APPENDIX D

STRUCTURAL CONCRETE DESIGN CALCULATIONS

SM &RC STRUCTURAL ENGINEERS INC.

CALCULATION TITLE SHEET

CLIENT & PROJECT:
Golder/Pinon Ridge Project

PAGE 1 OF 57
(including Attach)

CALCULATION TITLE:

ORE PAD CONCRETE SLAB DESIGN

CALCULATION IDENTIFICATION NUMBER

JOB NUMBER	DIVISION & GROUP	CURRENT CALC NO.	OPTIONAL TASK CODE
G1-2008-1	STRUCTURAL	SC-1	NA

APPROVALS – SIGNATURE & DATE

PREPARER(S)/ DATE(S)	REVIEWER(S)/ DATE(S)	QUALITY CONTROL REVIEWER(S)/ DATE(S)	REVISION NO.	SUPERSEDES REVISION NO.	CONFIRMATION (√)	
					YES	NO
DAVID BLANCHETTE	RAIN MUDADI RM 6/09/08		O	NA		X

COLORADO REGISTERED PROFESSIONAL ENGINEER
DAVID ALEXANDER BLANCHETTE
6/19/08
22599

DISTRIBUTION

GROUP	NAME & LOCATION	COPY SENT (√)	GROUP	NAME & LOCATION	COPY SENT (√)
PROJECT	FILE	X			
GOLDER	FILE	X			

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Calculation Title: Ore Pad Concrete Design
Client: Golder
Project: Pinon Ridge Project
Job No.: G1-2008-01

Sheet: 2 of
Calculation No.: SC-1
Preparer: Dave Blanchette
Revision: 0

Page No.	Description	Original Review	Revision No.	Revision Date	Remarks
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2	Table of Contents				
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4 to 6	Design Review Discussion				
7, 8	Wheel Loads Free Body				
9 to 34	FEM Analysis Discussion & Output Results				
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56, 57	Concrete Reinforcement Design				

Calculation Summary

Calculation Title: Ore Pad Concrete Design
Client: Golder
Project: Pinon Ridge Project
J.O. G1-2008-01

Sheet: 3 of
Calculation No.: SC-1
Preparer: Dave Blanchette
Revision: 0

Objective of Calculation:

Design Concrete Ore Pad and Truck Dump Pad for Pinion Ridge Uranium Project

Calculation Method & Assumptions:

1. Standard Engineering Elastic Analysis Methods
2. Ultimate Strength Concrete Design
3. Concrete Ore Pad and Dump Pad will be driven on by a Catipillar 988H Wheel Loader and a 770 Off-Highway Truck
4. Modulus of Subgrade Reaction for Pad foundation soils will be 200 pci or greater.

Sources of Data/Equations:

1. Catipillar Inc. Product Data (included in attachment A)
2. Golder Associates, Phase 2 Geotechnical Field and Laboratory Program for project
3. Army TM 5-809-12 Concrete Floor Slabs on Grade Subjected to Heavy Loads
4. ACI 360R-06 Design of Slabs-on-Ground
5. ACI 325.12R-02 Design of Jointed Pavements for streets and Local Roads
6. ACI 318 Building Code Requirements fo Structural Concrete

Conclusions:

See attached calculations for design of concrete Ore and Truck Dump Pads

Reviewer Comments:		Date
	Preparer: Dave Blanchette	5/29/2008
	Reviewer/Checker:	
	Independent Reviewer:	

Site Investigation Summary
Reference Golder Associates Phase 2 Geotechnical Field and Laboratory Program
Pinon Ridge Project, Montrose County Colorado

In the location of the 1- acre ore pad several boring were performed and one test pit was made. The pad is anticipated to be supported on or about existing grade. The test bore showed the following information about the foundation materials the slab would be placed on.

Test Pit GA-TP-10
Existing grade is at elevation 5529.5 feet
For depths of 1 to 4 feet foundation soil is silty clay (CL-ML)
For depths 4 to 5.5 feet the foundation soil is fined grain silty sand (SM)
For depths 5.5 to 10 feet the foundation soil fine grained silty sand (SM)

Bore Hole GA-BH-44
Existing grade is at elevation 5524.1 feet
For depths of 1 to15 feet foundation soil is sandy silt (ML)
Blow Count per 6" = range from 4 to 11

Bore Hole GA-BH-45
Existing grade is at elevation 5532.5 feet
For depths of 1 to 18 feet foundation soil is silty sand (SM)
Blow Count per 6" = range from 4 to 11

Bore Hole GA-BH-46
Existing grade is at elevation 5538.5 feet
For depths of 1 to 12 feet foundation soil is silty sand (SM)
For depths of 12 to 50 feet foundation soil is sand with some silt, some clay (SM-SC)
Blow Count top 12 feet per 6" = range from 7 to 10
Blow Count 12 to 30 feet per 6" = 9 to 40

Reference: Army TM 5-809-12 Concrete Floor Slabs on Grade Subjected to Heavy Loads (Following Data Provided for Info Only)

Modulus of sub-grade reaction for CL and ML soils at 9 to 12% moisture content = 175 lbs/in^3, at 13 to 16% moisture content = 150 lbs/in^3
Modulus of sub-grade reaction for SM and SC soils at 9 to 12% moisture content = 225 lbs/in^3, at 13 to 16% moisture content = 200 lbs/in^3

Concrete Slab Thickness Design

28 day concrete compressive strength required = 5000 psi

Modulus of rupture s = 9 $(fc')^{1/2}$ = 636 psi.

Modulus of elasticity = 4.0×10^6 psi

Allowable Tensile Stress in Concrete = 318 psi (safety factor = 2)

See stresses developed by FEM analysis

Modulus of sub-grade reaction for design shall be 200 pci. (Geotechnical Engineer to provide sub grade design to meet this design requirement)

Use of Steel Reinforcement

Reinforcement will be used for the project for the following reasons.

1. Increase bending strength of slab.
2. Allow for wider joint spacing.
3. Limit width of cracks which may develop and enhance the load transmission across cracked slab zones.
4. Control cracking which may occur as a result of unanticipated support foundation soil settlement.
5. To reduce crack size from sub-grade drag

Required reinforcement for sub grade drag forces.

As = (F)(L) (w) / 2 (fs) = 1.5 (80 ft) (125 lbs/ft^2)/ 2 (60,000 psi) = 0.125 in^2/ Ft

Slab Control Joint Dowel Design

Wheel Load Transfer Force = 30,000 lbs (occurs over a 4 Ft width)

Recommended Dowel size is 1-1/4 "

Recommended development into slab either side of joint = 9 " min.

Allowable bearing on dowel = 0.45 fc' = 2250 psi

Dowels required per 4 foot width = (2x30,000 lbs)/2250 psi (1.25")(9") = 2.37
Use 18 inch long, 1.25 "diameter, smooth dowels at 12 inch spacing.

Cracking Control Measures

Maximum Slump for concrete = 4"

Concrete course aggregate gradation shall be ASTM C 33, Size No. 467

Air Content of Mix shall be 5 +/- 1 percent

Concrete mix shall contain no admixtures except an air entrainer

Concrete for mix shall have low shrinkage properties. Use ASTM C 150, Type II Cement

Distribute reinforcement with a 14" spacing to allow for construction foot traffic access between bars during construction.

Thicken edges to reduce curling.

Sub-grade shall be compacted to a smooth surface uniform.

Frost Level for area is 20" below grade, Foundation material within frost zone shall be non-frost susceptible soil material, recommended soil classification is SM or better (SU,SP,SW)

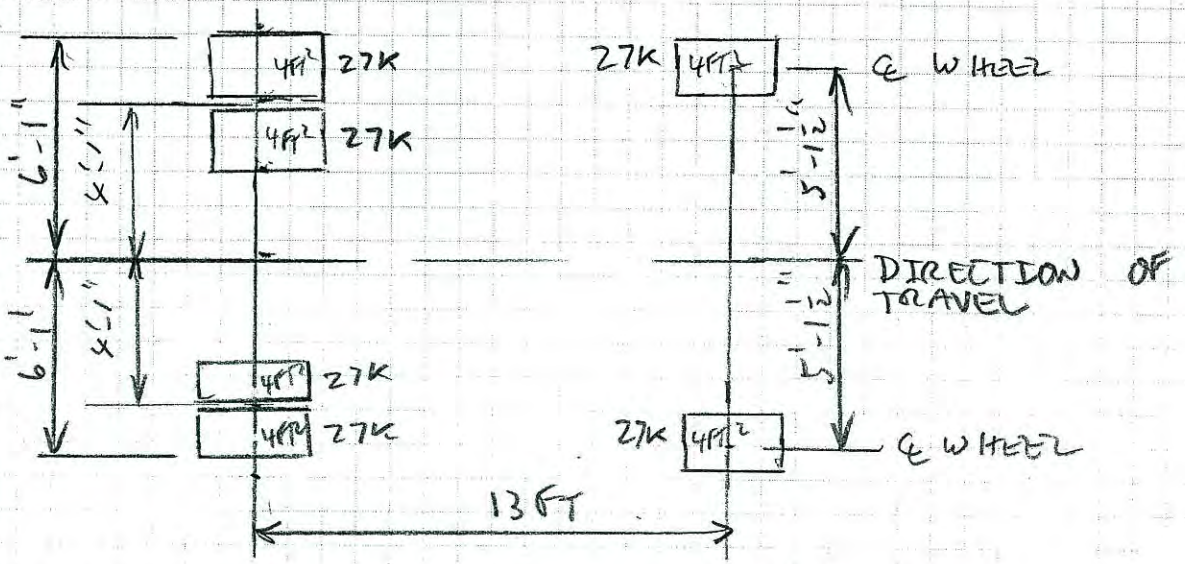
SM&RC Structural Engineers Inc.

Page No. 7
Preliminary
Item

CALCULATION SHEET

Client GOLDER | Location | Est. No. | J.O. No.
Subject PINON RIDGE ORE PAD | Date 5/29/08 By DAB
DEVELOP WHEEL LOAD PATTERN FOR TRUCK | Checked By
Based on SEE APPENDIX A | Revised By

WHEEL LOAD - 770 OFF HIGHWAY TRUCK CAT
TIRE = 18.00R33 (E4)



TOTAL AXIAL → 64% (157 KIPS) = 100 KIPS ±

34% (157 KIPS) = 53 KIPS ±

SPREAD OVER 16 FT²

SPREAD OVER 8 FT²

STATIC TIRE LOAD ≈ 27K/EACH

STATIC TIRE LOAD = 27K/EACH

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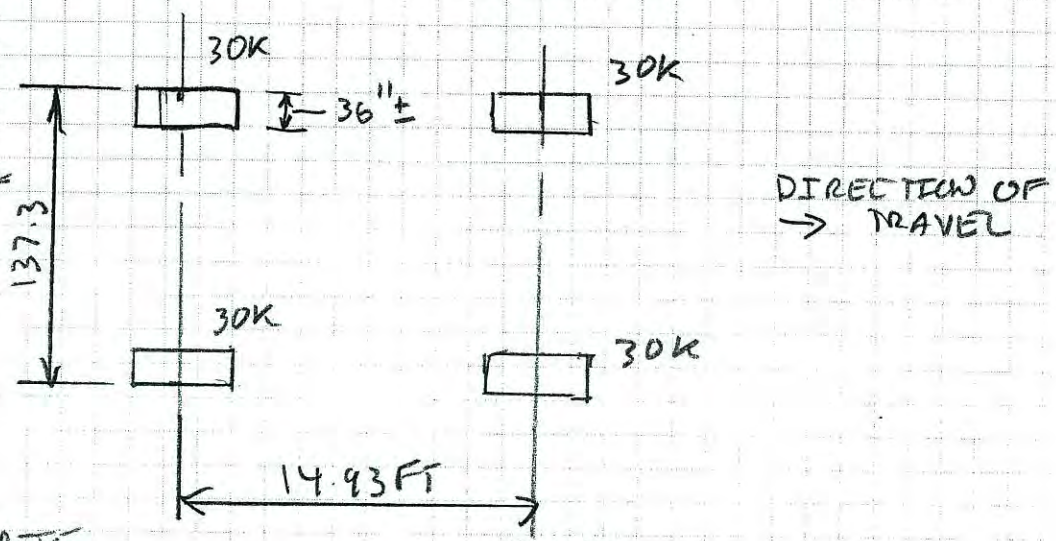
SM&RC Structural Engineers Inc.

Page No. 8
Preliminary
Item

CALCULATION SHEET

Client GOLDER | Location | Est. No. | J.O. No.
Subject PINON RIDGE ORE PAD | Date | By
DEVELOP WHEEL LOAD PATTERN FOR LOADER | Checked | By
Based on SEE APPENDIX A. | Revised | By

WHEEL LOAD LOADER 988H CATERPILLAR.
USE 35/65/R33 TIRES, DIA = 86.5", WIDTH = 35.7" ±
GROSS CONTACT AREA = 618 IN², LOAD LIMIT @ 5 M/HR
= 43,000 lbs



