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BSC

Design Calculation or Analysis Cover Sheet

Complete only applicable items.

1. QA: QA
2. Page 1

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CRCF Foundation Design

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Attachments	Total Number of Pages
See Calculation Section 5	65

RECORD OF REVISIONS

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DISCLAIMER

The calculations contained in this document were developed by Bechtel SAIC Company, LLC (BSC) and are intended solely for the use of BSC in its work for the Yucca Mountain Project.

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TABLES

ACRONYMS

3D	three-dimensional
FEs	finite elements
FEM	finite element model
CRCF	Canister Receipt and Closure Facility
c.g.	Center of Gravity
DBGM	Design Basis Ground Motion
BDBGM	Beyond Design Basis Ground Motion
D/C	Demand /Capacity

1. PURPOSE

The purpose of this calculation is to perform a preliminary foundation mat reinforcement design, and stability analysis for the Canister Receipt and Closure Facility (CRCF). The shear and flexural reinforcements for the foundation mat will be determined in this calculation. Building stability against overturning and sliding due to seismic loads will also be evaluated in this calculation.

2. REFERENCES

2.1 PROJECT PROCEDURES / DIRECTIVES

2.1.1 EG-PRO-3DP-G04B-00037, Rev. 007,ICN 0.*Calculations and Analyses*. Las Vegas, Nevada: Bechtel SAIC Company. ACC:ENG.20070122.0010.

2.1.2 IT-PRO-0011 Rev. 003, ICN 0. *Software Management.* Las Vegas, Nevada, Bechtel SAIC Company. ACC: DOC.20061221.0003.

2.1.3 Not used

2.1.4 ORD (Office of Repository Development) 2006. *Repository Project Management Automation Plan.* 000-PLN-MGR0-00200-000, Rev. 00D. Las Vegas, Nevada: U.S. Department of Energy, Office of Repository Development. ACC: ENG.20060703.0001

2.2 DESIGN INPUTS

2.2.1 BSC (Bechtel SAIC Company) 2006. *Project Design Criteria Document.* 000-3DR-MGR0-00100-000 Rev 006. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061201.0005.

2.2.2 BSC (Bechtel SAIC Company) 2006. *Basis of Design for the TAD Canister–Based Repository Design Concept.* 000-3DR-MGR0-00300-000-000. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG 20061023.0002.

2.2.3 BSC (Bechtel SAIC Company) 2006. *Canister Receipt and Closure Facility (CRCF) Seismic Analysis.* 060-SYC-CR00-00400-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061220.0029.

2.2.4 BSC (Bechtel SAIC Company) 2006. *Canister Receipt and Closure Facility (CRCF) Soil Springs.* 060-SYC-CR00-00300-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061129.0019.

2.2.5 BSC (Bechtel SAIC Company) 2006. *Canister Receipt and Closure Facility (CRCF) Mass Properties*. 060-SYC-CR00-00200-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061120.0019.

2.2.6 ACI 349-01. 2001. *Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-01).* Farmington Hills, Michigan: American Concrete Institute. TIC: 252732. [DIRS **158833**]

2.2.7 ASCE 4-98. 2000. *Seismic Analysis of Safety-Related Nuclear Structures and Commentary.* Reston, Virginia: American Society of Civil Engineers. TIC: 253158. [DIRS **159618**]

2.2.8 ASCE / SEI 43-05.2005. *Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities.* Reston, Virginia: American Society of Civil Engineers. TIC: 257275 [DIRS **173805**]

2.2.9 Bowles, J.E. 1996. *Foundation Analysis and Design.* 5th Edition. New York, New York: McGraw-Hill. TIC: 247039. [DIRS **157929**]

2.2.10 Not used.

2.2.11 DOE (U.S. Department of Energy) 2005. *Software Validation Report for*: SAP2000 version 9.1.4. Document ID: 11198-SVR-9.1.4-00-win 2000. Las Vegas, Nevada: U.S. Department of Energy, Office of Repository Development. ACC: MOL.20051012.0425. [DIRS **176790**]

2.2.12 Not used.

2.2.13 BSC (Bechtel SAIC Company) 2006. *Seismic Analysis and Design Approach Document.* 000-30R-MGR0-02000-000-000. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061214.0008.

2.3 DESIGN CONSTRAINTS

None

2.4 DESIGN OUTPUTS

Results of this calculation will be used in developing the CRCF foundation drawings. Document numbers have not been assigned to these drawings.

3. ASSUMPTIONS

3.1 ASSUMPTIONS REQUIRING VERIFICATION

There are no assumptions requiring verification used in this calculation.

3.2 ASSUMPTIONS NOT REQUIRING VERIFICATION

3.2.1 Stress Contour Plots generated by SAP2000 using nodal averaging will be used in the design of the required reinforcing steel.

Rationale: Reinforced concrete is a composite material comprised of concrete and reinforcing bars. While peak element forces exceed the average values shown on the contour plots (Attachment D) it is recognized that as concrete cracks and reinforcing bars yield that peak resultants are redistributed over adjacent elements. Utilizing force resultants based on nodal averaging accounts for the redistribution and is appropriate for use in reinforcement concrete design.

4. METHODOLOGY

4.1 QUALITY ASSURANCE

This calculation was prepared in accordance with EG-PRO-3DP-G04B-00037, *Calculations and Analyses* (Ref. 2.1.1). Section 4.1.2 of the *Basis of Design for the TAD Canister–Based Repository Design Concept* (Ref. 2.2.2) classifies the CRCF structure as ITS. Therefore, the approved version of this calculation is designated as QA: QA.

4.2 USE OF SOFTWARE

Excel 2000 and Word 2000, which are part of the Microsoft Office 2000 Professional suite of programs, were used in this calculation. Microsoft Office 2000 Professional as used in this calculation is classified as Level 2 software usage as defined in IT-PRO-0011 (Ref. 2.1.2). Microsoft Office 2000 is listed on the current Controlled Software Report (SW Tracking Number 610236-2000-00), as well as *the Repository Project Management Automation Plan* (Ref. 2.1.4).

The software was executed on a PC system running Microsoft Windows 2000 operating system. Results were confirmed by visual inspection and by performing hand calculations. Excel 2000 was used to generate SAP2000 model input in this calculation. Word 2000 was used in the text preparation of this document, no calculations functions contained in word were used in this document.

SAP2000, Version 9.1.4 as used in this calculation is classified as Level 1 software usage as defined in IT-PRO-0011 (Ref. 2.1.2). This software is a commercially available computer program qualified to perform static and dynamic analysis of structural systems. This software is listed in Qualified Controlled Software Report as qualified with Software Tracking Number

11198-9.1.4-00. The software is operated on a PC system running the Windows 2000 operating system. The SAP2000 Validation Report is contained in Ref. 2.2.11.

4.3 CALCULATION METHODOLOGY

As stated in section 1, this calculation investigates the flexural and shear reinforcing requirements in the CRCF foundation mat. The foundation stability against overturning and sliding is also evaluated in this calculation.

A finite element model of the CRCF foundation mat is developed and coupled to the tier-1 "beam-stick" model, developed in the CRCF seismic analysis (Ref. 2.2.3). The result is a finite element model of the foundation mat with the stiffening effects of the walls included. Non-linear (compression only) springs are used to model the soil underlying the foundation mat. Dead, live and seismic loads are applied to the model and loading combinations were developed that maximizes the soil pressures on each corner of the structure. Static and seismic load combinations were developed per Appendix A of Reference 2.2.13, *Seismic Analysis and Design Approach Document*. Since a non-linear spring element is utilized to model the soil stiffness a non-linear analysis is required for each loading combination (i.e. the principle of super position does not apply in a non-linear analysis). In each analysis case SAP2000 obtains a solution and then verifies that all of the spring elements are in compression. If tension exists in any spring element, SAP2000 will remove those springs and re-solve the problem. SAP2000 continues this iterative process until the solution converges and no tension exists in any spring elements.

Having completed the non-linear analysis cases described above, SAP2000 is utilized to generate moment and shear contour plots which are used in designing the shear and flexural reinforcing in the foundation mat. In designing the flexural reinforcing a standard rebar pattern is selected and the corresponding moment capacity resulting from that reinforcing is computed. The contour plots will then be utilized to identify areas that may require additional reinforcing above the standard reinforcement pattern. In evaluating the shear reinforcing requirements in the foundation mat the shear capacity of the concrete (without any reinforcing considerations) is computed and the shear contour plots are utilized to determine areas of the foundation mat requiring transverse shear reinforcing. Transverse shear reinforcing will then be designed to provide the additional capacity required above the capacity provided by the concrete.

After completing the reinforcing design of the foundation mat the overall stability of the CRCF structure against sliding and overturning is evaluated. As a result of the high seismic accelerations associated with the DBGM-2 ground motions it is not possible to compute a static factor of safety against sliding for the CRCF structure under DBGM-2 seismic input motions. As a result this calculation will utilize energy balance methods discussed in ASCE 43-05 (Ref. 2.2.8) to compute the maximum predicted sliding displacement. Any umbilical (i.e. utility piping, electrical raceway, etc) connecting from / to the CRCF from outside the structure will need to be designed to accommodate the sliding displacement with suitable safety factor.

Details of the finite element analysis of the foundation mat and the stability calculations are discussed in Section 6.

5. LIST OF ATTACHMENTS

Attachments	Number of Pages
Attachment A. Foundation Mat Plan at EL 0'-0"	2
Attachment B. SAP2000 Input File	CD
Attachment C. SAP2000 Output (Element Forces)	CD
Attachment D. SAP2000 Output – Moment and Shear Contours	63

6. BODY OF CALCULATION

6.1 FOUNDATION MAT FINITE ELEMENT MODEL

A finite element model of the CRCF foundation mat was created using SAP 2000. The CRCF foundation mat consists of shell elements with a nominal mesh size of 5 ft. by 5 ft. Actual mesh sizes vary slightly from this nominal size as required to maintain the correct location of the shear walls. The coordinate system and global origin chosen for this model coincides with the coordinate system and global origin used in the CRCF "beam-stick" model used in the seismic analysis (Ref. 2.2.3). The origin and orientation of the global axes are shown on Attachment A.

The shell elements used to model the foundation mat were located at a Z coordinate corresponding to the bottom of the foundation mat. In this case a 6 ft. thick slab is considered, thus the Z coordinate of the finite element mesh is located at Z=-6 ft. By modeling the foundation mat at this elevation the proper soil pressures are computed since the mat will rotate about a bottom corner of the slab.

Shell elements were also used to model the shear walls from the bottom of slab elevation up to elevation 0'-0". These walls will serve to stiffen the foundation mat from the resulting soil pressures computed in the analysis. The "beam-stick" model developed in the CRCF seismic analysis (Ref. 2.2.3) is then coupled to the finite element mesh of the walls by using the SAP 2000 rigid constraint definition. The resulting model yields an accurate representation of the foundation mat with the stiffening effects of the shear walls included in the model. Figure 6.1.1 shows an isometric view of the CRCF foundation mat with the "beam-stick" model coupled to it. An example of a "beam-stick" element coupled to wall finite elements is shown in figure 6.1.2. Figure 6.1.3 shows the foundation mat finite element mesh.

It should be noted that in this model the lower walls span from –6' to 32'. In reality the walls span from the top of the foundation mat at 0'- 0" to 32'. However, since the purpose of this model is for use in designing the foundation mat, the walls are represented here only to stiffen the foundation mat which is adequately represented in this model.

To consider the stiffness properties of the soil underlying the foundation mat a series of non-linear (compression only) springs were computed. The soil spring stiffness is computed using the 35 ft. upper bound soil springs computed in the CRCF soil spring calculation (Ref. 2.2.4). In this calculation a series of global springs, 3 translational and 3 rotational, were computed. This calculation uses these global springs to compute “local” springs to be placed under each node in the foundation mat mesh. The method of determining these “local” springs is discussed in the Seismic Analysis and Design Approach document (Ref. 2.2.13). Details of the soil spring calculation are given in section 6.2.

The vertical compression only springs were included in the SAP 2000 model using a 2 joint link element. The gap element option in the SAP 2000 link definition was used such that the link had a stiffness in compression as defined above and had 0 stiffness when the gap element is open, i.e. in tension. To create the 2 joints used to define the link element the nodes used to define the foundation finite element mesh were copied down an arbitrary distance of 10 ft. The joint id’s at this location were assigned joint numbers g1, g2, g3…gn. The joint numbers on the foundation mesh were assigned id’s base1, base2, base3…..base n. Such that g1 and base1 have the same X and Y coordinate and thus are located along the same vertical line. Link elements would then connect g1-base1, g2-base2, g3-base3, ………gn-base n.

Horizontal springs are used to model the lateral resistance of the soil. Since the primary load path to resist lateral loads is friction (passive pressure also exists) under the foundation mat the horizontal soil springs are located at the foundation mesh nodes, base1, base2, base3,…base n at elevation –6 ft. These springs are linear springs since friction occurs in any direction. An example of the soil springs is shown in figure 6.1.2.

Concrete material properties used in this finite model are taken from section 4.2.11.6.6 of the Project Design Criteria (Ref. 2.2.1) and are consistent with those used in the CRCF seismic analysis (Ref. 2.2.3).

In the “beam-stick” seismic model (Ref. 2.2.3) the foundation mass and lower half of the wall mass was lumped at the center of gravity of the foundation mat. In this analysis the foundation mat and lower walls are included in the model and thus their masses are included in the model through the density assigned to the concrete shell elements. Only 6 ft. of wall height is included in this model, however the lower half of the actual wall is 16 ft. The density assigned to the wall elements needs to be factored to obtain the correct wall weights. Thus the normal concrete density of 150 lbs/cubic ft. (Ref. 2.2.1) is multiplied by a factor equal to 16’/6’ or 2.67 resulting in a value of 150*2.67 = 400 lbs/cubic ft. is used to define the wall element concrete density.

SAP 2000 model files are included in attachment B.

