DEVCO engineering inc.

Structural Design Calculations

Heavy Duty Washout Pans

Prepared For: Consolidated Fabricators Corp.
Project No.: 18-668
Date: June 26, 2018

Table of Contents

Structural Design Calculations

for

Heavy Duty Washout Pans

Devco Job # 18-668
June 26, 2018

Subject	Page
Design Criteria	1
Discussion of RISA 3D Results	2
Padeye Design	3-4
Risa 3D Model Results	Appendix.

DEVCO engineering inc.

Physical Address
245 NE Conifer Blvd.
Corvallis, OR 97330

Mailing Address
P.O. BOX 1211
Corvallis, OR 97339

www.devcoengineering.com

(541) 757-8991
Fax: (541) 757-9885

PROJECT: Con-fab Washout Pans	PROJECT NO: 18-668	DESIGN: JC	DATE: 6/18

Design Criteria:

The design criteria of the washout pans includes the maximum allowable stresses provided by the AISC Steel Construction Manual Edition 14 and by the ASME Design of Below the Hook Lifting Devices 2014.

AISC Requirements (Steel Construction Manual Fourteenth Edition)

AISC requires the following factors of safety:

1.67 on Flexural Yielding	Ref. pg 16.1-46
1.5 on Shear Connections	Ref. pg 16.1-129
2.0 on Block Shear Connections	Ref. pg 16.1-129
2.0 on Welded Connections	Ref. pg 16.1-115

ASME Requirements (ASME BTH-1-2014)

ASME requires the following factors of safety:

2.0 on Flexural Yielding	Ref. pg 10
3.17 on Shear Connections	Ref. pg 16
Block shear is undefined	n/a
2.4 on Welded Connections	Ref. pg 17

Design Loads:

Design loads include the dead load of the pans and the hydrostatic live load of 150 lbs/cu. ft. at the full volume capacity of the pans.

84"x84"x24" Pan
DL= 1,300 lbs
LL= 587 gallon capacity = 78.5 cu. ft. x 150 lbs/cu. ft. = 11,775 lbs

84"x84"x14" Pan
DL= 930 lbs
LL= 271 gallon capacity = 36.2 cu. ft. x 150 lbs/cu. ft. = 5,430 lbs

Additional Information:

Only the design of the washout pans and lifting eyes has been considered. Design of elements and components of the rigging system is by others. The lifting configuration must load all (4) lifting eyes equally and at a minimum angle of 48 degrees measured from the horizontal.

DEVCO engineering inc.

Physical Address
245 NE Conifer Blvd.
Corvallis, OR 97330

Mailing Address
P.O. BOX 1211
Corvallis, OR 97339

www.devcoengineering.com

(541) 757-8991
Fax: (541) 757-9885

PROJECT: Con-fab Washout Pans	PROJECT NO: 18-668	DESIGN: JC	DATE: 6/18

Discussion of RISA 3D Results:

Finite element modeling (RISA 3D) was used to analyze the stresses in the washout pan created by a single pick point overhead lift. The maximum allowable stress (per the design criteria section of this calculation package) is equal to the yield strength of the material divided by a factor of safety of 2.0. In this case:

Fy/2.0 = (36 ksi)/2.0 = 18 ksi (Gr. A36 Steel)

Both the 84x84x24" pan and the 84x84x14" pan were limited in strength by flexural yielding in the base of the pan.

84x84x24" Pan:

Per the RISA 3D analysis, the maximum stress created by the design loads is 17 ksi, located along the extreme bending fibers of the base stiffeners. This falls below the maximum allowable stress of 18 ksi, therefore is ok for use at the rated live load of 12,000 lbs.

84x84x14" Pan:

Per the RISA 3D analysis, the average maximum stress created by the design loads is 14.8 ksi, located in the center of the base and along the perimeter of the base. Additionally, there are localized maximum stresses around the fork lift pockets up to 24.8 ksi. These localized maximum stresses are created by the additional stiffness of the fork lift pockets and since they fall within the elastic deformation region of the steel, they can be negated, as any deflection around the area will cause a redistribution of stresses.