STATIC TIRE LOAD ≈ 30 KIPS/EACH
SPREAD OVER 4 FT²

STATIC TIRE LOAD ≈ 30 KIPS / EACH
SPREAD OVER 4 FT²

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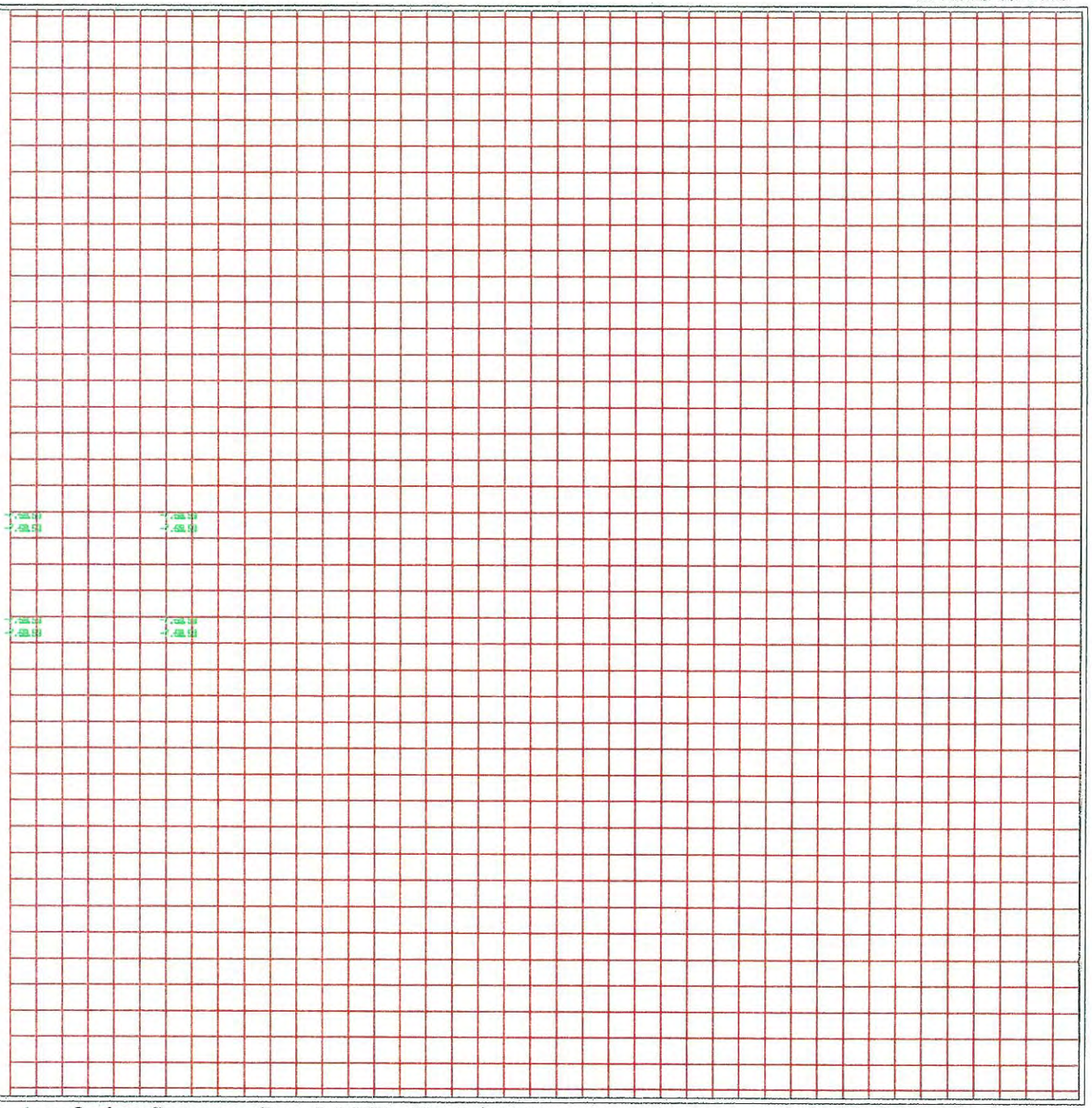
Pinon Ridge Ore Slab Design
Finite Element Analysis Discussion

The following analysis is for the ore pad and truck dump pad being loaded at their edge and at their interior areas. The loads used for analysis allow for the ore pad to be exposed to the specified loader loads and the truck pad to be exposed to the larger specified truck loads. The analysis shows that the maximum working stress positive moment in the interior of the slab is approximately 3.0ft-kips per foot width of slab. At the ore pad and truck dump pad edges the maximum negative working stress moment is 5.4ft-kips per foot.

Concrete ultimate moment design calculations show that the required area of steel is #5 at 14 inch on center in the interior of the slab. This moment steel is installed a minimum of 4 inches clear from the top of the slab. For the thickened edges of the slab an additional 2 #5s were installed to accommodate the higher slab edge moments. Ultimate moment design calculations include a load factor of 1.6 for the working stress load.

The maximum working stress shear stress calculated at the slab edge is equivalent to 4.20 kips/ft = an ultimate shear 0f 6.72kips/ft. The shear stress is = to 51psi (d=11, b=12). For the interior slab the max shear is 3.01 kips/ft. Assuming the worst possible case where this shear occurs at a positive bending (tension bottom of the slab) the shear in the slab = 94psi. Allowable slab shear stress is 0.75(4)(4500)^1/2 = 201 psi.

The following calculation pages are presented as a summary of the moment (M11, M22) and Shear V13, V23 output results for the FEM analysis.


FEM LOADED PRESSURE LOADS DIAGRAM

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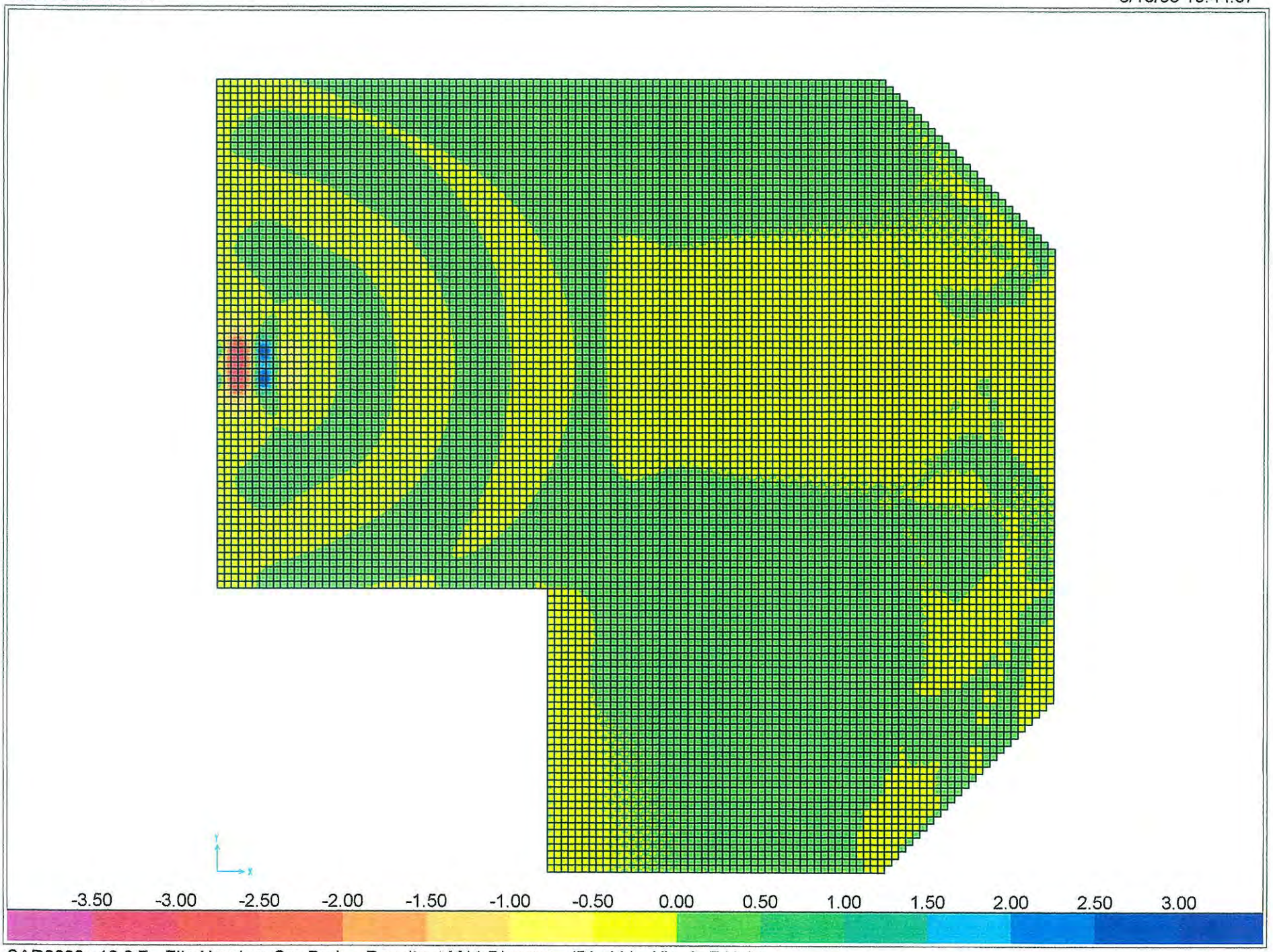

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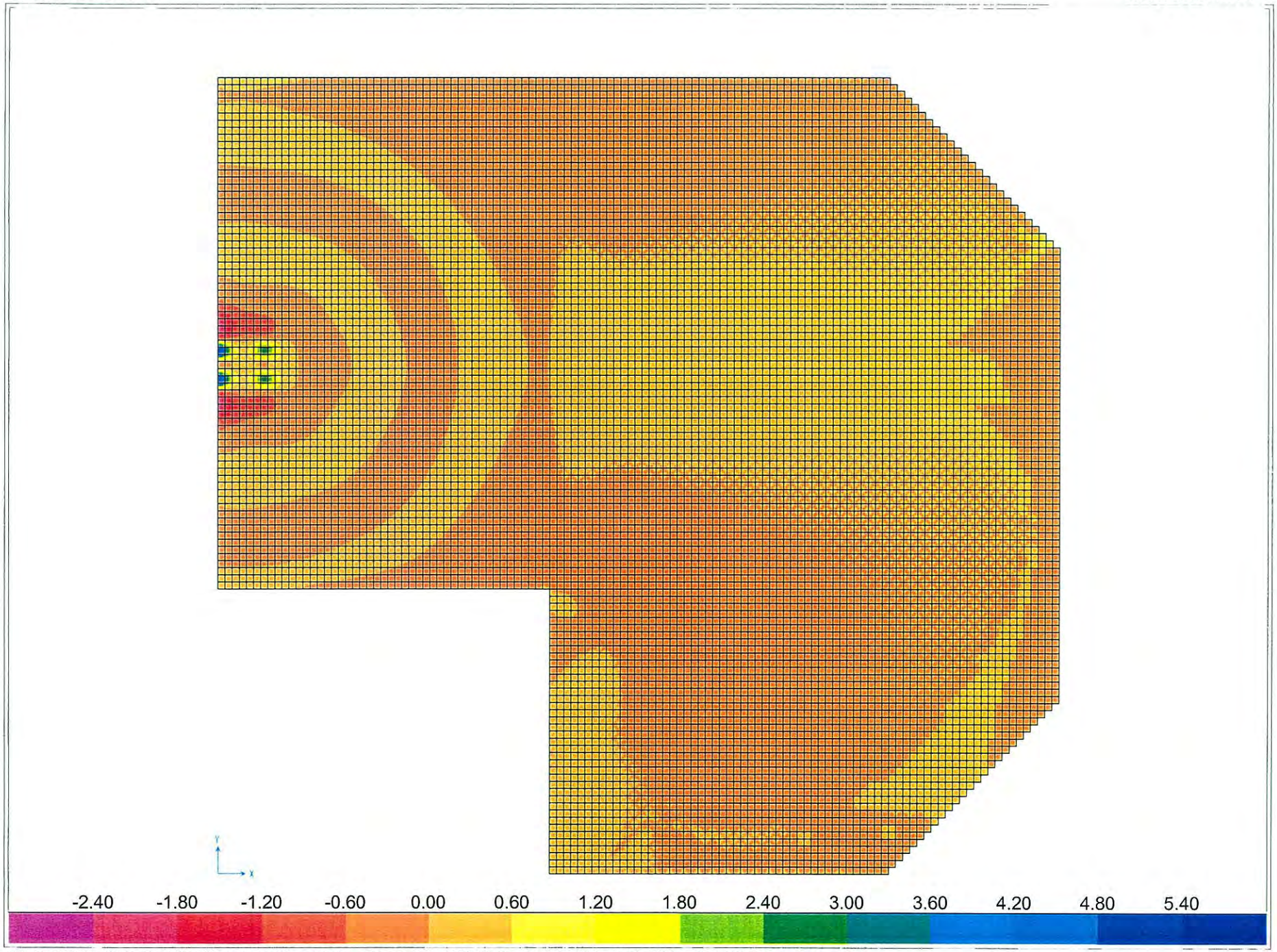

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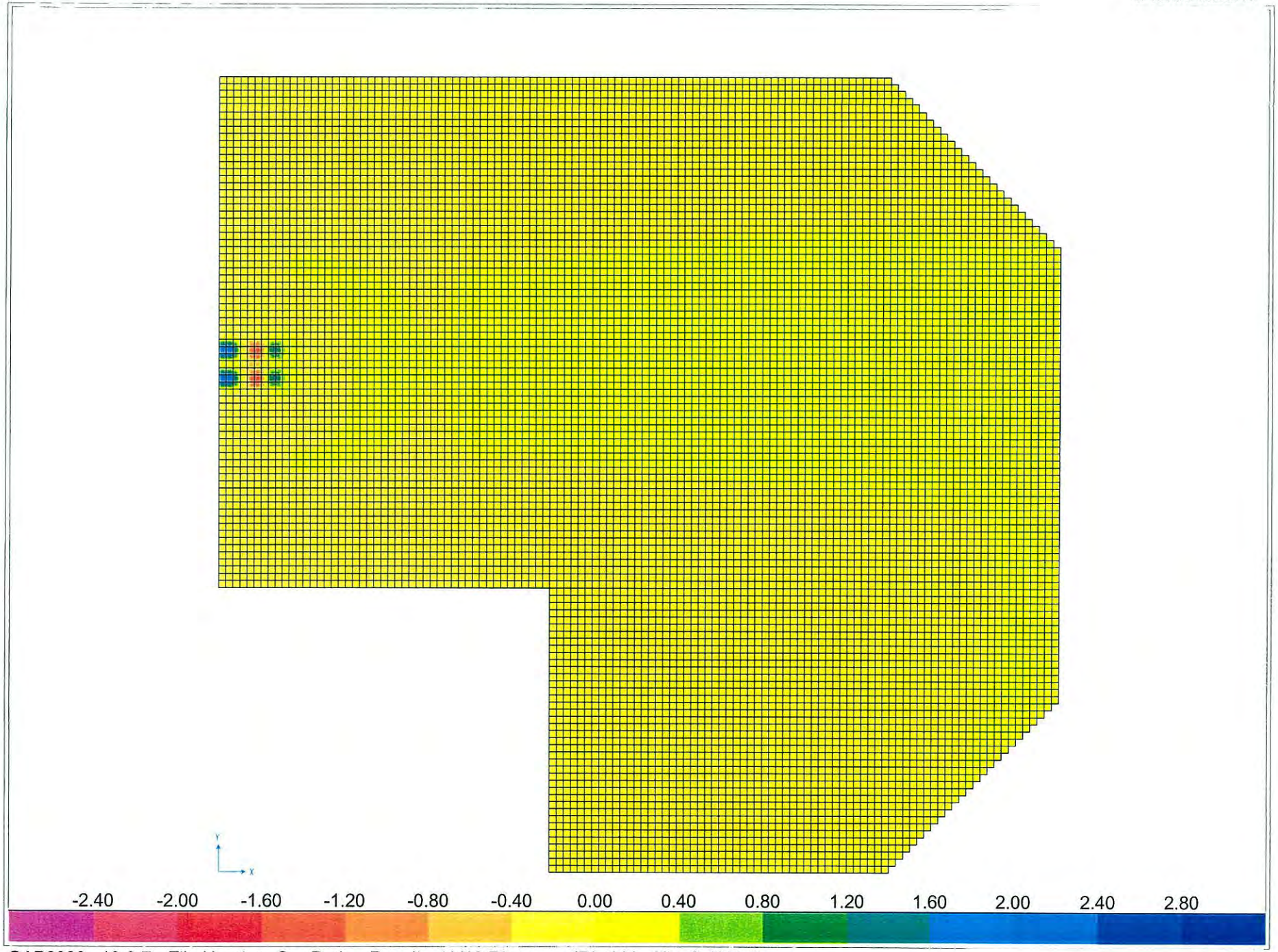

