CIP (in.) = **6.00E+00**  
 h\_slab (in.) = **1.20E+01**  
 E (psi) = **4.00E+06**  
 fy (psi) = **6.00E+04**

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)			
	From 0 days (t0-t)		Pre-slab				CIP-deck	CIP-deck	slab_bot		slab_Top	CIP_bot	CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck									
30	3.23E-04	0.00E+00	1.19E-04	3.23E-04	5.10E-05	1.51E-05	2.72E+02	-4.53E+02	3.63E+02	-1.21E+02	1.45E-01		
60	4.42E-04	3.23E-04	1.81E-04	4.42E-04	9.39E-05	1.93E-05	3.48E+02	-5.80E+02	4.64E+02	-1.56E+02	1.86E-01		
90	5.04E-04	4.42E-04	2.19E-04	5.04E-04	1.24E-04	2.11E-05	3.80E+02	-6.34E+02	5.07E+02	-1.69E+02	2.03E-01		
120	5.42E-04	5.04E-04	2.44E-04	5.42E-04	1.45E-04	2.20E-05	3.97E+02	-6.81E+02	5.29E+02	-1.76E+02	2.12E-01		
150	5.68E-04	5.42E-04	2.63E-04	5.68E-04	1.61E-04	2.26E-05	4.06E+02	-6.77E+02	5.42E+02	-1.81E+02	2.17E-01		
180	5.86E-04	5.68E-04	2.77E-04	5.86E-04	1.74E-04	2.29E-05	4.12E+02	-6.87E+02	5.50E+02	-1.83E+02	2.20E-01		
210	6.00E-04	5.86E-04	2.88E-04	6.00E-04	1.84E-04	2.31E-05	4.16E+02	-6.94E+02	5.56E+02	-1.85E+02	2.22E-01		
240	6.11E-04	6.00E-04	2.97E-04	6.11E-04	1.92E-04	2.33E-05	4.19E+02	-6.98E+02	5.59E+02	-1.86E+02	2.24E-01		
270	6.20E-04	6.11E-04	3.04E-04	6.20E-04	1.98E-04	2.34E-05	4.21E+02	-7.02E+02	5.62E+02	-1.87E+02	2.25E-01		
300	6.27E-04	6.20E-04	3.10E-04	6.27E-04	2.04E-04	2.35E-05	4.23E+02	-7.05E+02	5.64E+02	-1.88E+02	2.25E-01		
330	6.33E-04	6.27E-04	3.15E-04	6.33E-04	2.09E-04	2.36E-05	4.24E+02	-7.07E+02	5.65E+02	-1.88E+02	2.26E-01		
360	6.38E-04	6.33E-04	3.19E-04	6.38E-04	2.13E-04	2.36E-05	4.25E+02	-7.08E+02	5.67E+02	-1.89E+02	2.27E-01		
390	6.42E-04	6.38E-04	3.23E-04	6.42E-04	2.17E-04	2.37E-05	4.26E+02	-7.10E+02	5.68E+02	-1.89E+02	2.27E-01		
420	6.46E-04	6.42E-04	3.26E-04	6.46E-04	2.20E-04	2.37E-05	4.26E+02	-7.11E+02	5.68E+02	-1.89E+02	2.27E-01		
450	6.49E-04	6.46E-04	3.29E-04	6.49E-04	2.23E-04	2.37E-05	4.27E+02	-7.11E+02	5.69E+02	-1.90E+02	2.28E-01		
480	6.52E-04	6.49E-04	3.32E-04	6.52E-04	2.25E-04	2.37E-05	4.27E+02	-7.12E+02	5.70E+02	-1.90E+02	2.28E-01		
510	6.55E-04	6.52E-04	3.34E-04	6.55E-04	2.27E-04	2.38E-05	4.28E+02	-7.13E+02	5.70E+02	-1.90E+02	2.28E-01		
540	6.57E-04	6.55E-04	3.36E-04	6.57E-04	2.29E-04	2.38E-05	4.28E+02	-7.13E+02	5.71E+02	-1.90E+02	2.28E-01		
570	6.60E-04	6.57E-04	3.38E-04	6.60E-04	2.31E-04	2.38E-05	4.28E+02	-7.14E+02	5.71E+02	-1.90E+02	2.28E-01		
600	6.61E-04	6.60E-04	3.40E-04	6.61E-04	2.33E-04	2.38E-05	4.28E+02	-7.14E+02	5.71E+02	-1.90E+02	2.28E-01		
630	6.63E-04	6.61E-04	3.42E-04	6.63E-04	2.35E-04	2.38E-05	4.29E+02	-7.14E+02	5.72E+02	-1.91E+02	2.29E-01		
660	6.65E-04	6.63E-04	3.43E-04	6.65E-04	2.36E-04	2.38E-05	4.29E+02	-7.15E+02	5.72E+02	-1.91E+02	2.29E-01		
690	6.66E-04	6.65E-04	3.44E-04	6.66E-04	2.37E-04	2.38E-05	4.29E+02	-7.15E+02	5.72E+02	-1.91E+02	2.29E-01		
720	6.68E-04	6.66E-04	3.44E-04	6.68E-04	2.37E-04	2.38E-05	4.29E+02	-7.15E+02	5.72E+02	-1.91E+02	2.29E-01		

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00070)

Shrinkage strain =  $t/(t+35) \times A$       Distance from Bottom      0.00E+00  
 Slab was cast B days before CIP deck      Bottom of slab (in.) =      1.20E+01  
 A = 7.00E-04      Top of slab (in.) =      1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) =      2.00E+01  
 t start from casting of slab      Top of CIP (in.) =      2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain (ε <sub>t</sub> )	Strain Slop (tan θ)	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	Pre-slab	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_top	CIP_bot		CIP_top
30	3.23E-04	0.00E+00	1.19E-04	3.23E-04	5.18E-05	1.50E-05	2.69E+02	-4.51E+02	3.66E+02	-1.14E+02	1.76E-01
60	4.42E-04	3.23E-04	1.81E-04	4.42E-04	9.48E-05	1.92E-05	3.44E+02	-5.77E+02	4.68E+02	-1.46E+02	2.25E-01
90	5.04E-04	4.42E-04	2.19E-04	5.04E-04	1.25E-04	2.10E-05	3.76E+02	-6.30E+02	5.11E+02	-1.60E+02	2.46E-01
120	5.42E-04	5.04E-04	2.44E-04	5.42E-04	1.46E-04	2.19E-05	3.92E+02	-6.57E+02	5.33E+02	-1.67E+02	2.56E-01
150	5.68E-04	5.42E-04	2.63E-04	5.68E-04	1.63E-04	2.24E-05	4.02E+02	-6.73E+02	5.46E+02	-1.71E+02	2.63E-01
180	5.86E-04	5.68E-04	2.77E-04	5.86E-04	1.75E-04	2.27E-05	4.08E+02	-6.83E+02	5.54E+02	-1.73E+02	2.67E-01
210	6.00E-04	5.86E-04	2.88E-04	6.00E-04	1.85E-04	2.29E-05	4.12E+02	-6.89E+02	5.59E+02	-1.75E+02	2.69E-01
240	6.11E-04	6.00E-04	2.97E-04	6.11E-04	1.93E-04	2.31E-05	4.14E+02	-6.94E+02	5.63E+02	-1.76E+02	2.71E-01
270	6.20E-04	6.11E-04	3.10E-04	6.20E-04	2.00E-04	2.32E-05	4.17E+02	-6.98E+02	5.66E+02	-1.77E+02	2.72E-01
300	6.27E-04	6.20E-04	3.04E-04	6.27E-04	2.05E-04	2.33E-05	4.18E+02	-7.00E+02	5.68E+02	-1.78E+02	2.73E-01
330	6.33E-04	6.27E-04	3.15E-04	6.33E-04	2.10E-04	2.34E-05	4.19E+02	-7.02E+02	5.70E+02	-1.78E+02	2.74E-01
360	6.38E-04	6.33E-04	3.19E-04	6.38E-04	2.14E-04	2.34E-05	4.20E+02	-7.04E+02	5.71E+02	-1.78E+02	2.75E-01
390	6.42E-04	6.38E-04	3.23E-04	6.42E-04	2.18E-04	2.35E-05	4.21E+02	-7.05E+02	5.72E+02	-1.79E+02	2.75E-01
420	6.46E-04	6.42E-04	3.26E-04	6.46E-04	2.21E-04	2.35E-05	4.22E+02	-7.06E+02	5.73E+02	-1.79E+02	2.76E-01
450	6.49E-04	6.46E-04	3.29E-04	6.49E-04	2.24E-04	2.35E-05	4.22E+02	-7.07E+02	5.74E+02	-1.79E+02	2.76E-01
480	6.52E-04	6.49E-04	3.29E-04	6.52E-04	2.26E-04	2.35E-05	4.23E+02	-7.08E+02	5.74E+02	-1.79E+02	2.76E-01
510	6.55E-04	6.52E-04	3.32E-04	6.55E-04	2.29E-04	2.35E-05	4.23E+02	-7.09E+02	5.75E+02	-1.80E+02	2.77E-01
540	6.57E-04	6.55E-04	3.34E-04	6.57E-04	2.31E-04	2.36E-05	4.23E+02	-7.09E+02	5.75E+02	-1.80E+02	2.77E-01
570	6.60E-04	6.57E-04	3.36E-04	6.60E-04	2.32E-04	2.36E-05	4.23E+02	-7.09E+02	5.75E+02	-1.80E+02	2.77E-01
600	6.61E-04	6.60E-04	3.40E-04	6.61E-04	2.34E-04	2.36E-05	4.24E+02	-7.10E+02	5.76E+02	-1.80E+02	2.77E-01
630	6.63E-04	6.61E-04	3.42E-04	6.63E-04	2.36E-04	2.36E-05	4.24E+02	-7.10E+02	5.76E+02	-1.80E+02	2.77E-01
660	6.65E-04	6.63E-04	3.43E-04	6.65E-04	2.37E-04	2.36E-05	4.24E+02	-7.10E+02	5.76E+02	-1.80E+02	2.77E-01
690	6.66E-04	6.65E-04	3.43E-04	6.66E-04	2.37E-04	2.36E-05	4.24E+02	-7.11E+02	5.76E+02	-1.80E+02	2.77E-01
720	6.68E-04	6.66E-04	3.44E-04	6.68E-04	2.38E-04	2.36E-05	4.24E+02	-7.11E+02	5.76E+02	-1.80E+02	2.77E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00070)

Shrinkage strain =  $t/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = 7.00E-04  
 B (days) = 3.00E+01  
 t start from casting of slab  
 h\_CIP (in.) = 8.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04  
 Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Strain ( $\epsilon_t$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)		Reinf. Req. (sq. in. per ft.)		
	From 0 days (t0 - t)				slab_bot	slab_Top		CIP_bot	CIP_Top
	Pre-slab	CIP-deck							
30	3.23E-04	0.00E+00	5.37E-05	1.47E-05	2.61E+02	3.72E+02	2.19E-01		
60	4.42E-04	3.23E-04	9.73E-05	1.88E-05	3.34E+02	4.76E+02	2.81E-01		
90	5.04E-04	4.42E-04	1.28E-04	2.05E-05	3.65E+02	5.20E+02	3.07E-01		
120	5.42E-04	5.04E-04	1.49E-04	2.14E-05	3.81E+02	5.43E+02	3.20E-01		
150	5.68E-04	5.42E-04	1.65E-04	2.19E-05	3.90E+02	5.56E+02	3.28E-01		
180	5.86E-04	5.68E-04	1.78E-04	2.23E-05	3.96E+02	5.64E+02	3.32E-01		
210	6.00E-04	5.86E-04	1.88E-04	2.25E-05	4.00E+02	5.69E+02	3.36E-01		
240	6.11E-04	6.00E-04	1.96E-04	2.26E-05	4.02E+02	5.73E+02	3.38E-01		
270	6.20E-04	6.11E-04	2.03E-04	2.27E-05	4.04E+02	5.76E+02	3.40E-01		
300	6.27E-04	6.20E-04	2.08E-04	2.28E-05	4.06E+02	5.78E+02	3.41E-01		
330	6.33E-04	6.27E-04	2.13E-04	2.29E-05	4.07E+02	5.80E+02	3.42E-01		
360	6.38E-04	6.33E-04	2.17E-04	2.29E-05	4.08E+02	5.81E+02	3.43E-01		
390	6.42E-04	6.38E-04	2.21E-04	2.30E-05	4.09E+02	5.82E+02	3.44E-01		
420	6.46E-04	6.42E-04	2.24E-04	2.30E-05	4.09E+02	5.83E+02	3.44E-01		
450	6.49E-04	6.46E-04	2.27E-04	2.30E-05	4.10E+02	5.84E+02	3.44E-01		
480	6.52E-04	6.49E-04	2.29E-04	2.31E-05	4.10E+02	5.85E+02	3.45E-01		
510	6.55E-04	6.52E-04	2.32E-04	2.31E-05	4.11E+02	5.85E+02	3.45E-01		
540	6.57E-04	6.55E-04	2.34E-04	2.31E-05	4.11E+02	5.85E+02	3.45E-01		
570	6.60E-04	6.57E-04	2.36E-04	2.31E-05	4.11E+02	5.86E+02	3.45E-01		
600	6.61E-04	6.60E-04	2.37E-04	2.31E-05	4.11E+02	5.86E+02	3.45E-01		
630	6.63E-04	6.61E-04	2.39E-04	2.31E-05	4.12E+02	5.86E+02	3.46E-01		
660	6.65E-04	6.63E-04	2.40E-04	2.32E-05	4.12E+02	5.87E+02	3.46E-01		
690	6.66E-04	6.65E-04	2.42E-04	2.32E-05	4.12E+02	5.87E+02	3.46E-01		
720	6.68E-04	6.66E-04	2.42E-04	2.32E-05	4.12E+02	5.87E+02	3.46E-01		