By comparison of the average maximum stress of 14.8 ksi to the 18 ksi maximum allowable stress, this pan is ok for use at the rated live load of 5,500 lbs.

DEVCO engineering inc.

Physical Address
245 NE Conifer Blvd.
Corvallis, OR 97330

Mailing Address
P.O. BOX 1211
Corvallis, OR 97339

www.devcoengineering.com

(541) 757-8991
Fax: (541) 757-9885

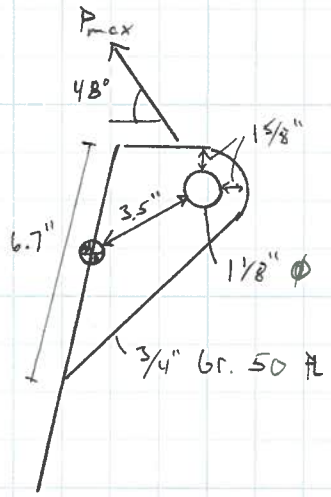
PROJECT: Con-tab Washout Pans	PROJECT NO: 18-648	DESIGN: JC	DATE: 6/18

Padeye Check

$$P_{max} = \frac{DL_{max} + LL_{max}}{4}$$

$$= \frac{1300\ lbs + 12{,}000\ lbs}{4}$$

$$= 3.4\ k$$



Shear Yielding

$R_n = 0.6\ F_y\ A_{nv}$ (AISC J4-4)

$F_y = 50\ ksi$
$A_{nv} = 2(3/4")(1\ 5/16") = 1.97\ in^2$

$R_n = 59\ kips$

$R_a = \frac{R_n}{FS = 3.17} = 18.6\ k > P_{max}$ ✓ok (FS = 17)

Block Shear Rupture

$R_n = 0.6\ F_y\ A_{gv} + U_{bs}\ F_u\ A_{nt}$ (AISC J4-5)

$F_y = 50\ ksi$
$F_u = 60\ ksi$
$A_{gv} = (3/4")(1\ 5/16") = 0.985\ in^2$
$A_{nt} = (3/4")(1\ 5/16") = 0.985\ in^2$
$U_{bs} = 1.0$

$R_n = 88.6\ kips$

$R_a = \frac{R_n}{F_s = 2} = 44\ k > P_{max}$ ✓ok (FS = 26)

DEVCO engineering inc.

Physical Address
245 NE Conifer Blvd.
Corvallis, OR 97330

Mailing Address
P.O. BOX 1211
Corvallis, OR 97339

www.devcoengineering.com

(541) 757-8991
Fax: (541) 757-9885

PROJECT: Con-tab Washout Pans	PROJECT NO: 18-668	DESIGN: JC	DATE: 6/18

Padeye Check (Cont.)

Weld

$$q_y = \frac{P_{max} \sin(48)}{2(6.7")} = 0.19 \text{ k/in}$$

$$q_x = \frac{P_{max} \cos(48)}{2(6.7")} = 0.17 \text{ k/in}$$

$$q_{mx} = \frac{P_{max}(3.5")}{\frac{(6.7")^2}{3}} = 0.795 \text{ k/in}$$

$$Q_r = q_y + (q_x^2 + q_{mx}^2)^{1/2} = 1.0 \text{ k/in}$$

Try 1/4" Fillet Weld (Minimum)?

$R_n = F_{nw} A_{we}$ (AISC J2-3)
$= 0.6 F_{Exx} \times 0.707 a$
$= 0.6 (70 \text{ ksi}) 0.707 (1/4")$
$= 7.42 \text{ k/in}$

$$R_a = \frac{R_n}{FS = 2.4} = 3.09 \text{ k/in} > Q_r \quad \underline{\text{Ok}} \quad (FS = 7.4)$$

∴ Padeye OK

Limiting Failure = Weld (FS = 7.4)