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13

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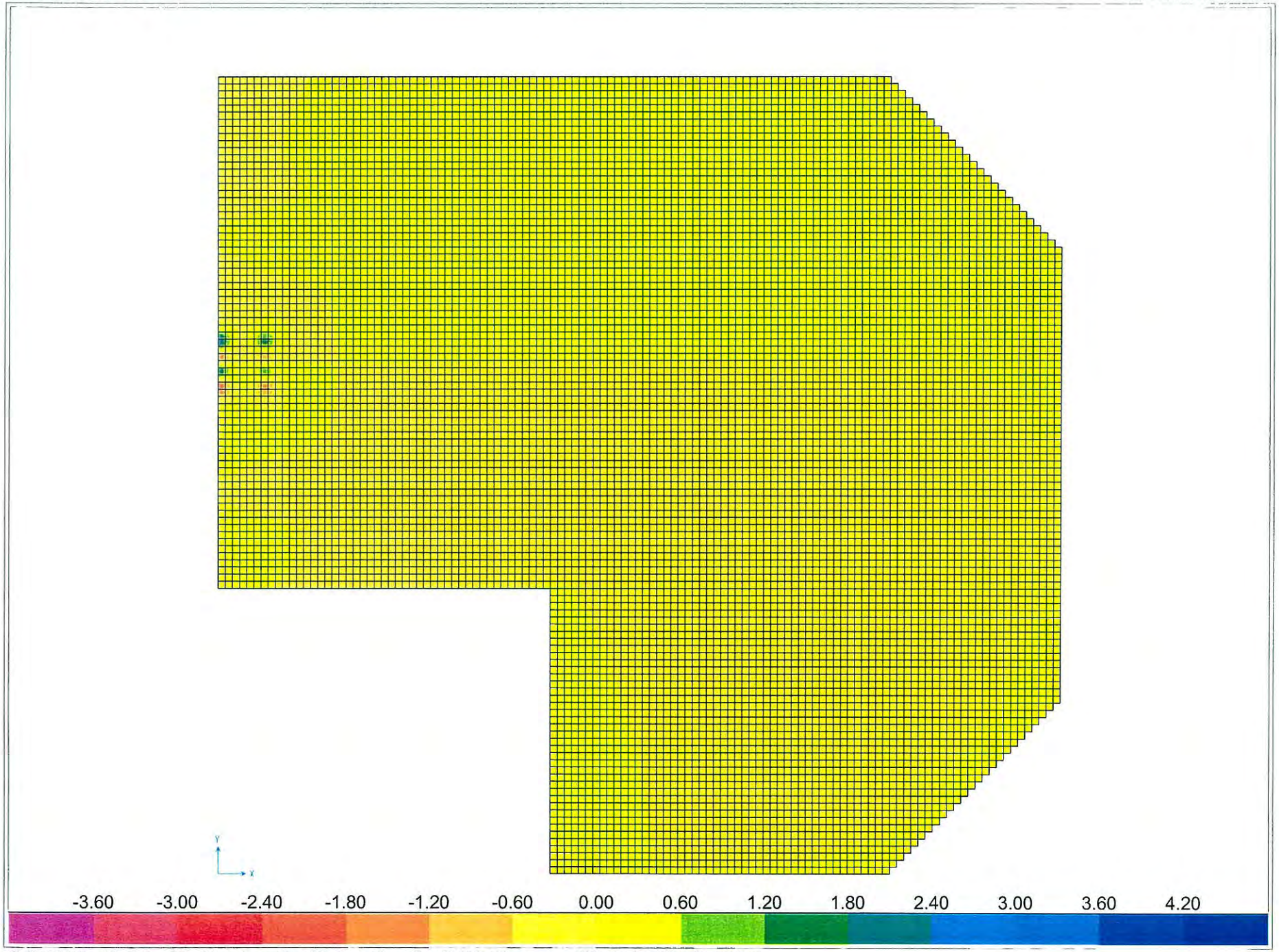

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14

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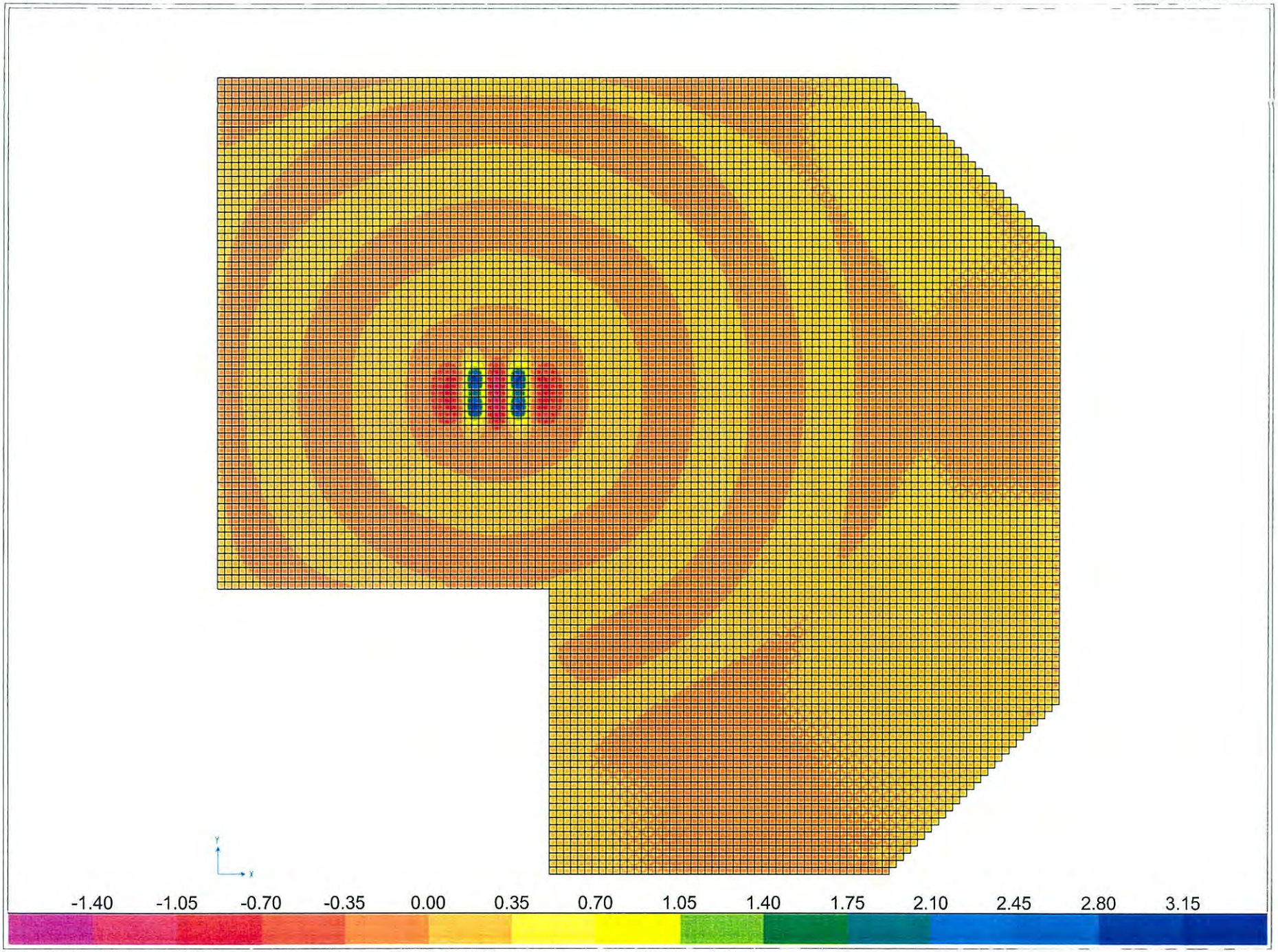

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15

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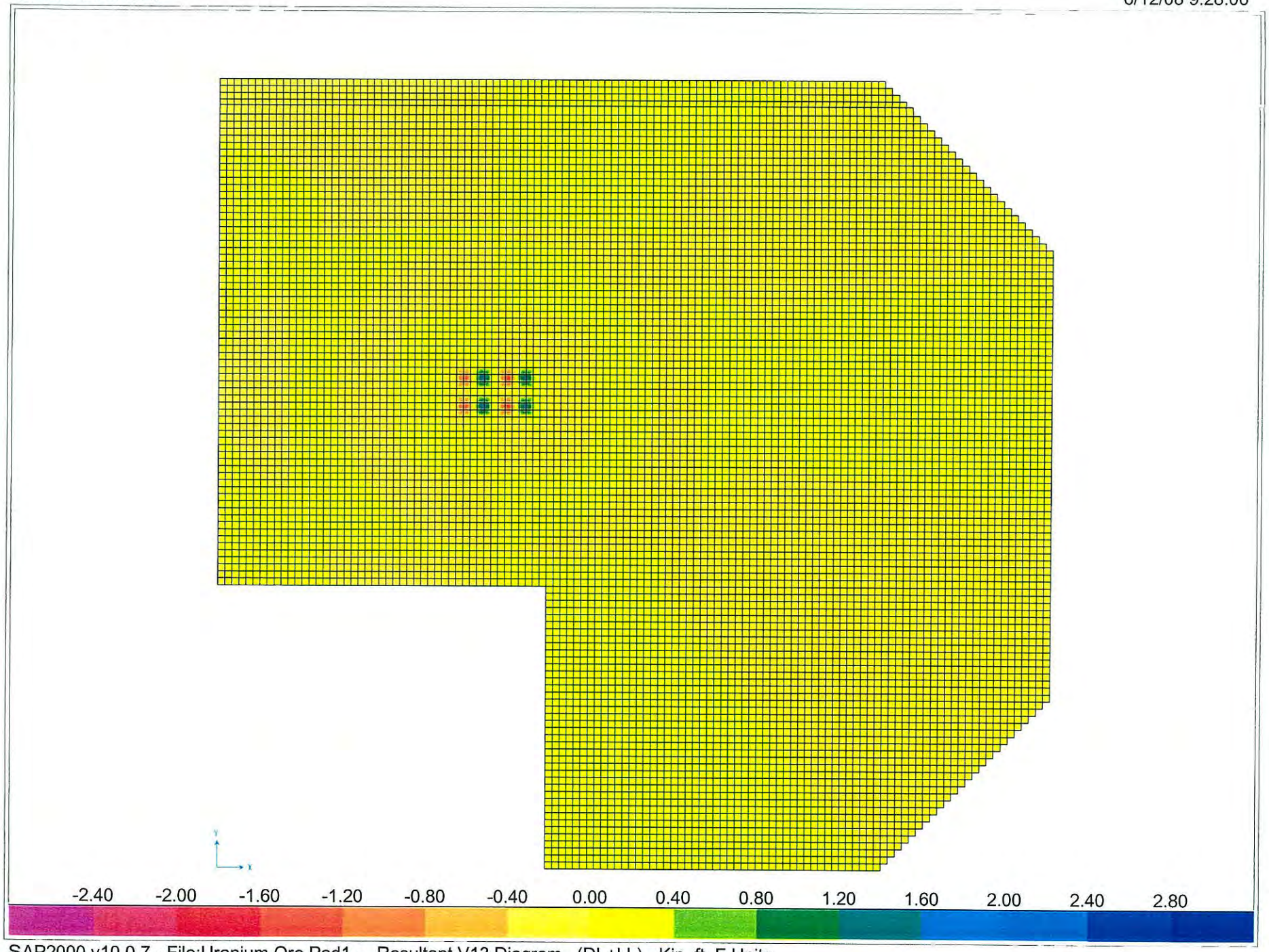

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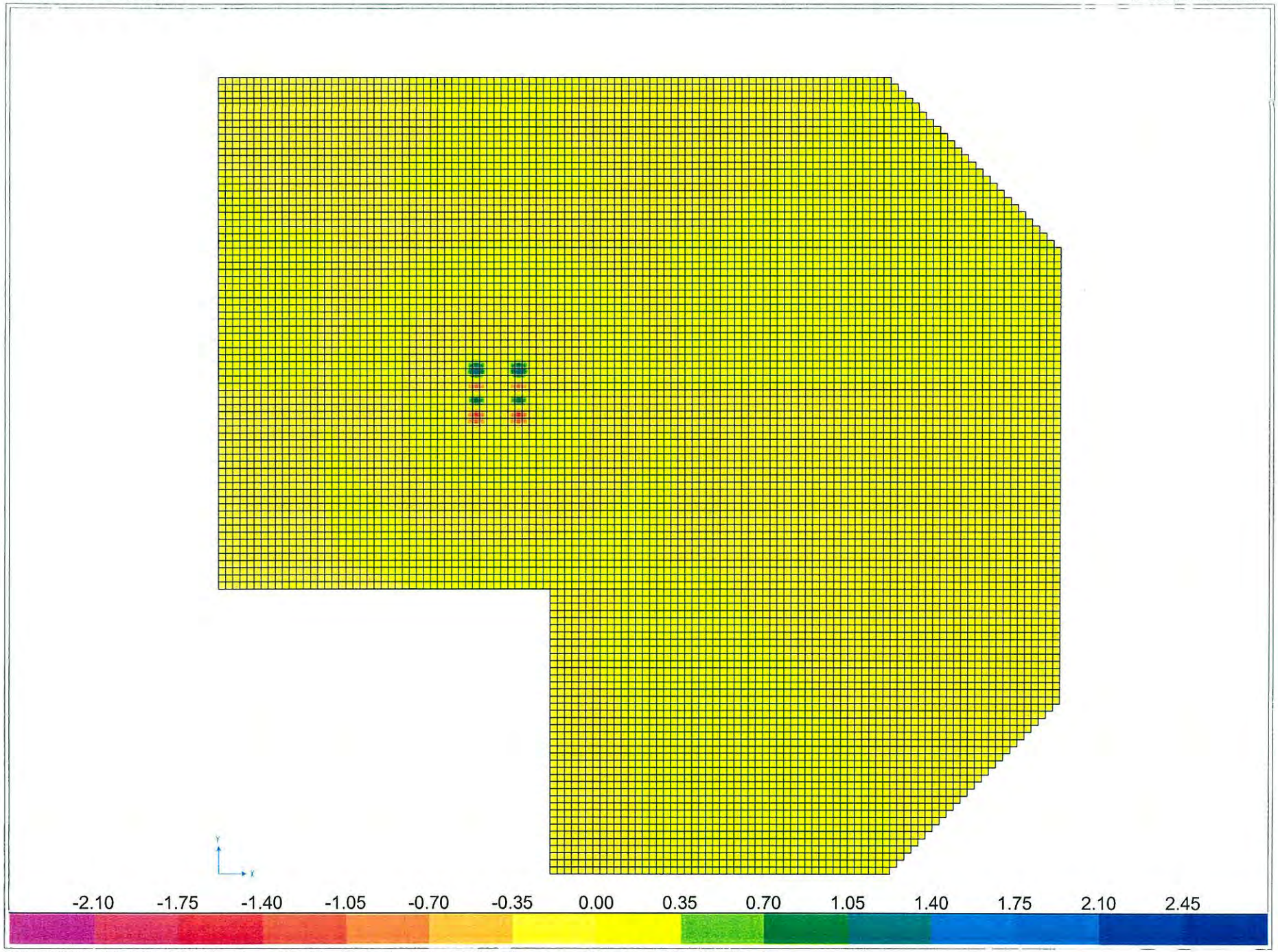