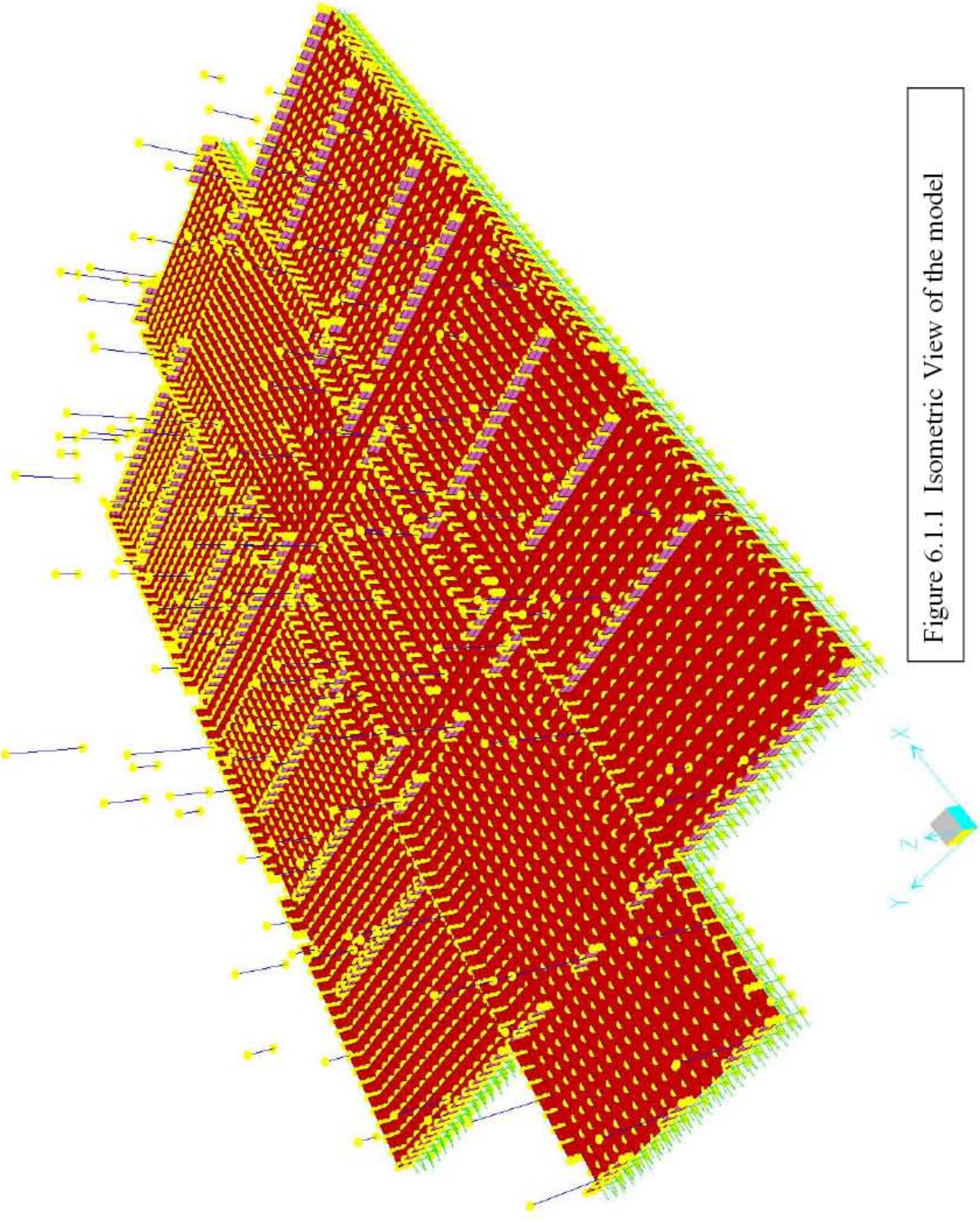


Figure 6.1.1 Isometric View of the model

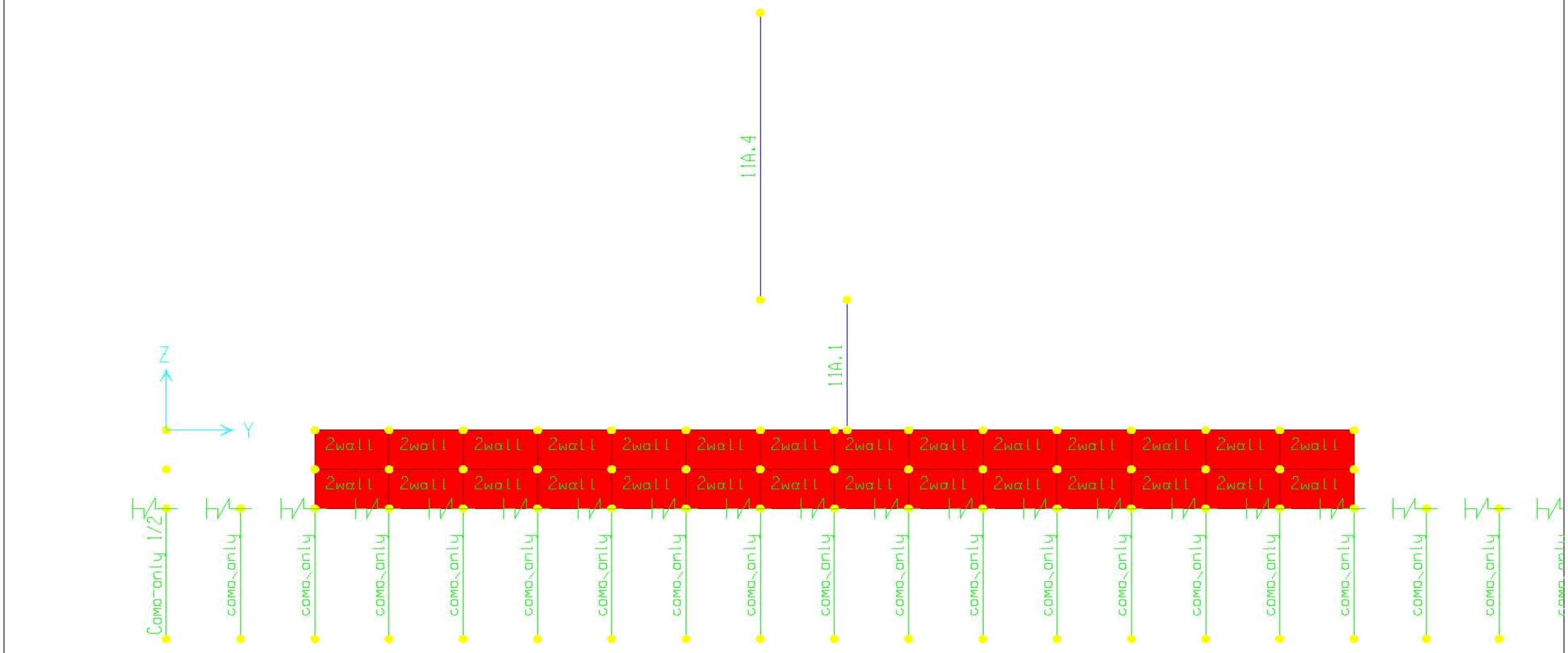


Figure 6.1.2 Wall and Stick Elements

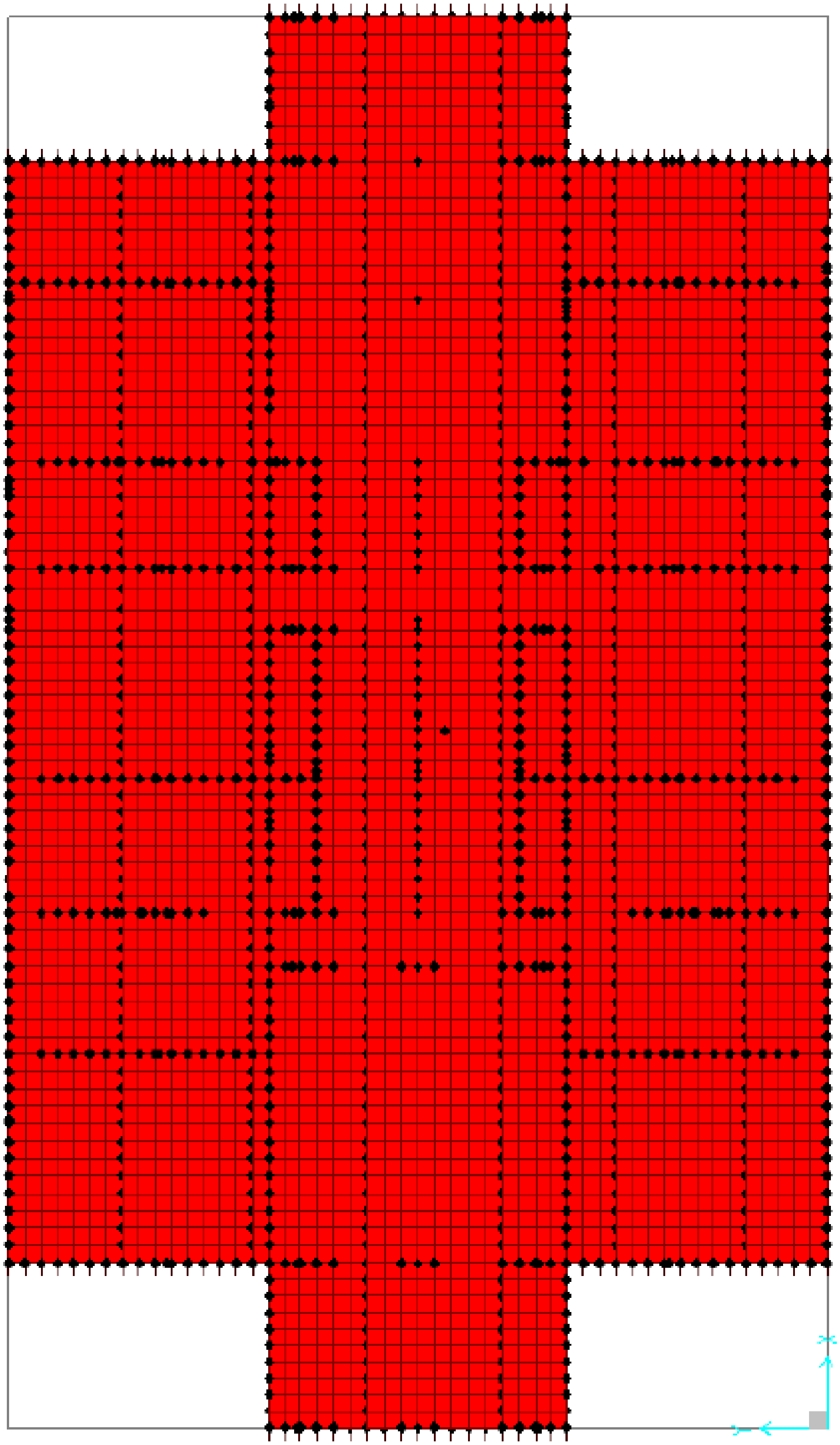


Figure 6.1.3 Foundation Mat Finite Element Mesh

6.2 SOIL SPRINGS

As stated in section 6.1, the boundary condition for the foundation mat was modeled using non-linear compression only springs based on the 5E-4 upper bound 35’ alluvium case, (Reference 2.2.4) for the vertical springs and linear springs in the horizontal direction. The soil springs used in the seismic analysis (Reference 2.2.3) were global springs, meaning that only one support point was used in the seismic analysis model. The foundation mat finite element model will have a support point located at each node of the foundation mat mesh. Therefore, the global spring must be converted into individual springs applied to each node of the foundation finite element mesh. This section contains the joint spring calculation.

The global upper bound 35’ alluvium spring constants for 5E-4 event (DBGM-2), from design calculation Canister Receipt and Closure Facility (CRCF) Soil Springs: 060-SYC-CR00-00300-00A (Reference 2.2.4) are listed below. (Note the coordinate system used in the Soil Spring calculation is different from the coordinate system used in this calculation.)

Global Translational Spring constants (units of kips/ft)

Soil Spring Coordinate System	Value, kips/ft	Finite Element Model Coordinate System
KX	4.369E+07	KFX
KZ	4.599E+07	KFY
KY	5.559E+07	KFZ

Global Rotational Spring Constants (units of ft-kips/radian)

Soil Spring Coordinate System	Value, kip-ft/rad	Finite Element Model Coordinate System
KΨX	9.99E+11	KΨX
KΨZ	1.64E+12	KΨY
KΨY	1.75E+12	KΨZ

The Seismic Analysis and Design Approach Document (Reference 2.2.13) Appendix C suggests two equations for calculating vertical soil springs per unit area from global spring values.

$k_v = K_V / A$ where k_v is vertical spring per unit area and K_V is the global vertical spring KZ and A is the basemat area. (Ref. 2.2.13, Eq. C-2)

$k_v = K\psi / I_A$ where $K\psi$ is the rotational spring stiffness and I_A is the moment of inertia of the basemat about the centroid. (Ref. 2.2.13, Eq. C-3) Note: Reference 2.2.13 defines the rotational spring as $K\varphi$ which has been defined as $K\psi$ in this calculation.

Basemat Area A= 95,540 ft^2 (Section 6.1.2.1, Ref. 2.2.4)

I_{XX} = 503.14E+6 ft^4 (Section 6.1.2.1, Ref. 2.2.4)
I_{YY} =1.105E+9 ft^4 (Section 6.1.2.1, Ref. 2.2.4)

Substituting,

k_v = 5.559E+7 / 95.542E+3 = 582 kips/ ft^3 (Ref. 2.2.13, Eq. C-2)

k_v = 1.64E+12 / 1.105E+9 =1484 kips/ ft^3 for rocking about in Y axis (Ref. 2.2.13, Eq. C-3)

k_v = 9.989E+11/ 503.14E+6 = 1986 kips/ ft^3 for rocking about in X axis (Ref. 2.2.13, Eq. C-3)

These values show that the vertical spring value based on global rotational springs are higher (stiffer) than the one derived from global vertical spring.

For a given load condition the stiffer spring will yield lower bending moment and shear forces in the basemat.

Therefore use 582 kips / ft^3 which will give more conservative (upper bound) design forces for the basemat design.

The nominal area of the basemat mesh element is 5ft by 5ft =25 sqft.

The nominal vertical spring values at an internal node = k_v times the tributary area of each node

= 582 * 25 = 14,550 kips per foot.

Since the basemat mesh is generated between the walls the area elements nodes are not equally spaced resulting in varying tributary areas. For simplicity the global spring value is distributed to 3606 nodes (see figure 6.2.1) as follows.

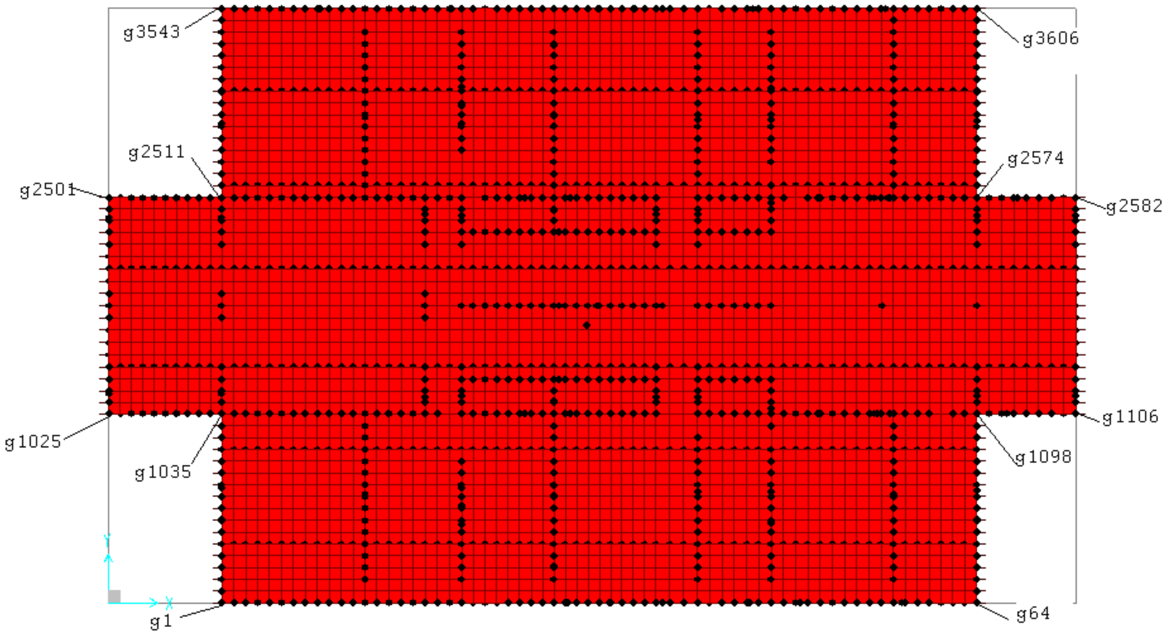


Figure 6.2.1 Link Nodes

For the 8 corner nodes (Nodes g1, g64, g1025, g1106, g2501, g2582, g3543, g3606) with a nominal tributary area of 25% of the interior node assigned spring value will be ¼ of the interior node spring.

For the 4 corner nodes at g1035, g1098 g2511 and g2574, with a nominal tributary area of 75% of the interior node the assigned spring value will be ¾ of the spring values of the interior node.

For the 250 perimeter nodes with a nominal tributary area of 50% of an interior node the assigned spring value will be 50% of that of the interior node.

Therefore number of interior nodes = 3606-250-4-8 = 3344

Letting X = spring value of the interior node, the total spring value can be computed as

K = 3344X+ 250*0.5 X + 8 * 0.25X + 4*0.75X = 3474X

X = 5.559E+7/ 3474 = 16,000 kips/ft

At 250 perimeter nodes =1/2(16,000) = 8,000 kips/ft

At 8 corner nodes = ¼(16000) = 4,000 kips/ ft

At 4 corner nodes = ¾(16000) = 12,000 kips/ft

These values are input in SAP2000 as link property assignments and Link Property definitions.

Example: For corner link at node g1,

Link Property Assignments

Link #	**Link Type**	**Link Joint**	**Link Property**
1	Gap	Two Joint	Comp-only ¼

Link Property Definition

Link Property	**DOF**	**Fixed**	**Nonlinear**	**Translation Stiffness**
Comp-only ¼	U1	No	Yes	4000 kips/ft

Similarly the translational springs are derived from global values as follows.

Horizontal Springs in X direction:

At 3344 interior nodes : 4.369E+07 / 3474 =12,576 k/ft

At 250 perimeter wall nodes(1/2) : 6288 k/ft

At 8 corner nodes(¼) : 3144 k/ft

At 4 corner nodes (3/4) : 9432 k/ft

Horizontal Springs in Y direction:

At 3344 interior nodes : 4.599E+07 / 3474 =13238 k/ft

At 250 perimeter wall nodes (1/2): 6619 k/ft

At 8 corner nodes (¼): 3309 k/ft

At 4 corner nodes (3/4): 9928 k/ft

These values are input as Joint Spring Assignments in the global X and Y directions at foundation mesh nodes.

6.3 LOADS AND LOADING COMBINATIONS

6.3.1 The forces and moments in the foundation mat will be determined based on a combination of the three global directions considered in the seismic analysis, which are; HX, HY, and VZ as well as the self weight of the structure. HX (east-west) and HY (north-south) represent both orthogonal horizontal directions and VZ represents the vertical direction. Self weight is in the negative VZ direction. To account for non-orthogonal seismic effects, the loading combinations to be considered are based on the 100-40-40 component factor method from ASCE 4-98, section 3.2.7.1.2 (Reference 2.2.7), which uses 100% seismic loading in one direction, combined with 40% seismic in the remaining two directions. The 100-40-40 component factor method (Reference 2.2.7) yields three basic load combinations:

- ± 1.0 HX ± 0.4 HY ± 0.4 VZ
- ± 0.4 HX ± 1.0 HY ± 0.4 VZ
- ± 0.4 HX ± 0.4 HY ± 1.0 VZ

Manipulating the above combinations (using the plus and minus signs) yields 24 loading permutations:

1: + 1.0 HX + 0.4 HY + 0.4 VZ
2: + 1.0 HX + 0.4 HY - 0.4 VZ
3: + 1.0 HX - 0.4 HY + 0.4 VZ
4: + 1.0 HX - 0.4 HY - 0.4 VZ
5: - 1.0 HX + 0.4 HY + 0.4 VZ
6: - 1.0 HX + 0.4 HY - 0.4 VZ
7: - 1.0 HX - 0.4 HY + 0.4 VZ
8: - 1.0 HX - 0.4 HY - 0.4 VZ
9: + 0.4 HX + 1.0 HY + 0.4 VZ
10: + 0.4 HX + 1.0 HY - 0.4 VZ
11: - 0.4 HX + 1.0 HY + 0.4 VZ
12: - 0.4 HX + 1.0 HY - 0.4 VZ
13: + 0.4 HX - 1.0 HY + 0.4 VZ
14: + 0.4 HX - 1.0 HY - 0.4 VZ
15: - 0.4 HX - 1.0 HY + 0.4 VZ
16: - 0.4 HX - 1.0 HY - 0.4 VZ
17: + 0.4 HX + 0.4 HY + 1.0 VZ
18: + 0.4 HX - 0.4 HY + 1.0 VZ
19: - 0.4 HX + 0.4 HY + 1.0 VZ
20: - 0.4 HX - 0.4 HY + 1.0 VZ
21: + 0.4 HX + 0.4 HY - 1.0 VZ
22: + 0.4 HX - 0.4 HY - 1.0 VZ
23: - 0.4 HX + 0.4 HY - 1.0 VZ
24: - 0.4 HX - 0.4 HY - 1.0 VZ

The CRCF foundation mat and wall layout is symmetrical with respect to global X axis (except for a few wall openings). Thus the maximum foundation pressure at the northeast corner will be same as the maximum foundation pressure at the southeast corner. Similarly the maximum foundation pressure at the northwest corner will be same as the pressure at the southwest corner. Therefore 12 combinations with negative HY force component will be similar to the twelve combinations with positive HY force components. Therefore the following 12 load combinations will provide the required foundation loads for design.

1: DL + 1.0 HX + 0.4 HY + 0.4 VZ
2: DL + 0.4 HX + 1.0 HY + 0.4 VZ
3: DL + 0.4 HX + 0.4 HY + 1.0 VZ
4: DL + 1.0 HX + 0.4 HY - 0.4 VZ
5: DL + 0.4 HX + 1.0 HY - 0.4 VZ
6: DL - 0.4 HX + 1.0 HY - 0.4 VZ
7: DL - 0.4 HX + 0.4 HY + 1.0 VZ
8: DL - 0.4 HX + 0.4 HY - 1.0 VZ
9: DL + 0.4 HX + 0.4 HY - 1.0 VZ
10: DL - 1.0 HX + 0.4 HY -0.4 VZ
11: DL -1.0 HX + 0.4 HY +0.4 VZ
12: DL - 0.4 HX + 1.0 HY +0.4 VZ

DL = Non-seismic loads which include wall and floor dead loads and 25% of floor design live loads. These loads are calculated in Ref. 2.2.5.
Note: Live load considered in combination with seismic loads is 25% of floor design live load per Ref. 2.2.13, Section 8.3.1.

6.3.2 Non- Seismic Loads (DL)

The floor and wall dead and live loads are applied at center of mass of each floor. These loads are taken directly from calculation 060-SYC-CR00-00200-000-00A, Canister Receipt and Closure Facility (CRCF) Mass Properties (Page 22 of Ref. 2.2.5). The center of mass nodes and corresponding loads are listed below.

Floor El.	Node	Load in –Z direction (Kips)
32’-0”	299	96852
64’-0”	499	60758
72’-0”	599	3780
100’-0”	699	18626

The self weight of the foundation mat and first 16’of wall weight are applied as distributed element loads in the finite element model. The self weight of these elements is accounted for by specifying unit weight, thickness, and gravity multipliers (-1.0 for vertical loads). The weight of the lower 16’ of wall is accounted for by specifying a weight modifier for wall elements. The total height of two wall elements is 6 feet, therefore a weight modifier of 16/6 =2.67 is applied to the 2’ and 4’ thick wall elements to obtain the correct wall weights for the lower 16 feet of wall.

These loads are combined with seismic loads to form combinations listed in section 6.3.1

6.3.3 Seismic Loads

Floor level seismic loads are derived from accelerations extracted from the calculation 060-SYC-CR00-00400-000-00A, Canister Receipt and Closure Facility (CRCF) Seismic Analysis (Ref. 2.2.3).

The base level and floor level accelerations for 35' alluvium upper bound analysis case (Ref. 2.2.3 Attachment D) were used to calculate seismic loads. As demonstrated in Ref. 2.2.3 the upper bound 35' soil case was found to be the bounding seismic load condition.

In the following table, HX is the seismic load in X direction, HY is the seismic load in Y direction and VZ is the seismic load in Z direction.

Ux, Uy and Uz are joint accelerations in ft/sec^2 in X, Y, and Z directions respectively due to HX, HY and VZ. It is noted that as a result of eccentricities between the center of mass and center of rigidity, HX seismic loading produces accelerations in the X, Y, and Z directions. Similar behavior is seen for HY and VZ seismic loadings.