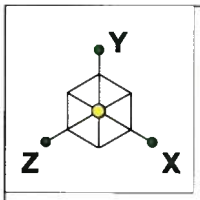
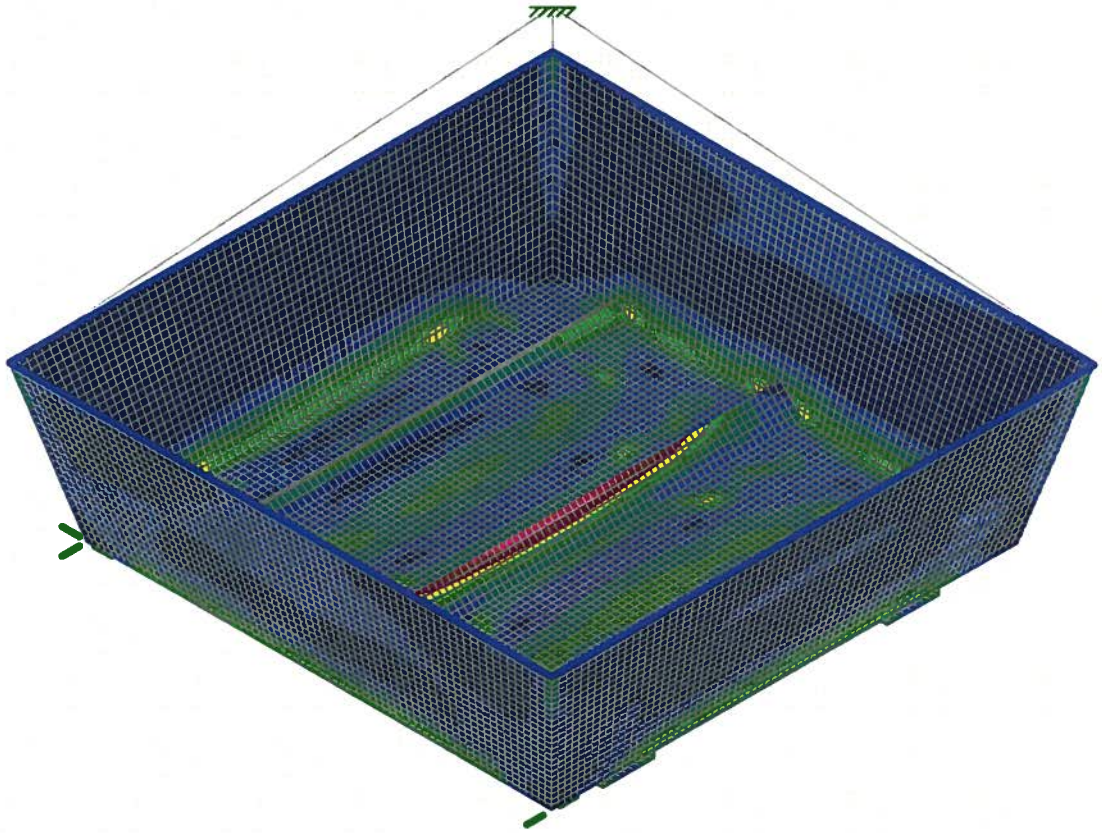