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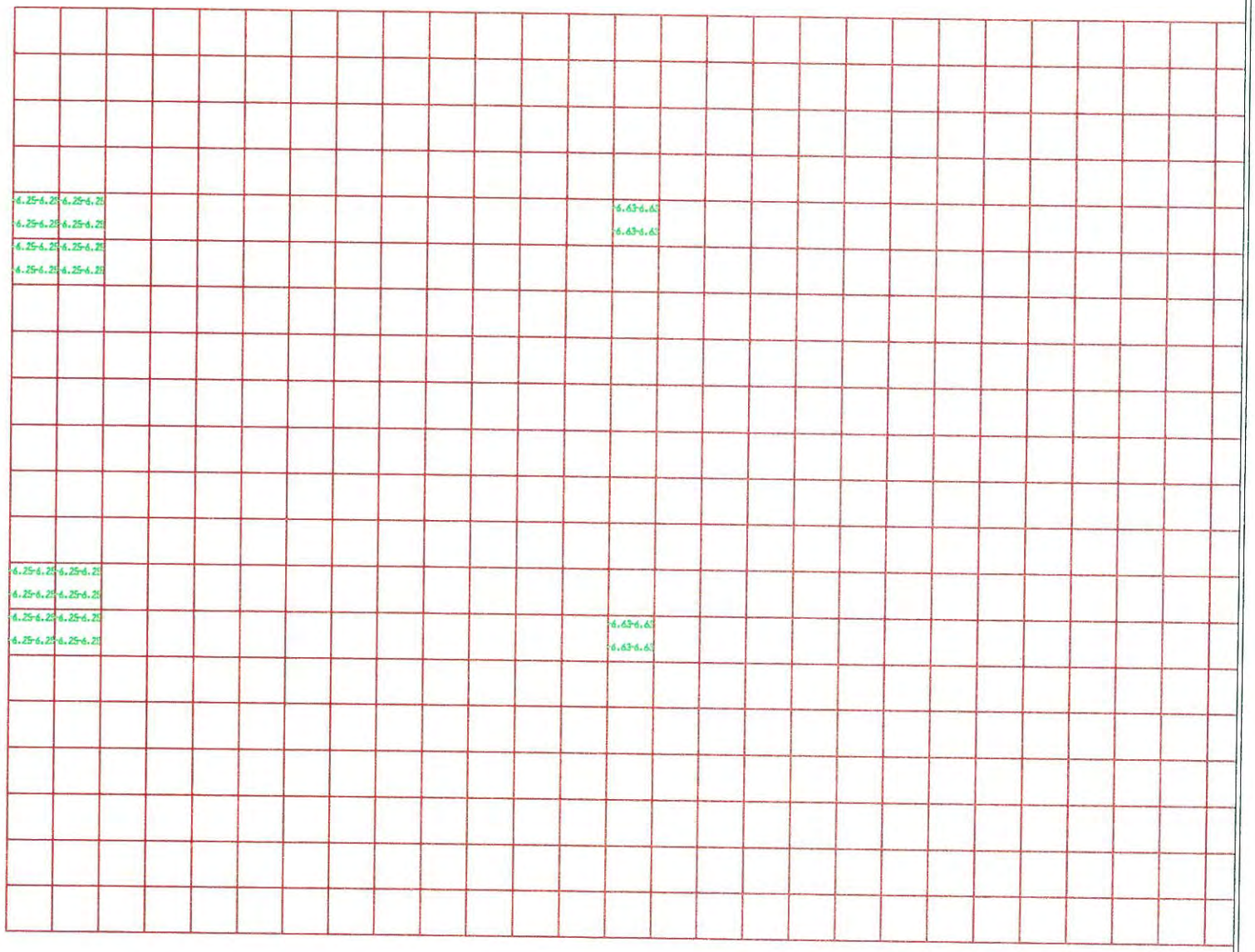

FEM TRUCK PRESSURE LOADS DIAGRAM

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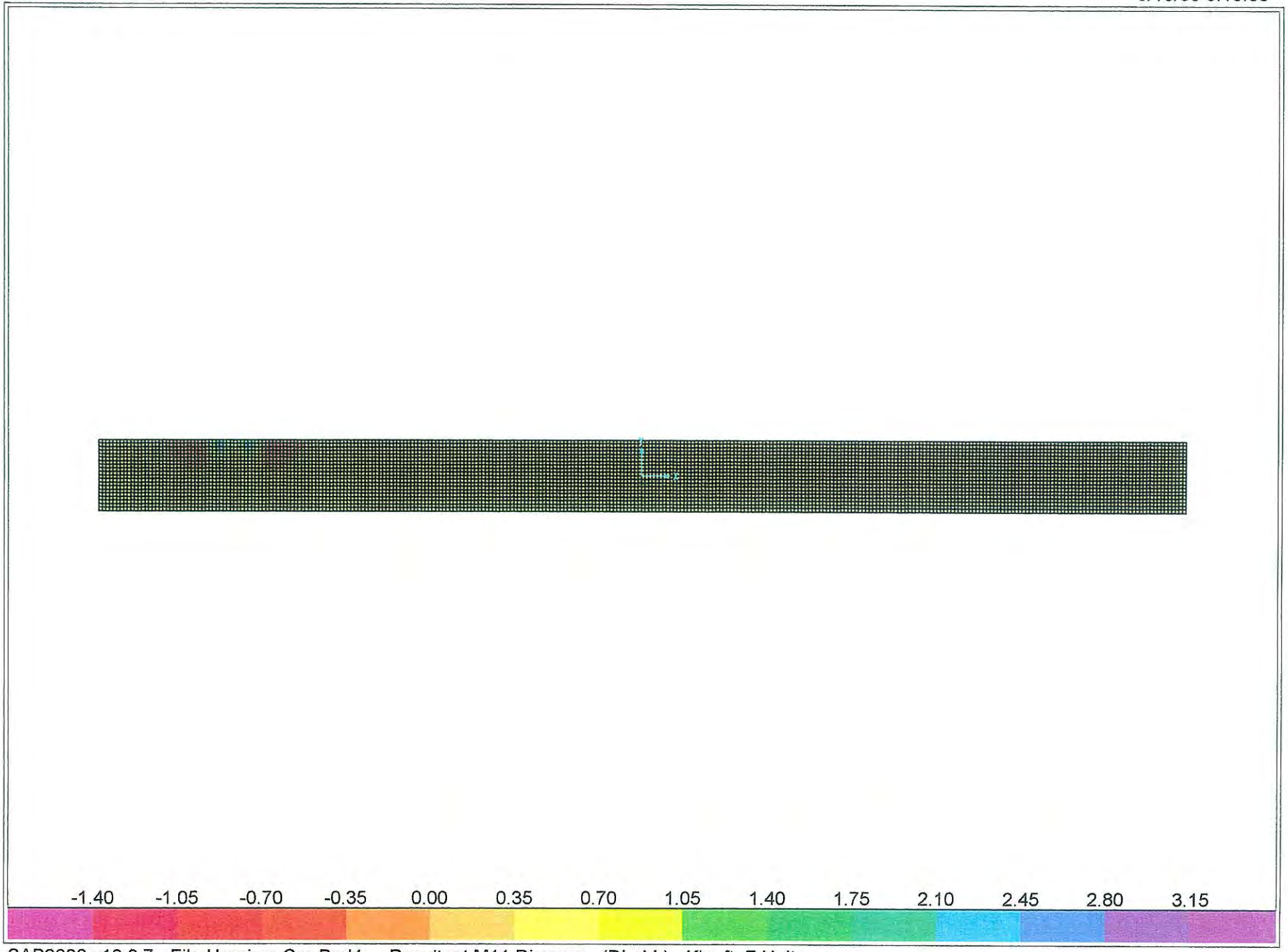

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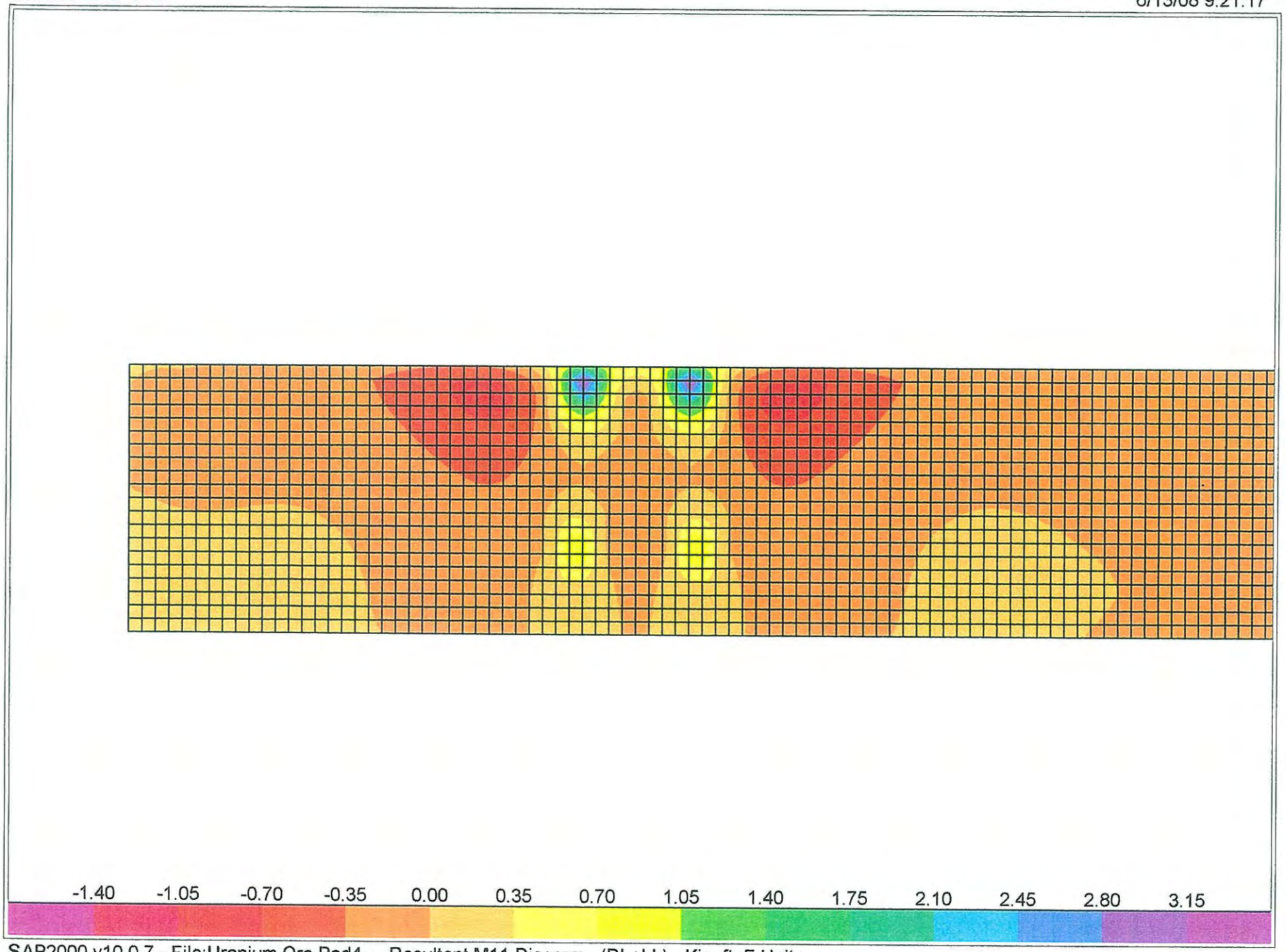