Table 6.3.3.1 Design Basis In Structure Accelerations

35' Alluvium,Upper Bound HX Response Accelerations				
Floor El.	Node	Ux ft/sec^2	Uy ft/sec^2	Uz ft/sec^2
0'-0"	99	14.2539	0.4847	0.1852
32'-0"	299	21.3982	0.8713	0.1872
64'-0"	499	29.1548	1.1136	0.2944
72'-0"	599	30.7676	1.3697	4.1415
100'-0"	699	45.3995	1.3973	0.9358

35' Alluvium,Upper Bound HY Response Accelerations				
Floor El.	Node	Ux ft/sec^2	Uy ft/sec^2	Uz ft/sec^2
0'-0"	99	0.5103	15.5398	0.0932
32'-0"	299	0.8484	22.3587	0.1124
64'-0"	499	1.1407	28.0851	0.2708
72'-0"	599	1.2049	32.0737	0.1629
100'-0"	699	1.5606	43.3764	0.1276

35' Alluvium,Upper Bound VZ Response Accelerations				
Floor El.	Node	Ux ft/sec^2	Uy ft/sec^2	Uz ft/sec^2
0'-0"	99	0.2203	0.1052	19.9934
32'-0"	299	0.2268	0.1084	22.7328
64'-0"	499	0.1735	0.0923	24.4267
72'-0"	599	1.15	0.1505	25.4216
100'-0"	699	0.5349	0.1891	26.3433

Source: Ref. 2.2.3 Attachment D (Table Joint Accelerations- Absolute)

The seismic load at each joint is calculated from the joint dead load listed above and converting it to mass and then multiplying by the acceleration. (F= m*a)

Example Calculation:

Determine Seismic load due to HX at joint 699.

Dead load at joint 699 =18626 kips g =32.2 ft/sec^2 Acceleration due to gravity

Mass at 699 = 18626/ 32.2 =578.45 kip-sec^2/ft

Joint load in X direction due to HX = Mass at 699* acceleration in X direction Ux due to HX

= 578.45*45.3995 =26261.2 kips

Joint Load in Y direction due to HX = 578.45 *Uy

=578.45* 1.3973 =808.3 kips

Joint Load in Z direction due to HX =578.45*0.9358 =541.3 kips

Seismic load due to basemat weight and first 16' of wall will be distributed to each area element by using gravity multipliers in SAP2000 area element load input. Gravity multipliers are derived by dividing tabulated accelerations at floor elevation 0.0 (Joint 99) by acceleration due to gravity (32.2 ft/sec^2)

Example : Gravity multipliers for basemat and wall elements due to HY

X direction = 0.5103 /32.2 = 0.0158

Y direction = 15.5398 /32.2 = 0.4826

Z direction = 0.0932 /32.2 = 0.003

Similar joint loads due to seismic load in X, Y and Z direction are calculated and presented in the following table.

Table 6.3.3.2 Equivalent Static Seismic Loads

HX RESPONSE LOADS			
	Area Element Gravity Multiplier		
	X direction	Y direction	Z direction
	0.443	0.015	0.006
	Joint Loads (kips)		
Joint	X direction	Y direction	Z direction
299	64362	2621	563
499	55012	2101	555
599	3612	160.8	486
699	26261	808	541

HY RESPONSE LOADS			
	Area Element Gravity Multiplier		
	X direction	Y direction	Z direction
	0.016	0.483	0.003
	Joint Loads (kips)		
Joint	X direction	Y direction	Z direction
299	2552	67251	338
499	2152	52994	511
599	141	3765	19
699	903	25091	74

VZ RESPONSE LOADS			
	Area Element Gravity Multiplier		
	X direction	Y direction	Z direction
	0.007	0.003	0.621
	Joint Loads (kips)		
Joint	X direction	Y direction	Z direction
299	682	326	68376
499	327	174	46090
599	135	17	2984
699	309	109	15238

6.3.4 Load Combinations

From non -seismic and seismic loads twelve combinations as described in section 6.3.1 are developed by simple additions as shown in the following tables. These joint loads and gravity multipliers were directly input as nonlinear load cases in SAP2000 foundation model.

Table 6.3.4.1 Combination 1 DL+HX+0.4HY+0.4VZ

LOADS				
DEAD LOADS			Joint Loads (kips)	
	Joints	FX	FY	FZ
	299			-96852
	499			-60758
	599			-3780
	699			-18626
		Basemat and Wall Area Element Gravity Multiplier		
				-1.00
HX		Basemat and Wall Area Element Gravity Multiplier		
		0.443	0.015	0.006
	Joints		Joint Loads (kips)	
	299	64362	2621	563
	499	55012	2101	555
	599	3612	160.8	486
	699	26261	808	541
0.4HY		Basemat and Wall Area Element Gravity Multiplier		
		0.0064	0.1932	0.0012
	Joints		Joint Loads (kips)	
	299	1020.8	26900.4	135.2
	499	860.8	21197.6	204.4
	599	56.4	1506	7.6
	699	361.2	10036.4	29.6
0.4VZ		Basemat and Wall Area Element Gravity Multiplier		
		0.0028	0.0012	0.2484
	Joints		Joint Loads (kips)	
	299	272.8	130.4	27350.4
	499	130.8	69.6	18436
	599	54	6.8	1193.6
	699	123.6	43.6	6095.2
DEAD LOAD +HX +0.4HY +0.4VZ				
		Basemat and Wall Area Element Gravity Multiplier		
		0.4522	0.2094	-0.7444
	Joints		Joint Loads (kips)	
	299	65655.6	29651.8	-68803.4
	499	56003.6	23368.2	-41562.6
	599	3722.4	1673.6	-2092.8
	699	26745.8	10888	-11960.2

Table 6.3.4.2 Combination 2 DL+0.4HX+HY+0.4VZ

LOADS				
DEAD LOADS			**Joint Loads (kips)**	
	Joints	FX	FY	FZ
	299			-96852
	499			-60758
	599			-3780
	699			-18626
		Basemat and Wall Area Element Gravity Multiplier		
				-1.00
0.4HX		**Basemat and Wall Area Element Gravity Multiplier**		
		0.1772	0.006	0.0024
	Joints		Joint Loads (kips)	
	299	25744.8	1048.4	225.2
	499	22004.8	840.4	222
	599	1444.8	64.32	194.4
	699	10504.4	323.2	216.4
HY		**Basemat and Wall Area Element Gravity Multiplier**		
		0.016	0.483	0.003
	Joints		**Joint Loads (kips)**	
	299	2552	67251	338
	499	2152	52994	511
	599	141	3765	19
	699	903	25091	74
0.4VZ		**Basemat and Wall Area Element Gravity Multiplier**		
		0.0028	0.0012	0.2484
	Joints		**Joint Loads (kips)**	
	299	272.8	130.4	27350.4
	499	130.8	69.6	18436
	599	54	6.8	1193.6
	699	123.6	43.6	6095.2
		DEAD LOAD+0.4HX+HY+0.4VZ		
		Basemat and Wall Area Element Gravity Multiplier		
		0.196	0.4902	-0.7462
	Joints		**Joint Loads (kips)**	
	299	28569.6	68429.8	-68938.4
	499	24287.6	53904	-41589
	599	1639.8	3836.12	-2373
	699	11531	25457.8	-12240.4

Table 6.3.4.3 Combination 3 DL+0.4HX+0.4HY+VZ

LOADS				
DEAD LOADS			**Joint Loads (kips)**	
	Joints	FX	FY	FZ
	299			-96852
	499			-60758
	599			-3780
	699			-18626
		Basemat and Wall Area Element Gravity Multiplier		
				-1.00
0.4HX		**Basemat and Wall Area Element Gravity Multiplier**		
	Joints	0.1772	0.006	0.0024
			Joint Loads (kips)	
	299	25744.8	1048.4	225.2
	499	22004.8	840.4	222
	599	1444.8	64.32	194.4
	699	10504.4	323.2	216.4
0.4HY		**Basemat and Wall Area Element Gravity Multiplier**		
	Joints	0.0064	0.1932	0.0012
			Joint Loads (kips)	
	299	1020.8	26900.4	135.2
	499	860.8	21197.6	204.4
	599	56.4	1506	7.6
	699	361.2	10036.4	29.6
VZ		**Basemat and Wall Area Element Gravity Multiplier**		
	Joints	0.007	0.003	0.621
			Joint Loads (kips)	
	299	682	326	68376
	499	327	174	46090
	599	135	17	2984
	699	309	109	15238
DEAD LOAD+0.4HX+0.4HY+VZ				
		Basemat and Wall Area Element Gravity Multiplier		
		0.1906	0.2022	0.6246
	Joints		**Joint Loads (kips)**	
	299	27447.6	28274.8	-28115.6
	499	23192.6	22212	-14241.6
	599	1636.2	1587.32	-594
	699	11174.6	10468.6	-3142

Table 6.3.4.4 Combination 4 DL+HX+0.4HY-0.4VZ

Combination 4				
LOADS				
Dead Load			**Joint Loads (Kips)**	
	Joints	FX	FY	FZ
	299			-96852
	499			-60758
	599			-3780
	699			-18626
		Basemat and Wall Area Element Gravity Multiplier		
				-1.00
HX		**Basemat and Wall Area Element Gravity Multiplier**		
		0.443	0.015	0.006
	Joints		**Joint Loads (Kips)**	
	299	64362	2621	563
	499	55012	2101	555
	599	3612	160.8	486
	699	26261	808	541
0.4HY		**Basemat and Wall Area Element Gravity Multiplier**		
		0.0064	0.1932	0.0012
	Joints		**Joint Loads (Kips)**	
	299	1020.8	26900.4	135.2
	499	860.8	21197.6	204.4
	599	56.4	1506	7.6
	699	361.2	10036.4	29.6
-0.4VZ		**Basemat and Wall Area Element Gravity Multiplier**		
		-0.0028	-0.0012	-0.2484
	Joints		**Joint Loads (Kips)**	
	299	-272.8	-130.4	-27350.4
	499	-130.8	-69.6	-18436
	599	-54	-6.8	-1193.6
	699	-123.6	-43.6	-6095.2
DEAD LOAD +HX +0.4HY -0.4VZ				
		Basemat and Wall Area Element Gravity Multiplier		
		0.4466	0.207	-1.2412
	Joints		**Joint Loads (Kips)**	
	299	65110	29391	-123504.2
	499	55742	23229	-78434.6
	599	3614.4	1660	-4480
	699	26498.6	10800.8	-24150.6

Table 6.3.4.5 Combination 5 DL+0.4HX+HY-0.4VZ

LOADS				
Dead Load		**Joint Loads (Kips)**		
		FX	FY	FZ
	Joints			
	299			-96852
	499			-60758
	599			-3780
	699			-18626
		Basemat and Wall Area Element Gravity Multiplier		
				-1
0.4HX		**Basemat and Wall Area Element Gravity Multiplier**		
		0.1772	0.006	0.0024
	Joints	**Joint Loads (Kips)**		
	299	25744.8	1048.4	225.2
	499	22004.8	840.4	222
	599	1444.8	64.32	194.4
	699	10504.4	323.2	216.4
HY		**Basemat and Wall Area Element Gravity Multiplier**		
		0.016	0.483	0.003
	Joints	**Joint Loads (Kips)**		
	299	2552	67251	338
	499	2152	52994	511
	599	141	3765	19
	699	903	25091	74
-0.4VZ		**Basemat and Wall Area Element Gravity Multiplier**		
		-0.0028	-0.0012	-0.2484
	Joints	**Joint Loads (Kips)**		
	299	-272.8	-130.4	-27350.4
	499	-130.8	-69.6	-18436
	599	-54	-6.8	-1193.6
	699	-123.6	-43.6	-6095.2
DEAD LOAD +0.4HX +HY -0.4VZ				
		Basemat and Wall Area Element Gravity Multiplier		
		0.1904	0.4878	-1.243
	Joints	**Joint Loads (Kips)**		
	299	28024	68169	-123639.2
	499	24026	53764.8	-78461
	599	1531.8	3822.52	-4760.2
	699	11283.8	25370.6	-24430.8

Table 6.3.4.6 Combination 6 DL-0.4HX+HY-0.4VZ

LOADS				
Dead Load			Joint Loads (Kips)	
		FX	FY	FZ
	Joints			
	299			-96852
	499			-60758
	599			-3780
	699			-18626
		Basemat and Wall Area Element Gravity Multiplier		
				-1.00
-0.4HX		Basemat and Wall Area Element Gravity Multiplier		
		-0.1772	-0.006	-0.0024
	Joints		Joint Loads (Kips)	
	299	-25744.8	-1048.4	-225.2
	499	-22004.8	-840.4	-222
	599	-1444.8	-64.32	-194.4
	699	-10504.4	-323.2	-216.4
HY		Basemat and Wall Area Element Gravity Multiplier		
		0.016	0.483	0.003
	Joints		Joint Loads (Kips)	
	299	2552	67251	338
	499	2152	52994	511
	599	141	3765	19
	699	903	25091	74
-0.4VZ			Basemat and Wall Area Element Gravity Multiplier	
		-0.0028	-0.0012	-0.2484
	Joints		Joint Loads (Kips)	
	299	-272.8	-130.4	-27350.4
	499	-130.8	-69.6	-18436
	599	-54	-6.8	-1193.6
	699	-123.6	-43.6	-6095.2
DEAD LOAD -0.4HX +HY -0.4VZ				
		Basemat and Wall Area Element Gravity Multiplier		
		-0.164	0.4758	-1.2478
	Joints		Joint Loads (Kips)	
	299	-23465.6	66072.2	-124089.6
	499	-19983.6	52084	-78905
	599	-1357.8	3693.88	-5149
	699	-9725	24724.2	-24863.6

Table 6.3.4.7 Combination 7 DL-0.4HX+0.4HY+VZ

LOADS				
DEAD LOADS		**Joint Loads (kips)**		
		FX	FY	FZ
	Joints			
	299			-96852
	499			-60758
	599			-3780
	699			-18626
		Basemat and Wall Area Element Gravity Multiplier		
				-1.00
-0.4HX		**Basemat and Wall Area Element Gravity Multiplier**		
		-0.1772	-0.006	-0.0024
	Joints	**Joint Loads (kips)**		
	299	-25744.8	-1048	-225.2
	499	-22004.8	-840.4	-222
	599	-1444.8	-64.32	-194.4
	699	-10504.4	-323.2	-216.4
0.4HY		**Basemat and Wall Area Element Gravity Multiplier**		
		0.0064	0.1932	0.0012
	Joints	**Joint Loads (kips)**		
	299	1020.8	26900.4	135.2
	499	860.8	21197.6	204.4
	599	56.4	1506	7.6
	699	361.2	10036.4	29.6
VZ		**Basemat and Wall Area Element Gravity Multiplier**		
		0.007	0.003	0.621
	Joints	**Joint Loads (kips)**		
	299	682	326	68376
	499	327	174	46090
	599	135	17	2984
	699	309	109	15238
DEAD LOAD-0.4HX+0.4HY+VZ				
		Basemat and Wall Area Element Gravity Multiplier		
		-0.1638	0.1902	-0.3802
	Joints	**Joint Loads (kips)**		
	299	-24042	26178.4	-28566
	499	-20817	20531.2	-14685.6
	599	-1253.4	1458.68	-982.8
	699	-9834.2	9822.2	-3574.8

Table 6.3.4.8 Combination 8 DL-0.4HX+0.4HY-VZ

LOADS				
DEAD LOADS			**Joint Loads (kips)**	
		FX	FY	FZ
	Joints			
	299			-96852
	499			-60758
	599			-3780
	699			-18626
		Basemat and Wall Area Element Gravity Multiplier		
				-1.00
-0.4HX		**Basemat and Wall Area Element Gravity Multiplier**		
		-0.1772	-0.006	-0.0024
	Joints		**Joint Loads (kips)**	
	299	-25744.8	-1048	-225.2
	499	-22004.8	-840.4	-222
	599	-1444.8	-64.32	-194.4
	699	-10504.4	-323.2	-216.4
0.4HY		**Basemat and Wall Area Element Gravity Multiplier**		
		0.0064	0.1932	0.0012
	Joints		**Joint Loads (kips)**	
	299	1020.8	26900.4	135.2
	499	860.8	21197.6	204.4
	599	56.4	1506	7.6
	699	361.2	10036.4	29.6
-VZ		**Basemat and Wall Area Element Gravity Multiplier**		
		-0.007	-0.003	-0.621
	Joints		**Joint Loads (kips)**	
	299	-682	-326	-68376
	499	-327	-174	-46090
	599	-135	-17	-2984
	699	-309	-109	-15238
DEAD LOAD-0.4HX+0.4HY-VZ				
		Basemat and Wall Area Element Gravity Multiplier		
		-0.1778	0.1842	-1.6222
	Joints		**Joint Loads (kips)**	
	299	-25406	25526.4	-165318
	499	-21471	20183.2	-106865.6
	599	-1523.4	1424.68	-6950.8
	699	-10452.2	9604.2	-34050.8

Table 6.3.4.9 Combination 9 DL+0.4HX+0.4HY-VZ

LOADS				
DEAD LOADS				
		FX	FY	FZ
	Joints		**Joint Loads (kips)**	
	299			-96852
	499			-60758
	599			-3780
	699			-18626
		Basemat and Wall Area Element Gravity Multiplier		
				-1.00
0.4HX		**Basemat and Wall Area Element Gravity Multiplier**		
		0.1772	0.006	0.0024
	Joints		**Joint Loads (kips)**	
	299	25744.8	1048	225.2
	499	22004.8	840.4	222
	599	1444.8	64.32	194.4
	699	10504.4	323.2	216.4
0.4HY		**Basemat and Wall Area Element Gravity Multiplier**		
		0.0064	0.1932	0.0012
	Joints		**Joint Loads (kips)**	
	299	1020.8	26900.4	135.2
	499	860.8	21197.6	204.4
	599	56.4	1506	7.6
	699	361.2	10036.4	29.6
-VZ		**Basemat and Wall Area Element Gravity Multiplier**		
		-0.007	-0.003	-0.621
	Joints		**Joint Loads (kips)**	
	299	-682	-326	-68376
	499	-327	-174	-46090
	599	-135	-17	-2984
	699	-309	-109	-15238
DEAD LOAD +0.4HX+0.4HY-VZ				
		Basemat and Wall Area Element Gravity Multiplier		
		0.1766	0.1962	-1.6174
	Joints		**Joint Loads (kips)**	
	299	26083.6	27622.4	-164867.6
	499	22538.6	21864	-106421.6
	599	1366.2	1553.32	-6562
	699	10556.6	10250.6	-33618

Table 6.3.4.10 Combination 10 DL-HX+0.4HY-0.4VZ

LOADS				
DEAD LOADS		**Joint Loads (kips)**		
		FX	FY	FZ
	Joints			
	299			-96852
	499			-60758
	599			-3780
	699			-18626
	Basemat and Wall Area Element Gravity Multiplier			
				-1.00
-HX	**Basemat and Wall Area Element Gravity Multiplier**			
		-0.443	-0.015	-0.006
	Joint	**Joint Loads (kips)**		
	299	-64362	-2621	-563
	499	-55012	-2101	-555
	599	-3612	-160.8	-486
	699	-26261	-808	-541
0.4HY	**Basemat and Wall Area Element Gravity Multiplier**			
		0.0064	0.1932	0.0012
	Joint	**Joint Loads (kips)**		
	299	1020.8	26900.4	135.2
	499	860.8	21197.6	204.4
	599	56.4	1506	7.6
	699	361.2	10036.4	29.6
-0.4VZ	**Basemat and Wall Area Element Gravity Multiplier**			
		-0.0028	-0.0012	-0.2484
	Joint	**Joint Loads (kips)**		
	299	-272.8	-130.4	-27350.4
	499	-130.8	-69.6	-18436
	599	-54	-6.8	-1193.6
	699	-123.6	-43.6	-6095.2
DEAD LOAD -HX +0.4HY -0.4VZ				
	Basemat and Wall Area Element Gravity Multiplier			
		-0.4394	0.177	-1.2532
	Joint		**Joint Loads (kips)**	
	299	-63614	24149	-124630.2
	499	-54282	19027	-79544.6
	599	-3609.6	1338.4	-5452
	699	-26023.4	9184.8	-25232.6