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00070)

Shrinkage strain =  $\frac{t}{t+(35)^A}$  Distance from Bottom  
 Slab was cast B days before CIP deck Bottom of slab (in.) = 0.00E+00  
 A = 7.00E-04 Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01 Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_r$ )	Strain Slip (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.23E-04	0.00E+00	1.19E-04	3.23E-04	5.66E-05	1.43E-05	2.50E+02	-4.35E+02	3.81E+02	-7.61E+01	2.74E-01
60	4.42E-04	3.23E-04	1.81E-04	4.42E-04	1.01E-04	1.83E-05	3.20E+02	-5.57E+02	4.87E+02	-9.75E+01	3.51E-01
90	5.04E-04	4.42E-04	2.19E-04	5.04E-04	1.32E-04	2.00E-05	3.49E+02	-6.09E+02	5.32E+02	-1.06E+02	3.83E-01
120	5.42E-04	5.04E-04	2.44E-04	5.42E-04	1.53E-04	2.08E-05	3.64E+02	-6.35E+02	5.55E+02	-1.11E+02	4.00E-01
150	5.68E-04	5.42E-04	2.63E-04	5.68E-04	1.70E-04	2.13E-05	3.73E+02	-6.50E+02	5.68E+02	-1.14E+02	4.09E-01
180	5.86E-04	5.68E-04	2.77E-04	5.86E-04	1.82E-04	2.16E-05	3.79E+02	-6.60E+02	5.77E+02	-1.15E+02	4.15E-01
210	6.00E-04	5.86E-04	2.88E-04	6.00E-04	1.92E-04	2.18E-05	3.82E+02	-6.66E+02	5.82E+02	-1.16E+02	4.19E-01
240	6.11E-04	6.00E-04	2.97E-04	6.11E-04	2.00E-04	2.20E-05	3.85E+02	-6.71E+02	5.86E+02	-1.17E+02	4.22E-01
270	6.20E-04	6.11E-04	3.04E-04	6.20E-04	2.07E-04	2.21E-05	3.87E+02	-6.74E+02	5.89E+02	-1.18E+02	4.24E-01
300	6.27E-04	6.20E-04	3.10E-04	6.27E-04	2.13E-04	2.22E-05	3.88E+02	-6.77E+02	5.92E+02	-1.18E+02	4.26E-01
330	6.33E-04	6.27E-04	3.15E-04	6.33E-04	2.18E-04	2.22E-05	3.89E+02	-6.79E+02	5.93E+02	-1.19E+02	4.27E-01
360	6.38E-04	6.33E-04	3.19E-04	6.38E-04	2.22E-04	2.23E-05	3.90E+02	-6.80E+02	5.95E+02	-1.19E+02	4.28E-01
390	6.42E-04	6.38E-04	3.23E-04	6.42E-04	2.25E-04	2.23E-05	3.91E+02	-6.81E+02	5.96E+02	-1.19E+02	4.28E-01
420	6.46E-04	6.42E-04	3.26E-04	6.46E-04	2.29E-04	2.24E-05	3.92E+02	-6.82E+02	5.97E+02	-1.19E+02	4.30E-01
450	6.49E-04	6.46E-04	3.29E-04	6.49E-04	2.31E-04	2.24E-05	3.92E+02	-6.83E+02	5.97E+02	-1.19E+02	4.30E-01
480	6.52E-04	6.49E-04	3.32E-04	6.52E-04	2.34E-04	2.24E-05	3.92E+02	-6.84E+02	5.98E+02	-1.20E+02	4.31E-01
510	6.55E-04	6.52E-04	3.34E-04	6.55E-04	2.36E-04	2.24E-05	3.93E+02	-6.85E+02	5.98E+02	-1.20E+02	4.31E-01
540	6.57E-04	6.55E-04	3.36E-04	6.57E-04	2.38E-04	2.25E-05	3.93E+02	-6.85E+02	5.99E+02	-1.20E+02	4.31E-01
570	6.60E-04	6.57E-04	3.38E-04	6.60E-04	2.40E-04	2.25E-05	3.93E+02	-6.86E+02	5.99E+02	-1.20E+02	4.31E-01
600	6.61E-04	6.60E-04	3.40E-04	6.61E-04	2.42E-04	2.25E-05	3.93E+02	-6.86E+02	6.00E+02	-1.20E+02	4.32E-01
630	6.63E-04	6.61E-04	3.42E-04	6.63E-04	2.43E-04	2.25E-05	3.94E+02	-6.86E+02	6.00E+02	-1.20E+02	4.32E-01
660	6.65E-04	6.63E-04	3.43E-04	6.65E-04	2.45E-04	2.25E-05	3.94E+02	-6.86E+02	6.00E+02	-1.20E+02	4.32E-01
690	6.66E-04	6.65E-04	3.44E-04	6.66E-04	2.46E-04	2.25E-05	3.94E+02	-6.87E+02	6.00E+02	-1.20E+02	4.32E-01
720	6.68E-04	6.66E-04	3.44E-04	6.68E-04	2.46E-04	2.25E-05	3.94E+02	-6.87E+02	6.00E+02	-1.20E+02	4.32E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A =0.00070)

Shrinkage strain =  $\epsilon(t+35)^A$   
 Slab was cast B days before CIP deck  
 A = 7.00E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 1.00E+01  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain		Strain ( $\epsilon$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t-0)		After Composite (t1-t)				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.23E-04	0.00E+00	1.19E-04	3.23E-04	6.00E-05	1.38E-05	2.36E+02	-4.26E+02	3.90E+02	-5.15E+01	3.38E-01
60	4.42E-04	4.42E-04	1.81E-04	4.42E-04	1.05E-04	1.77E-05	3.02E+02	-5.46E+02	4.99E+02	-6.59E+01	4.33E-01
90	5.04E-04	5.04E-04	2.19E-04	5.04E-04	1.36E-04	1.93E-05	3.30E+02	-5.96E+02	5.48E+02	-7.20E+01	4.73E-01
120	5.42E-04	5.42E-04	2.44E-04	5.42E-04	1.58E-04	2.01E-05	3.44E+02	-6.21E+02	5.69E+02	-7.51E+01	4.93E-01
150	5.68E-04	5.68E-04	2.63E-04	5.68E-04	1.75E-04	2.08E-05	3.52E+02	-6.36E+02	5.82E+02	-7.69E+01	5.05E-01
180	5.86E-04	5.86E-04	2.77E-04	5.86E-04	1.88E-04	2.09E-05	3.58E+02	-6.46E+02	5.91E+02	-7.80E+01	5.13E-01
210	6.00E-04	6.00E-04	2.88E-04	6.00E-04	1.98E-04	2.11E-05	3.61E+02	-6.52E+02	5.97E+02	-7.88E+01	5.18E-01
240	6.11E-04	6.11E-04	2.97E-04	6.11E-04	2.06E-04	2.13E-05	3.64E+02	-6.56E+02	6.01E+02	-7.93E+01	5.21E-01
270	6.20E-04	6.20E-04	3.04E-04	6.20E-04	2.12E-04	2.14E-05	3.65E+02	-6.60E+02	6.04E+02	-7.97E+01	5.24E-01
300	6.33E-04	6.27E-04	3.10E-04	6.27E-04	2.18E-04	2.14E-05	3.67E+02	-6.62E+02	6.06E+02	-8.00E+01	5.26E-01
330	6.38E-04	6.33E-04	3.15E-04	6.33E-04	2.23E-04	2.15E-05	3.68E+02	-6.64E+02	6.08E+02	-8.03E+01	5.27E-01
360	6.42E-04	6.38E-04	3.19E-04	6.38E-04	2.27E-04	2.15E-05	3.69E+02	-6.66E+02	6.09E+02	-8.05E+01	5.29E-01
390	6.46E-04	6.42E-04	3.23E-04	6.42E-04	2.31E-04	2.16E-05	3.69E+02	-6.67E+02	6.10E+02	-8.06E+01	5.30E-01
420	6.49E-04	6.46E-04	3.26E-04	6.46E-04	2.34E-04	2.16E-05	3.70E+02	-6.68E+02	6.11E+02	-8.07E+01	5.30E-01
450	6.52E-04	6.49E-04	3.29E-04	6.49E-04	2.37E-04	2.16E-05	3.70E+02	-6.69E+02	6.12E+02	-8.08E+01	5.31E-01
480	6.55E-04	6.52E-04	3.32E-04	6.52E-04	2.39E-04	2.17E-05	3.71E+02	-6.69E+02	6.13E+02	-8.09E+01	5.32E-01
510	6.57E-04	6.55E-04	3.34E-04	6.55E-04	2.42E-04	2.17E-05	3.71E+02	-6.70E+02	6.13E+02	-8.10E+01	5.32E-01
540	6.60E-04	6.57E-04	3.36E-04	6.57E-04	2.44E-04	2.17E-05	3.72E+02	-6.70E+02	6.13E+02	-8.10E+01	5.32E-01
570	6.61E-04	6.60E-04	3.38E-04	6.60E-04	2.45E-04	2.17E-05	3.72E+02	-6.71E+02	6.14E+02	-8.11E+01	5.33E-01
600	6.63E-04	6.61E-04	3.40E-04	6.61E-04	2.47E-04	2.17E-05	3.72E+02	-6.71E+02	6.14E+02	-8.11E+01	5.33E-01
630	6.65E-04	6.63E-04	3.42E-04	6.63E-04	2.49E-04	2.17E-05	3.72E+02	-6.72E+02	6.15E+02	-8.12E+01	5.33E-01
660	6.66E-04	6.65E-04	3.43E-04	6.65E-04	2.50E-04	2.17E-05	3.72E+02	-6.72E+02	6.15E+02	-8.12E+01	5.34E-01
690	6.68E-04	6.66E-04	3.44E-04	6.66E-04	2.51E-04	2.18E-05	3.72E+02	-6.72E+02	6.15E+02	-8.12E+01	5.34E-01
720	6.68E-04	6.66E-04	3.44E-04	6.66E-04	2.51E-04	2.18E-05	3.72E+02	-6.72E+02	6.15E+02	-8.12E+01	5.34E-01



## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A =0.00070)