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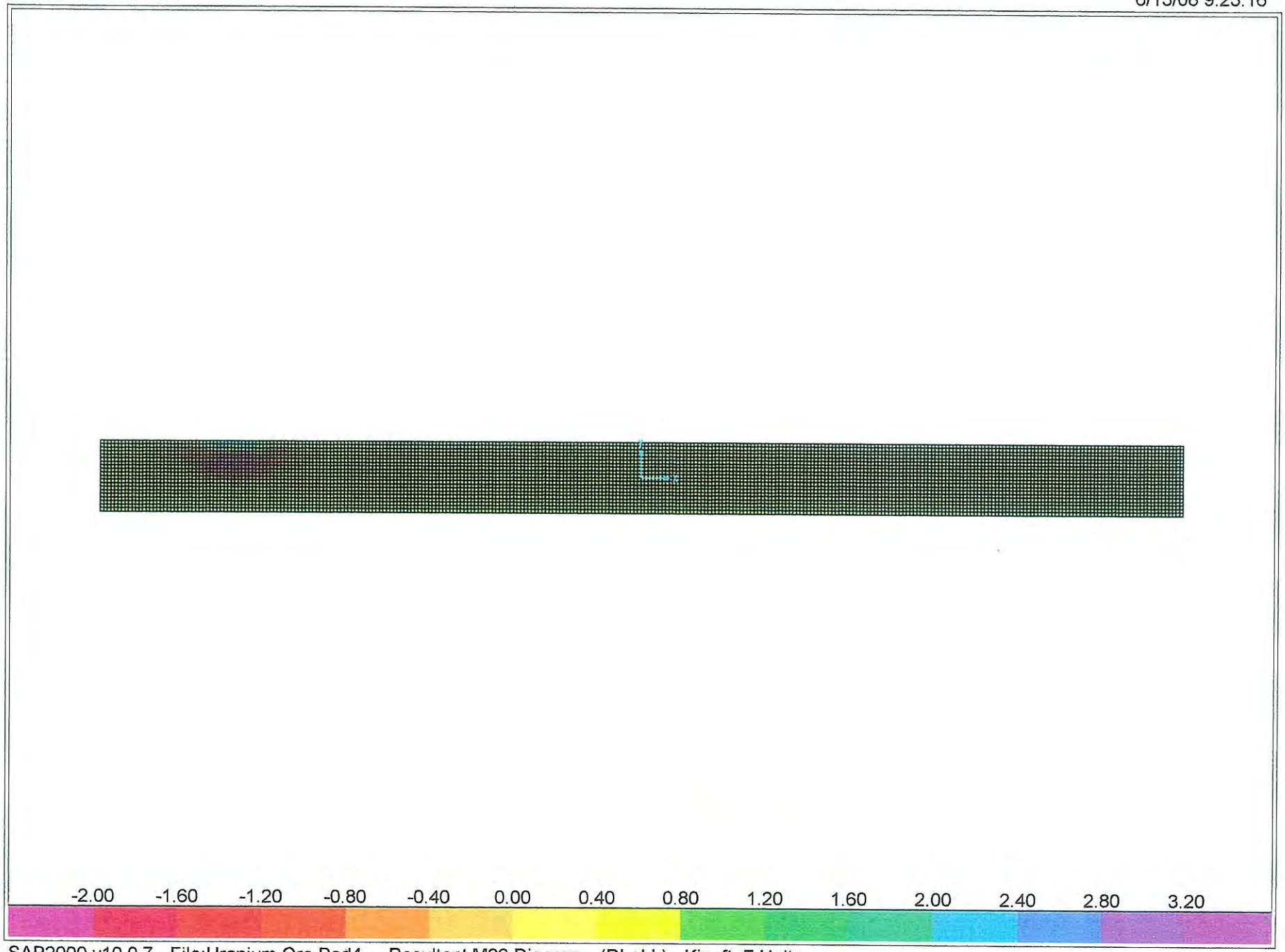

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21

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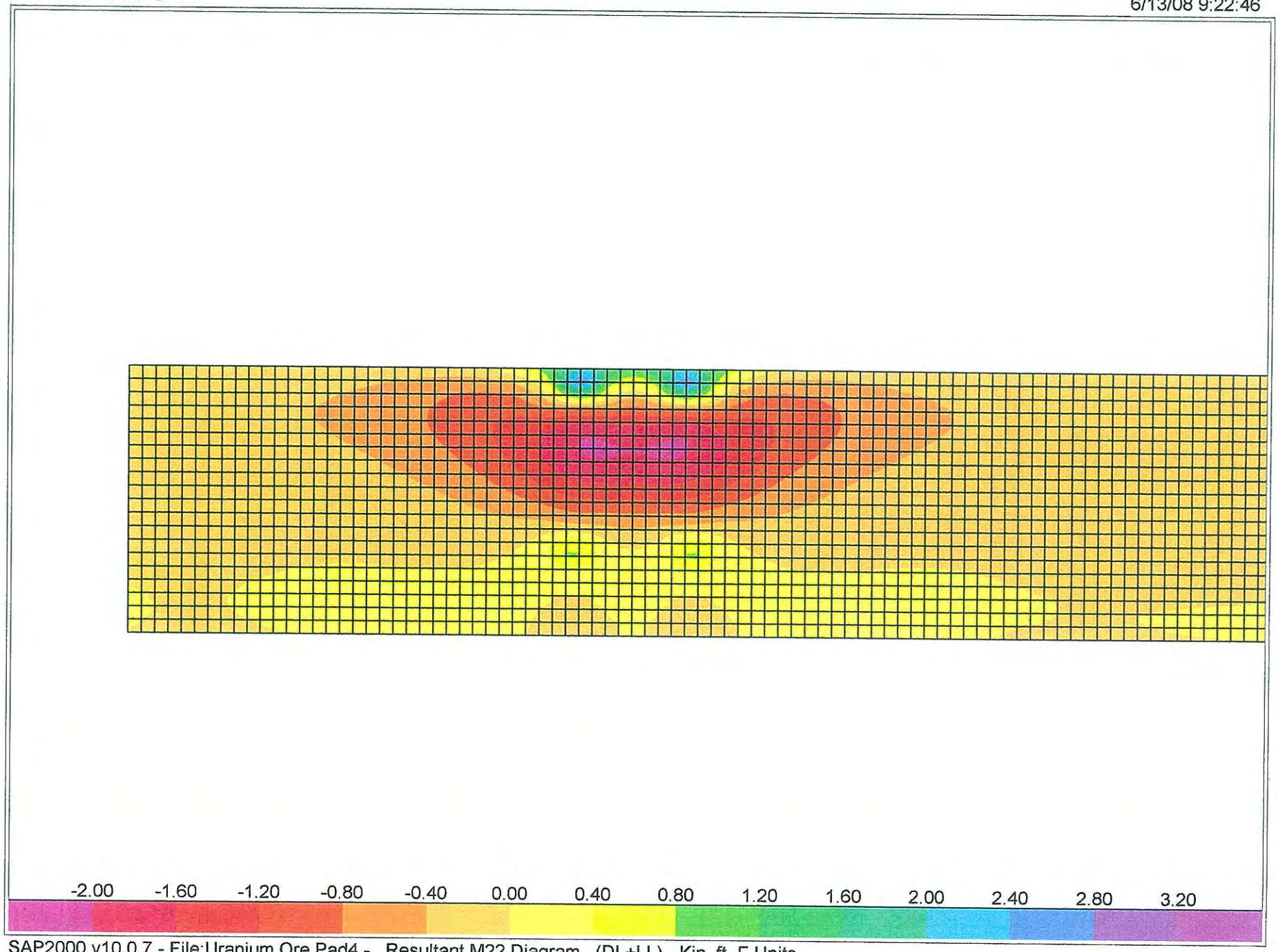

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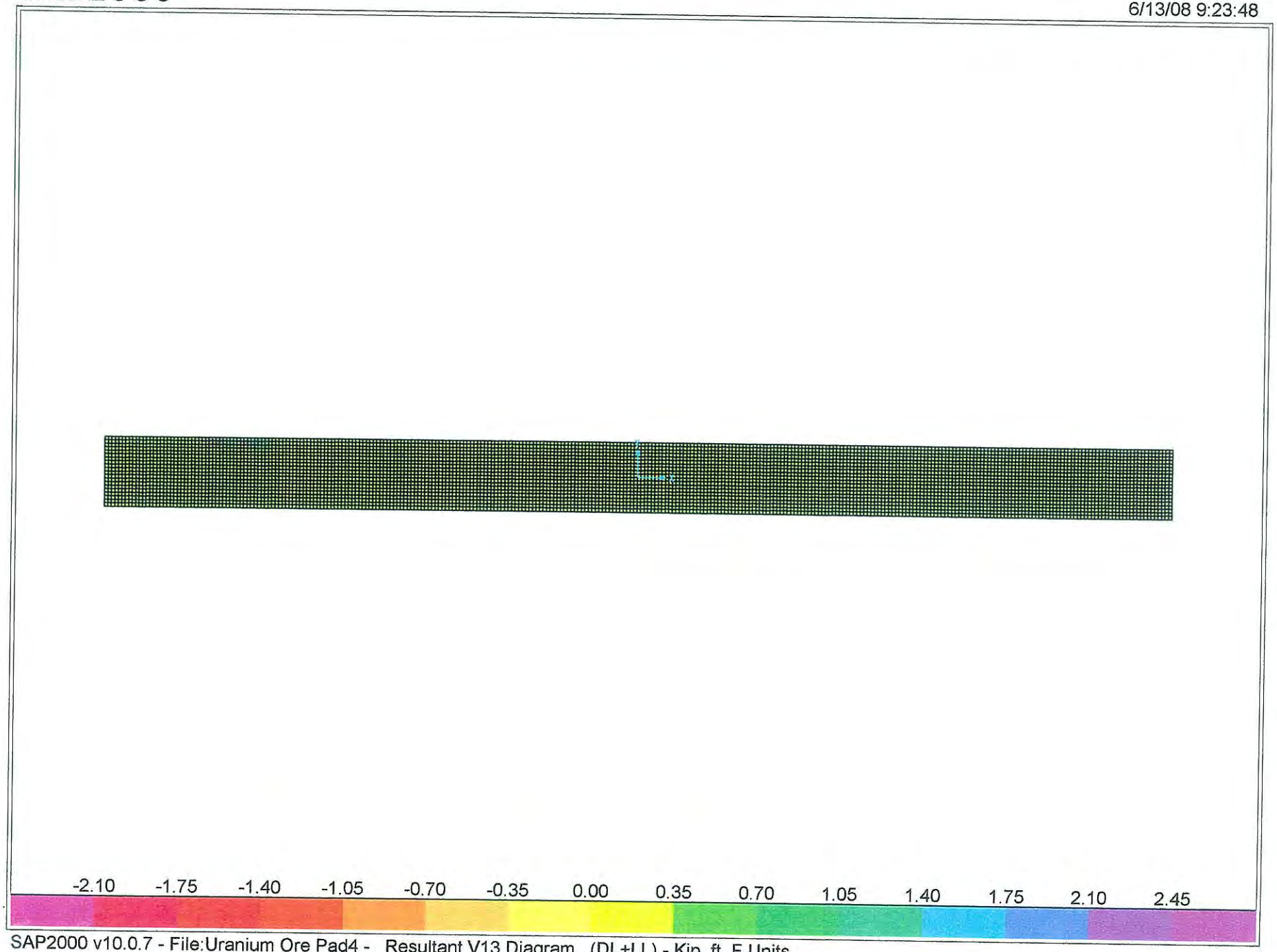

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23

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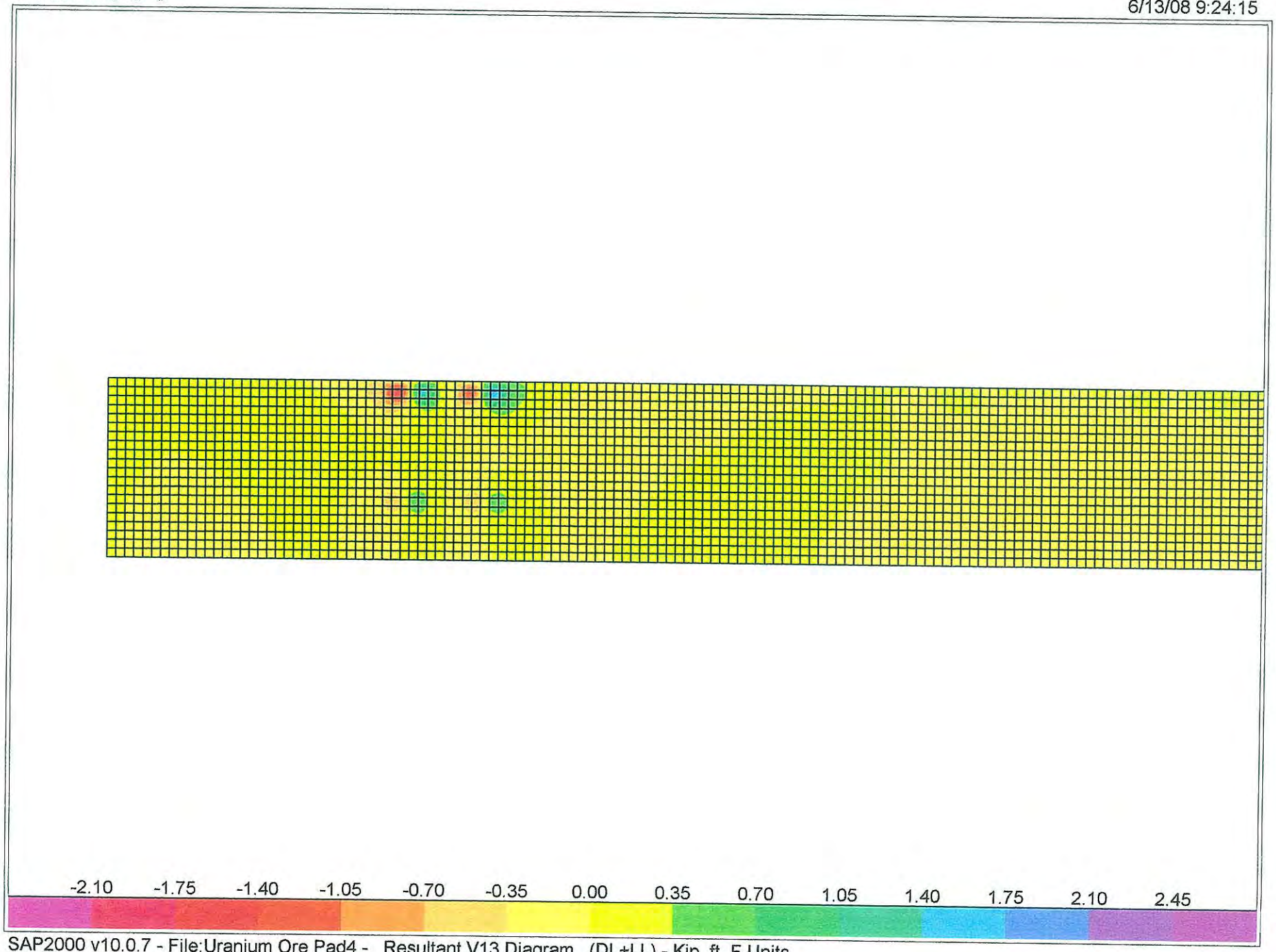