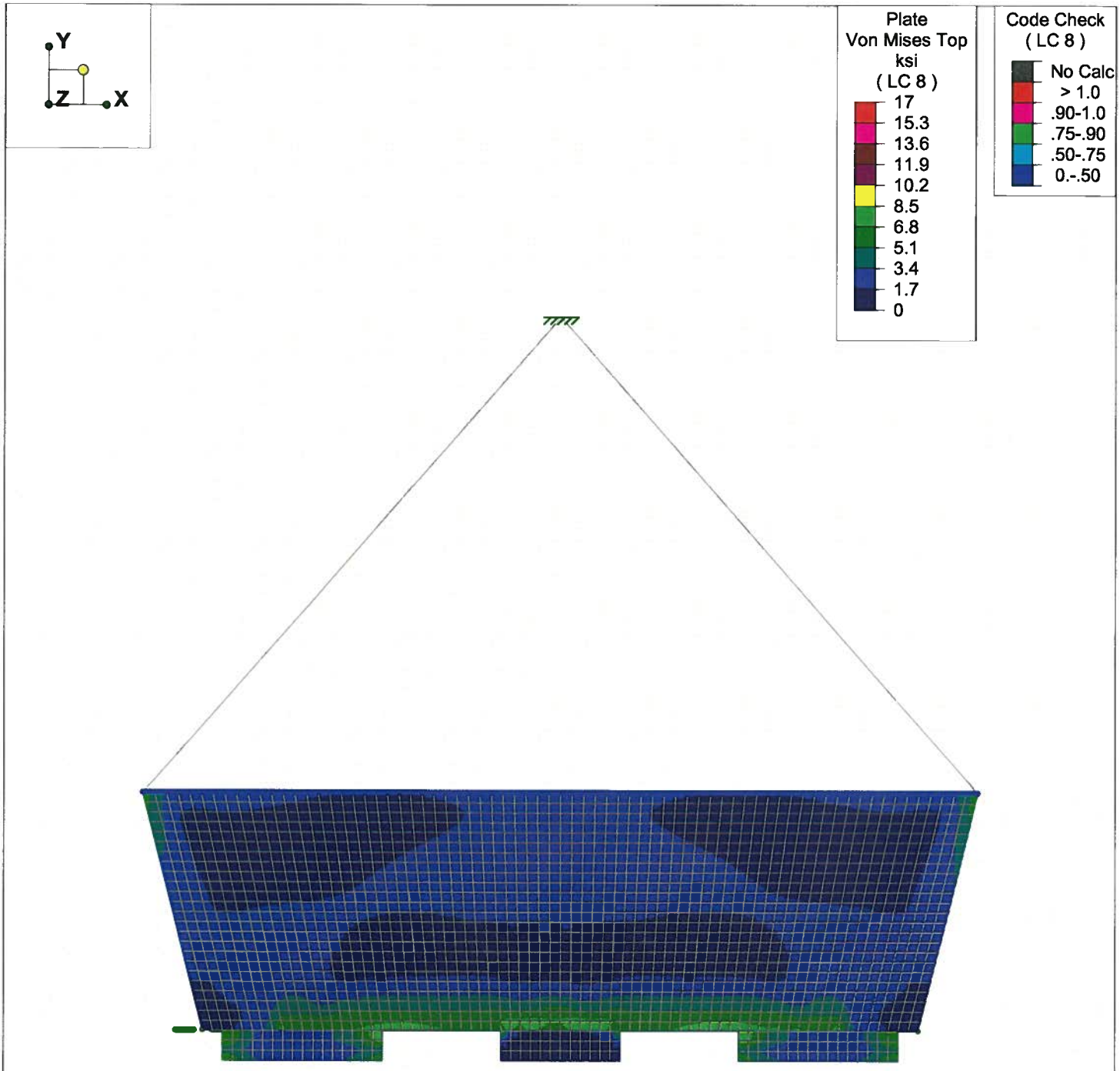
Plate
Von Mises Top
ksi
(LC 8)
17
15.3
13.6
11.9
10.2
8.5
6.8
5.1
3.4
1.7
0