Shrinkage strain =  $t/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = 7.00E-04  
 B (days) = 3.00E+01  
 t start from casting of slab  
 Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 1.10E+01  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)		Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top		CIP_bot
30	3.23E-04	0.00E+00	1.19E-04	3.29E-04	6.99E-05	1.33E-05	-4.17E+02	3.99E+02	-2.58E+01	4.11E-01
60	4.42E-04	3.23E-04	1.81E-04	4.42E-04	1.10E-04	1.70E-05	-5.34E+02	5.11E+02	-3.30E+01	5.26E-01
90	5.04E-04	4.42E-04	2.19E-04	5.04E-04	1.42E-04	1.86E-05	-5.83E+02	5.58E+02	-3.60E+01	5.74E-01
120	5.42E-04	5.04E-04	2.44E-04	5.42E-04	1.64E-04	1.94E-05	-6.08E+02	5.82E+02	-3.76E+01	5.99E-01
150	5.68E-04	5.42E-04	2.63E-04	5.68E-04	1.81E-04	1.98E-05	-6.22E+02	5.96E+02	-3.85E+01	6.13E-01
180	5.86E-04	5.68E-04	2.77E-04	5.86E-04	1.93E-04	2.01E-05	-6.32E+02	6.05E+02	-3.90E+01	6.22E-01
210	6.00E-04	6.00E-04	2.88E-04	6.00E-04	2.03E-04	2.03E-05	-6.38E+02	6.11E+02	-3.94E+01	6.29E-01
240	6.11E-04	6.11E-04	2.97E-04	6.11E-04	2.12E-04	2.05E-05	-6.42E+02	6.15E+02	-3.97E+01	6.33E-01
270	6.20E-04	6.20E-04	3.04E-04	6.20E-04	2.18E-04	2.06E-05	-6.45E+02	6.18E+02	-3.99E+01	6.36E-01
300	6.27E-04	6.27E-04	3.10E-04	6.27E-04	2.24E-04	2.06E-05	-6.48E+02	6.20E+02	-4.00E+01	6.38E-01
330	6.33E-04	6.33E-04	3.15E-04	6.33E-04	2.29E-04	2.07E-05	-6.50E+02	6.22E+02	-4.01E+01	6.40E-01
360	6.38E-04	6.38E-04	3.19E-04	6.38E-04	2.33E-04	2.07E-05	-6.51E+02	6.24E+02	-4.02E+01	6.42E-01
390	6.42E-04	6.42E-04	3.23E-04	6.42E-04	2.37E-04	2.08E-05	-6.52E+02	6.25E+02	-4.03E+01	6.43E-01
420	6.46E-04	6.46E-04	3.26E-04	6.46E-04	2.40E-04	2.08E-05	-6.53E+02	6.26E+02	-4.04E+01	6.44E-01
450	6.49E-04	6.49E-04	3.29E-04	6.49E-04	2.43E-04	2.08E-05	-6.54E+02	6.26E+02	-4.04E+01	6.45E-01
480	6.52E-04	6.52E-04	3.32E-04	6.52E-04	2.45E-04	2.09E-05	-6.55E+02	6.27E+02	-4.05E+01	6.45E-01
510	6.55E-04	6.55E-04	3.34E-04	6.55E-04	2.48E-04	2.09E-05	-6.55E+02	6.28E+02	-4.05E+01	6.46E-01
540	6.57E-04	6.57E-04	3.36E-04	6.57E-04	2.50E-04	2.09E-05	-6.56E+02	6.28E+02	-4.05E+01	6.46E-01
570	6.60E-04	6.60E-04	3.38E-04	6.60E-04	2.52E-04	2.09E-05	-6.56E+02	6.28E+02	-4.05E+01	6.47E-01
600	6.61E-04	6.61E-04	3.40E-04	6.61E-04	2.53E-04	2.09E-05	-6.57E+02	6.29E+02	-4.06E+01	6.47E-01
630	6.63E-04	6.63E-04	3.42E-04	6.63E-04	2.55E-04	2.09E-05	-6.57E+02	6.29E+02	-4.06E+01	6.47E-01
660	6.65E-04	6.65E-04	3.43E-04	6.65E-04	2.56E-04	2.09E-05	-6.57E+02	6.29E+02	-4.06E+01	6.48E-01
690	6.66E-04	6.66E-04	3.43E-04	6.66E-04	2.56E-04	2.09E-05	-6.57E+02	6.29E+02	-4.06E+01	6.48E-01
720	6.68E-04	6.68E-04	3.44E-04	6.68E-04	2.58E-04	2.09E-05	-6.57E+02	6.30E+02	-4.06E+01	6.48E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00070)

Shrinkage strain =  $\frac{1}{t+(35)^2} \times A$  Distance from Bottom  
 Slab was cast B days before CIP deck Bottom of slab (in.) = 0.00E+00  
 A = 7.00E-04 Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01 Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_r$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Relinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.23E-04	0.00E+00	1.19E-04	3.23E-04	6.80E-05	1.28E-05	2.04E+02	-4.08E+02	4.08E+02	2.17E-13	4.90E-01
60	4.42E-04	3.23E-04	1.81E-04	4.42E-04	1.16E-04	1.63E-05	2.61E+02	-5.22E+02	5.22E+02	0.00E+00	6.27E-01
90	5.04E-04	4.42E-04	2.19E-04	5.04E-04	1.48E-04	1.78E-05	2.85E+02	-5.70E+02	5.70E+02	0.00E+00	6.84E-01
120	5.42E-04	5.04E-04	2.44E-04	5.42E-04	1.70E-04	1.86E-05	2.97E+02	-5.95E+02	5.95E+02	0.00E+00	7.14E-01
150	5.68E-04	5.42E-04	2.63E-04	5.68E-04	1.87E-04	1.90E-05	3.05E+02	-6.09E+02	6.09E+02	4.34E-13	7.31E-01
180	5.86E-04	5.68E-04	2.77E-04	5.86E-04	2.00E-04	1.93E-05	3.09E+02	-6.18E+02	6.18E+02	0.00E+00	7.42E-01
210	6.00E-04	6.00E-04	2.88E-04	6.00E-04	2.10E-04	1.95E-05	3.12E+02	-6.24E+02	6.24E+02	0.00E+00	7.49E-01
240	6.11E-04	6.11E-04	2.97E-04	6.11E-04	2.18E-04	1.96E-05	3.14E+02	-6.29E+02	6.29E+02	-4.34E-13	7.54E-01
270	6.20E-04	6.20E-04	3.04E-04	6.20E-04	2.25E-04	1.97E-05	3.16E+02	-6.32E+02	6.32E+02	0.00E+00	7.58E-01
300	6.27E-04	6.27E-04	3.10E-04	6.27E-04	2.31E-04	1.98E-05	3.17E+02	-6.34E+02	6.34E+02	-4.34E-13	7.61E-01
330	6.33E-04	6.33E-04	3.15E-04	6.33E-04	2.35E-04	1.99E-05	3.18E+02	-6.36E+02	6.36E+02	4.34E-13	7.63E-01
360	6.38E-04	6.38E-04	3.19E-04	6.38E-04	2.39E-04	1.99E-05	3.19E+02	-6.37E+02	6.37E+02	0.00E+00	7.65E-01
390	6.42E-04	6.42E-04	3.23E-04	6.42E-04	2.43E-04	2.00E-05	3.20E+02	-6.39E+02	6.39E+02	0.00E+00	7.66E-01
420	6.46E-04	6.46E-04	3.26E-04	6.46E-04	2.46E-04	2.00E-05	3.20E+02	-6.39E+02	6.39E+02	0.00E+00	7.67E-01
450	6.49E-04	6.49E-04	3.29E-04	6.49E-04	2.49E-04	2.00E-05	3.20E+02	-6.40E+02	6.40E+02	0.00E+00	7.68E-01
480	6.52E-04	6.52E-04	3.29E-04	6.52E-04	2.49E-04	2.00E-05	3.20E+02	-6.41E+02	6.41E+02	4.34E-13	7.69E-01
510	6.55E-04	6.55E-04	3.32E-04	6.55E-04	2.52E-04	2.00E-05	3.20E+02	-6.41E+02	6.41E+02	4.34E-13	7.69E-01
540	6.57E-04	6.57E-04	3.34E-04	6.57E-04	2.54E-04	2.00E-05	3.21E+02	-6.42E+02	6.42E+02	4.34E-13	7.70E-01
570	6.60E-04	6.60E-04	3.36E-04	6.60E-04	2.56E-04	2.01E-05	3.21E+02	-6.42E+02	6.42E+02	0.00E+00	7.71E-01
600	6.61E-04	6.61E-04	3.38E-04	6.61E-04	2.58E-04	2.01E-05	3.21E+02	-6.42E+02	6.42E+02	-4.34E-13	7.71E-01
630	6.63E-04	6.63E-04	3.40E-04	6.63E-04	2.60E-04	2.01E-05	3.21E+02	-6.43E+02	6.43E+02	4.34E-13	7.72E-01
660	6.65E-04	6.65E-04	3.42E-04	6.65E-04	2.61E-04	2.01E-05	3.22E+02	-6.43E+02	6.43E+02	0.00E+00	7.72E-01
690	6.66E-04	6.66E-04	3.43E-04	6.66E-04	2.63E-04	2.01E-05	3.22E+02	-6.43E+02	6.43E+02	0.00E+00	7.72E-01
720	6.68E-04	6.68E-04	3.44E-04	6.68E-04	2.64E-04	2.01E-05	3.22E+02	-6.43E+02	6.43E+02	4.34E-13	7.72E-01

Curing Coefficient  $A = 0.00075$

CIP depth 6 to 12 inches

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A =0.00075)

Shrinkage strain =  $\frac{t}{t+(35)^A}$   
 Slab was cast B days before CIP deck  
 A = 7.50E-04  
 B (days) = 3.00E+01  
 t start from casting of slab  
 Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)
	Pre-slab	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top	CIP_bot	
30	3.46E-04	0.00E+00	1.28E-04	3.46E-04	5.47E-05	1.62E-05	2.91E+02	3.89E+02	-1.30E+02	1.55E-01
60	4.74E-04	3.46E-04	1.94E-04	4.74E-04	1.01E-04	2.07E-05	3.73E+02	4.97E+02	-1.66E+02	1.99E-01
90	5.40E-04	4.74E-04	2.34E-04	5.40E-04	1.33E-04	2.26E-05	4.07E+02	5.43E+02	-1.81E+02	2.17E-01
120	6.08E-04	5.40E-04	2.62E-04	5.81E-04	1.56E-04	2.36E-05	4.25E+02	5.67E+02	-1.89E+02	2.27E-01
150	6.28E-04	6.08E-04	2.82E-04	6.08E-04	1.73E-04	2.42E-05	4.35E+02	5.80E+02	-1.93E+02	2.32E-01
180	6.43E-04	6.28E-04	2.97E-04	6.28E-04	1.86E-04	2.45E-05	4.42E+02	5.89E+02	-1.96E+02	2.36E-01
210	6.55E-04	6.43E-04	3.08E-04	6.43E-04	1.97E-04	2.48E-05	4.46E+02	5.95E+02	-1.98E+02	2.38E-01
240	6.64E-04	6.55E-04	3.18E-04	6.55E-04	2.06E-04	2.49E-05	4.49E+02	5.99E+02	-2.00E+02	2.39E-01
270	6.72E-04	6.64E-04	3.25E-04	6.64E-04	2.13E-04	2.51E-05	4.51E+02	6.02E+02	-2.01E+02	2.41E-01
300	6.78E-04	6.72E-04	3.32E-04	6.72E-04	2.19E-04	2.52E-05	4.53E+02	6.04E+02	-2.01E+02	2.42E-01
330	6.84E-04	6.78E-04	3.37E-04	6.78E-04	2.24E-04	2.52E-05	4.54E+02	6.06E+02	-2.02E+02	2.42E-01
360	6.88E-04	6.84E-04	3.42E-04	6.84E-04	2.28E-04	2.53E-05	4.55E+02	6.07E+02	-2.02E+02	2.43E-01
390	6.92E-04	6.88E-04	3.46E-04	6.88E-04	2.32E-04	2.53E-05	4.56E+02	6.08E+02	-2.03E+02	2.43E-01
420	6.96E-04	6.92E-04	3.50E-04	6.92E-04	2.36E-04	2.54E-05	4.57E+02	6.09E+02	-2.03E+02	2.44E-01
450	6.99E-04	6.96E-04	3.53E-04	6.96E-04	2.39E-04	2.54E-05	4.57E+02	6.10E+02	-2.03E+02	2.44E-01
480	7.02E-04	6.99E-04	3.56E-04	6.99E-04	2.41E-04	2.54E-05	4.58E+02	6.10E+02	-2.03E+02	2.44E-01
510	7.04E-04	7.02E-04	3.58E-04	7.02E-04	2.44E-04	2.55E-05	4.58E+02	6.11E+02	-2.04E+02	2.44E-01
540	7.07E-04	7.04E-04	3.60E-04	7.04E-04	2.46E-04	2.55E-05	4.59E+02	6.11E+02	-2.04E+02	2.45E-01
570	7.09E-04	7.07E-04	3.63E-04	7.07E-04	2.48E-04	2.55E-05	4.59E+02	6.12E+02	-2.04E+02	2.45E-01
600	7.11E-04	7.09E-04	3.64E-04	7.09E-04	2.50E-04	2.55E-05	4.59E+02	6.12E+02	-2.04E+02	2.45E-01
630	7.12E-04	7.11E-04	3.66E-04	7.11E-04	2.51E-04	2.55E-05	4.59E+02	6.12E+02	-2.04E+02	2.45E-01
660	7.14E-04	7.12E-04	3.68E-04	7.12E-04	2.53E-04	2.55E-05	4.59E+02	6.13E+02	-2.04E+02	2.45E-01
690	7.15E-04	7.14E-04	3.69E-04	7.14E-04	2.54E-04	2.55E-05	4.60E+02	6.13E+02	-2.04E+02	2.45E-01
720	7.15E-04	7.14E-04	3.69E-04	7.14E-04	2.54E-04	2.55E-05	4.60E+02	6.13E+02	-2.04E+02	2.45E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A =0.00075)