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2 of

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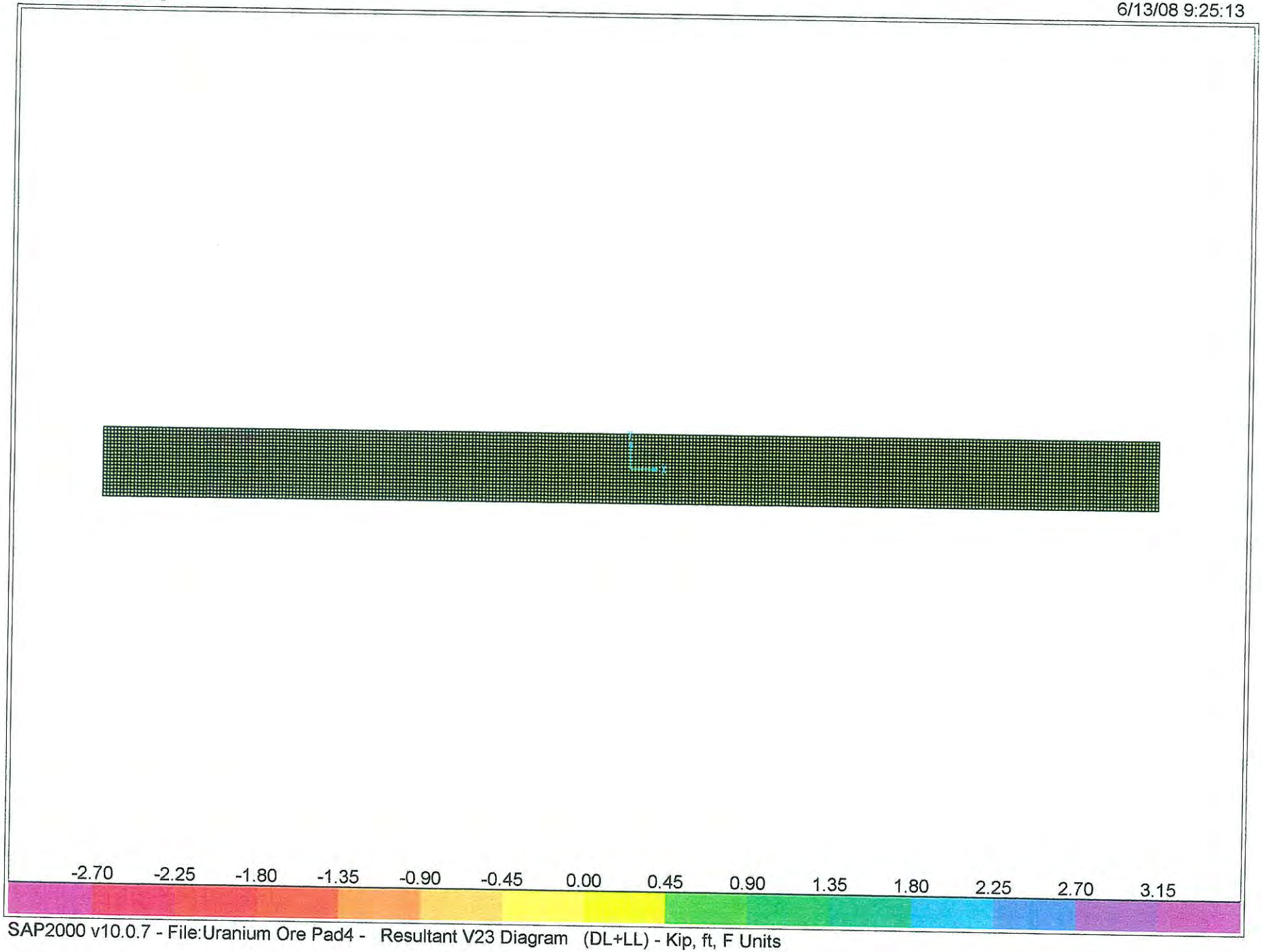

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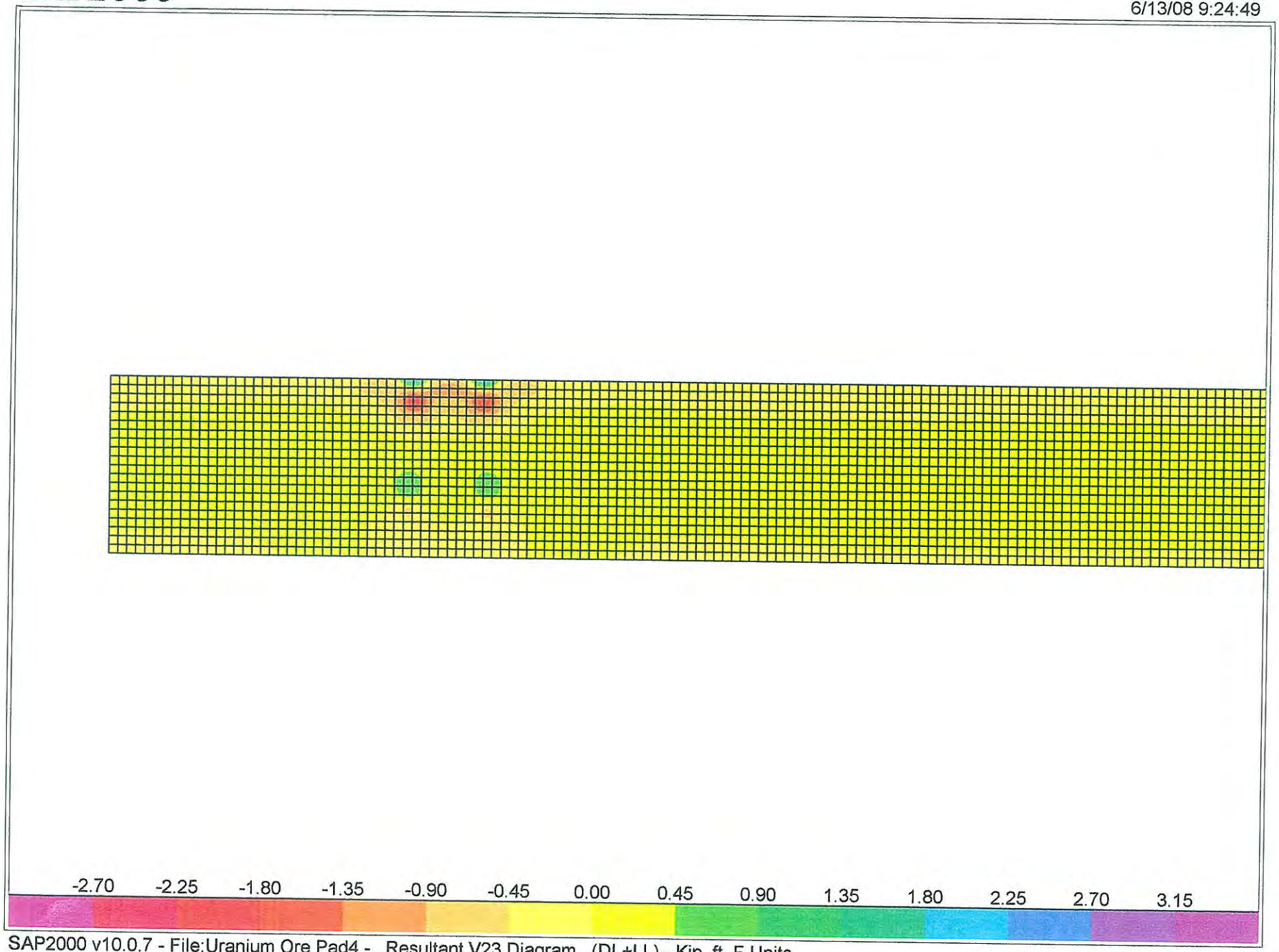

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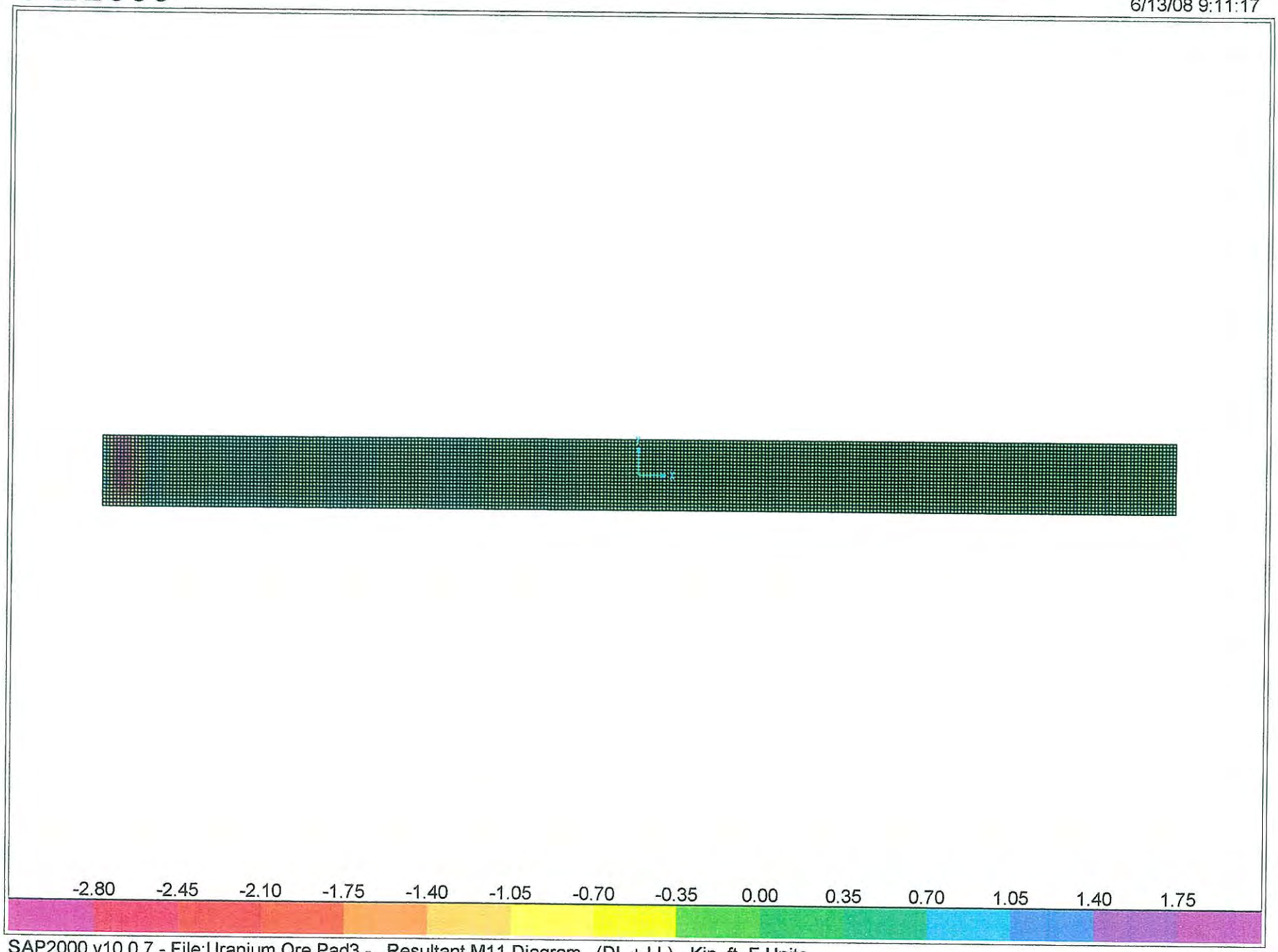

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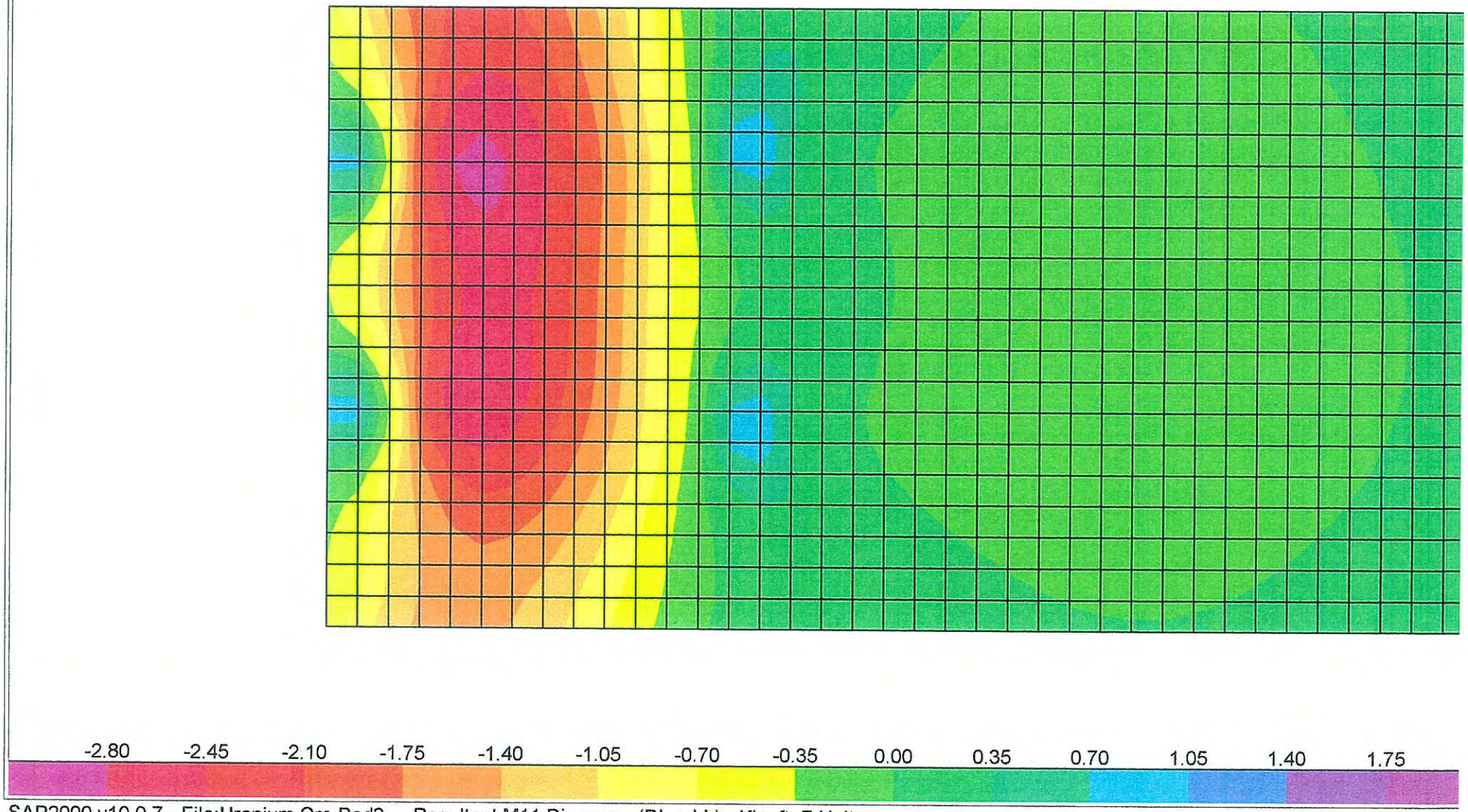