Code Check
(LC 8)
No Calc
> 1.0
.90-1.0
.75-.90
.50-.75
0.-.50



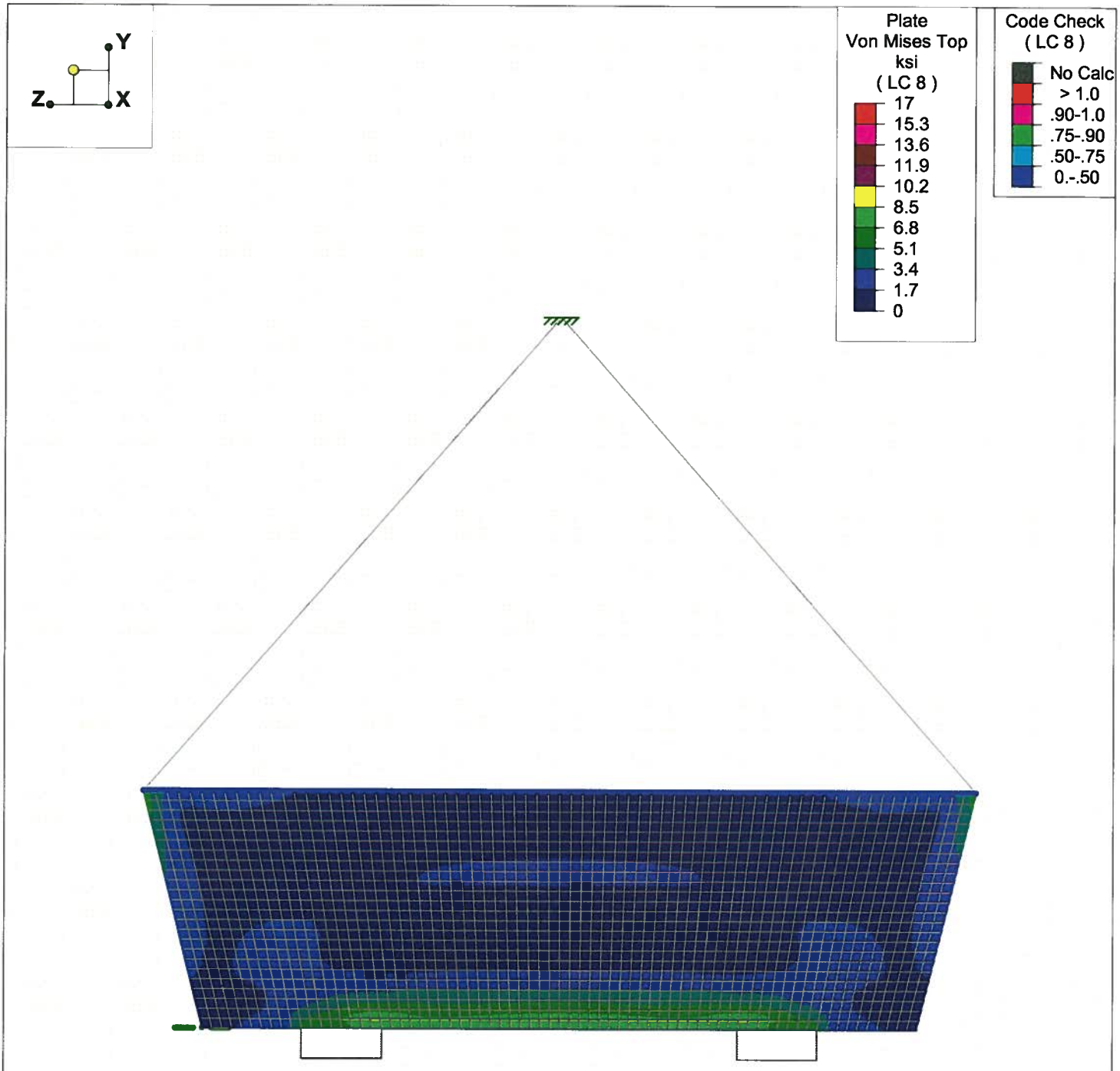
Results for LC 8, 12000 lb Load Rating

Devco Engineering	84x84x24 Bin Pan	SK - 1
JC		June 22, 2018 at 3:33 PM
18-668		Large Pan_Singlepick_stiffened2.r3d