Table 6.3.4.11 Combination 11 DL-HX+0.4HY+0.4VZ

LOADS **DEAD LOADS**		**Joint Loads (kips)**		
		FX	FY	FZ
	Joints			
	299			-96852
	499			-60758
	599			-3780
	699			-18626
	Basemat and Wall Area Element Gravity Multiplier			
				-1.00
-HX	**Basemat and Wall Area Element Gravity Multiplier**			
		-0.443	-0.015	-0.006
	Joints	**Joint Loads (kips)**		
	299	-64362	-2621	-563
	499	-55012	-2101	-555
	599	-3612	-160.8	-486
	699	-26261	-808	-541
0.4HY	**Basemat and Wall Area Element Gravity Multiplier**			
		0.0064	0.1932	0.0012
	Joints	**Joint Loads (kips)**		
	299	1020.8	26900.4	135.2
	499	860.8	21197.6	204.4
	599	56.4	1506	7.6
	699	361.2	10036.4	29.6
0.4VZ	Select Are **Basemat and Wall Area Element Gravity Multiplier**			
		0.0028	0.0012	0.2484
	Joints	**Joint Loads (kips)**		
	299	272.8	130.4	27350.4
	499	130.8	69.6	18436
	599	54	6.8	1193.6
	699	123.6	43.6	6095.2
DEAD LOAD -HX +0.4HY +0.4VZ				
	Basemat and Wall Area Element Gravity Multiplier			
		-0.4338	0.1794	-0.7564
	Joints	**Joint Loads (kips)**		
	299	-63068.4	24409.8	-69929.4
	499	-54020.4	19166.2	-42672.6
	599	-3501.6	1352	-3064.8
	699	-25776.2	9272	-13042.2

Table 6.3.4.12 Combination 12 DL-0.4HX+HY+0.4VZ

LOADS				
DEAD LOADS			**Joint Loads (kips)**	
		FX	FY	FZ
	Joints			
	299			-96852
	499			-60758
	599			-3780
	699			-18626
		Basemat and Wall Area Element Gravity Multiplier		
				-1.00
-0.4HX		**Basemat and Wall Area Element Gravity Multiplier**		
		-0.1772	-0.006	-0.0024
	Joints		**Joint Loads (kips)**	
	299	-25744.8	-1048.4	-225.2
	499	-22004.8	-840.4	-222
	599	-1444.8	-64.32	-194.4
	699	-10504.4	-323.2	-216.4
HY		**Basemat and Wall Area Element Gravity Multiplier**		
		0.016	0.483	0.003
	Joints		**Joint Loads (kips)**	
	299	2552	67251	338
	499	2152	52994	511
	599	141	3765	19
	699	903	25091	74
0.4VZ		**Basemat and Wall Area Element Gravity Multiplier**		
		0.0028	0.0012	0.2484
	Joints		**Joint Loads (kips)**	
	299	272.8	130.4	27350.4
	499	130.8	69.6	18436
	599	54	6.8	1193.6
	699	123.6	43.6	6095.2
DEAD LOAD -0.4HX +HY +0.4VZ				
		Basemat and Wall Area Element Gravity Multiplier		
		-0.1584	0.4782	-0.751
	Joints		**Joint Loads (kips)**	
	299	-22920	66333	-69388.8
	499	-19722	52223.2	-42033
	599	-1249.8	3707.48	-2761.8
	699	-9477.8	24811.4	-12673.2

6.4 SAP 2000 ANALYSIS RESULTS

6.4.1 Bending Moments and Shear Forces in Foundation Mat

Stress contour plots for the four corners of the basemat are included in Attachment D. The contour plots represent the bending moments M11 and M22, twisting moment M12, and shear forces V13 and V23. For further information on the definitions of M11, M22, M12, V13, and V23, refer to Figure 6.4.1. and Figure 6.4.2.

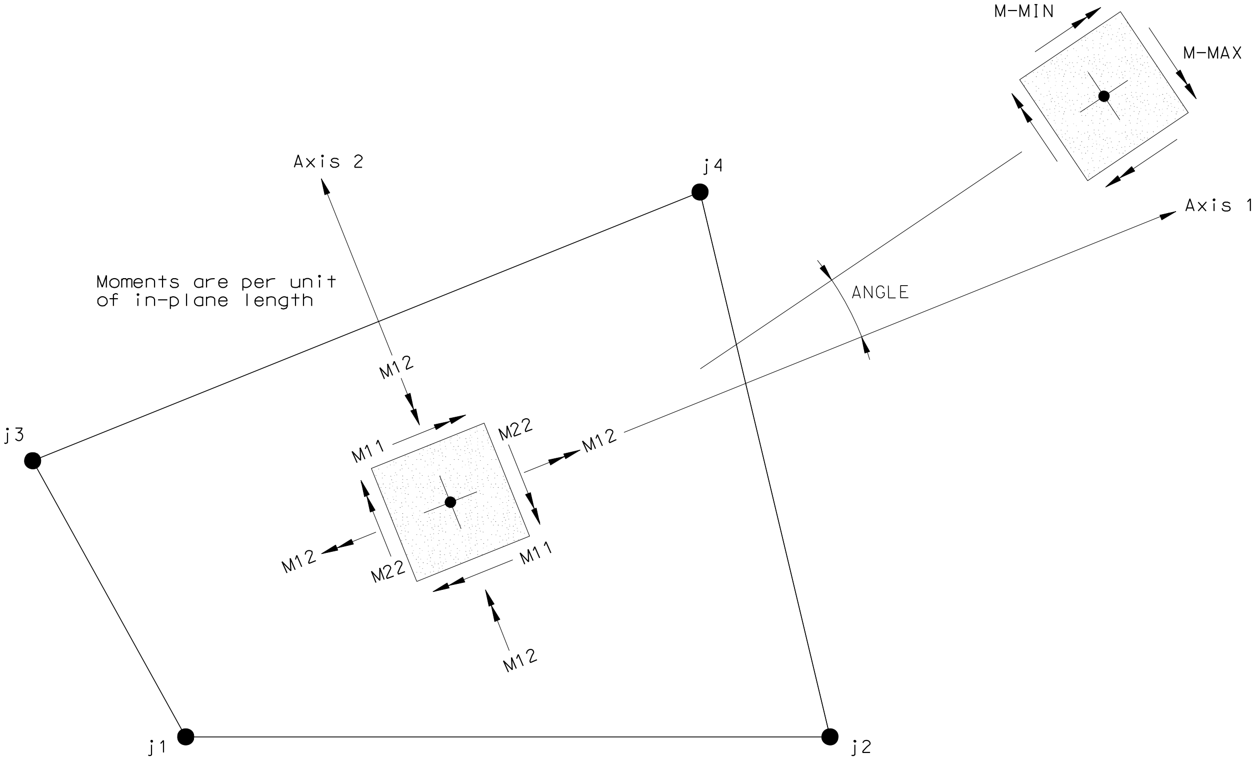


Figure 6.4.1 Shell Element Bending and Twisting Moments

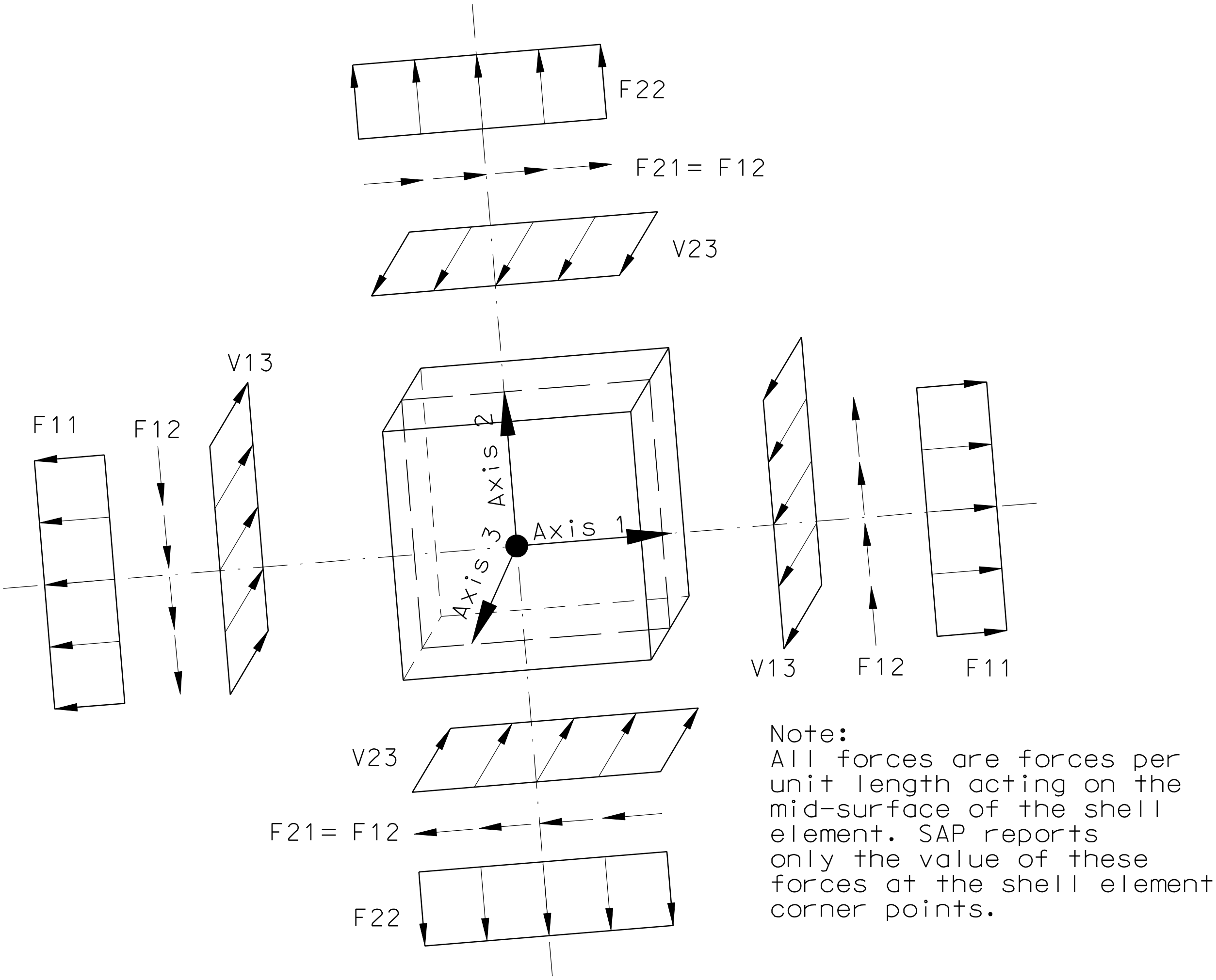


Figure 6.4.2 Shell Element Membrane and Shear Forces

The contour plots included in Attachment D have shear force V23 designated as Vmax and V13 designated as V23 in SAP 2000. This can be verified by comparing the values of element forces listed for each load combination in Attachment C to the values on the force contour plots.

SAP 2000 stress averaging at joints is used to develop the contour plots. SAP2000 computes the resultant force/ moment values at a joint by merging the element resultants tributary to that joint. The maximum moment and shear values are derived graphically by visual inspection of the force contours (Assumption 3.2.1 & Attachment D). Maximum shear and moment values are documented in table 6.5.2 and 6.5.1 respectively.

6.4.2 Maximum Bearing Pressure on foundation mat.

The Maximum bearing pressure on the mat is determined by dividing the maximum link element reaction force by the tributary area of the link. The maximum link reaction at (link #3541) the north east corner of the mat is 286 kips under load case 5. (Attachment C Load Combination 5) Therefore the maximum bearing pressure on the mat = 286 / 5'*5' = 11.4 kips per square foot.

6.5 REINFORCING DESIGN

The project design criteria document (Reference 2.2.1) specifies a concrete compressive strength f'_c of 4,000 psi or 5,000 psi for Important to Safety (ITS) structures. A concrete strength of 5,000 psi will be used for this calculation and for the design of the CRCF structure. This will be documented later on design drawings during detailed Engineering.

Determine the effective structural depth "d" by using one layer of number 18 bars each-way at top and bottom of basemat:
Assumed depth of basemat = 72"

$$d = 72'' - 3''(\text{cover}) - 1.5d_b = 72'' - 3'' - 1.5(2.257'') = 65.6''$$

Calculate the moment capacity by using one layer of number 18 bars at 12 in. on-center, $A_s = 4.0\ in^2$:

$$\phi M_n = \phi A_s f_y (d - \frac{a}{2}) \geq M_u$$ ACI 349-01, Chapter 10 (Reference 2.2.6)

where $a = \frac{A_s f_y}{0.85 f'_c b} = \frac{4\ in^2 (60\ ksi)}{0.85\ (5\ ksi)(12'')} = 4.7\ in$

$$\phi M_n = \frac{0.9\ (4\ in^2)(60\ ksi)(65.6'' - \frac{4.7''}{2})}{12\ in/ft} = 1138\ ft - k/ft$$

Determine the shear capacity of concrete requirement per ACI 349-01, Chapter 11 (Reference 2.2.6 Eq-11-13)

$$\phi V_c = \phi 2 \sqrt{f'_c}\ bd = \frac{0.85\ (2)\ \sqrt{5000 psi}\ (12\ in/ft)(65.6 in)}{1000 lb/kip} = 94\ k/ft$$

Determine the shear capacity of #5 ties at 12" on center each way:

$\phi\ V_S = \phi\ A_v * f_y d / s$ (Ref. 2.2.6, Eq-11-15)

s = 12 inches

$A_v = .31\ in^2 / ft$

$$\phi\ V_S = 0.85 * 0.31 * 60 * 65.6 / 12 = 86 kips/\text{ft}$$

Shear Capacity of concrete + ties = 94 +86 = 180 kips / ft

Moment and shear capacity was compared to demand from the contour plots for M11, M22, V13 and V23. The torsional moment M12 was added to demand values for M11 and M22 to determine demand. The following tables summarize the maximum demand for moments and shears in comparison to the capacity. Moment values are based on values at the face of the walls and shear is based on values "d" from face of walls. (Ref.2.2.6 Section 11.1.3.1)

Table 6.5.1 Maximum Moment D/C Ratios

Maximum Moment M (kft)	M12 at Max moment (kft)	Total Demand (D) (kft) M+ M12	Capacity (C) (kft)	D/C	Load Combination	Reference to Attachment
-M11 -600.0	-90	690	1138	0.61	6	D-29 & D-31
+M11 600.0	+90	690	1138	0.61	6	D-29 & D-31
-M22 -700.0	-90	790	1138	0.69	6	D-30 & D-31
+M22 700.0	+45	745	1138	0.65	6	D-30 & D-31

Table 6.5.2 Maximum Shear D/C Ratios

Maximum Shear V (kips) D	Capacity (C)	D/C	Load Combination	Reference to Attachment
-V13 100	180	0.56	6	D-32
+V13 100	180	0.56	6	D-32
-V23 120	180	0.67	9	D-48
+V23 120	180	0.67	6	D-33

From the contour plots, the maximum shear V13, does not occur in the same location as maximum V23. Therefore, additional shear reinforcement for V23 is not required beyond what is provided for maximum V13 or V23.

For a foundation plan view and section showing flexural and shear reinforcement, see the following two sheets. (Figures 6.5.1 and 6.5.2)

FIGURE 6.5.1 FOUNDATION MAT REINFORCEMENT
(6'-0" THICK CONCRETE MAT)

NOTE: ALL DIMENSIONS ARE +/- SIX INCHES

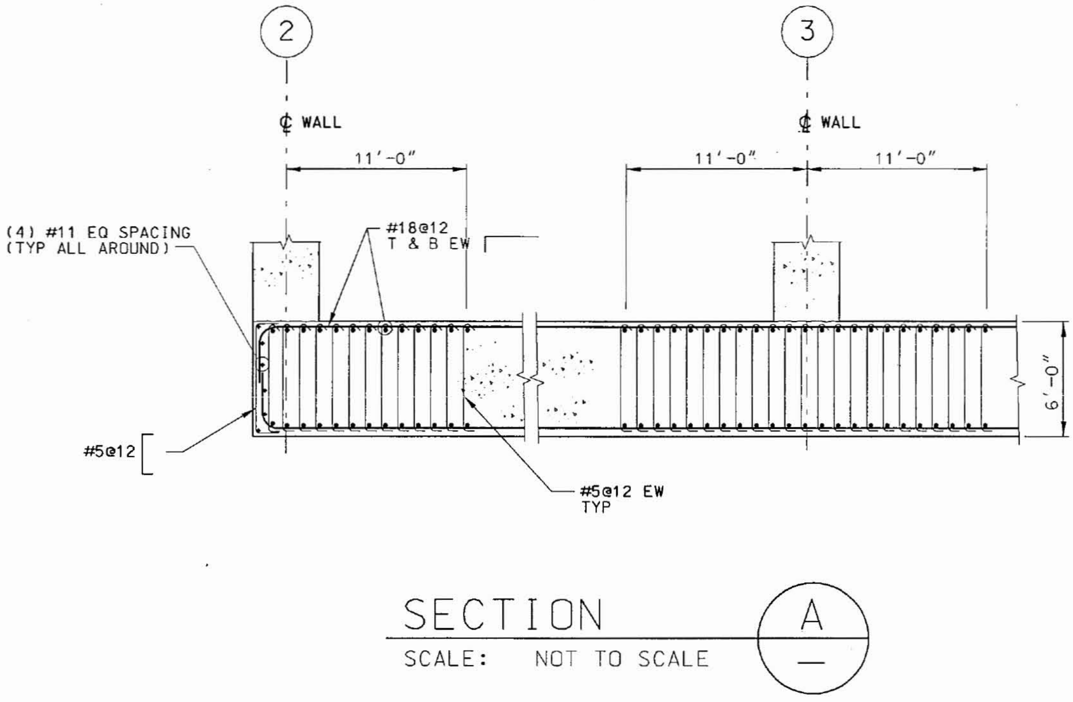


Figure 6.5.2 Foundation Mat Cross Section

6.6 STRUCTURAL STABILITY EVALUATION

This section evaluates the stability of the structure for sliding and overturning under the design basis ground motions. Seismic Analysis and Design approach document (Section 11.1 of Ref. 2.2.13) is used for the evaluation of sliding stability. Sliding displacement is calculated by using the approximate method suggested in Appendix A of the ASCE /SEI 43-05 Seismic Design Criteria for Structures, Systems and components in Nuclear Facilities (Ref.2.2.8).

6.6.1 CHECK SLIDING STABILITY

6.6.1.1 Static Check

The static resistance to sliding V_R, is a function of the soil cohesion c, the resistance due to passive soil pressure P_P *L and the available friction force $N\mu$.

Therefore $V_R = c + N\mu + P_P *L$
Using c=0 (for granular soils) minimizes the sliding resistance and results in an upper bound value for the computed soil displacement.
N = Normal compressive force (sum of vertical reactions on gap elements) from SAP2000 model for any combination listed in 4.3.