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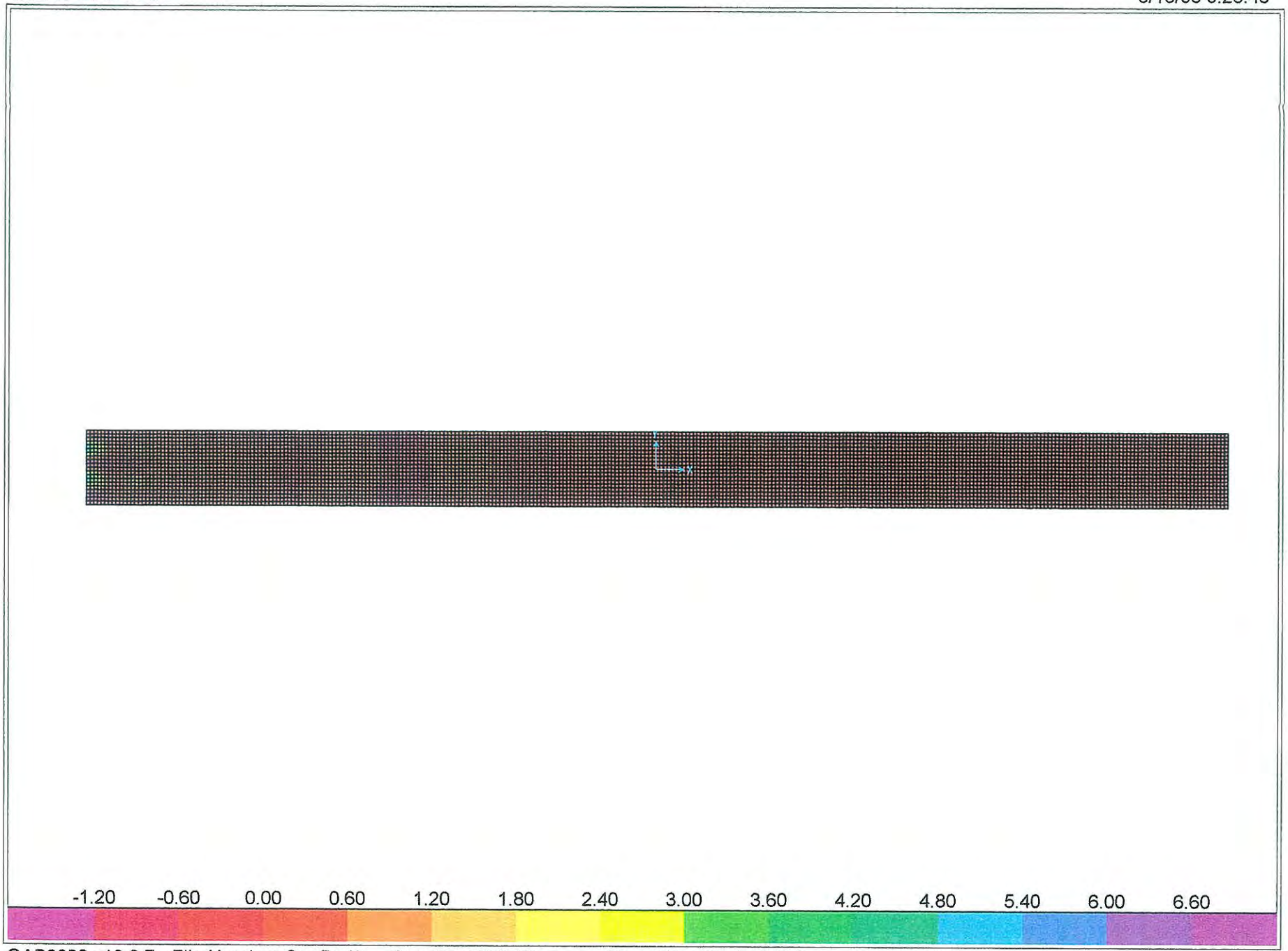

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27

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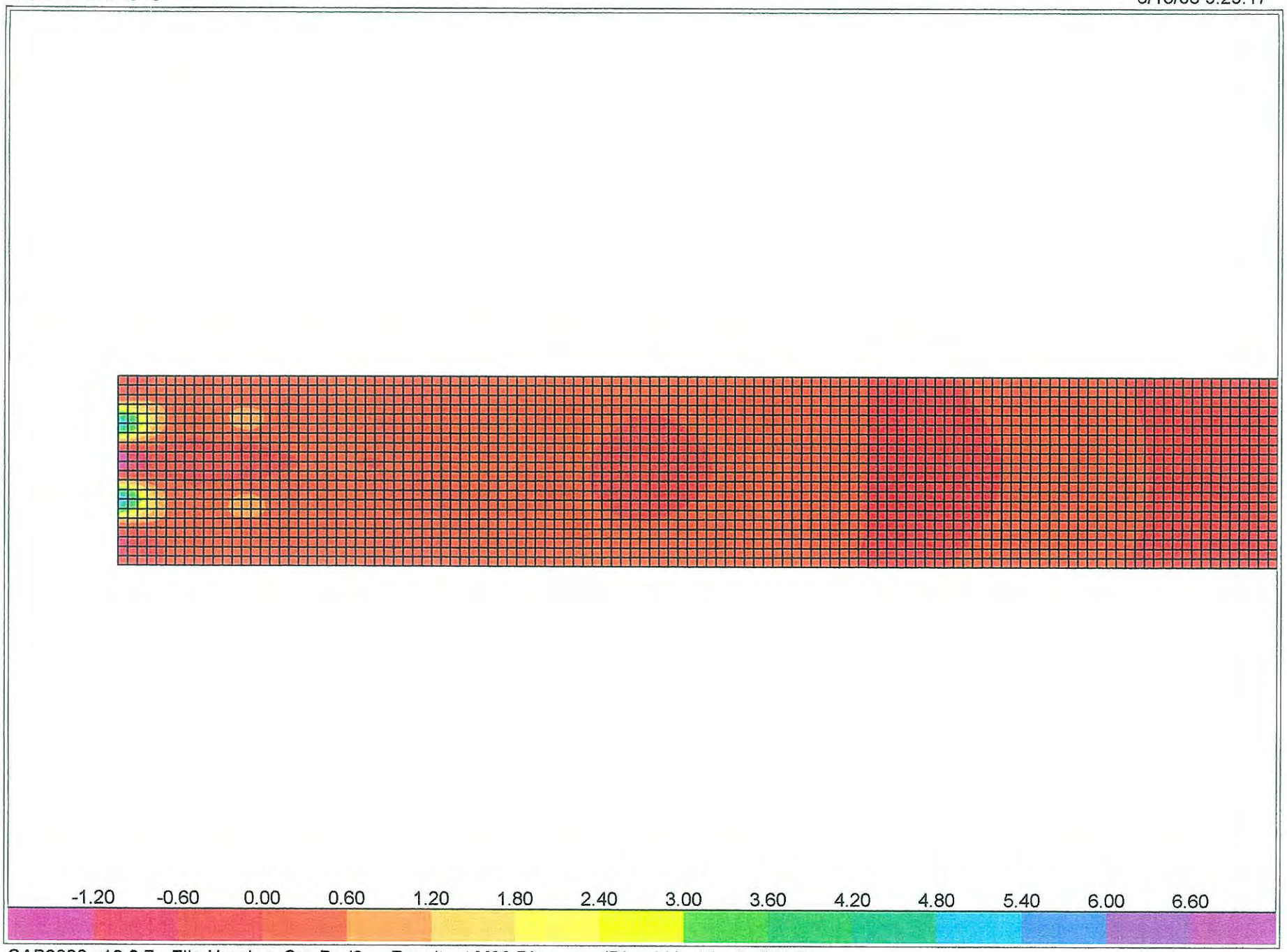

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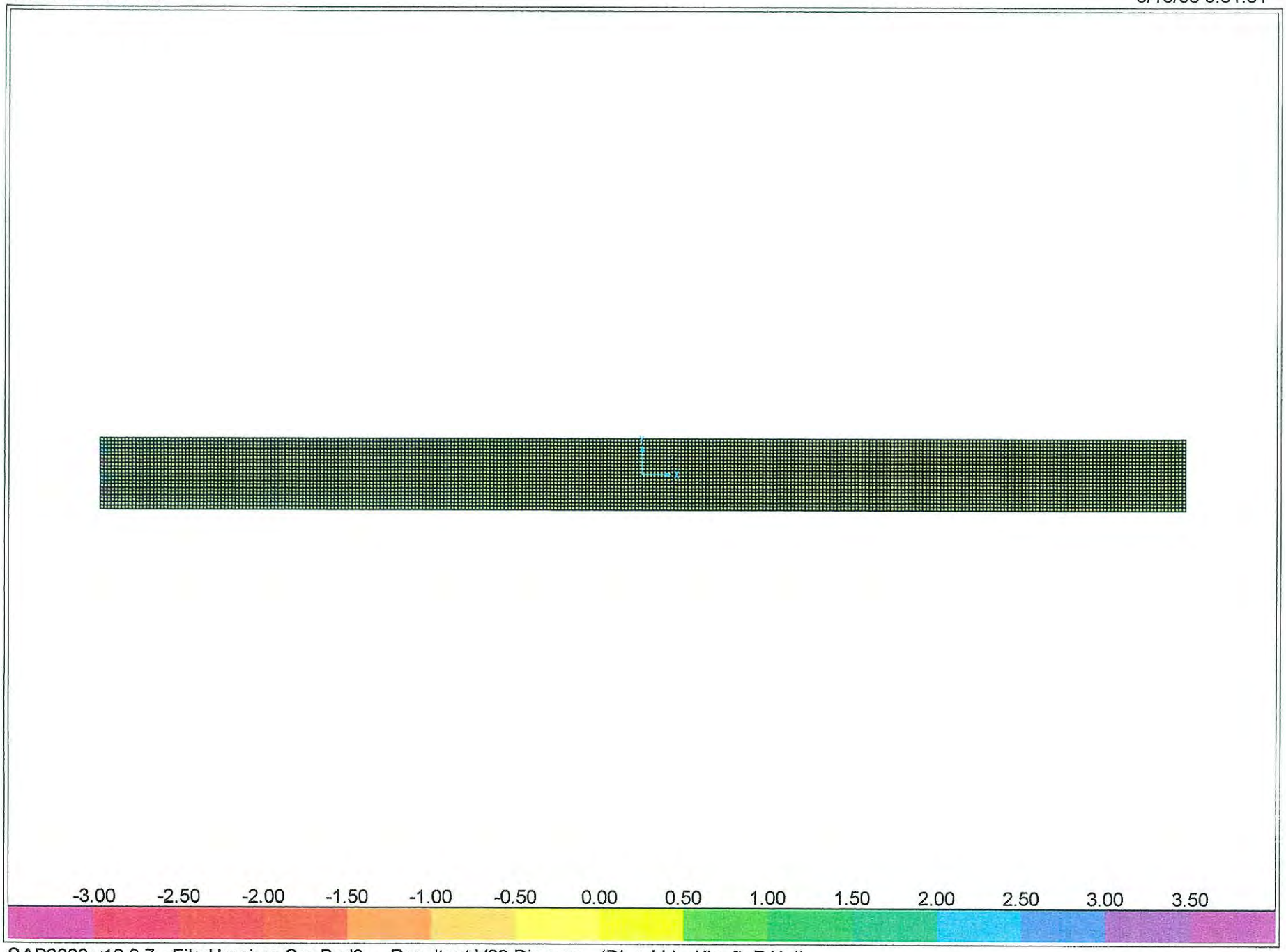

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5

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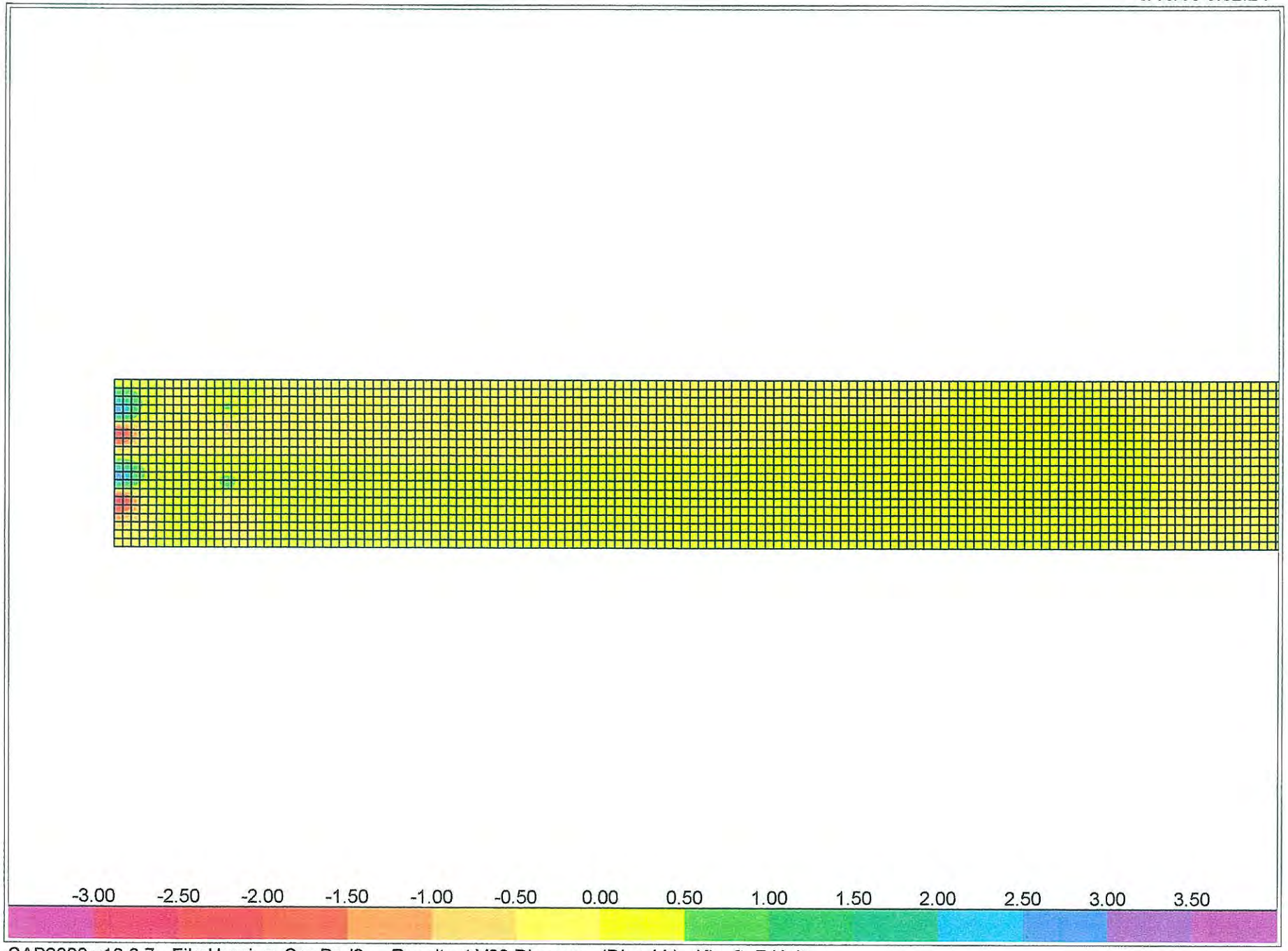