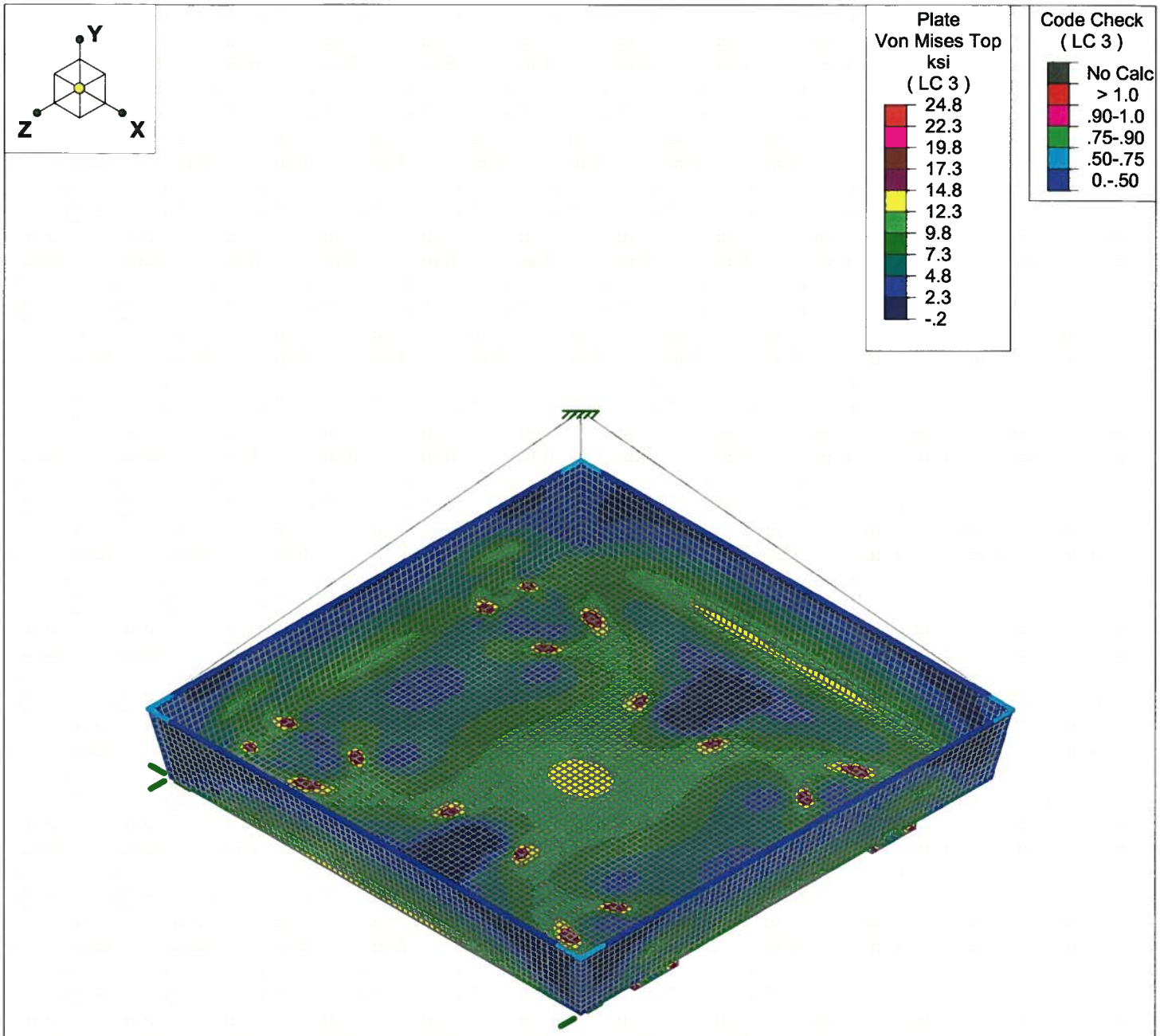
Results for LC 8, 12000 lb Load Rating

Devco Engineering	84x84x24 Bin Pan	SK - 2
JC		June 22, 2018 at 3:33 PM
18-668		Large Pan_Singlepick_stiffened2.r3d