Shrinkage strain =  $\nu / (t+35) * A$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 7.50E-04      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 7.00E+00      Strain Slop (tan  $\theta$ )  
 h\_slab (in.) = 1.20E+01      Strain ( $\epsilon_r$ )  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (1-t)		Strain ( $\epsilon_r$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	Pre-slab	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top	CIP_bot		CIP_Top
30	3.46E-04	0.00E+00	1.28E-04	3.46E-04	5.55E-05	1.61E-05	2.88E+02	-4.83E+02	3.92E+02	-1.22E+02	1.88E-01
60	4.74E-04	3.46E-04	1.94E-04	4.74E-04	1.02E-04	2.06E-05	3.69E+02	-6.18E+02	5.01E+02	-1.57E+02	2.41E-01
90	5.40E-04	4.74E-04	2.34E-04	5.40E-04	1.34E-04	2.24E-05	4.03E+02	-6.75E+02	5.47E+02	-1.71E+02	2.63E-01
120	5.81E-04	5.40E-04	2.62E-04	5.81E-04	1.57E-04	2.34E-05	4.20E+02	-7.04E+02	5.71E+02	-1.78E+02	2.75E-01
150	6.08E-04	5.81E-04	2.82E-04	6.08E-04	1.74E-04	2.40E-05	4.30E+02	-7.21E+02	5.85E+02	-1.83E+02	2.81E-01
180	6.28E-04	6.08E-04	2.97E-04	6.28E-04	1.88E-04	2.43E-05	4.37E+02	-7.31E+02	5.93E+02	-1.85E+02	2.86E-01
210	6.43E-04	6.28E-04	3.08E-04	6.43E-04	1.98E-04	2.46E-05	4.41E+02	-7.39E+02	5.99E+02	-1.87E+02	2.88E-01
240	6.55E-04	6.43E-04	3.18E-04	6.55E-04	2.07E-04	2.47E-05	4.44E+02	-7.44E+02	6.03E+02	-1.89E+02	2.90E-01
270	6.64E-04	6.55E-04	3.25E-04	6.64E-04	2.14E-04	2.49E-05	4.46E+02	-7.47E+02	6.06E+02	-1.89E+02	2.92E-01
300	6.72E-04	6.64E-04	3.32E-04	6.72E-04	2.20E-04	2.50E-05	4.48E+02	-7.50E+02	6.09E+02	-1.90E+02	2.93E-01
330	6.78E-04	6.72E-04	3.37E-04	6.78E-04	2.25E-04	2.50E-05	4.49E+02	-7.52E+02	6.10E+02	-1.91E+02	2.94E-01
360	6.84E-04	6.78E-04	3.42E-04	6.84E-04	2.30E-04	2.51E-05	4.50E+02	-7.54E+02	6.12E+02	-1.91E+02	2.94E-01
390	6.88E-04	6.84E-04	3.46E-04	6.88E-04	2.33E-04	2.51E-05	4.51E+02	-7.55E+02	6.13E+02	-1.92E+02	2.95E-01
420	6.92E-04	6.88E-04	3.50E-04	6.92E-04	2.37E-04	2.52E-05	4.52E+02	-7.57E+02	6.14E+02	-1.92E+02	2.95E-01
450	6.96E-04	6.92E-04	3.53E-04	6.96E-04	2.40E-04	2.52E-05	4.52E+02	-7.58E+02	6.14E+02	-1.92E+02	2.96E-01
480	6.99E-04	6.96E-04	3.56E-04	6.99E-04	2.42E-04	2.52E-05	4.53E+02	-7.58E+02	6.15E+02	-1.92E+02	2.96E-01
510	7.02E-04	6.99E-04	3.58E-04	7.02E-04	2.45E-04	2.53E-05	4.53E+02	-7.59E+02	6.16E+02	-1.92E+02	2.96E-01
540	7.04E-04	7.02E-04	3.60E-04	7.04E-04	2.47E-04	2.53E-05	4.54E+02	-7.59E+02	6.16E+02	-1.93E+02	2.96E-01
570	7.07E-04	7.04E-04	3.63E-04	7.07E-04	2.49E-04	2.53E-05	4.54E+02	-7.60E+02	6.16E+02	-1.93E+02	2.97E-01
600	7.09E-04	7.07E-04	3.64E-04	7.09E-04	2.51E-04	2.53E-05	4.54E+02	-7.60E+02	6.17E+02	-1.93E+02	2.97E-01
630	7.11E-04	7.09E-04	3.66E-04	7.11E-04	2.53E-04	2.53E-05	4.54E+02	-7.61E+02	6.17E+02	-1.93E+02	2.97E-01
660	7.12E-04	7.11E-04	3.68E-04	7.12E-04	2.54E-04	2.53E-05	4.54E+02	-7.61E+02	6.17E+02	-1.93E+02	2.97E-01
690	7.14E-04	7.12E-04	3.68E-04	7.14E-04	2.54E-04	2.53E-05	4.55E+02	-7.61E+02	6.18E+02	-1.93E+02	2.97E-01
720	7.15E-04	7.14E-04	3.69E-04	7.15E-04	2.55E-04	2.53E-05	4.55E+02	-7.61E+02	6.18E+02	-1.93E+02	2.97E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00075)

Shrinkage strain =  $v/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = 7.50E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 8.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.46E-04	0.00E+00	1.28E-04	3.46E-04	5.76E-05	1.57E-05	2.80E+02	-4.76E+02	3.99E+02	-1.05E+02	2.35E-01
60	4.74E-04	3.46E-04	1.94E-04	4.74E-04	1.04E-04	2.01E-05	3.58E+02	-6.09E+02	5.10E+02	-1.34E+02	3.01E-01
90	5.40E-04	4.74E-04	2.34E-04	5.40E-04	1.37E-04	2.20E-05	3.91E+02	-6.65E+02	5.57E+02	-1.47E+02	3.28E-01
120	5.81E-04	5.40E-04	2.62E-04	5.81E-04	1.60E-04	2.29E-05	4.08E+02	-6.93E+02	5.81E+02	-1.53E+02	3.43E-01
150	6.08E-04	5.81E-04	2.82E-04	6.08E-04	1.77E-04	2.35E-05	4.18E+02	-7.10E+02	5.95E+02	-1.57E+02	3.51E-01
180	6.28E-04	6.08E-04	2.97E-04	6.28E-04	1.91E-04	2.38E-05	4.24E+02	-7.21E+02	6.04E+02	-1.59E+02	3.56E-01
210	6.43E-04	6.28E-04	3.08E-04	6.43E-04	2.01E-04	2.41E-05	4.28E+02	-7.28E+02	6.10E+02	-1.61E+02	3.60E-01
240	6.55E-04	6.43E-04	3.18E-04	6.55E-04	2.10E-04	2.42E-05	4.31E+02	-7.33E+02	6.14E+02	-1.62E+02	3.62E-01
270	6.64E-04	6.55E-04	3.25E-04	6.64E-04	2.17E-04	2.44E-05	4.33E+02	-7.36E+02	6.17E+02	-1.62E+02	3.64E-01
300	6.72E-04	6.64E-04	3.32E-04	6.72E-04	2.23E-04	2.45E-05	4.35E+02	-7.39E+02	6.20E+02	-1.63E+02	3.65E-01
330	6.78E-04	6.72E-04	3.37E-04	6.78E-04	2.28E-04	2.45E-05	4.36E+02	-7.41E+02	6.21E+02	-1.64E+02	3.66E-01
360	6.84E-04	6.78E-04	3.42E-04	6.84E-04	2.33E-04	2.46E-05	4.37E+02	-7.43E+02	6.23E+02	-1.64E+02	3.67E-01
390	6.88E-04	6.84E-04	3.46E-04	6.88E-04	2.37E-04	2.46E-05	4.38E+02	-7.44E+02	6.24E+02	-1.64E+02	3.68E-01
420	6.92E-04	6.88E-04	3.50E-04	6.92E-04	2.40E-04	2.47E-05	4.39E+02	-7.45E+02	6.25E+02	-1.64E+02	3.68E-01
450	6.96E-04	6.92E-04	3.53E-04	6.96E-04	2.43E-04	2.47E-05	4.39E+02	-7.46E+02	6.26E+02	-1.65E+02	3.69E-01
480	6.99E-04	6.96E-04	3.56E-04	6.99E-04	2.46E-04	2.47E-05	4.39E+02	-7.47E+02	6.26E+02	-1.65E+02	3.69E-01
510	7.02E-04	6.99E-04	3.58E-04	7.02E-04	2.48E-04	2.47E-05	4.40E+02	-7.48E+02	6.27E+02	-1.65E+02	3.69E-01
540	7.04E-04	7.02E-04	3.58E-04	7.04E-04	2.48E-04	2.48E-05	4.40E+02	-7.48E+02	6.27E+02	-1.65E+02	3.70E-01
570	7.07E-04	7.04E-04	3.60E-04	7.07E-04	2.50E-04	2.48E-05	4.40E+02	-7.49E+02	6.28E+02	-1.65E+02	3.70E-01
600	7.09E-04	7.07E-04	3.63E-04	7.09E-04	2.52E-04	2.48E-05	4.41E+02	-7.49E+02	6.28E+02	-1.65E+02	3.70E-01
630	7.11E-04	7.09E-04	3.64E-04	7.09E-04	2.54E-04	2.48E-05	4.41E+02	-7.49E+02	6.28E+02	-1.65E+02	3.70E-01
660	7.12E-04	7.11E-04	3.66E-04	7.11E-04	2.56E-04	2.48E-05	4.41E+02	-7.50E+02	6.29E+02	-1.65E+02	3.70E-01
690	7.14E-04	7.12E-04	3.68E-04	7.12E-04	2.57E-04	2.48E-05	4.41E+02	-7.50E+02	6.29E+02	-1.65E+02	3.71E-01
720	7.15E-04	7.14E-04	3.69E-04	7.14E-04	2.59E-04	2.48E-05	4.41E+02	-7.50E+02	6.29E+02	-1.65E+02	3.71E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00075)