μ = Friction coefficient for alluvium = 0.81 (Table 6-2, Reference 2.2.13)

L = Length of foundation mat = 262’ (Least dimension of the building for max overturning effect)

P_P = passive soil pressure on the foundation mat = $K_P \rho H^2 /2$ (Ref.2.2.9) (Eq.11-5)

K_P = Coefficient of passive resistance = 4.4 (alluvium, Table 6-2 Reference 2.2.13)

ρ = Moist Density =114 pcf (alluvium, Table 6-2 Reference 2.2.13)

H = Thickness of mat = 6’

$P_P = 4.4*114*6^2 /2 = 9028$ lbs/ft

$P_P *L = 2365545$ lbs = 2365 kips

The total weight of the CRCF = 314,229 kips = W (Ref.2.2.5)

V_R (Total) = 314229*0.81 + 2365 = 256890 kips
Equivalent coefficient of friction = V_R /W = 256890 /314229 = 0.817 (Ref.2.2.8)
Check static factor of safety against sliding for load combination 7:

Dead load –0.4HX+0.4HY +VZ

This case will have seismic load in vertical direction minimizing the building weight and therefore resulting in least $V_{R.}$

From analysis out put for this case the sum of link reactions (FZ) and spring reactions (FX and FY) are summarized as follows. (Attachment C, Load Combination 7, Table Joint Reactions)

Σ FZ = 90425 kips
Σ FX = 74263 kips
Σ FY = 79259 Kips
Resultant lateral force on foundation = $(FX^2 + FY^2)^{1/2} = (74263^2 + 79259^2)^{½}$

= 108613 kips

V_R = 0.817* 90425 = 73877 kips

Factor of safety against sliding = Resistance / lateral force = 73877/ 108613 = 0.68 < 1.1

Section 11.1.1 of Ref. 2.2.13 recommends a minimum factor of safety of 1.1.

Therefore calculate predicted magnitude of building displacement using ASCE /SEI 43-05 (Ref. 2.2.8)

6.6.1.2 Sliding displacement

Equivalent Coefficient of sliding friction = 0.817

Peak vertical ground acceleration (Ref 2.2.15) $A_V = 0.52g$

Effective coefficient of friction $\mu_e = \mu (1-0.4 A_V/g) = 0.647$ (Eq. A-1, Ref.2.2. 8)

Sliding coefficient $C_S = 2 \mu_e g = 1.294g$ (Eq. A-2, Ref.2.2. 8)

Best estimate of sliding distance, $d_s = C_S / (2 \pi f_{es})^2$ (Eq. A-3, Ref.2.2. 8)

f_{es} = the lowest natural frequency at which the horizontal 10% damped vector spectral acceleration SA_{VH} equals $C_{S,}$

$SA_{VH} = [SA_{H1}^2 + 0.16 SA_{H2}^2]^{1/2}$ (Eq. A-4, Ref.2.2. 8)

SA_{H1} and SA_{H2} are the 10% damped spectral accelerations for each of the two orthogonal horizontal components. Since $SA_{H1} = SA_{H2}$

$SA_{VH} = 1.08 SA_{H1} = C_S$

$SA_{H1} = 1.294g / 1.08 = 1.198g$

Horizontal spectral accelerations for 10% damped condition are well below 1.198g for all frequency ranges. Therefore it can be concluded that the building will not slide when subjected to the 10% damped spectral accelerations.

However an estimate of upper bound displacement value can be made by substituting the natural frequency (first mode frequency) for f_{es}. The natural frequency of CRCF is determined to be 8 hz for 35' upper bound alluvium case.(Ref. 2.2.3)

$d_s = C_S / (2 \pi f_{es})^2 = 1.294g / (2 \pi 8)^2 = 0.016$ ft = 0.197" say 0.2 inches.

Considering a factor of safety of 2 (Reference 2.2.13) any connection that enters the structure should have a flexibility of at least 2 ds or 0.4 inches.

6.6.2 CHECK OVERTURNING STABILITY

6.6.2.1 Static Check – Overturning

Since the building plan dimension in the north /south direction 262' is significantly less than east /west dimension 421', overturning in the Y direction will be the critical condition. The two cases to be considered are: full seismic load in the Y direction coupled with 40% seismic load in the upward (+Z) direction, full seismic load in the upward (+Z) direction with 40% seismic load in the Y direction. The governing load cases are shown below.

Load combination 7, DEAD LOAD – 0.4HX +0.4HY +VZ will have the least restoring force with associated overturning loads.

Load combination 12, DEAD LOAD – 0.4HX +HY +0.4VZ will have the maximum overturning loads in the weak direction with associated restoring forces.

The applied joint loads for these two cases are summarized in Tables 6.3.4.7 and 6.3.4.12.

The load due to foundation mat weight is determined by multiplying foundation mat and 16' wall weight by acceleration values (gravity Multiplier) listed for each combination. The weight of foundation mat including 16' of wall is directly taken from calculation 060-SYC-CR00-00200-000-00A (Ref. 2.2.5)

Base slab and wall weight = 134214 kips Ref. 2.2.5, Summary of Mass and Center of Mass.

Example: Load Case 12

F1 due to base slab and wall weight = - 0.1584 *134214 = -21,259 kips

F2 due to base slab and wall weight = 0.4782 *134214 = 64,181 kips

F3 due to base slab and wall weight = -0.751 *134214 = -100,795 kips

From these loads the Overturning and restoring moments are calculated for Load cases 7 and 12 as follows.

Load Combination 7
Overturning Moments

Node	Elevation	Moment Arm –h (ft)	FY (kips)	Moment X (kft)
299	32’	38’	26,178	994,764
499	64’	70’	20,531	1,437,170
599	72’	78’	1459	113,802
699	100’	106’	9822	1,041,132
Base Slab		6’	25528*	153,168
Total Overturning Moment				3,740,036

* 134214 kips x 0.1902
0.1902 gravity multiplier in Y direction and FY at upper floors from Table 6.3.4.7

Restoring Moment

Node	Elevation	FZ (kips)	Moment Arm –h (ft)	Restoring Moment (kipft)
299	32’	-28566	131	3,742,146
499	64’	-14685	126	1,850,310
599	72’	-983	131	128,773
699	100’	-3574	131	468,194
Base Slab		-51028*	131	6,684,668
Total Restoring Force		-98836		12,874,091

* 134214kips x(–0.3802)
-0.3802 gravity multiplier in Z direction and FZ at upper floors from Table 6.3.4.7

Factor of safety Restoring moment / Overturning moment. = 12,874,091 / 3,740,036

= **3.44** > 1.1

Load Combination 12
Overturning Moments

Node	Elevation	Moment Arm –h (ft)	FY (kips)	Moment X (kft)
299	32’	38’	66,333	2,520,654
499	64’	70’	52,223	3,655,610
599	72’	78’	3707	289,146
699	100’	106’	24811	2,629,966
Base Slab		6’	64181	385,086
Total Overturning Moment				9,480,462

Source Table 6.3.4.12

Restoring Moment

Node	Elevation	FZ (kips)	Moment Arm –h (ft)	Restoring Moment (kipft)
299	32’	-69389	131	9,089,959
499	64’	-42033	126	5,296,158
599	72’	-2762	131	361,822
699	100’	-12673	131	1,660,163
Base Slab		-100795	131	13,204,145
Total Restoring Force		-227,651	Total	29,612,247

Source Table 6.3.4.12

Factor of safety Restoring moment / Overturning moment. = **3.1** > 1.1

These calculations show that the structure has adequate safety margin against overturning.

7. RESULTS AND CONCLUSIONS

7.1 RESULTS

The primary results of this calculation are:

- Design forces and moments:

The contour plots shown in Attachment D represent the shear forces and bending moments that will occur in the CRCF foundation mat under the design loading combinations. The contours were used to obtain the design forces for designing the preliminary flexural and shear reinforcement for the CRCF basemat.

- Foundation mat flexural reinforcement:

The basemat was designed for a maximum bending moment, M_u , of 790 ft-k/ft. The preliminary reinforcement selected was #18 bars at 12 inch spacing on center, each way, top and bottom. This reinforcement yields a design moment capacity, ϕM_n , is 1138 ft-k/ft. Therefore, the flexural demand/capacity ratio = $M_u / \phi M_n = 0.69 < 1.0$.

- Basemat shear reinforcement:

The basemat was designed for a maximum shear, V_u, of 120 k/ft. This exceeds the concrete capacity, $\phi V_{c,}$ of 94 k/ft, which indicates that shear reinforcement is required in some areas of the mat. The preliminary shear reinforcement selected was #5 bars at 12 inch spacing on center, which provides 0.31 in^2/ft. The total shear capacity including steel capacity is 180 kips. Therefore, the shear demand/capacity ratio = 120/180 = 0.67 < 1.0. Areas requiring shear reinforcement is identified on Figure 6.5.1.

The mat reinforcement is designed for uniform thickness of 6 feet. Where thickness is reduced due to rail or other pockets the slab will be designed to account for local variations during final design.

- Maximum bearing pressure on the foundation mat is 11.4 kips per square foot.
- Foundation overturning stability check:

The structure has a static factor of safety against overturning of about 3.1which indicates that the structure is stable against overturning.

- Foundation sliding stability check:

A static margin of safety against sliding could not be demonstrated for the CRCF, which means that the structure will slide when subjected to the 2000 year return period earthquake. The sliding stability was then evaluated based on the reserve energy method described in Appendix A.1 of the ASCE /SEI 43-05 (Ref.2.2.8), to determine the distance d_s that the structure will slide. Although the reserve energy method did not indicate that the CRCF would slide under DBGM-2 seismic loads the sliding distance was conservatively calculated to be 0.2 inches.

7.2 CONCLUSIONS

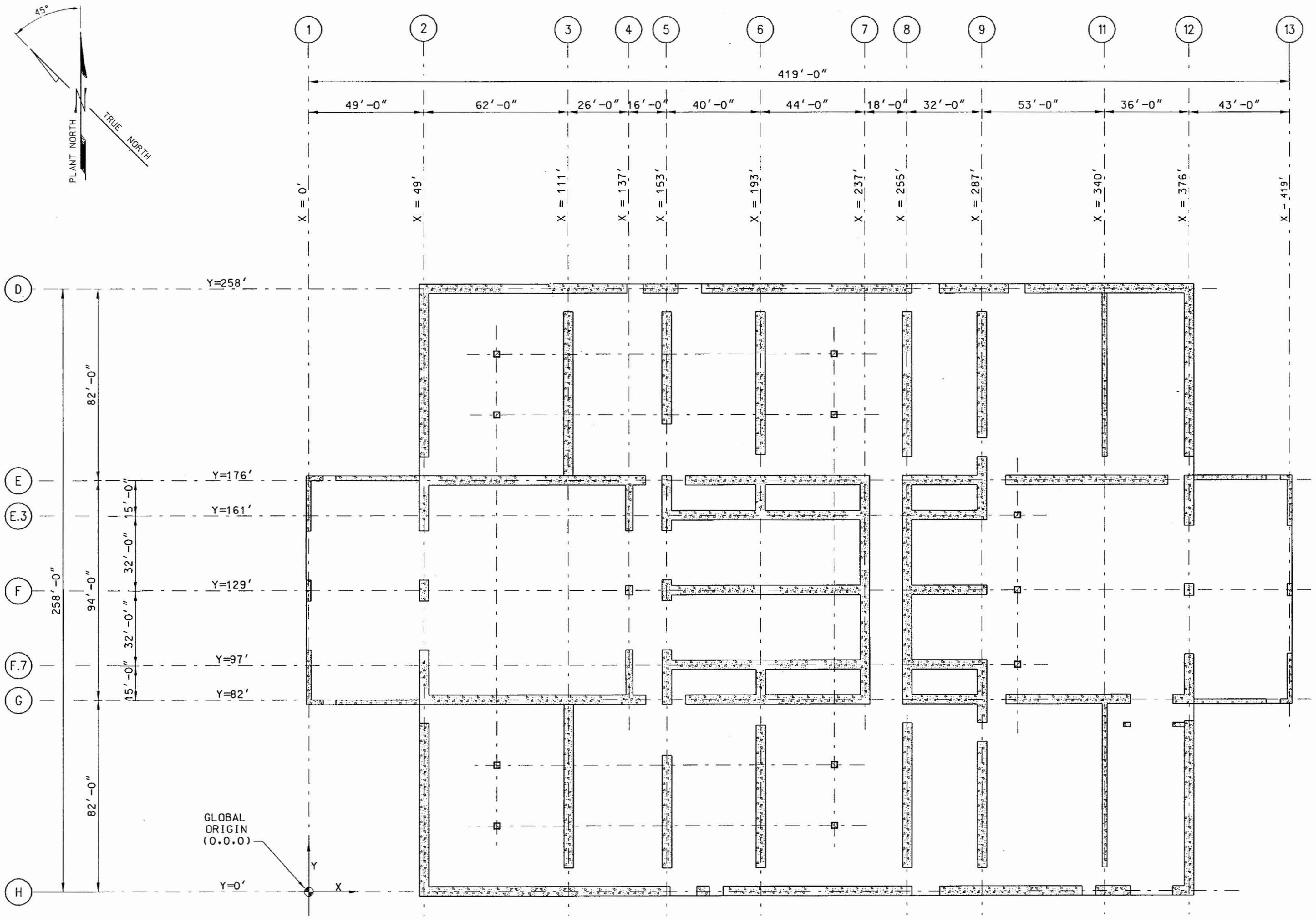
Results from this calculation demonstrate that for the foundation mat investigated a reasonable mat design is achieved for the imposed design loads. The maximum shear forces and moments occur at the corner areas of the structure, as expected, due to non-orthogonal effects. The maximum shear forces occur at the face of supports (walls), as expected. The preliminary flexural and shear reinforcement is indicative of the basemat thickness and provides a reasonable design.

The structure is stable against overturning.

Based on the reserve energy method described in Appendix A.1 of Reference 2.2.8, the structure may slide when subjected to the maximum 2000 year return period earthquake. A safety factor of two will be applied to the computed sliding displacement d_s of 0.2 inches. Therefore, 0.4 inches ($2d_s$) will be used when evaluating the flexibility of any commodities or utilities entering the structure, or clearance of any adjacent structures such as the Entrance Vestibule. This methodology ensures that no unacceptable interaction will occur between the structure and any ITS commodities entering the structure, or any adjacent structure, under seismic loading conditions.

Attachment A

Foundation Mat Plan At El 0’-0”



FOUNDATION MAT PLAN AT EL 0'-0"
(6'-0" THICK CONCRETE MAT)

NOTE: ALL DIMENSIONS ARE +/- SIX INCHES

Attachment D

Moment and Shear Contours

Attachment D Moment and Shear Contours

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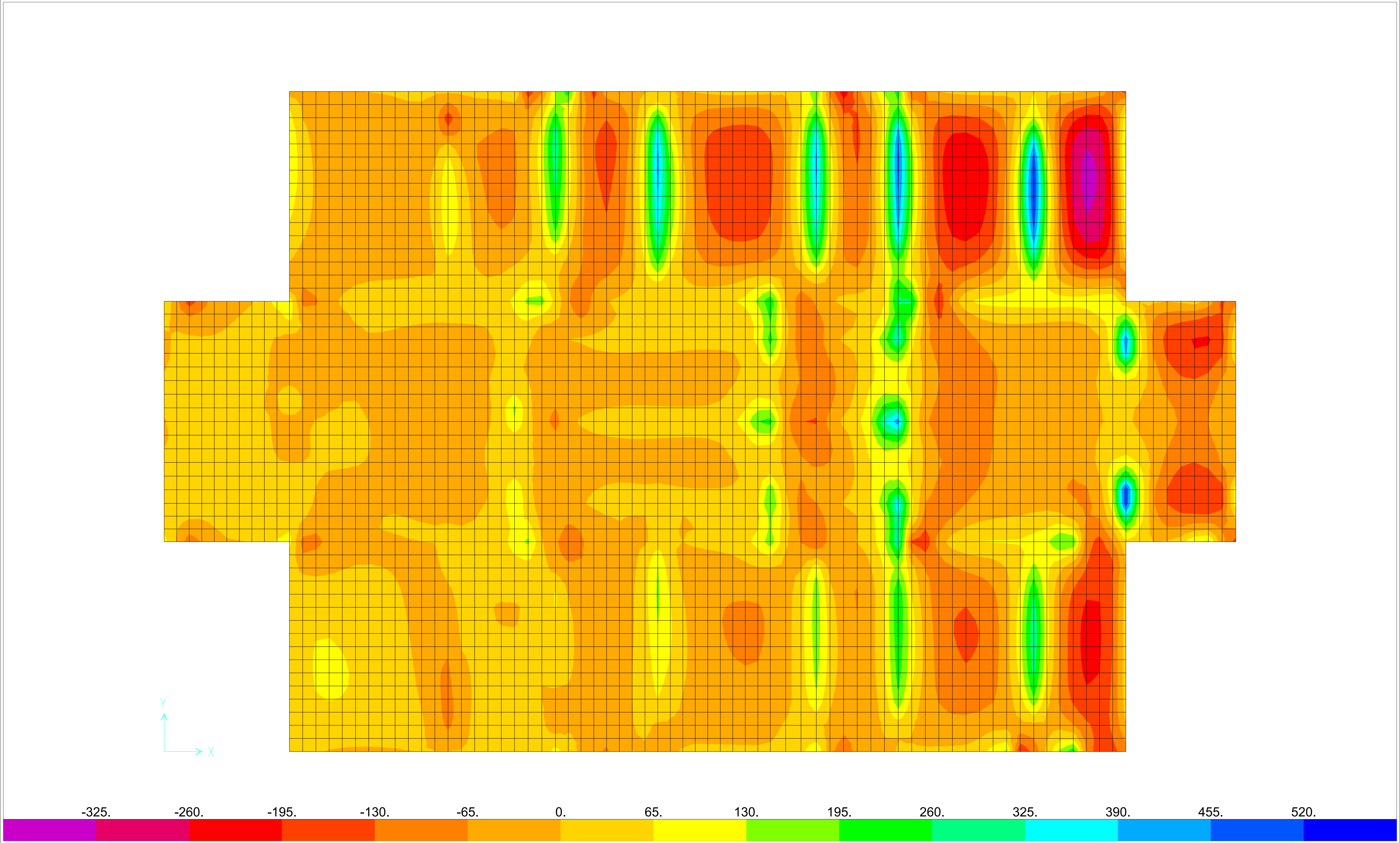

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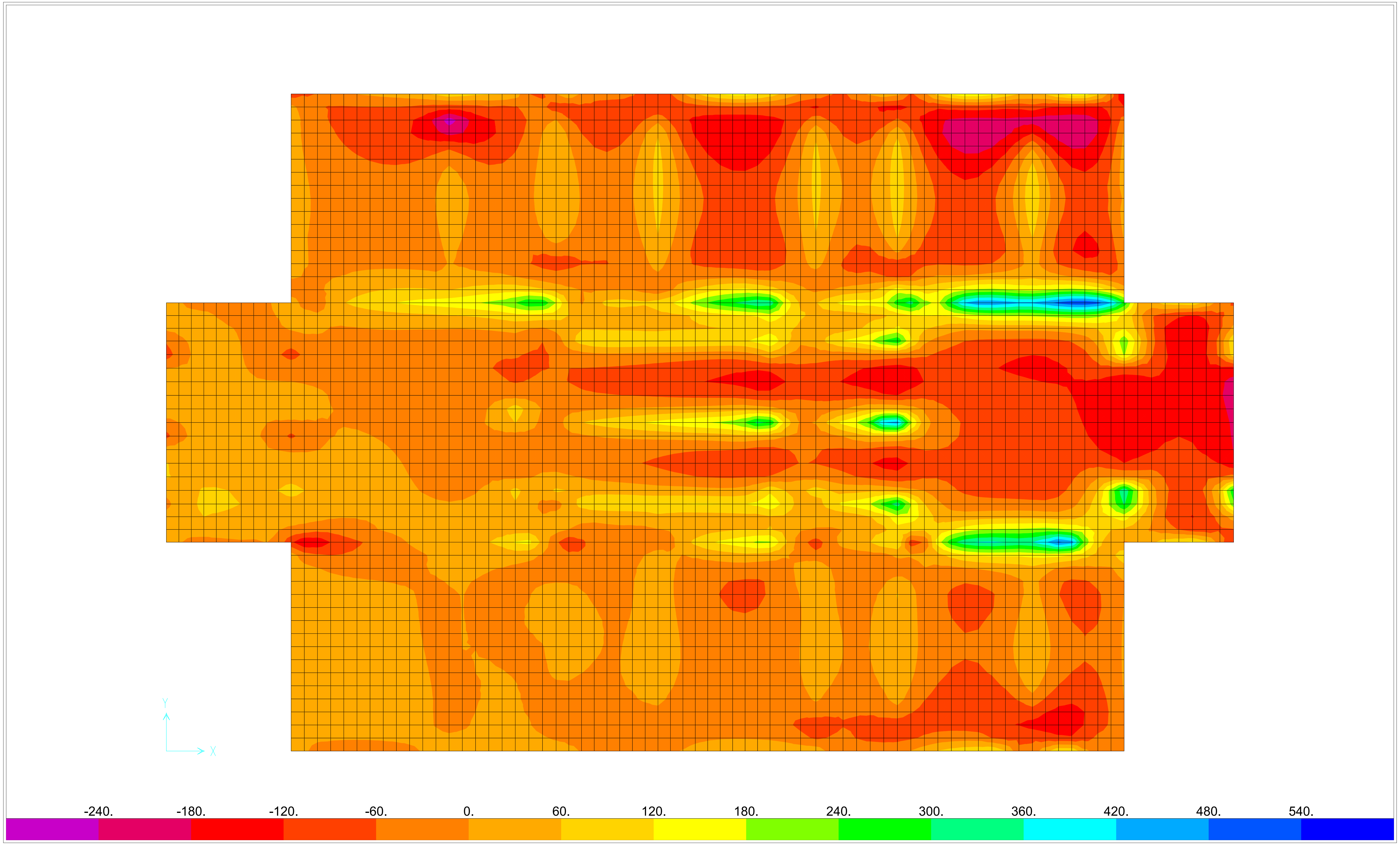