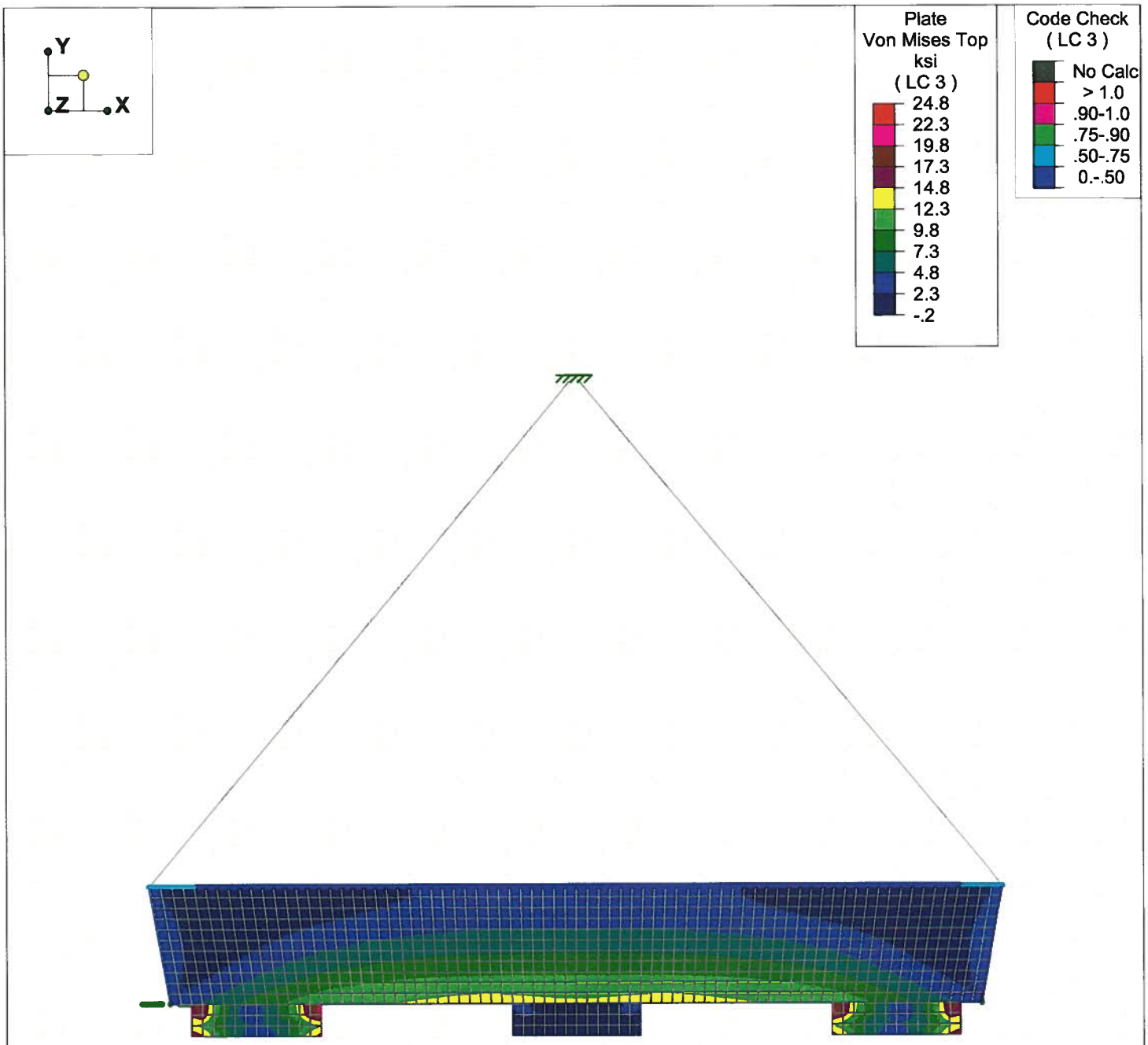
Results for LC 8, 12000 lb Load Rating

Devco Engineering	84x84x24 Bin Pan	SK - 3
JC		June 22, 2018 at 3:33 PM
18-668		Large Pan_Singlepick_stiffened2.r3d