Shrinkage strain =  $\nu/(t+35)^*A$   
 Slab was cast B days before CIP deck  
 A = 7.50E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

h\_CIP (in.) = 9.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)		Reinf. Req. (sq. in. per ft.)
	Pre-slab	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top	
30	3.46E-04	0.00E+00	1.28E-04	3.46E-04	6.06E-05	1.53E-05	2.68E+02	4.08E+02	2.94E-01
60	4.74E-04	3.46E-04	1.94E-04	4.74E-04	1.08E-04	1.96E-05	3.43E+02	5.22E+02	3.76E-01
90	5.40E-04	4.74E-04	2.34E-04	5.40E-04	1.41E-04	2.14E-05	3.74E+02	5.70E+02	4.10E-01
120	5.81E-04	5.40E-04	2.62E-04	5.81E-04	1.64E-04	2.23E-05	3.90E+02	5.95E+02	4.28E-01
150	6.08E-04	5.81E-04	2.82E-04	6.08E-04	1.82E-04	2.28E-05	4.00E+02	6.09E+02	4.38E-01
180	6.28E-04	6.08E-04	2.97E-04	6.28E-04	1.95E-04	2.32E-05	4.06E+02	6.18E+02	4.45E-01
210	6.43E-04	6.28E-04	3.08E-04	6.43E-04	2.06E-04	2.34E-05	4.10E+02	6.24E+02	4.49E-01
240	6.55E-04	6.43E-04	3.18E-04	6.55E-04	2.15E-04	2.36E-05	4.12E+02	6.28E+02	4.52E-01
270	6.64E-04	6.55E-04	3.25E-04	6.64E-04	2.22E-04	2.37E-05	4.14E+02	6.32E+02	4.55E-01
300	6.72E-04	6.64E-04	3.32E-04	6.72E-04	2.28E-04	2.38E-05	4.16E+02	6.34E+02	4.56E-01
330	6.78E-04	6.72E-04	3.37E-04	6.78E-04	2.33E-04	2.38E-05	4.17E+02	6.36E+02	4.56E-01
360	6.84E-04	6.78E-04	3.42E-04	6.84E-04	2.38E-04	2.39E-05	4.18E+02	6.37E+02	4.59E-01
390	6.88E-04	6.84E-04	3.46E-04	6.88E-04	2.41E-04	2.39E-05	4.19E+02	6.38E+02	4.60E-01
420	6.92E-04	6.88E-04	3.50E-04	6.92E-04	2.45E-04	2.40E-05	4.19E+02	6.39E+02	4.60E-01
450	6.96E-04	6.92E-04	3.53E-04	6.96E-04	2.48E-04	2.40E-05	4.20E+02	6.40E+02	4.61E-01
480	6.99E-04	6.96E-04	3.56E-04	6.99E-04	2.51E-04	2.40E-05	4.20E+02	6.41E+02	4.61E-01
510	7.02E-04	6.99E-04	3.58E-04	7.02E-04	2.53E-04	2.40E-05	4.21E+02	6.41E+02	4.62E-01
540	7.04E-04	7.02E-04	3.59E-04	7.04E-04	2.55E-04	2.41E-05	4.21E+02	6.42E+02	4.62E-01
570	7.07E-04	7.04E-04	3.60E-04	7.07E-04	2.57E-04	2.41E-05	4.21E+02	6.42E+02	4.62E-01
600	7.09E-04	7.07E-04	3.63E-04	7.09E-04	2.59E-04	2.41E-05	4.22E+02	6.42E+02	4.63E-01
630	7.11E-04	7.09E-04	3.64E-04	7.09E-04	2.61E-04	2.41E-05	4.22E+02	6.43E+02	4.63E-01
660	7.12E-04	7.11E-04	3.66E-04	7.12E-04	2.62E-04	2.41E-05	4.22E+02	6.43E+02	4.63E-01
690	7.14E-04	7.12E-04	3.68E-04	7.14E-04	2.64E-04	2.41E-05	4.22E+02	6.43E+02	4.63E-01
720	7.15E-04	7.14E-04	3.69E-04	7.15E-04	2.64E-04	2.41E-05	4.22E+02	6.43E+02	4.63E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00075)

Shrinkage strain =  $v/(t+35)^A$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 7.50E-04      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      E (psi) = 4.00E+06      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      fy (psi) = 6.00E+04      Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)
	From 0 days	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top	CIP_bot	
30	3.46E-04	0.00E+00	1.28E-04	3.46E-04	6.43E-05	1.48E-05	-4.57E+02	4.18E+02	-5.52E+01	3.63E-01
60	4.74E-04	3.46E-04	1.94E-04	4.74E-04	1.13E-04	1.89E-05	-5.84E+02	5.35E+02	-7.06E+01	4.64E-01
90	5.40E-04	4.74E-04	2.34E-04	5.40E-04	1.46E-04	2.07E-05	-6.38E+02	5.84E+02	-7.71E+01	5.07E-01
120	5.81E-04	5.40E-04	2.62E-04	5.81E-04	1.70E-04	2.15E-05	-6.66E+02	6.09E+02	-8.05E+01	5.29E-01
150	6.08E-04	5.81E-04	2.82E-04	6.08E-04	1.87E-04	2.21E-05	-6.82E+02	6.24E+02	-8.24E+01	5.41E-01
180	6.28E-04	6.08E-04	2.97E-04	6.28E-04	2.01E-04	2.24E-05	-6.92E+02	6.33E+02	-8.36E+01	5.49E-01
210	6.43E-04	6.28E-04	3.08E-04	6.43E-04	2.12E-04	2.26E-05	-6.99E+02	6.39E+02	-8.44E+01	5.55E-01
240	6.55E-04	6.43E-04	3.18E-04	6.55E-04	2.20E-04	2.28E-05	-7.03E+02	6.44E+02	-8.50E+01	5.59E-01
270	6.64E-04	6.55E-04	3.25E-04	6.64E-04	2.28E-04	2.29E-05	-7.07E+02	6.47E+02	-8.54E+01	5.61E-01
300	6.72E-04	6.64E-04	3.32E-04	6.72E-04	2.34E-04	2.30E-05	-7.10E+02	6.49E+02	-8.58E+01	5.64E-01
330	6.78E-04	6.72E-04	3.37E-04	6.78E-04	2.39E-04	2.30E-05	-7.12E+02	6.51E+02	-8.60E+01	5.65E-01
360	6.84E-04	6.78E-04	3.42E-04	6.84E-04	2.43E-04	2.31E-05	-7.13E+02	6.53E+02	-8.62E+01	5.66E-01
390	6.88E-04	6.84E-04	3.46E-04	6.88E-04	2.47E-04	2.31E-05	-7.14E+02	6.54E+02	-8.64E+01	5.67E-01
420	6.92E-04	6.88E-04	3.50E-04	6.92E-04	2.51E-04	2.32E-05	-7.15E+02	6.55E+02	-8.65E+01	5.68E-01
450	6.96E-04	6.92E-04	3.53E-04	6.96E-04	2.54E-04	2.32E-05	-7.16E+02	6.56E+02	-8.66E+01	5.69E-01
480	6.99E-04	6.96E-04	3.56E-04	6.99E-04	2.56E-04	2.32E-05	-7.17E+02	6.57E+02	-8.67E+01	5.70E-01
510	7.02E-04	6.99E-04	3.58E-04	7.02E-04	2.59E-04	2.32E-05	-7.18E+02	6.57E+02	-8.67E+01	5.70E-01
540	7.04E-04	7.02E-04	3.60E-04	7.04E-04	2.61E-04	2.33E-05	-7.18E+02	6.57E+02	-8.68E+01	5.70E-01
570	7.07E-04	7.04E-04	3.63E-04	7.07E-04	2.63E-04	2.33E-05	-7.19E+02	6.58E+02	-8.69E+01	5.71E-01
600	7.09E-04	7.07E-04	3.64E-04	7.09E-04	2.65E-04	2.33E-05	-7.19E+02	6.58E+02	-8.69E+01	5.71E-01
630	7.11E-04	7.09E-04	3.66E-04	7.11E-04	2.66E-04	2.33E-05	-7.19E+02	6.58E+02	-8.70E+01	5.71E-01
660	7.12E-04	7.11E-04	3.68E-04	7.12E-04	2.68E-04	2.33E-05	-7.20E+02	6.59E+02	-8.70E+01	5.72E-01
690	7.14E-04	7.12E-04	3.68E-04	7.14E-04	2.68E-04	2.33E-05	-7.20E+02	6.59E+02	-8.70E+01	5.72E-01
720	7.15E-04	7.14E-04	3.69E-04	7.15E-04	2.69E-04	2.33E-05	-7.20E+02	6.59E+02	-8.70E+01	5.72E-01



## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00075)

Shrinkage strain =  $\frac{1}{t+(t-35)^*A}$       Distance from Bottom  
 Slab was cast B days before CIP deck      Bottom of slab (in.) = 0.00E+00  
 A = 7.50E-04      Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01      E (psi) = 4.00E+06      Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab      fy (psi) = 6.00E+04      Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain Slop (tan θ)	Strain (ε <sub>1</sub> )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.46E-04	0.00E+00	1.28E-04	3.46E-04	1.42E-05	6.84E-05	2.36E+02	-4.47E+02	4.28E+02	-2.76E+01	4.40E-01
60	4.74E-04	3.46E-04	1.94E-04	4.74E-04	1.82E-05	1.18E-04	3.03E+02	-5.72E+02	5.48E+02	-3.53E+01	5.63E-01
90	5.40E-04	4.74E-04	2.34E-04	5.40E-04	1.99E-05	1.52E-04	3.30E+02	-6.24E+02	5.98E+02	-3.86E+01	6.15E-01
120	5.81E-04	5.40E-04	2.62E-04	5.81E-04	2.07E-05	1.76E-04	3.45E+02	-6.51E+02	6.24E+02	-4.02E+01	6.42E-01
150	6.08E-04	5.81E-04	2.82E-04	6.08E-04	2.12E-05	1.94E-04	3.53E+02	-6.67E+02	6.39E+02	-4.12E+01	6.57E-01
180	6.28E-04	6.08E-04	2.97E-04	6.28E-04	2.16E-05	2.07E-04	3.58E+02	-6.77E+02	6.48E+02	-4.18E+01	6.67E-01
210	6.43E-04	6.28E-04	3.08E-04	6.43E-04	2.18E-05	2.18E-04	3.62E+02	-6.83E+02	6.54E+02	-4.22E+01	6.73E-01
240	6.55E-04	6.43E-04	3.18E-04	6.55E-04	2.19E-05	2.27E-04	3.64E+02	-6.88E+02	6.59E+02	-4.25E+01	6.78E-01
270	6.64E-04	6.55E-04	3.25E-04	6.64E-04	2.20E-05	2.34E-04	3.66E+02	-6.92E+02	6.62E+02	-4.27E+01	6.81E-01
300	6.72E-04	6.64E-04	3.32E-04	6.72E-04	2.21E-05	2.40E-04	3.67E+02	-6.94E+02	6.65E+02	-4.29E+01	6.84E-01
330	6.78E-04	6.72E-04	3.37E-04	6.78E-04	2.22E-05	2.45E-04	3.68E+02	-6.96E+02	6.67E+02	-4.30E+01	6.86E-01
360	6.84E-04	6.78E-04	3.42E-04	6.84E-04	2.23E-05	2.50E-04	3.69E+02	-6.98E+02	6.68E+02	-4.31E+01	6.88E-01
390	6.88E-04	6.84E-04	3.46E-04	6.88E-04	2.23E-05	2.54E-04	3.70E+02	-6.99E+02	6.69E+02	-4.32E+01	6.89E-01
420	6.92E-04	6.88E-04	3.50E-04	6.92E-04	2.23E-05	2.57E-04	3.70E+02	-7.00E+02	6.70E+02	-4.32E+01	6.90E-01
450	6.96E-04	6.92E-04	3.53E-04	6.96E-04	2.23E-05	2.60E-04	3.71E+02	-7.01E+02	6.71E+02	-4.33E+01	6.91E-01
480	6.99E-04	6.96E-04	3.56E-04	6.99E-04	2.23E-05	2.63E-04	3.71E+02	-7.02E+02	6.72E+02	-4.33E+01	6.91E-01
510	7.02E-04	6.99E-04	3.58E-04	7.02E-04	2.24E-05	2.65E-04	3.72E+02	-7.02E+02	6.72E+02	-4.34E+01	6.92E-01
540	7.04E-04	7.02E-04	3.60E-04	7.04E-04	2.24E-05	2.67E-04	3.72E+02	-7.03E+02	6.73E+02	-4.34E+01	6.92E-01
570	7.07E-04	7.04E-04	3.63E-04	7.07E-04	2.24E-05	2.69E-04	3.72E+02	-7.03E+02	6.73E+02	-4.34E+01	6.93E-01
600	7.09E-04	7.07E-04	3.64E-04	7.09E-04	2.24E-05	2.71E-04	3.72E+02	-7.03E+02	6.74E+02	-4.35E+01	6.93E-01
630	7.11E-04	7.09E-04	3.66E-04	7.11E-04	2.24E-05	2.73E-04	3.72E+02	-7.04E+02	6.74E+02	-4.35E+01	6.94E-01
660	7.12E-04	7.11E-04	3.68E-04	7.12E-04	2.24E-05	2.74E-04	3.73E+02	-7.04E+02	6.74E+02	-4.35E+01	6.94E-01
690	7.14E-04	7.12E-04	3.68E-04	7.14E-04	2.24E-05	2.76E-04	3.73E+02	-7.04E+02	6.75E+02	-4.35E+01	6.94E-01
720	7.15E-04	7.14E-04	3.69E-04	7.15E-04	2.24E-05	2.76E-04	3.73E+02	-7.04E+02	6.75E+02	-4.35E+01	6.94E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00075)

