Julio Ramirez

ANALYSIS OF NON-COMPOSITE CONCRETE SLAB ON METAL DECK

Lab #4

A 5" light weight concrete slab on a galvanized 2C22 steel deck. The concrete strength is 3000 psi and it is placed on the simple supported deck.

#1) Determine the maximum steel deck construction stress on a 6 ft simple span. Does it meet SDI requirements? If not choose an adequate deck.

For 2C22 deck (pg 28,29 of manual) $L := 6$ ft $S_p := 0.283$ in^3 / ft $S_n := 0.287$ in^3 / ft

$I_p := 0.338$ in^4

$Fy := 33$ ksi $Fb_{allow} := 0.6 \cdot Fy$ $Fb_{allow} = 19.8$ ksi or 36 ksi (whichever is less)

Define loads W1 = slab weight + deck weight $W1 := 39$ psf Chart on pg 28

W2 = 20 psf construction load $W2 := 20$ psf Sec 3.2a

P1 = 150 lb concentrated load $P1 := 150$ lb Sec 3.2a

For the simple span check the 2 cases on page 36

Case 1 positive moment $M1 := \left[(0.25 \cdot P1 \cdot L) + 0.188 \cdot W1 \cdot L^2\right]$ $M1 = 488.952$ lb*ft

Positive Moment Stress $fb_1 := \frac{M1 \cdot 12}{S_p \cdot 1000}$ $fb_1 = 20.73$ ksi

$fb_1 = 20.733$ ksi < $Fb_{allow} = 19.8$ ksi **NOT OK**

Case 2 positive moment $M2 := 0.125 \cdot (1.5W1 + W2) \cdot L^2$ $M2 = 353.25$ lb*ft

Positive Moment Stress $fb_2 := \frac{M2 \cdot 12}{S_p \cdot 1000}$ $fb_2 = 14.98$ ksi

$fb_2 = 14.979$ ksi < $Fb_{allow} = 19.8$ ksi **OK**

Steel deck does not work for Case 1 - Choose adequate deck

Julio Ramirez

If we keep the same weight of deck the moment on the deck will stay the same. We can solve for a required S value

$$S_{req} := \frac{Fb_{allow} \cdot 1000}{M1 \cdot 12} \qquad S_{req} = 3.375 \text{ in^3}$$

A 2C20 Deck will meet this required S value - OK

Also Check Deflection for the 2C20 deck $E := 29000000$ psi $I_{p2} := 0.423$ in^4

$$\Delta 1 := \frac{0.013 \cdot W1 \cdot L^4}{E \cdot I_{p2}} \cdot 1728 \qquad \Delta 1 = 0.093 \text{ in}$$

Allowable Deflection $\Delta_{allow} := \frac{L \cdot 12}{180}$ $\Delta_{allow} = 0.4$ in Therefore deflection is OK

#2) Revise the design assuming the 2C22 deck is used on a 3-span condition. Does the deck now meet SDI construction load limits on a 6 ft span?

3 span conditions on pg 36

Case 1 positive moment $M1 := \left[(0.20 \cdot P1 \cdot L) + 0.094 \cdot W1 \cdot L^2\right] \cdot 12$ $M1 = 3743.712$ lb*in

Positive Moment Stress $fb_1 := \frac{M1}{S_p \cdot 1000}$ $fb_1 = 13.23$ ksi

$fb_1 = 13.229$ ksi < $Fb_{allow} = 19.8$ ksi **OK**

Case 2 positive moment $M2 := 0.094 \cdot (W1 + W2) \cdot L^2 \cdot 12$ $M2 = 2395.872$ lb*in

Positive Moment Stress $fb_2 := \frac{M2}{S_p \cdot 1000}$ $fb_2 = 8.47$ ksi

$fb_2 = 8.466$ ksi < $Fb_{allow} = 19.8$ ksi **OK**

Case 3 negative moment $M3 := 0.117 \cdot (W1 + W2) \cdot L^2 \cdot 12$ $M3 = 2982.096$ lb*in

Negative Moment Stress $fb_3 := \frac{M3}{S_p \cdot 1000}$ $fb_3 = 10.54$ ksi

$fb_3 = 10.537$ ksi < $Fb_{allow} = 19.8$ ksi **OK**

Stress on 3-span condition meet SDI requirements - OK

Julio Ramirez

Deflection

$\Delta 2 := \frac{0.0069 \cdot W1 \cdot L^4}{E \cdot I_p} \cdot 1728$ $\Delta 2 = 0.061$ in < $\Delta_{allow} = 0.4$ in OK

Steel Deck meets deflection requirements - OK

#3) Based on ACI-318 Criteria, select 4x4 W2.9xW2.9 as reinforcement to carry a service live load of 120psf on the 6 ft simply supported span. Assume the reinforcing is undraped. Does the reinforcement satisfy the requirements for moment capacity of the slab?

Known Values	2C22 Steel Deck	$h := 2$	in		
	Height of slab	$D := 5$	in		
	thickness above deck	$t := D - h$	$t = 3$	in	
	Undraped WWF reinforcement distance from comp face to reinf.	$d1 := \frac{t}{2}$	$d1 = 1.5$	in	compression top

Maximum Moments due to superimposed loads

$w := 120$ psf Given in problem

The value from the chart is a service live load - Must use load factors to determine maximum moment

Load factor for live load $ll := 1.7$

Positive Moment only for a simply supported slab

$Mu_p := \frac{ll \cdot w \cdot L^2}{8}$ $Mu_p = 918$ lb-ft

Julio Ramirez

Find moment capacity of slab (per foot width)

Flexure Positive Moment - Compression on Top, Tension on Bottom

Known Values	Area of steel (per foot)	$As := 0.087$	in^2	Pg 28
	Yield of Steel	$fy := 60$	ksi	
	Conc comp. strength	$f_c := 3$	ksi	
	width	$b := 12$	in	

Sum of forces in horizontal direction = 0 C=T

C = 0.85*f.c*a*b T = As*fy

Find value of a $a1 := \frac{As \cdot fy}{0.85 \cdot f_c \cdot b}$ $a1 = 0.171$ in compression zone in concrete

Sum of moments = 0 Sum moments about C

Force $T1 := As \cdot fy$ Distance $z1 := d1 - \frac{a1}{2}$ $z1 = 1.415$ in

Nominal Positive Moment Capacity of Slab

$Mn1 := T1 \cdot z1$ $Mn1 = 7.385$ k-in

Factored Nominal Capacity $\phi := 0.9$ ACI 318 factor for flexure

$\phi Mn1 := \phi \cdot Mn1 \cdot \frac{1000}{12}$ $\phi Mn1 = 553.86$ ft-lb

Compare Maximum Positive Moment and Factored Nominal Moment

$Mu_p = 918$ lb-ft > $\phi Mn1 = 553.857$ lb-ft **NO GOOD**

The reinforcement does not satisfy the requirements for moment capacity