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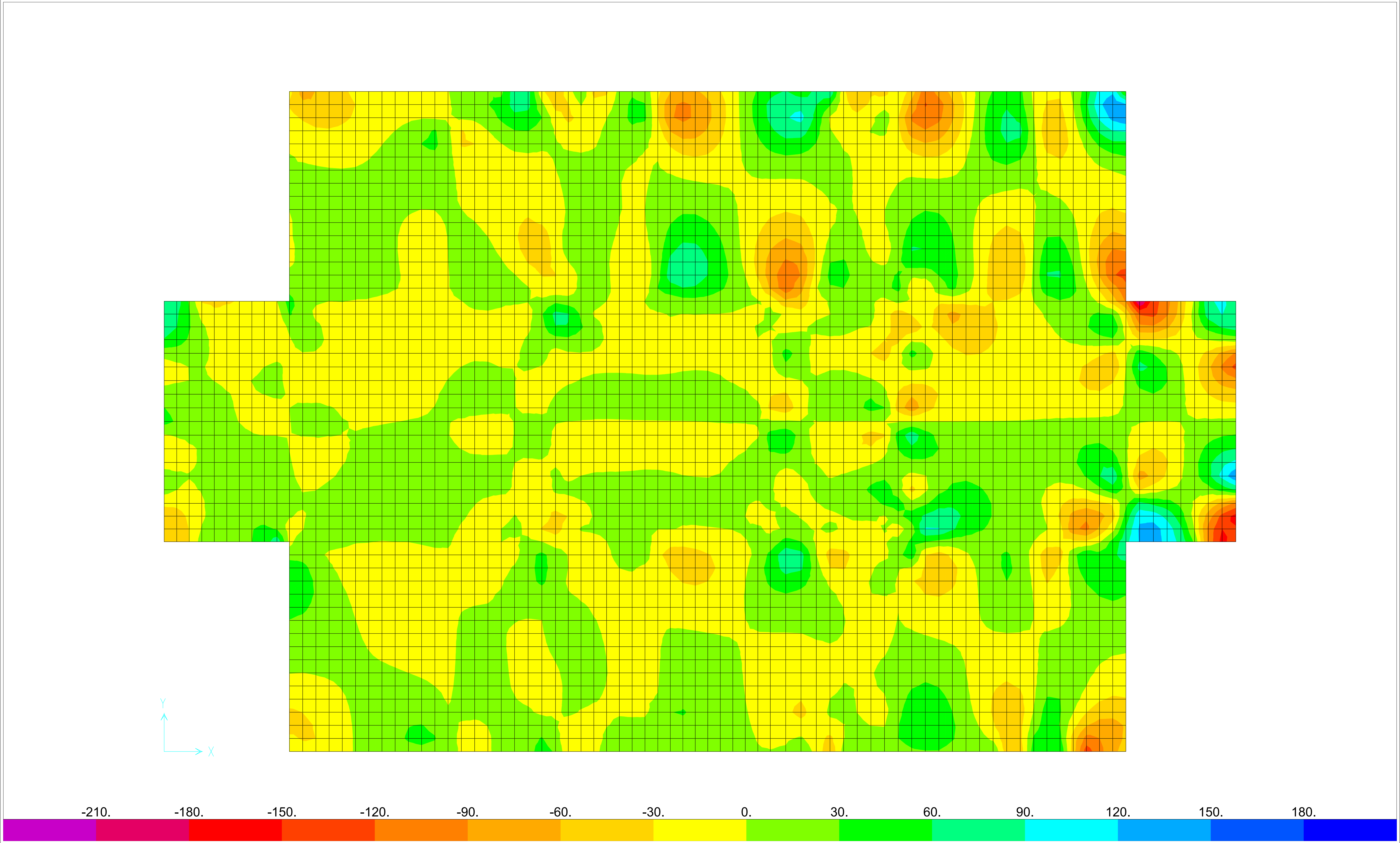

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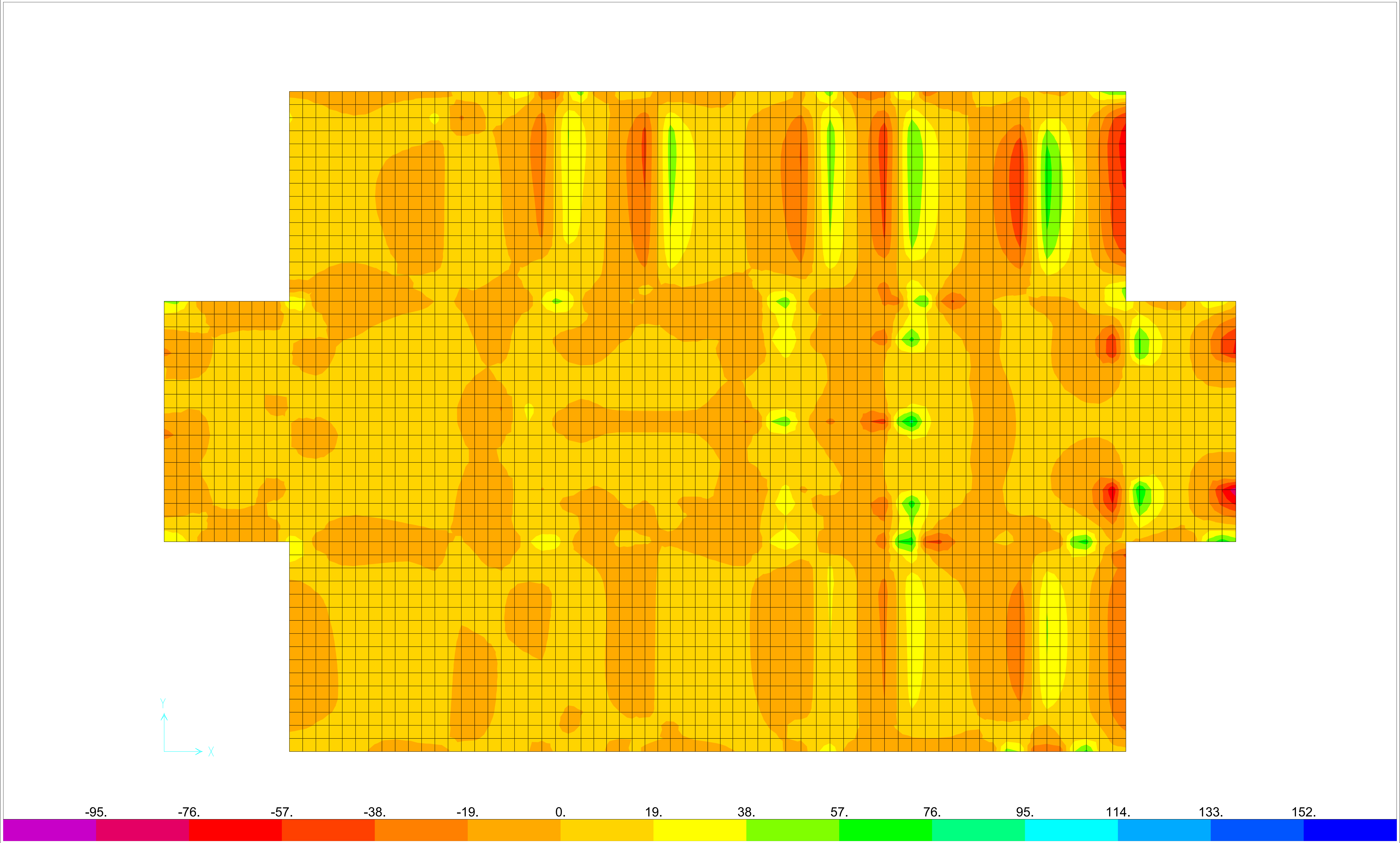

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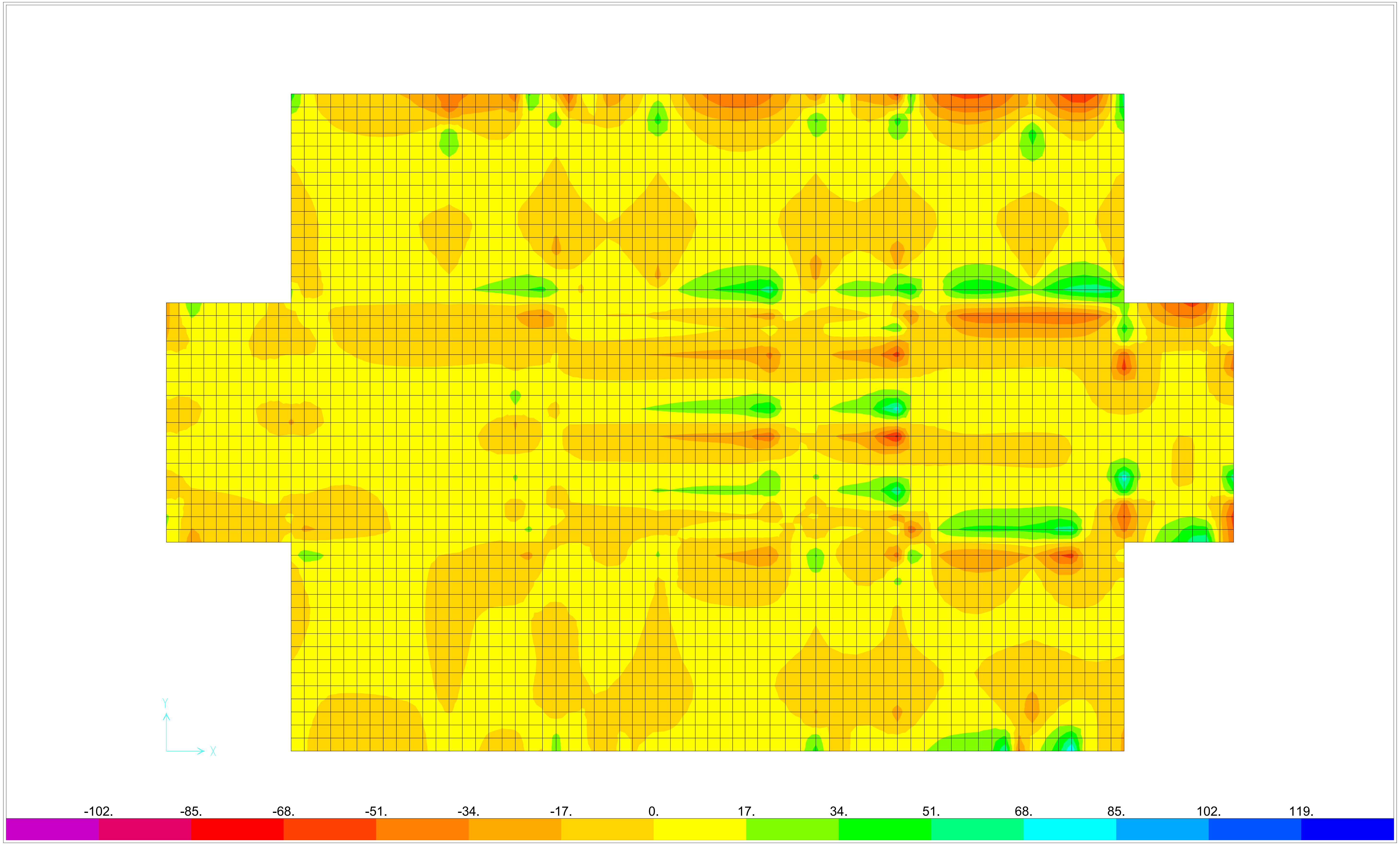

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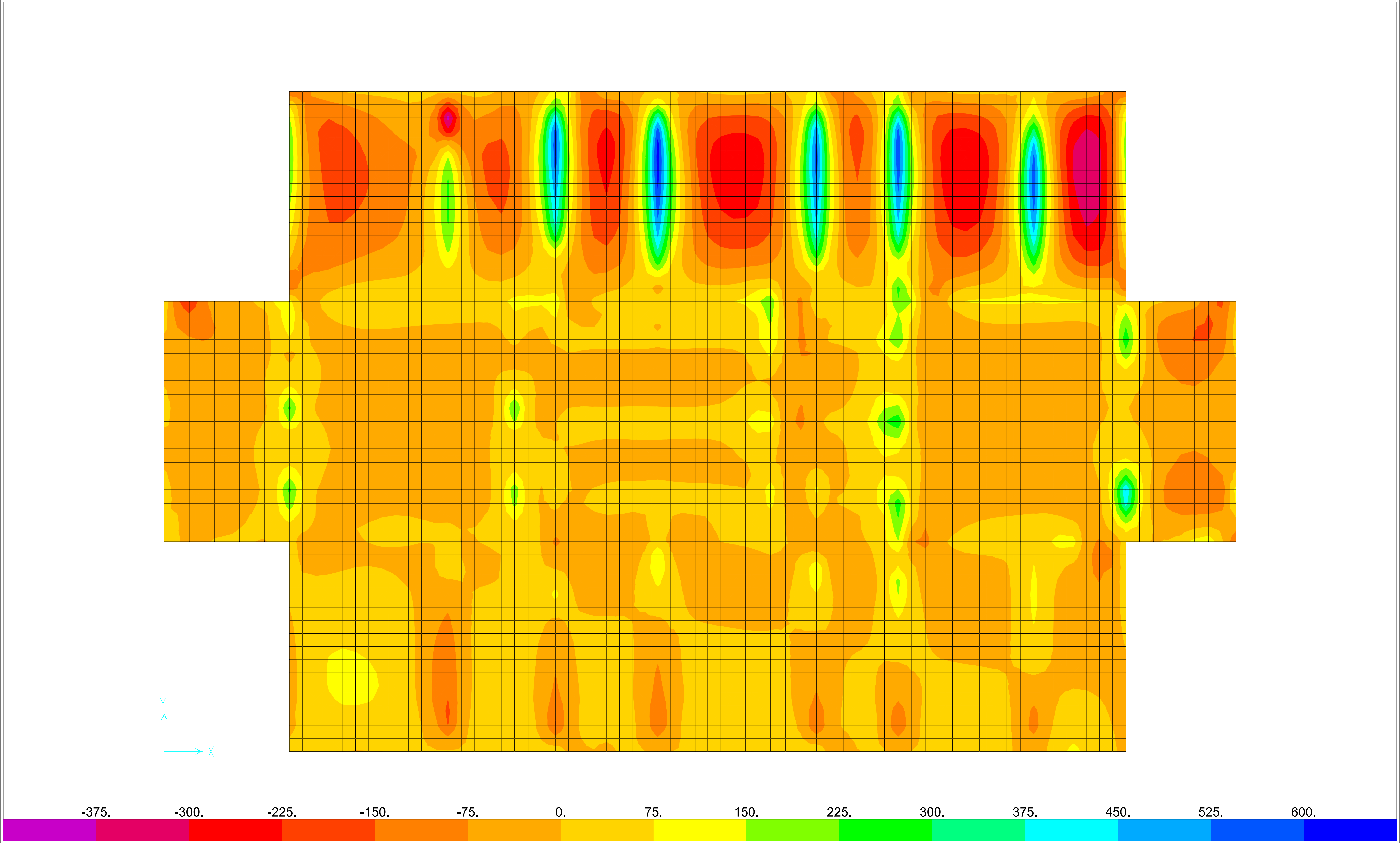

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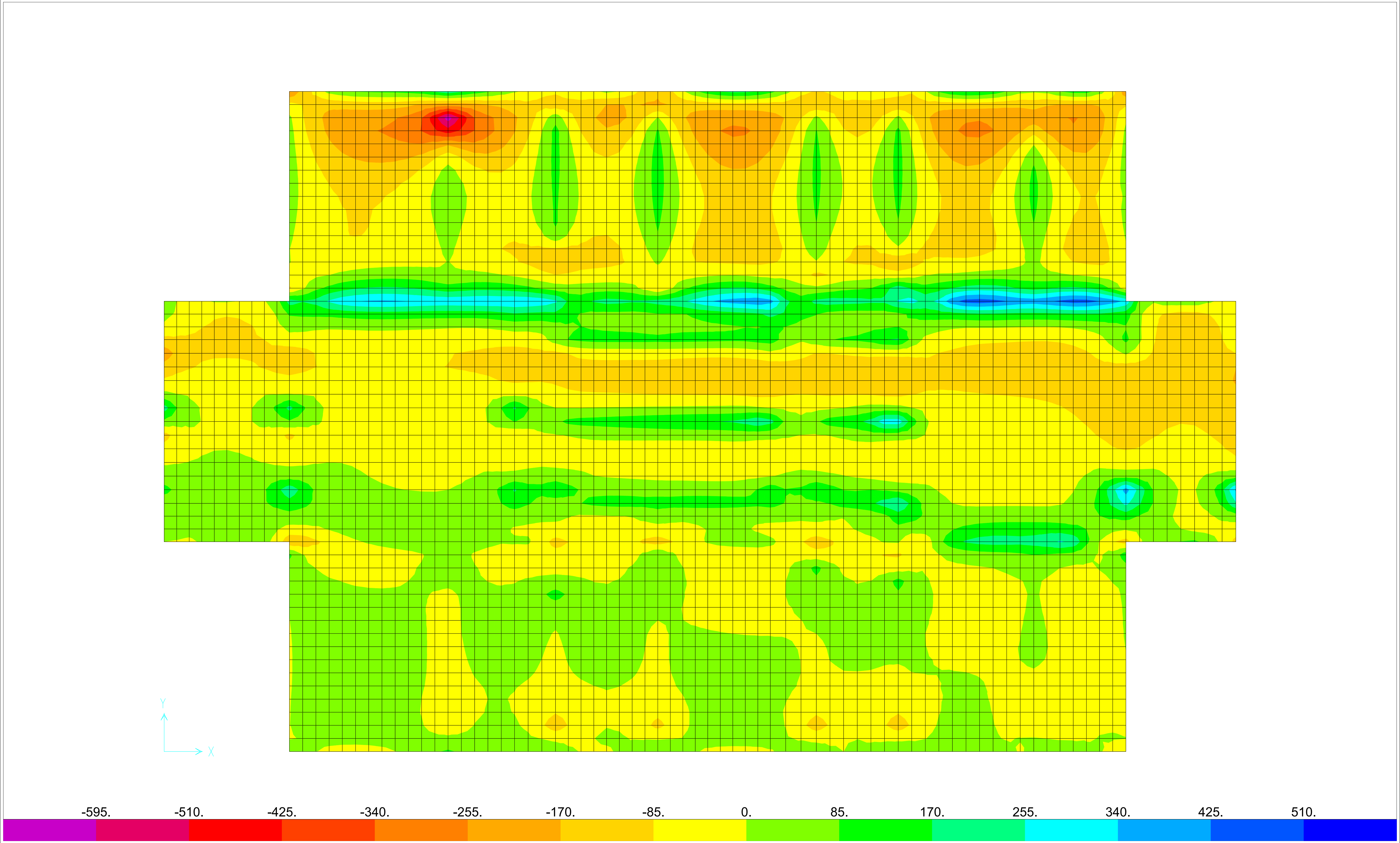