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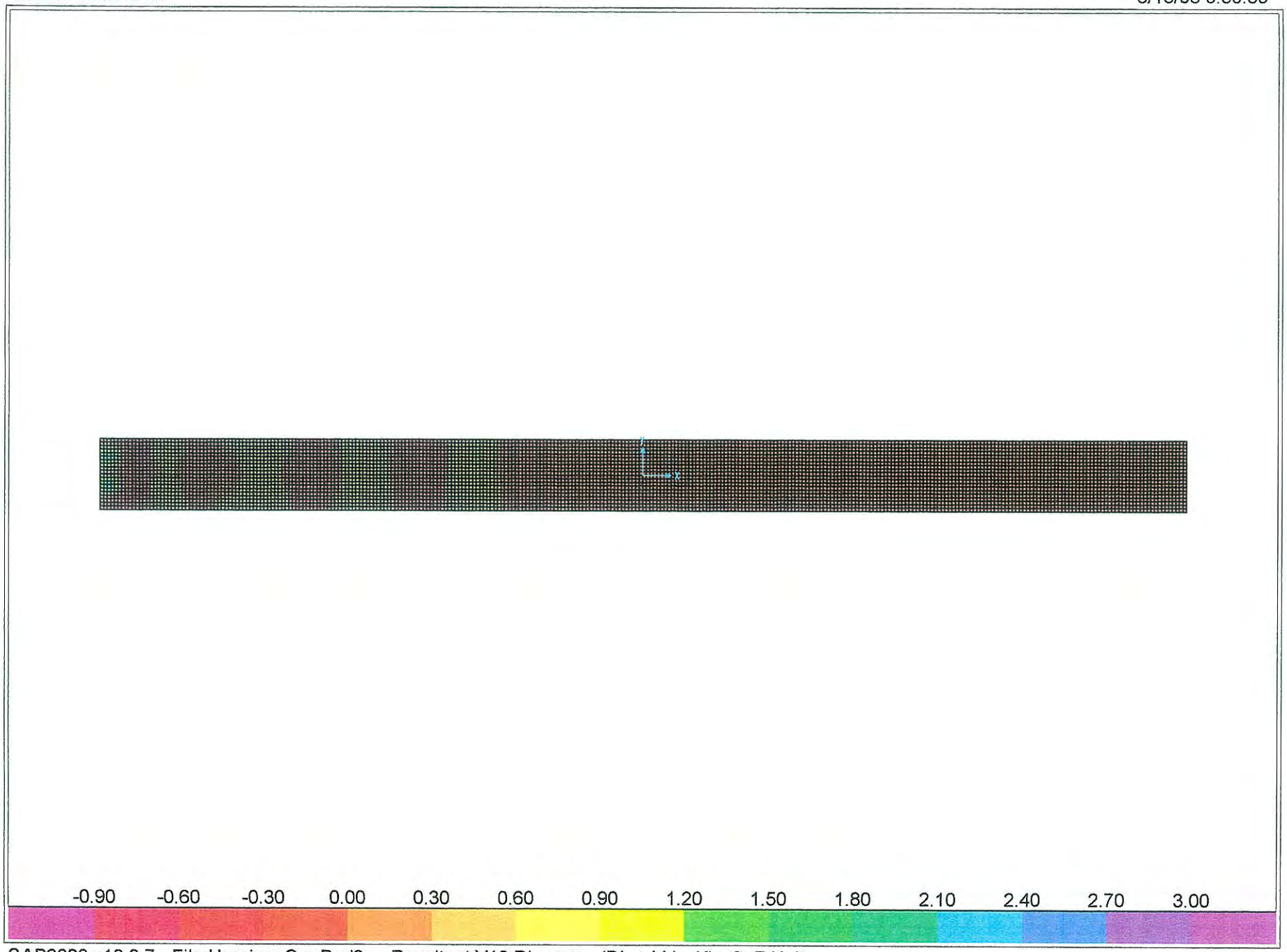

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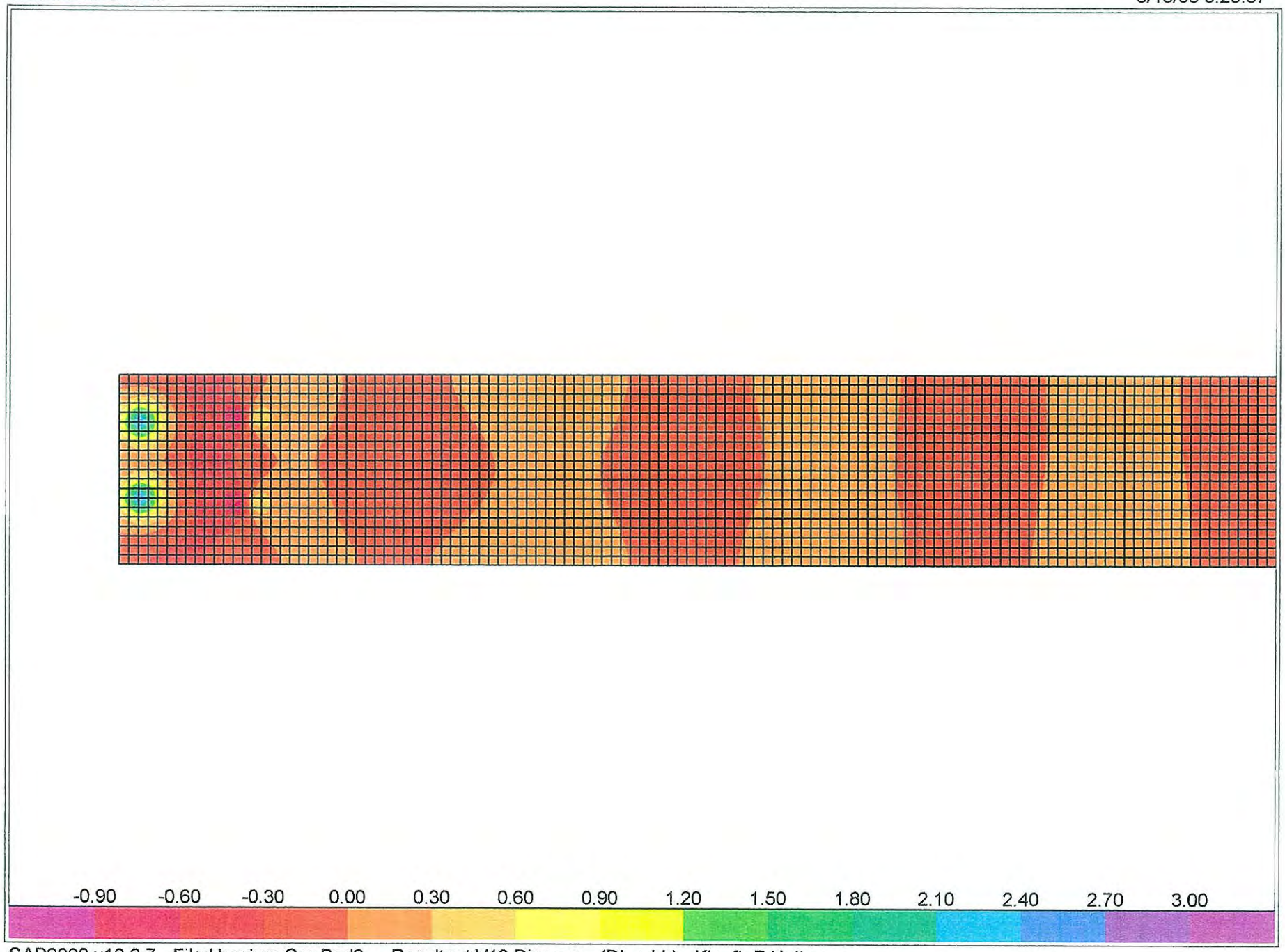

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SMRC Structural Engineers Inc.

CALCULATION SHEET

Client GOLDER | Location | Est. No. | J.O. No.
Subject PINON RIDGE ORE PAD | Date 5/29/08 | By DAB
CHECK FEM PROGRAM RESULTS | Checked | By
Based on | Revised | By

ALTERNATE CHECK

CHECK CASE WHERE WHEEL LOAD IS A CONSIDERABLE DISTANCE FROM THE EDGES OF A SLAB. $h = 10''$ $a = 14$ IN $P = 30{,}000$ lbs $k = 200$ pci

$$f_b = 0.316 \frac{P}{h^2}\left[\log h^3 - 4\log\left(\overset{20.337}{\sqrt{1.6a^2+h^2}} - 0.675h\right) - \log k + 6.48\right]$$

$$= 0.316 \frac{30{,}000}{(10)^2}\left[3 - 4.53 - 2.3 + 6.48\right] = 251.22 \text{ psi}$$

✓ OK

CHECK CASE WHERE WHEEL LOAD IS AT EDGE BUT AWAY FROM CORNER. - $h = 10''$ AT EDGE

$$f_b = 0.572 \frac{P}{h^2}\left[\log h^3 - 4\log\left(\sqrt{1.6a^2+h^2} - 0.675h\right) - \log k + 5.77\right]$$

$$= 0.572 \frac{P}{(10)^2}\left[3 - 4.53 - 2.3 + 5.77\right] = 332 \text{ psi}$$

ALLOWABLE FLEXURAL STRENGTH $= \frac{604}{2} = 302$ psi < 332

THICKEN SLAB AT EDGE TO 14"

$$f_b = .572 \frac{30{,}000}{(14)^2}\left[3.44 - 4.47 - 2.3 + 5.77\right] = 213.6 \text{ psi}$$

✓ OK

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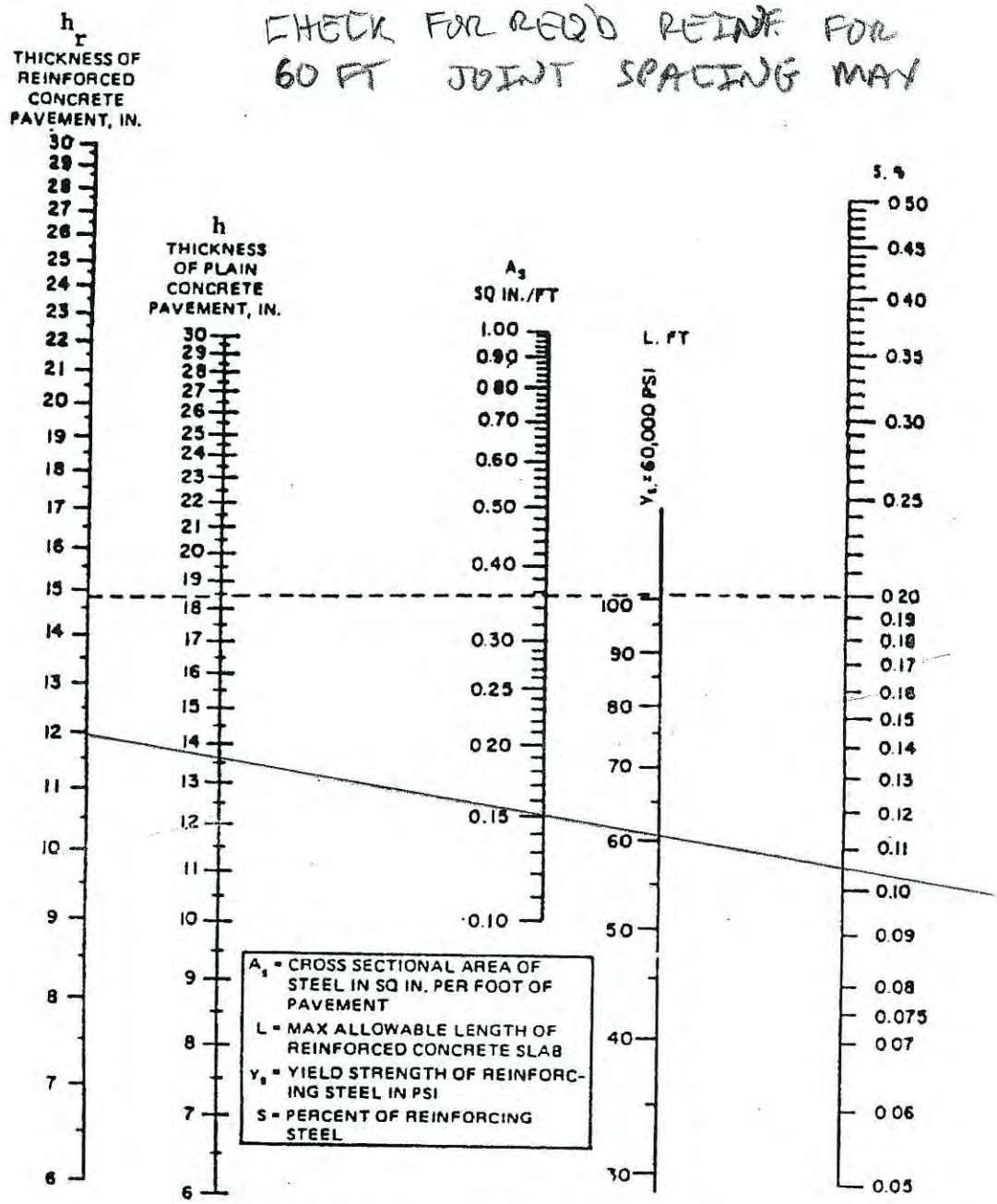
ALTERNATE CHECK
CHECK FOR REQ'D REINF FOR
60 FT JOINT SPACING MAY



REINFORCED CONCRETE PAVEMENT DESIGN 12" SLAB

NOTE: MINIMUM THICKNESS OF REINFORCED CONCRETE FLOOR SLABS WILL BE 6 IN.

Figure 5-4. Design thickness for reinforced floor slabs.

#5 @ 14 PROVIDED

PROVIDE $.29\left(\frac{12}{14}\right)$

$= .248 \frac{IN^2}{FT} > .105$ INDICATED