Shrinkage strain =  $t/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = 7.50E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 1.20E+01  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.46E-04	0.00E+00	1.28E-04	3.46E-04	7.29E-05	1.37E-05	2.19E+02	-4.37E+02	4.37E+02	0.00E+00	5.25E-01
60	4.74E-04	3.46E-04	1.94E-04	4.74E-04	1.24E-04	1.75E-05	2.80E+02	-5.60E+02	5.60E+02	2.17E-13	6.72E-01
90	5.40E-04	4.74E-04	2.34E-04	5.40E-04	1.58E-04	1.91E-05	3.06E+02	-6.11E+02	6.11E+02	0.00E+00	7.33E-01
120	5.81E-04	5.40E-04	2.62E-04	5.81E-04	1.82E-04	1.99E-05	3.19E+02	-6.37E+02	6.37E+02	0.00E+00	7.65E-01
150	6.08E-04	5.81E-04	2.82E-04	6.08E-04	2.00E-04	2.04E-05	3.26E+02	-6.53E+02	6.53E+02	0.00E+00	7.83E-01
180	6.28E-04	6.08E-04	2.97E-04	6.28E-04	2.14E-04	2.07E-05	3.31E+02	-6.62E+02	6.62E+02	0.00E+00	7.95E-01
210	6.43E-04	6.28E-04	3.08E-04	6.43E-04	2.25E-04	2.09E-05	3.34E+02	-6.69E+02	6.69E+02	0.00E+00	8.03E-01
240	6.55E-04	6.43E-04	3.18E-04	6.55E-04	2.34E-04	2.10E-05	3.37E+02	-6.74E+02	6.74E+02	0.00E+00	8.08E-01
270	6.64E-04	6.55E-04	3.25E-04	6.64E-04	2.41E-04	2.12E-05	3.38E+02	-6.77E+02	6.77E+02	0.00E+00	8.12E-01
300	6.72E-04	6.64E-04	3.32E-04	6.72E-04	2.47E-04	2.12E-05	3.40E+02	-6.79E+02	6.79E+02	0.00E+00	8.15E-01
330	6.78E-04	6.72E-04	3.37E-04	6.78E-04	2.52E-04	2.13E-05	3.41E+02	-6.81E+02	6.81E+02	0.00E+00	8.18E-01
360	6.84E-04	6.78E-04	3.42E-04	6.84E-04	2.57E-04	2.13E-05	3.41E+02	-6.83E+02	6.83E+02	0.00E+00	8.20E-01
390	6.88E-04	6.84E-04	3.46E-04	6.88E-04	2.61E-04	2.14E-05	3.42E+02	-6.84E+02	6.84E+02	4.34E-13	8.21E-01
420	6.92E-04	6.88E-04	3.50E-04	6.92E-04	2.64E-04	2.14E-05	3.43E+02	-6.85E+02	6.85E+02	4.34E-13	8.22E-01
450	6.96E-04	6.92E-04	3.53E-04	6.96E-04	2.67E-04	2.14E-05	3.43E+02	-6.86E+02	6.86E+02	-4.34E-13	8.23E-01
480	6.99E-04	6.96E-04	3.56E-04	6.99E-04	2.70E-04	2.15E-05	3.43E+02	-6.87E+02	6.87E+02	0.00E+00	8.24E-01
510	7.02E-04	6.99E-04	3.58E-04	7.02E-04	2.72E-04	2.15E-05	3.44E+02	-6.87E+02	6.87E+02	0.00E+00	8.25E-01
540	7.04E-04	7.02E-04	3.60E-04	7.04E-04	2.74E-04	2.15E-05	3.44E+02	-6.88E+02	6.88E+02	0.00E+00	8.25E-01
570	7.07E-04	7.04E-04	3.63E-04	7.07E-04	2.76E-04	2.15E-05	3.44E+02	-6.88E+02	6.88E+02	0.00E+00	8.26E-01
600	7.09E-04	7.07E-04	3.64E-04	7.09E-04	2.78E-04	2.15E-05	3.44E+02	-6.89E+02	6.89E+02	0.00E+00	8.26E-01
630	7.11E-04	7.09E-04	3.66E-04	7.11E-04	2.80E-04	2.15E-05	3.44E+02	-6.89E+02	6.89E+02	-4.34E-13	8.27E-01
660	7.12E-04	7.11E-04	3.68E-04	7.12E-04	2.81E-04	2.15E-05	3.45E+02	-6.89E+02	6.89E+02	-4.34E-13	8.27E-01
690	7.14E-04	7.12E-04	3.68E-04	7.14E-04	2.81E-04	2.15E-05	3.45E+02	-6.89E+02	6.89E+02	4.34E-13	8.27E-01
720	7.15E-04	7.14E-04	3.69E-04	7.15E-04	2.83E-04	2.15E-05	3.45E+02	-6.89E+02	6.89E+02	4.34E-13	8.27E-01

Curing Coefficient A = 0.00080

CIP depth 6 to 12 inches

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00080)

Shrinkage strain =  $\nu/(t+35)^A$   
 Slab was cast B days before CIP deck  
 A = 8.00E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Free Shrinkage Strain  
 After Composite (t1-t)  
 Pre-slab  
 CIP-deck

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 6.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain (ε <sub>r</sub> )	Strain Slop (tan θ)	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)
	Pre-slab	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top	CIP_bot	
30	3.69E-04	0.00E+00	1.36E-04	3.69E-04	5.83E-05	1.73E-05	3.11E+02	4.15E+02	-1.38E+02	1.66E-01
60	5.05E-04	3.69E-04	2.07E-04	5.05E-04	1.07E-04	2.21E-05	3.98E+02	5.31E+02	-1.77E+02	2.12E-01
90	5.76E-04	5.05E-04	2.50E-04	5.76E-04	1.41E-04	2.41E-05	4.35E+02	5.79E+02	-1.93E+02	2.32E-01
120	6.19E-04	5.76E-04	2.79E-04	6.19E-04	1.66E-04	2.52E-05	4.53E+02	6.04E+02	-2.01E+02	2.42E-01
150	6.49E-04	6.19E-04	3.01E-04	6.49E-04	1.84E-04	2.58E-05	4.64E+02	6.19E+02	-2.06E+02	2.48E-01
180	6.70E-04	6.49E-04	3.16E-04	6.70E-04	1.99E-04	2.62E-05	4.71E+02	6.28E+02	-2.09E+02	2.51E-01
210	6.86E-04	6.70E-04	3.29E-04	6.86E-04	2.10E-04	2.64E-05	4.76E+02	6.34E+02	-2.11E+02	2.54E-01
240	6.98E-04	6.86E-04	3.39E-04	6.98E-04	2.19E-04	2.66E-05	4.79E+02	6.39E+02	-2.13E+02	2.55E-01
270	7.08E-04	6.98E-04	3.47E-04	7.08E-04	2.27E-04	2.67E-05	4.81E+02	6.42E+02	-2.14E+02	2.57E-01
300	7.16E-04	7.08E-04	3.54E-04	7.16E-04	2.33E-04	2.68E-05	4.83E+02	6.44E+02	-2.15E+02	2.58E-01
330	7.23E-04	7.16E-04	3.60E-04	7.23E-04	2.39E-04	2.69E-05	4.85E+02	6.46E+02	-2.15E+02	2.58E-01
360	7.29E-04	7.23E-04	3.65E-04	7.29E-04	2.43E-04	2.70E-05	4.86E+02	6.48E+02	-2.16E+02	2.59E-01
390	7.34E-04	7.29E-04	3.69E-04	7.34E-04	2.48E-04	2.70E-05	4.87E+02	6.49E+02	-2.16E+02	2.59E-01
420	7.38E-04	7.34E-04	3.73E-04	7.38E-04	2.51E-04	2.71E-05	4.87E+02	6.50E+02	-2.17E+02	2.60E-01
450	7.42E-04	7.38E-04	3.76E-04	7.42E-04	2.54E-04	2.71E-05	4.88E+02	6.50E+02	-2.17E+02	2.60E-01
480	7.46E-04	7.42E-04	3.79E-04	7.46E-04	2.57E-04	2.71E-05	4.88E+02	6.51E+02	-2.17E+02	2.60E-01
510	7.49E-04	7.46E-04	3.82E-04	7.49E-04	2.60E-04	2.72E-05	4.89E+02	6.52E+02	-2.17E+02	2.61E-01
540	7.51E-04	7.49E-04	3.84E-04	7.51E-04	2.62E-04	2.72E-05	4.89E+02	6.52E+02	-2.17E+02	2.61E-01
570	7.54E-04	7.51E-04	3.87E-04	7.54E-04	2.64E-04	2.72E-05	4.89E+02	6.53E+02	-2.18E+02	2.61E-01
600	7.56E-04	7.54E-04	3.89E-04	7.56E-04	2.66E-04	2.72E-05	4.90E+02	6.53E+02	-2.18E+02	2.61E-01
630	7.58E-04	7.56E-04	3.90E-04	7.58E-04	2.68E-04	2.72E-05	4.90E+02	6.53E+02	-2.18E+02	2.61E-01
660	7.60E-04	7.58E-04	3.92E-04	7.60E-04	2.70E-04	2.72E-05	4.90E+02	6.53E+02	-2.18E+02	2.61E-01
690	7.61E-04	7.60E-04	3.94E-04	7.61E-04	2.71E-04	2.72E-05	4.90E+02	6.54E+02	-2.18E+02	2.61E-01
720	7.63E-04	7.61E-04	3.94E-04	7.61E-04	2.71E-04	2.72E-05	4.90E+02	6.54E+02	-2.18E+02	2.61E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A =0.00080)

Shrinkage strain =  $v/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = **8.00E-04**  
 B (days) = **3.00E+01**  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = **0.00E+00**  
 Top of slab (in.) = **1.20E+01**  
 Bottom of CIP (in.) = **1.20E+01**  
 Top of CIP (in.) = **2.00E+01**

h\_CIP (in.) = **7.00E+00**  
 h\_slab (in.) = **1.20E+01**  
 E (psi) = **4.00E+06**  
 fy (psi) = **6.00E+04**