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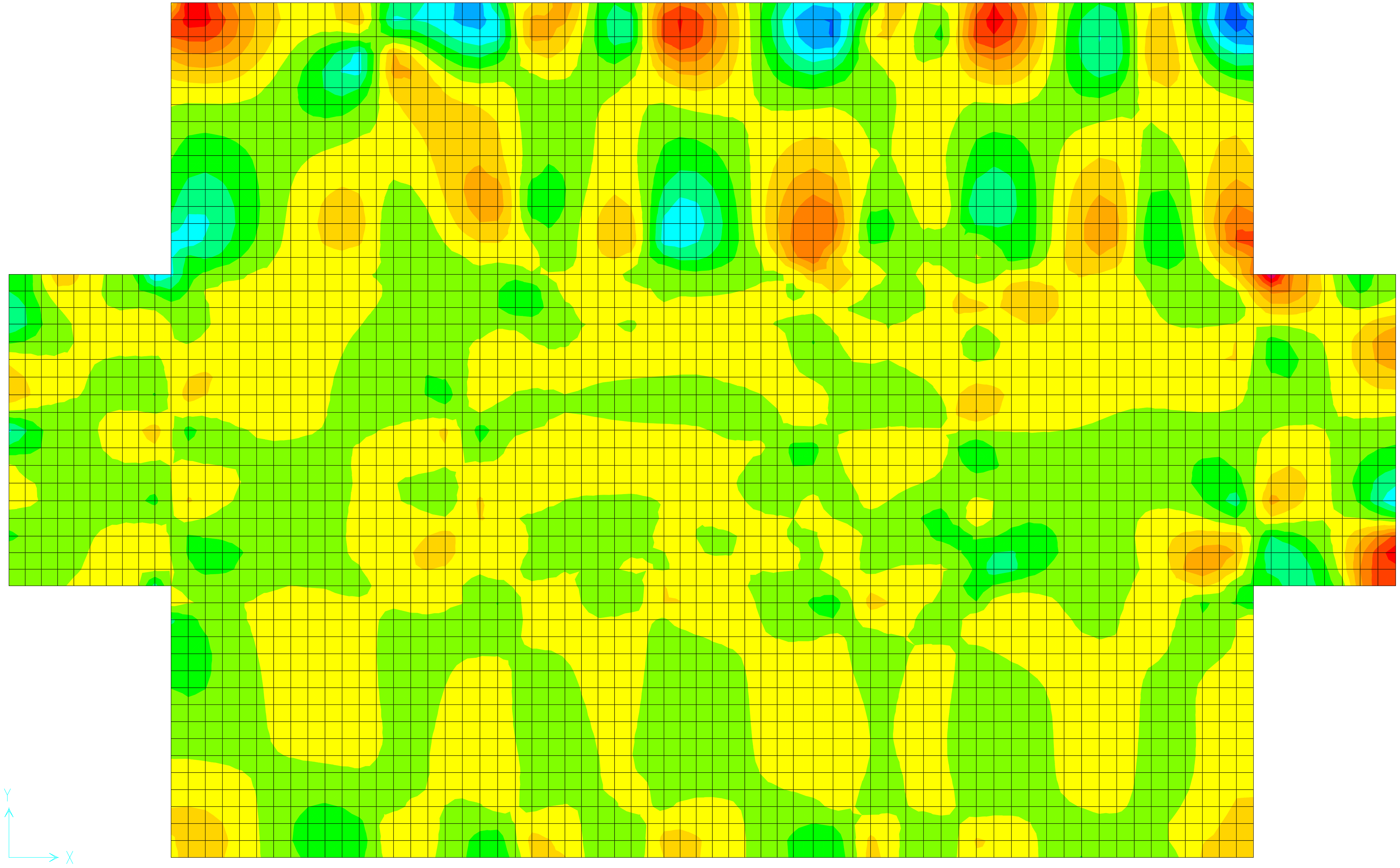

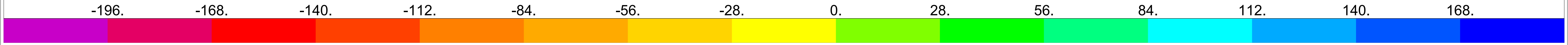

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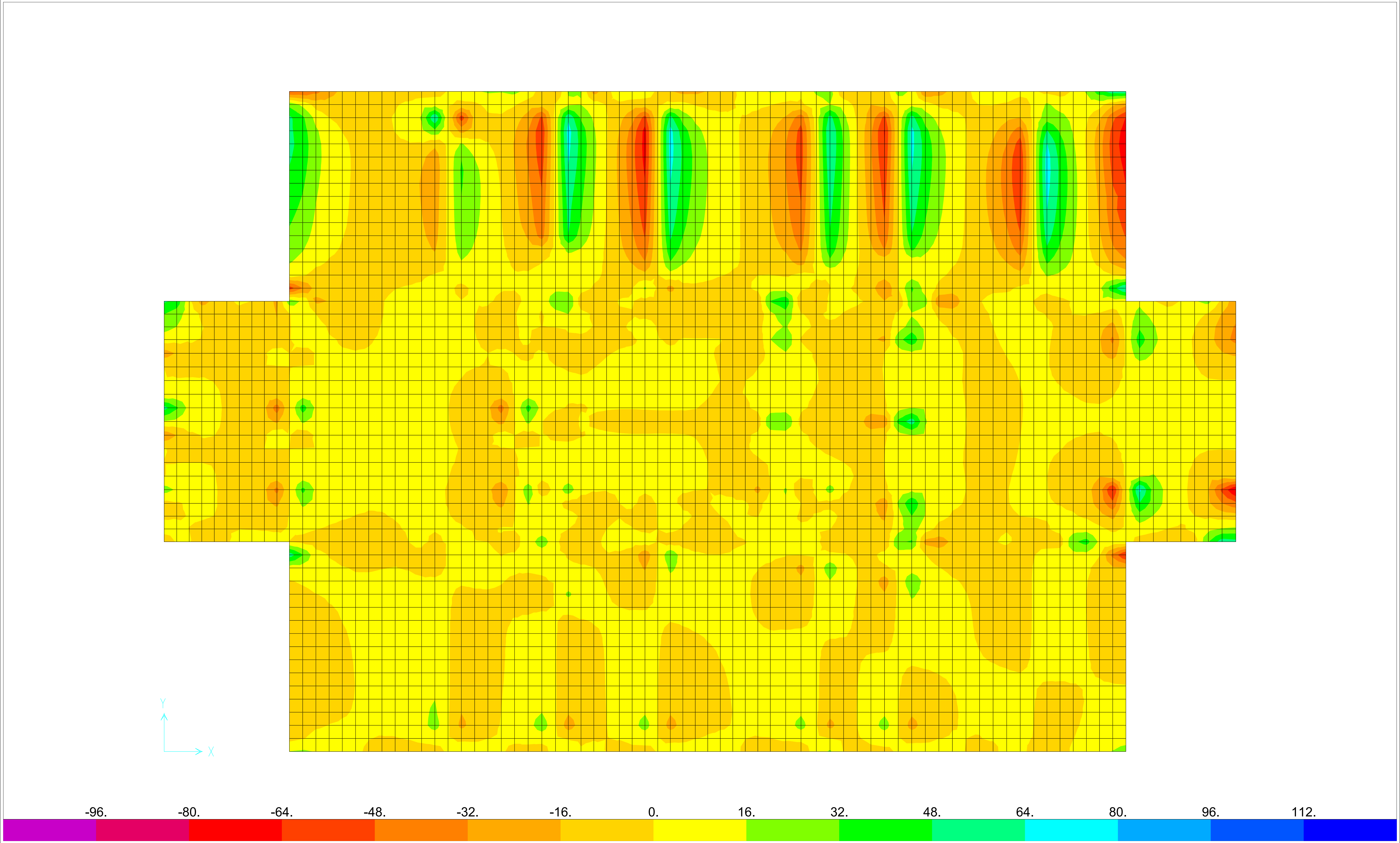

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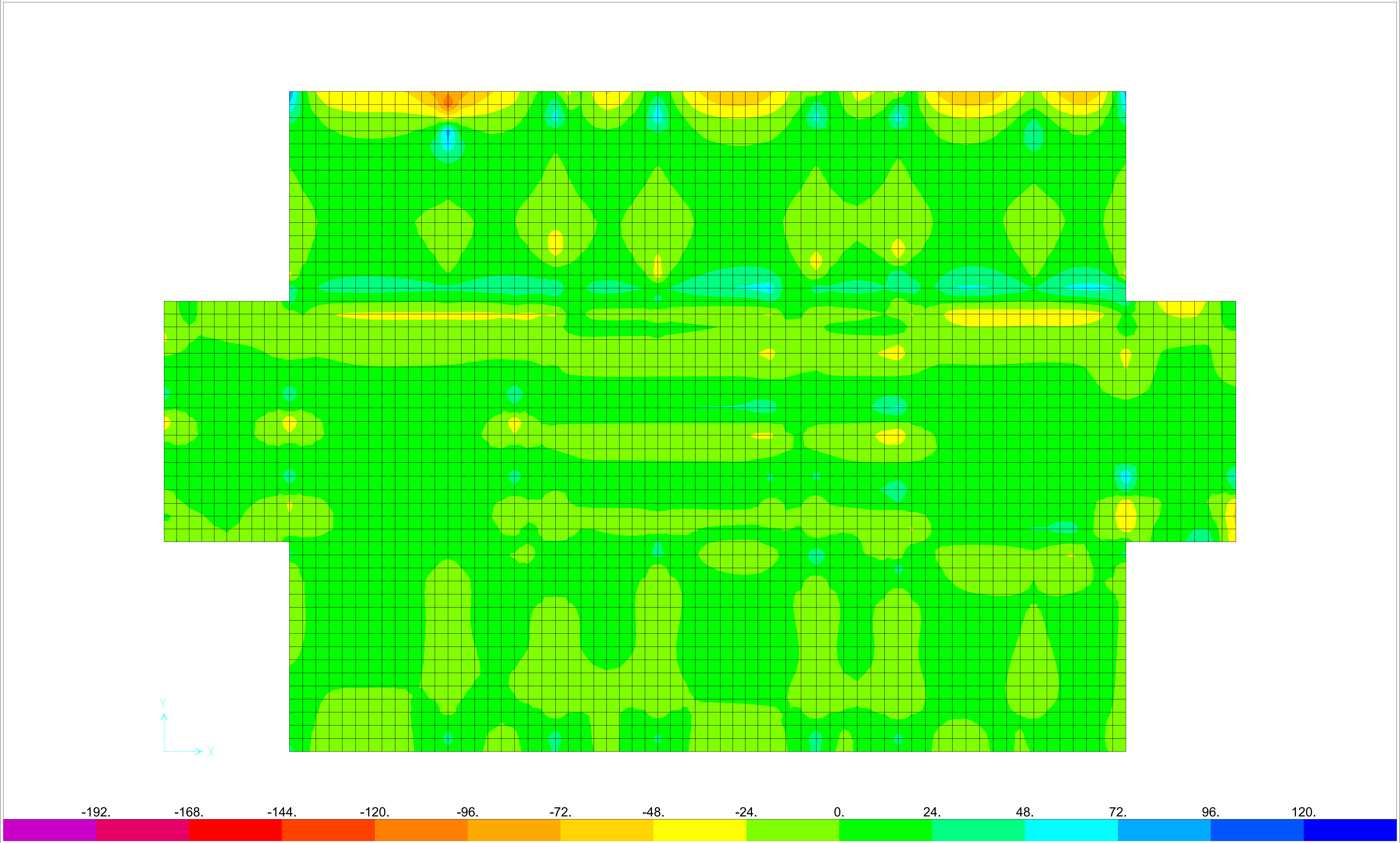

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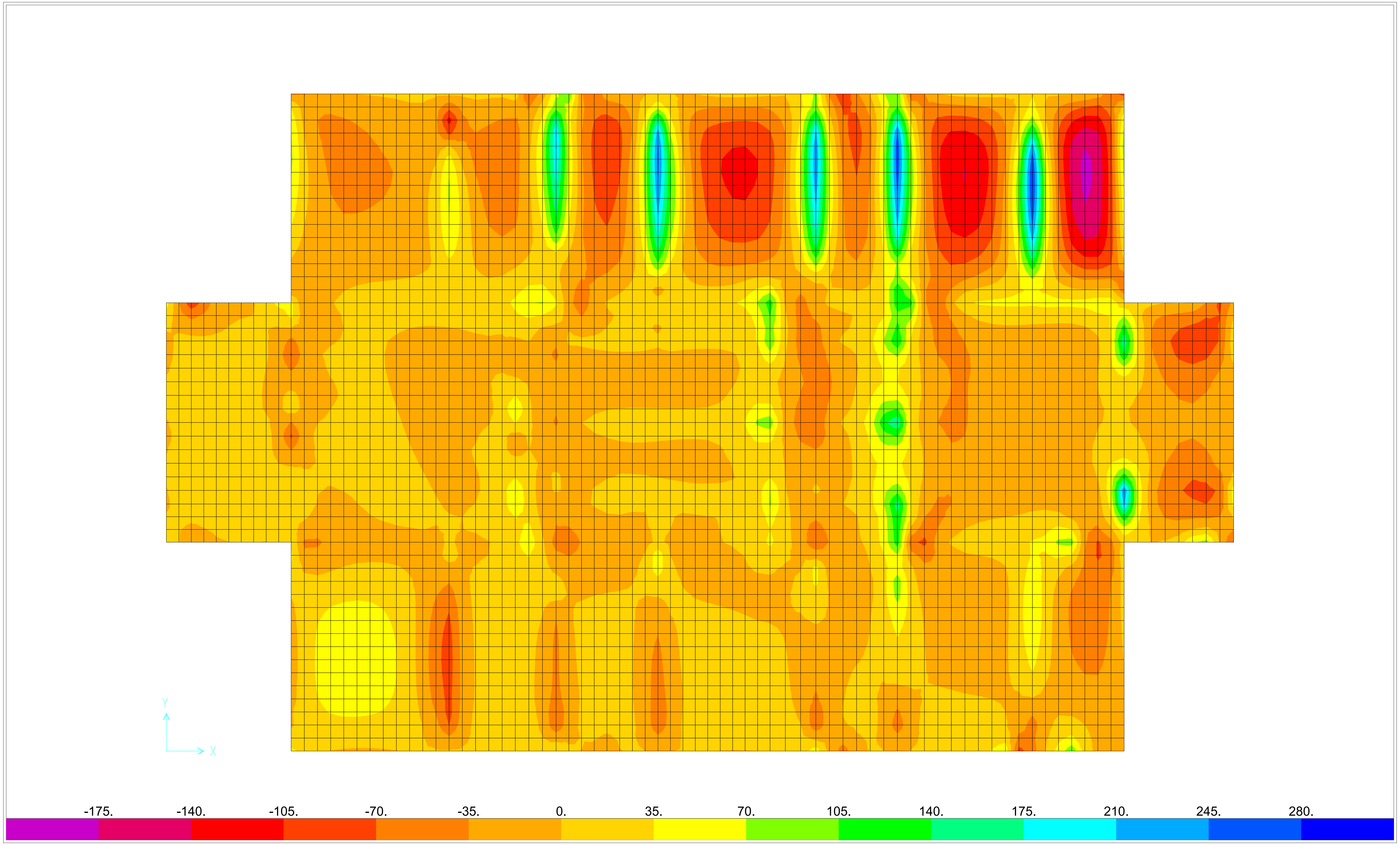