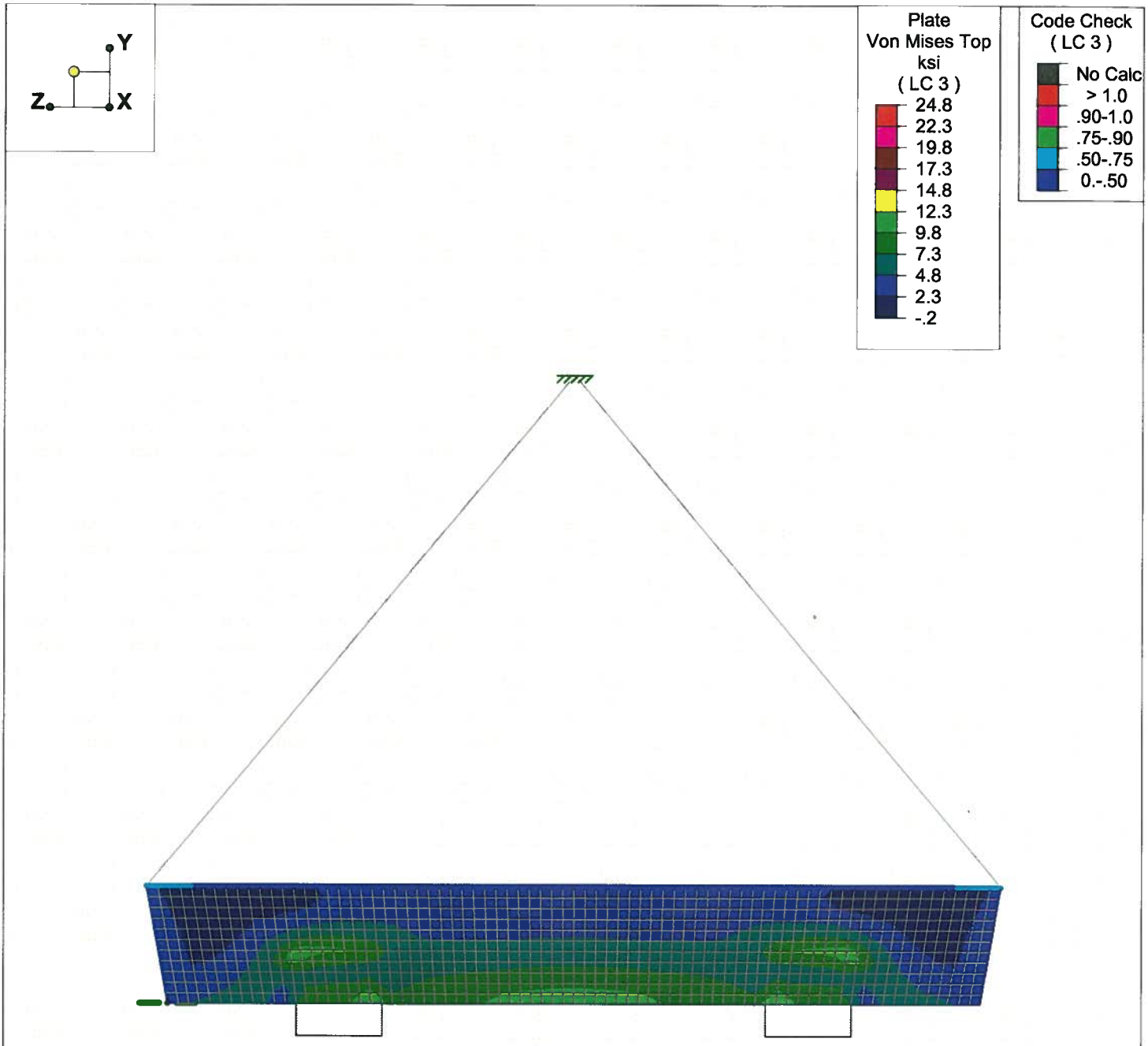
Results for LC 3, 5500 lbs Live Load

Devco Engineering	84x84x14 Bin Pan	SK - 1
JC		June 22, 2018 at 3:57 PM
18-668		Small Pan_Singlepick.r3d



Results for LC 3, 5500 lbs Live Load

Devco Engineering	84x84x14 Bin Pan	SK - 2
JC		June 22, 2018 at 3:57 PM
18-668		Small Pan_Singlepick.r3d



Results for LC 3, 5500 lbs Live Load

Devco Engineering	84x84x14 Bin Pan	SK - 4
JC		June 22, 2018 at 3:29 PM
18-668		Small Pan_Singlepick.r3d