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_1$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.69E-04	0.00E+00	1.36E-04	3.69E-04	5.92E-05	1.71E-05	3.07E+02	-5.15E+02	4.18E+02	-1.31E+02	2.01E-01
60	5.05E-04	3.69E-04	2.07E-04	5.05E-04	1.08E-04	2.19E-05	3.94E+02	-6.59E+02	5.35E+02	-1.67E+02	2.57E-01
90	5.76E-04	5.05E-04	2.50E-04	5.76E-04	1.43E-04	2.39E-05	4.30E+02	-7.20E+02	5.84E+02	-1.82E+02	2.81E-01
120	6.19E-04	5.76E-04	2.79E-04	6.19E-04	1.67E-04	2.50E-05	4.48E+02	-7.51E+02	6.09E+02	-1.90E+02	2.93E-01
150	6.49E-04	6.19E-04	3.01E-04	6.49E-04	1.86E-04	2.56E-05	4.59E+02	-7.69E+02	6.24E+02	-1.95E+02	3.00E-01
180	6.70E-04	6.49E-04	3.16E-04	6.70E-04	2.00E-04	2.60E-05	4.66E+02	-7.80E+02	6.33E+02	-1.98E+02	3.05E-01
210	6.86E-04	6.70E-04	3.29E-04	6.86E-04	2.11E-04	2.62E-05	4.70E+02	-7.88E+02	6.39E+02	-2.00E+02	3.08E-01
240	6.98E-04	6.86E-04	3.39E-04	6.98E-04	2.21E-04	2.64E-05	4.74E+02	-7.93E+02	6.44E+02	-2.01E+02	3.10E-01
270	7.08E-04	6.98E-04	3.47E-04	7.08E-04	2.28E-04	2.65E-05	4.78E+02	-7.97E+02	6.47E+02	-2.02E+02	3.11E-01
300	7.16E-04	7.08E-04	3.54E-04	7.16E-04	2.35E-04	2.66E-05	4.78E+02	-8.00E+02	6.49E+02	-2.03E+02	3.12E-01
330	7.23E-04	7.16E-04	3.54E-04	7.23E-04	2.40E-04	2.67E-05	4.79E+02	-8.03E+02	6.51E+02	-2.03E+02	3.13E-01
360	7.29E-04	7.23E-04	3.60E-04	7.29E-04	2.45E-04	2.68E-05	4.80E+02	-8.04E+02	6.53E+02	-2.04E+02	3.14E-01
390	7.34E-04	7.29E-04	3.65E-04	7.34E-04	2.49E-04	2.68E-05	4.81E+02	-8.06E+02	6.54E+02	-2.04E+02	3.15E-01
420	7.38E-04	7.34E-04	3.69E-04	7.38E-04	2.53E-04	2.69E-05	4.82E+02	-8.07E+02	6.55E+02	-2.05E+02	3.15E-01
450	7.42E-04	7.38E-04	3.73E-04	7.42E-04	2.56E-04	2.69E-05	4.82E+02	-8.08E+02	6.55E+02	-2.05E+02	3.15E-01
480	7.46E-04	7.42E-04	3.76E-04	7.46E-04	2.59E-04	2.69E-05	4.83E+02	-8.09E+02	6.56E+02	-2.05E+02	3.16E-01
510	7.49E-04	7.46E-04	3.79E-04	7.49E-04	2.61E-04	2.69E-05	4.83E+02	-8.10E+02	6.57E+02	-2.05E+02	3.16E-01
540	7.51E-04	7.49E-04	3.82E-04	7.51E-04	2.64E-04	2.70E-05	4.84E+02	-8.11E+02	6.57E+02	-2.05E+02	3.16E-01
570	7.54E-04	7.51E-04	3.84E-04	7.54E-04	2.66E-04	2.70E-05	4.84E+02	-8.11E+02	6.58E+02	-2.06E+02	3.16E-01
600	7.56E-04	7.54E-04	3.87E-04	7.56E-04	2.68E-04	2.70E-05	4.84E+02	-8.11E+02	6.58E+02	-2.06E+02	3.17E-01
630	7.58E-04	7.56E-04	3.89E-04	7.58E-04	2.69E-04	2.70E-05	4.84E+02	-8.12E+02	6.58E+02	-2.06E+02	3.17E-01
660	7.60E-04	7.58E-04	3.90E-04	7.60E-04	2.71E-04	2.70E-05	4.85E+02	-8.12E+02	6.58E+02	-2.06E+02	3.17E-01
690	7.61E-04	7.60E-04	3.92E-04	7.61E-04	2.71E-04	2.70E-05	4.85E+02	-8.12E+02	6.59E+02	-2.06E+02	3.17E-01
720	7.63E-04	7.61E-04	3.94E-04	7.63E-04	2.72E-04	2.70E-05	4.85E+02	-8.12E+02	6.59E+02	-2.06E+02	3.17E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00080)

Shrinkage strain =  $t/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = 8.00E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

h\_CIP (in.) = 8.00E+00  
 h\_slab (in.) = 1.20E+01  
 E (psi) = 4.00E+06  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_t$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.69E-04	0.00E+00	1.36E-04	3.69E-04	6.14E-05	1.68E-05	2.98E+02	-5.07E+02	4.25E+02	-1.12E+02	2.51E-01
60	5.05E-04	3.69E-04	2.07E-04	5.05E-04	1.11E-04	2.15E-05	3.82E+02	-6.50E+02	5.44E+02	-1.43E+02	3.21E-01
90	5.76E-04	5.05E-04	2.50E-04	5.76E-04	1.46E-04	2.35E-05	4.17E+02	-7.09E+02	5.94E+02	-1.56E+02	3.50E-01
120	6.19E-04	5.76E-04	2.79E-04	6.19E-04	1.71E-04	2.45E-05	4.35E+02	-7.40E+02	6.20E+02	-1.63E+02	3.66E-01
150	6.49E-04	6.19E-04	3.01E-04	6.49E-04	1.89E-04	2.51E-05	4.46E+02	-7.57E+02	6.35E+02	-1.67E+02	3.74E-01
180	6.70E-04	6.49E-04	3.16E-04	6.70E-04	2.03E-04	2.54E-05	4.52E+02	-7.69E+02	6.44E+02	-1.70E+02	3.80E-01
210	6.86E-04	6.70E-04	3.29E-04	6.86E-04	2.15E-04	2.57E-05	4.57E+02	-7.76E+02	6.51E+02	-1.71E+02	3.84E-01
240	6.98E-04	6.86E-04	3.39E-04	6.98E-04	2.24E-04	2.59E-05	4.60E+02	-7.82E+02	6.55E+02	-1.72E+02	3.86E-01
270	7.08E-04	6.98E-04	3.47E-04	7.08E-04	2.32E-04	2.60E-05	4.62E+02	-7.86E+02	6.58E+02	-1.73E+02	3.88E-01
300	7.23E-04	7.08E-04	3.54E-04	7.16E-04	2.38E-04	2.61E-05	4.64E+02	-7.88E+02	6.61E+02	-1.74E+02	3.90E-01
330	7.29E-04	7.16E-04	3.60E-04	7.23E-04	2.44E-04	2.62E-05	4.65E+02	-7.91E+02	6.63E+02	-1.74E+02	3.91E-01
360	7.34E-04	7.23E-04	3.65E-04	7.29E-04	2.48E-04	2.62E-05	4.66E+02	-7.93E+02	6.64E+02	-1.75E+02	3.92E-01
390	7.38E-04	7.34E-04	3.69E-04	7.34E-04	2.52E-04	2.63E-05	4.67E+02	-7.94E+02	6.66E+02	-1.75E+02	3.92E-01
420	7.42E-04	7.38E-04	3.73E-04	7.38E-04	2.56E-04	2.63E-05	4.68E+02	-7.95E+02	6.67E+02	-1.75E+02	3.93E-01
450	7.46E-04	7.42E-04	3.76E-04	7.42E-04	2.59E-04	2.64E-05	4.69E+02	-7.97E+02	6.67E+02	-1.76E+02	3.93E-01
480	7.49E-04	7.46E-04	3.79E-04	7.46E-04	2.62E-04	2.64E-05	4.69E+02	-7.98E+02	6.68E+02	-1.76E+02	3.94E-01
510	7.51E-04	7.49E-04	3.82E-04	7.49E-04	2.65E-04	2.64E-05	4.69E+02	-7.98E+02	6.69E+02	-1.76E+02	3.94E-01
540	7.54E-04	7.51E-04	3.84E-04	7.51E-04	2.67E-04	2.64E-05	4.70E+02	-7.99E+02	6.69E+02	-1.76E+02	3.94E-01
570	7.56E-04	7.54E-04	3.87E-04	7.54E-04	2.69E-04	2.64E-05	4.70E+02	-7.99E+02	6.70E+02	-1.76E+02	3.95E-01
600	7.58E-04	7.56E-04	3.89E-04	7.56E-04	2.71E-04	2.64E-05	4.70E+02	-7.99E+02	6.70E+02	-1.76E+02	3.95E-01
630	7.60E-04	7.58E-04	3.90E-04	7.58E-04	2.73E-04	2.65E-05	4.70E+02	-8.00E+02	6.70E+02	-1.76E+02	3.95E-01
660	7.61E-04	7.60E-04	3.92E-04	7.60E-04	2.75E-04	2.65E-05	4.70E+02	-8.00E+02	6.71E+02	-1.76E+02	3.95E-01
690	7.63E-04	7.61E-04	3.94E-04	7.61E-04	2.76E-04	2.65E-05	4.71E+02	-8.00E+02	6.71E+02	-1.76E+02	3.95E-01
720	7.63E-04	7.61E-04	3.94E-04	7.61E-04	2.76E-04	2.65E-05	4.71E+02	-8.00E+02	6.71E+02	-1.76E+02	3.95E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A = 0.00080)

Shrinkage strain =  $\frac{t}{t+(35)*A}$  Distance from Bottom  
 Slab was cast B days before CIP deck Bottom of slab (in.) = 0.00E+00  
 A = 8.00E-04 h\_CIP (in.) = 9.00E+00 Top of slab (in.) = 1.20E+01  
 B (days) = 3.00E+01 h\_slab (in.) = 1.20E+01 Bottom of CIP (in.) = 1.20E+01  
 t start from casting of slab fy (psi) = 4.00E+06 Top of CIP (in.) = 2.00E+01  
 fy (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain ( $\epsilon_r$ )	Strain Slop (tan $\theta$ )	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_Top	CIP_bot		CIP_Top
30	3.69E-04	0.00E+00	1.36E-04	3.69E-04	6.46E-05	1.63E-05	2.86E+02	-4.98E+02	4.35E+02	-8.70E+01	3.13E-01
60	5.05E-04	3.69E-04	2.07E-04	5.05E-04	1.15E-04	2.09E-05	3.66E+02	-6.37E+02	5.57E+02	-1.11E+02	4.01E-01
90	5.76E-04	5.05E-04	2.50E-04	5.76E-04	1.50E-04	2.28E-05	3.99E+02	-6.95E+02	6.08E+02	-1.22E+02	4.38E-01
120	6.19E-04	5.76E-04	2.79E-04	6.19E-04	1.75E-04	2.38E-05	4.16E+02	-7.25E+02	6.34E+02	-1.27E+02	4.57E-01
150	6.49E-04	6.19E-04	3.01E-04	6.49E-04	1.94E-04	2.44E-05	4.26E+02	-7.43E+02	6.50E+02	-1.30E+02	4.68E-01
180	6.70E-04	6.49E-04	3.16E-04	6.70E-04	2.08E-04	2.47E-05	4.33E+02	-7.54E+02	6.59E+02	-1.32E+02	4.75E-01
210	6.86E-04	6.70E-04	3.29E-04	6.86E-04	2.20E-04	2.50E-05	4.37E+02	-7.61E+02	6.66E+02	-1.33E+02	4.79E-01
240	6.98E-04	6.86E-04	3.39E-04	6.98E-04	2.29E-04	2.51E-05	4.40E+02	-7.67E+02	6.70E+02	-1.34E+02	4.83E-01
270	7.08E-04	7.08E-04	3.47E-04	7.08E-04	2.37E-04	2.53E-05	4.42E+02	-7.70E+02	6.74E+02	-1.35E+02	4.85E-01
300	7.16E-04	7.16E-04	3.54E-04	7.16E-04	2.43E-04	2.54E-05	4.44E+02	-7.73E+02	6.78E+02	-1.35E+02	4.87E-01
330	7.23E-04	7.23E-04	3.60E-04	7.23E-04	2.49E-04	2.54E-05	4.45E+02	-7.76E+02	6.78E+02	-1.36E+02	4.88E-01
360	7.29E-04	7.29E-04	3.65E-04	7.29E-04	2.53E-04	2.55E-05	4.46E+02	-7.77E+02	6.80E+02	-1.36E+02	4.89E-01
390	7.34E-04	7.34E-04	3.69E-04	7.34E-04	2.58E-04	2.55E-05	4.47E+02	-7.79E+02	6.81E+02	-1.36E+02	4.90E-01
420	7.38E-04	7.38E-04	3.73E-04	7.38E-04	2.61E-04	2.56E-05	4.47E+02	-7.80E+02	6.82E+02	-1.36E+02	4.91E-01
450	7.42E-04	7.42E-04	3.76E-04	7.42E-04	2.64E-04	2.56E-05	4.48E+02	-7.81E+02	6.83E+02	-1.37E+02	4.92E-01
480	7.46E-04	7.46E-04	3.79E-04	7.46E-04	2.67E-04	2.56E-05	4.48E+02	-7.82E+02	6.83E+02	-1.37E+02	4.92E-01
510	7.49E-04	7.49E-04	3.82E-04	7.49E-04	2.70E-04	2.56E-05	4.49E+02	-7.82E+02	6.84E+02	-1.37E+02	4.92E-01
540	7.51E-04	7.51E-04	3.84E-04	7.51E-04	2.72E-04	2.57E-05	4.49E+02	-7.83E+02	6.84E+02	-1.37E+02	4.93E-01
570	7.54E-04	7.54E-04	3.87E-04	7.54E-04	2.74E-04	2.57E-05	4.49E+02	-7.83E+02	6.85E+02	-1.37E+02	4.93E-01
600	7.56E-04	7.56E-04	3.89E-04	7.56E-04	2.76E-04	2.57E-05	4.50E+02	-7.84E+02	6.85E+02	-1.37E+02	4.93E-01
630	7.58E-04	7.58E-04	3.90E-04	7.58E-04	2.78E-04	2.57E-05	4.50E+02	-7.84E+02	6.86E+02	-1.37E+02	4.94E-01
660	7.60E-04	7.60E-04	3.92E-04	7.60E-04	2.80E-04	2.57E-05	4.50E+02	-7.84E+02	6.86E+02	-1.37E+02	4.94E-01
690	7.61E-04	7.61E-04	3.92E-04	7.61E-04	2.81E-04	2.57E-05	4.50E+02	-7.85E+02	6.86E+02	-1.37E+02	4.94E-01
720	7.63E-04	7.61E-04	3.94E-04	7.61E-04	2.81E-04	2.57E-05	4.50E+02	-7.85E+02	6.86E+02	-1.37E+02	4.94E-01

## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A =0.00080)

Shrinkage strain =  $t/(t+35)*A$   
 Slab was cast B days before CIP deck  
 A = 8.00E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Free Shrinkage Strain  
 After Composite (f1-t)  
 CIP-deck

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

t (day)	Free Shrinkage Strain		Free Shrinkage Strain		Strain Slop (tan θ)	Strain (ε <sub>1</sub> )	Calculated Stress (psi)		Reinf. Req. (sq. in. per ft.)		
	From 0 days (0-t)	CIP-deck	Pre-slab	CIP-deck			slab_bot	slab_top		CIP_bot	CIP_Top
30	3.69E-04	0.00E+00	1.36E-04	3.69E-04	1.58E-05	6.86E-05	2.70E+02	-4.87E+02	4.46E+02	-5.89E+01	3.87E-01
60	5.05E-04	3.69E-04	2.07E-04	5.05E-04	2.02E-05	1.20E-04	3.45E+02	-6.23E+02	5.71E+02	-7.54E+01	4.95E-01
90	5.76E-04	5.05E-04	2.50E-04	5.76E-04	2.20E-05	1.56E-04	3.77E+02	-6.81E+02	6.23E+02	-8.23E+01	5.41E-01
120	6.19E-04	5.76E-04	2.79E-04	6.19E-04	2.30E-05	1.81E-04	3.93E+02	-7.10E+02	6.50E+02	-8.58E+01	5.64E-01
150	6.49E-04	6.19E-04	3.01E-04	6.49E-04	2.35E-05	2.00E-04	4.03E+02	-7.27E+02	6.65E+02	-8.79E+01	5.77E-01
180	6.70E-04	6.49E-04	3.16E-04	6.70E-04	2.39E-05	2.14E-04	4.09E+02	-7.38E+02	6.75E+02	-8.92E+01	5.86E-01
210	6.86E-04	6.70E-04	3.29E-04	6.86E-04	2.41E-05	2.26E-04	4.13E+02	-7.45E+02	6.82E+02	-9.01E+01	5.92E-01
240	6.98E-04	6.86E-04	3.39E-04	6.98E-04	2.43E-05	2.35E-04	4.16E+02	-7.50E+02	6.87E+02	-9.07E+01	5.96E-01
270	7.08E-04	6.98E-04	3.47E-04	7.08E-04	2.44E-05	2.43E-04	4.18E+02	-7.54E+02	6.90E+02	-9.11E+01	5.99E-01
300	7.16E-04	7.08E-04	3.54E-04	7.16E-04	2.45E-05	2.49E-04	4.19E+02	-7.57E+02	6.93E+02	-9.15E+01	6.01E-01
330	7.23E-04	7.16E-04	3.60E-04	7.23E-04	2.46E-05	2.55E-04	4.20E+02	-7.59E+02	6.95E+02	-9.17E+01	6.03E-01
360	7.29E-04	7.23E-04	3.65E-04	7.29E-04	2.46E-05	2.60E-04	4.21E+02	-7.61E+02	6.96E+02	-9.19E+01	6.04E-01
390	7.34E-04	7.29E-04	3.69E-04	7.34E-04	2.47E-05	2.64E-04	4.22E+02	-7.62E+02	6.97E+02	-9.21E+01	6.05E-01
420	7.38E-04	7.34E-04	3.73E-04	7.38E-04	2.47E-05	2.67E-04	4.23E+02	-7.63E+02	6.98E+02	-9.22E+01	6.06E-01
450	7.42E-04	7.38E-04	3.76E-04	7.42E-04	2.47E-05	2.71E-04	4.23E+02	-7.64E+02	6.99E+02	-9.24E+01	6.07E-01
480	7.46E-04	7.42E-04	3.79E-04	7.46E-04	2.48E-05	2.73E-04	4.24E+02	-7.65E+02	7.00E+02	-9.25E+01	6.08E-01
510	7.49E-04	7.46E-04	3.82E-04	7.49E-04	2.48E-05	2.76E-04	4.24E+02	-7.66E+02	7.01E+02	-9.25E+01	6.08E-01
540	7.51E-04	7.49E-04	3.84E-04	7.51E-04	2.48E-05	2.78E-04	4.24E+02	-7.66E+02	7.01E+02	-9.25E+01	6.09E-01
570	7.54E-04	7.51E-04	3.87E-04	7.54E-04	2.48E-05	2.81E-04	4.25E+02	-7.67E+02	7.02E+02	-9.26E+01	6.09E-01
600	7.56E-04	7.54E-04	3.89E-04	7.56E-04	2.48E-05	2.82E-04	4.25E+02	-7.67E+02	7.02E+02	-9.27E+01	6.09E-01
630	7.58E-04	7.56E-04	3.90E-04	7.58E-04	2.48E-05	2.84E-04	4.25E+02	-7.67E+02	7.02E+02	-9.28E+01	6.10E-01
660	7.60E-04	7.58E-04	3.92E-04	7.60E-04	2.49E-05	2.86E-04	4.25E+02	-7.68E+02	7.03E+02	-9.28E+01	6.10E-01
690	7.61E-04	7.60E-04	3.94E-04	7.61E-04	2.49E-05	2.87E-04	4.25E+02	-7.68E+02	7.03E+02	-9.28E+01	6.10E-01
720	7.63E-04	7.61E-04	3.94E-04	7.61E-04	2.49E-05	2.87E-04	4.25E+02	-7.68E+02	7.03E+02	-9.28E+01	6.10E-01



## CALCULATION OF STRESS DUE TO SHRINKAGE DIFFERENTIAL (A =0.00080)

Shrinkage strain =  $\frac{1}{t+(35)^*A}$   
 Slab was cast B days before CIP deck  
 A = 8.00E-04  
 B (days) = 3.00E+01  
 t start from casting of slab

Distance from Bottom  
 Bottom of slab (in.) = 0.00E+00  
 Top of slab (in.) = 1.20E+01  
 Bottom of CIP (in.) = 1.20E+01  
 Top of CIP (in.) = 2.00E+01

$h_{CIP}$  (in.) = 1.10E+01  
 $h_{slab}$  (in.) = 1.20E+01  
 $E$  (psi) = 4.00E+06  
 $f_y$  (psi) = 6.00E+04

t (day)	Free Shrinkage Strain		Free Shrinkage Strain After Composite (t1-t)		Strain (ε)	Strain Slop (tan θ)	Calculated Stress (psi)			Reinf. Req. (sq. in. per ft.)	
	From 0 days (t0-t)		CIP-deck				slab_bot	slab_Top	CIP_bot		CIP_Top
	Pre-slab	CIP-deck	Pre-slab	CIP-deck							
30	3.69E-04	0.00E+00	1.36E-04	3.69E-04	7.30E-05	1.52E-05	2.52E+02	-4.76E+02	4.56E+02	-2.94E+01	4.70E-01
60	5.05E-04	3.69E-04	2.07E-04	5.05E-04	1.26E-04	1.94E-05	3.23E+02	-6.10E+02	5.84E+02	-3.77E+01	6.01E-01
90	5.76E-04	5.05E-04	2.50E-04	5.76E-04	1.62E-04	2.12E-05	3.52E+02	-6.66E+02	6.38E+02	-4.11E+01	6.56E-01
120	6.19E-04	5.76E-04	2.79E-04	6.19E-04	1.88E-04	2.21E-05	3.68E+02	-6.95E+02	6.65E+02	-4.29E+01	6.84E-01
150	6.49E-04	6.19E-04	3.01E-04	6.49E-04	2.06E-04	2.27E-05	3.76E+02	-7.11E+02	6.81E+02	-4.39E+01	7.01E-01
180	6.70E-04	6.49E-04	3.16E-04	6.70E-04	2.21E-04	2.30E-05	3.82E+02	-7.22E+02	6.91E+02	-4.46E+01	7.11E-01
210	6.86E-04	6.70E-04	3.29E-04	6.86E-04	2.33E-04	2.32E-05	3.86E+02	-7.29E+02	6.98E+02	-4.50E+01	7.18E-01
240	6.98E-04	6.86E-04	3.39E-04	6.98E-04	2.42E-04	2.34E-05	3.88E+02	-7.34E+02	7.03E+02	-4.53E+01	7.23E-01
270	7.08E-04	6.98E-04	3.47E-04	7.08E-04	2.50E-04	2.35E-05	3.90E+02	-7.38E+02	7.06E+02	-4.56E+01	7.27E-01
300	7.16E-04	7.08E-04	3.54E-04	7.16E-04	2.56E-04	2.36E-05	3.92E+02	-7.40E+02	7.09E+02	-4.57E+01	7.30E-01
330	7.23E-04	7.16E-04	3.60E-04	7.23E-04	2.62E-04	2.37E-05	3.93E+02	-7.43E+02	7.11E+02	-4.59E+01	7.32E-01
360	7.29E-04	7.23E-04	3.65E-04	7.29E-04	2.66E-04	2.37E-05	3.94E+02	-7.44E+02	7.13E+02	-4.60E+01	7.33E-01
390	7.34E-04	7.29E-04	3.69E-04	7.34E-04	2.71E-04	2.38E-05	3.95E+02	-7.46E+02	7.14E+02	-4.61E+01	7.35E-01
420	7.38E-04	7.34E-04	3.73E-04	7.38E-04	2.74E-04	2.38E-05	3.95E+02	-7.47E+02	7.15E+02	-4.61E+01	7.36E-01
450	7.42E-04	7.38E-04	3.76E-04	7.42E-04	2.77E-04	2.38E-05	3.96E+02	-7.48E+02	7.16E+02	-4.62E+01	7.37E-01
480	7.46E-04	7.42E-04	3.79E-04	7.46E-04	2.80E-04	2.38E-05	3.96E+02	-7.48E+02	7.17E+02	-4.62E+01	7.37E-01
510	7.49E-04	7.46E-04	3.82E-04	7.49E-04	2.83E-04	2.39E-05	3.96E+02	-7.49E+02	7.17E+02	-4.63E+01	7.38E-01
540	7.51E-04	7.49E-04	3.84E-04	7.51E-04	2.85E-04	2.39E-05	3.97E+02	-7.49E+02	7.18E+02	-4.63E+01	7.39E-01
570	7.54E-04	7.51E-04	3.87E-04	7.54E-04	2.87E-04	2.39E-05	3.97E+02	-7.50E+02	7.18E+02	-4.63E+01	7.39E-01
600	7.56E-04	7.54E-04	3.89E-04	7.56E-04	2.89E-04	2.39E-05	3.97E+02	-7.50E+02	7.19E+02	-4.64E+01	7.39E-01
630	7.58E-04	7.56E-04	3.90E-04	7.58E-04	2.91E-04	2.39E-05	3.97E+02	-7.51E+02	7.19E+02	-4.64E+01	7.40E-01
660	7.60E-04	7.58E-04	3.92E-04	7.60E-04	2.93E-04	2.39E-05	3.97E+02	-7.51E+02	7.19E+02	-4.64E+01	7.40E-01
690	7.61E-04	7.60E-04	3.92E-04	7.61E-04	2.94E-04	2.39E-05	3.98E+02	-7.51E+02	7.19E+02	-4.64E+01	7.40E-01
720	7.63E-04	7.61E-04	3.94E-04	7.63E-04	2.94E-04	2.39E-05	3.98E+02	-7.51E+02	7.19E+02	-4.64E+01	7.40E-01