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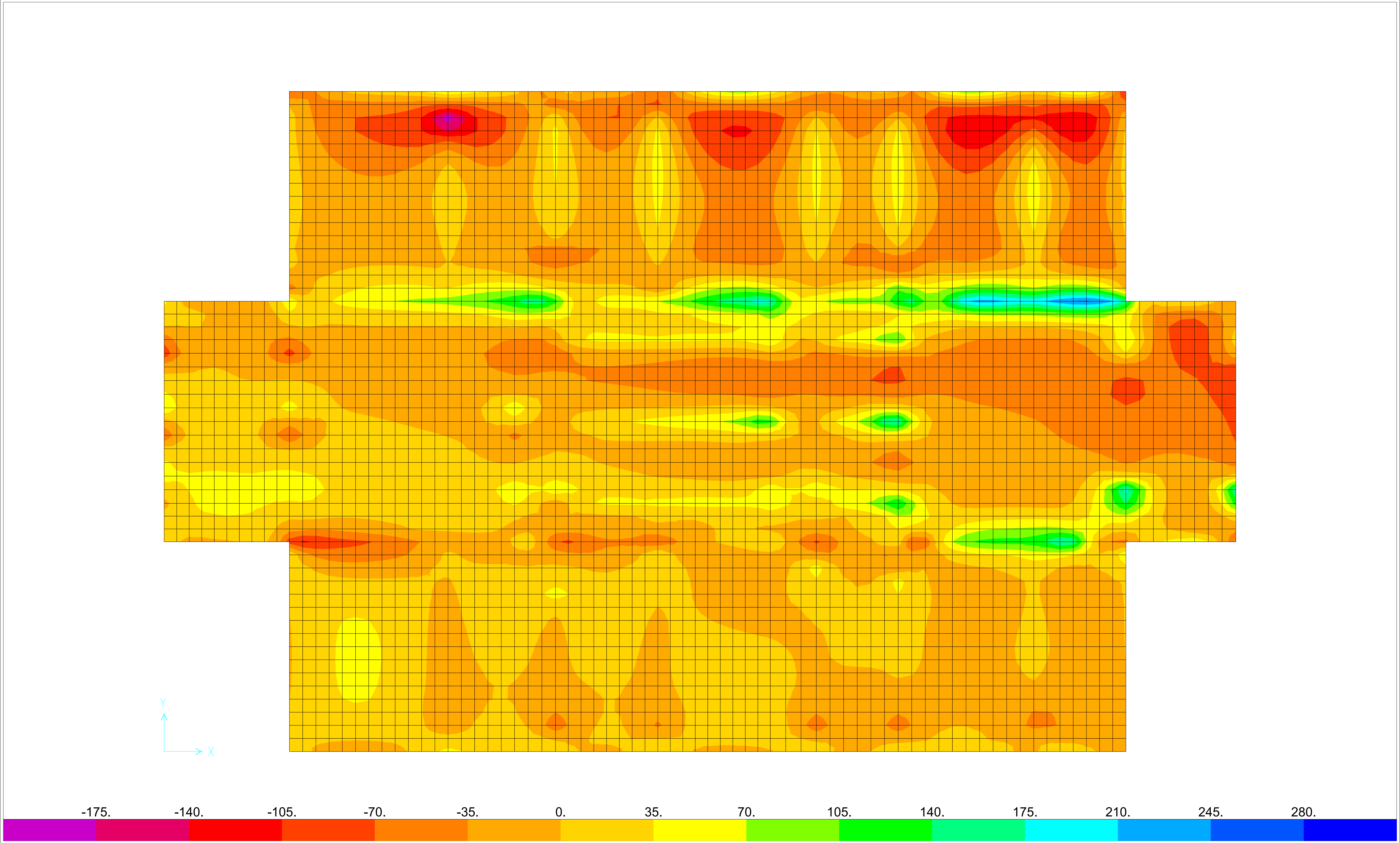
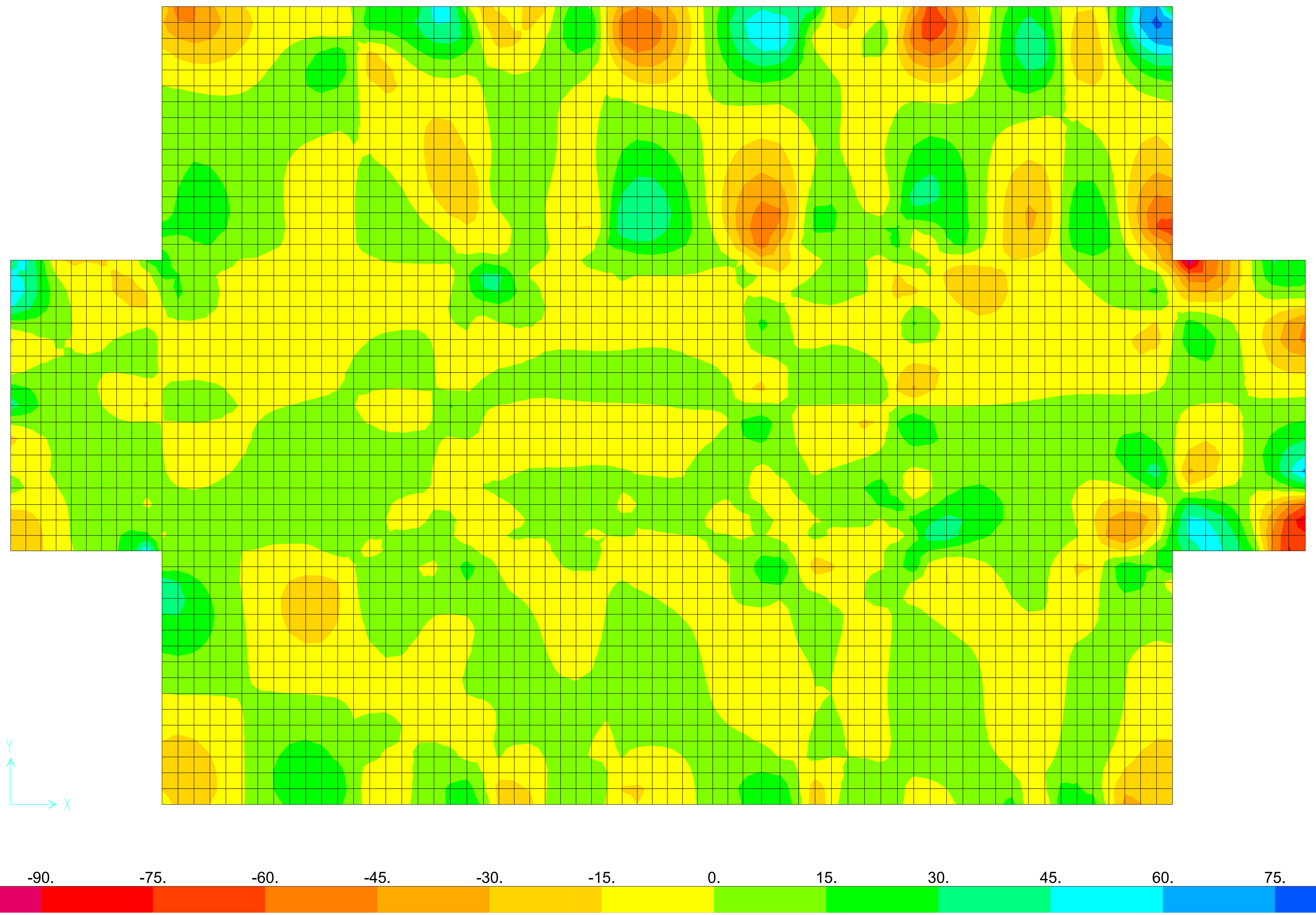


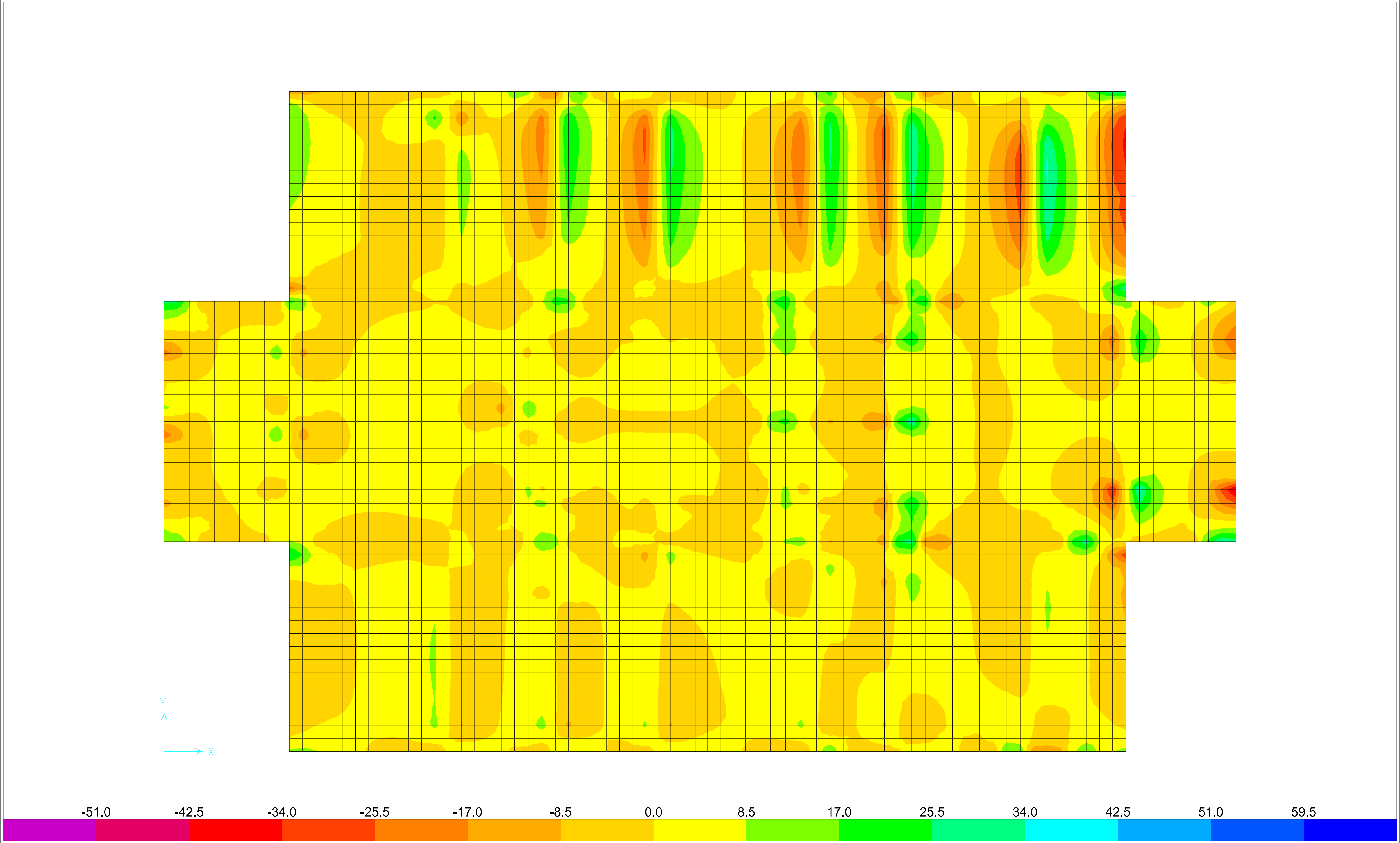
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M22 Diagram (DL+0.4X+0.4HY+VZ) - Kip, ft, F Units



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M12 Diagram (DL+0.4X+0.4HY+VZ) - Kip, ft, F Units

SAP2000

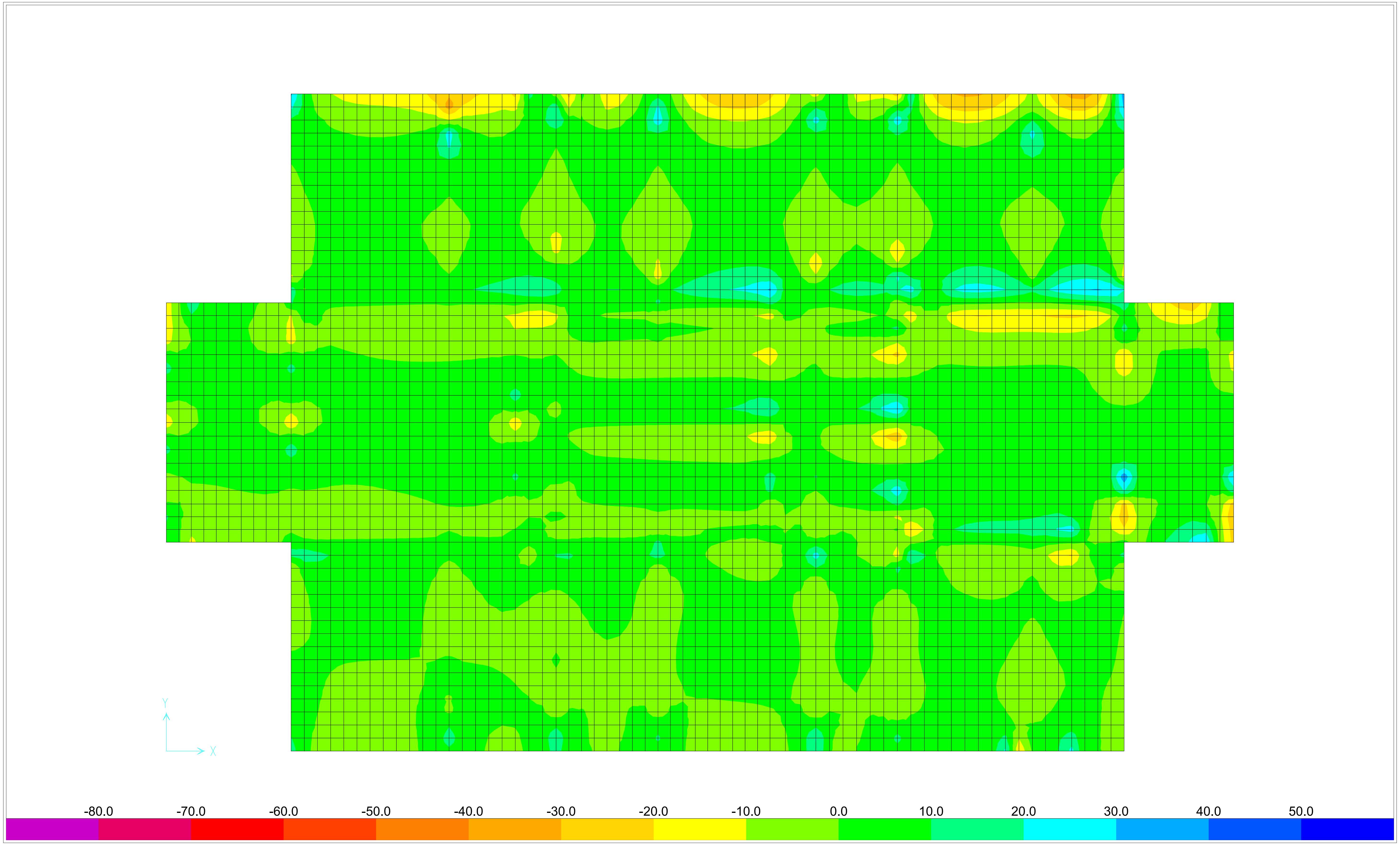
3/7/07 13:46:11



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant V23 Diagram (DL+0.4X+0.4HY+VZ) - Kip, ft, F Units

SAP2000

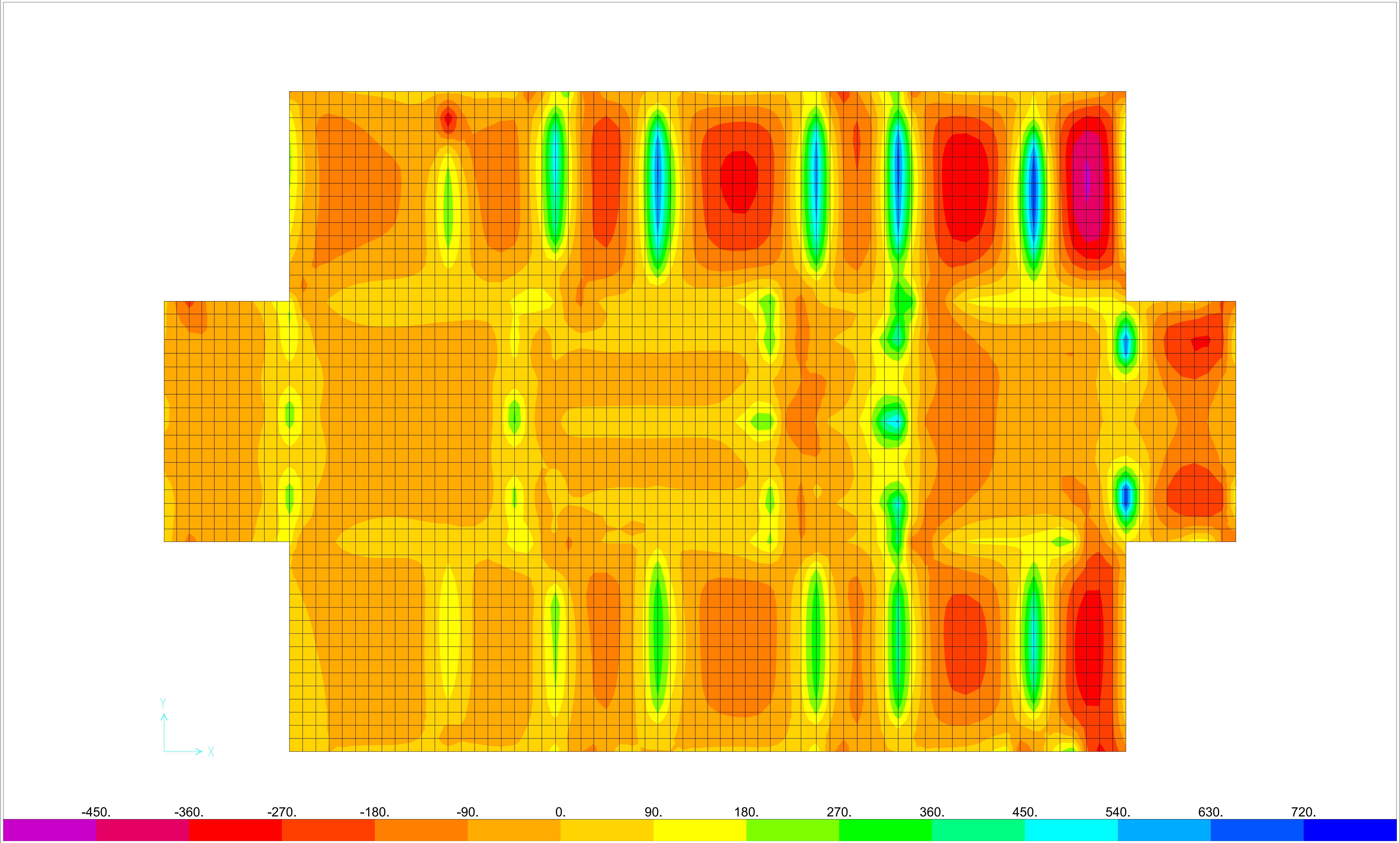
3/7/07 13:49:33



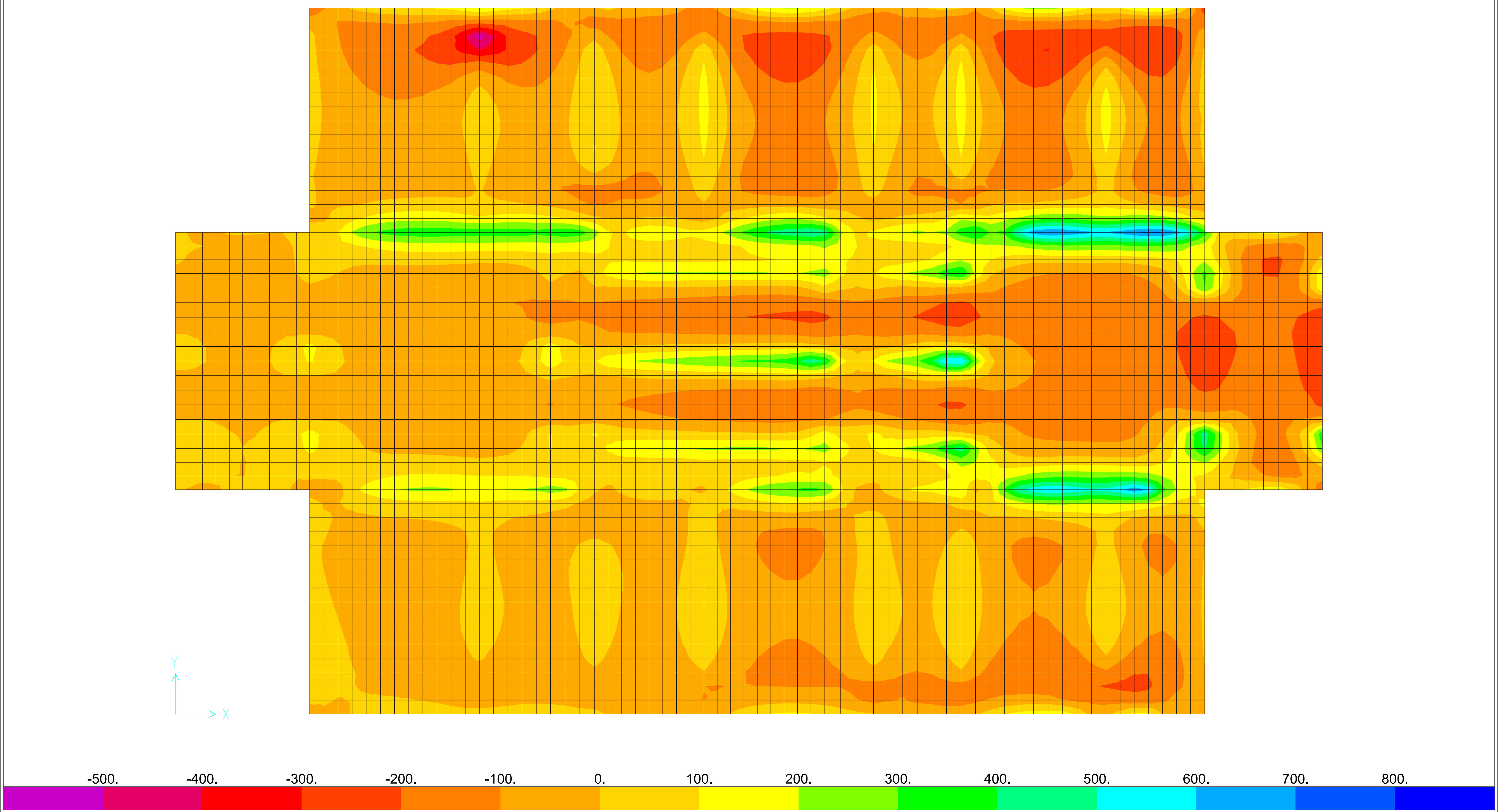
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant VMAX Diagram (DL+0.4X+0.4HY+VZ) - Kip, ft, F Units

SAP2000

3/7/07 13:53:45



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M11 Diagram (DL+HX+0.4HY-0.4VZ) - Kip, ft, F Units



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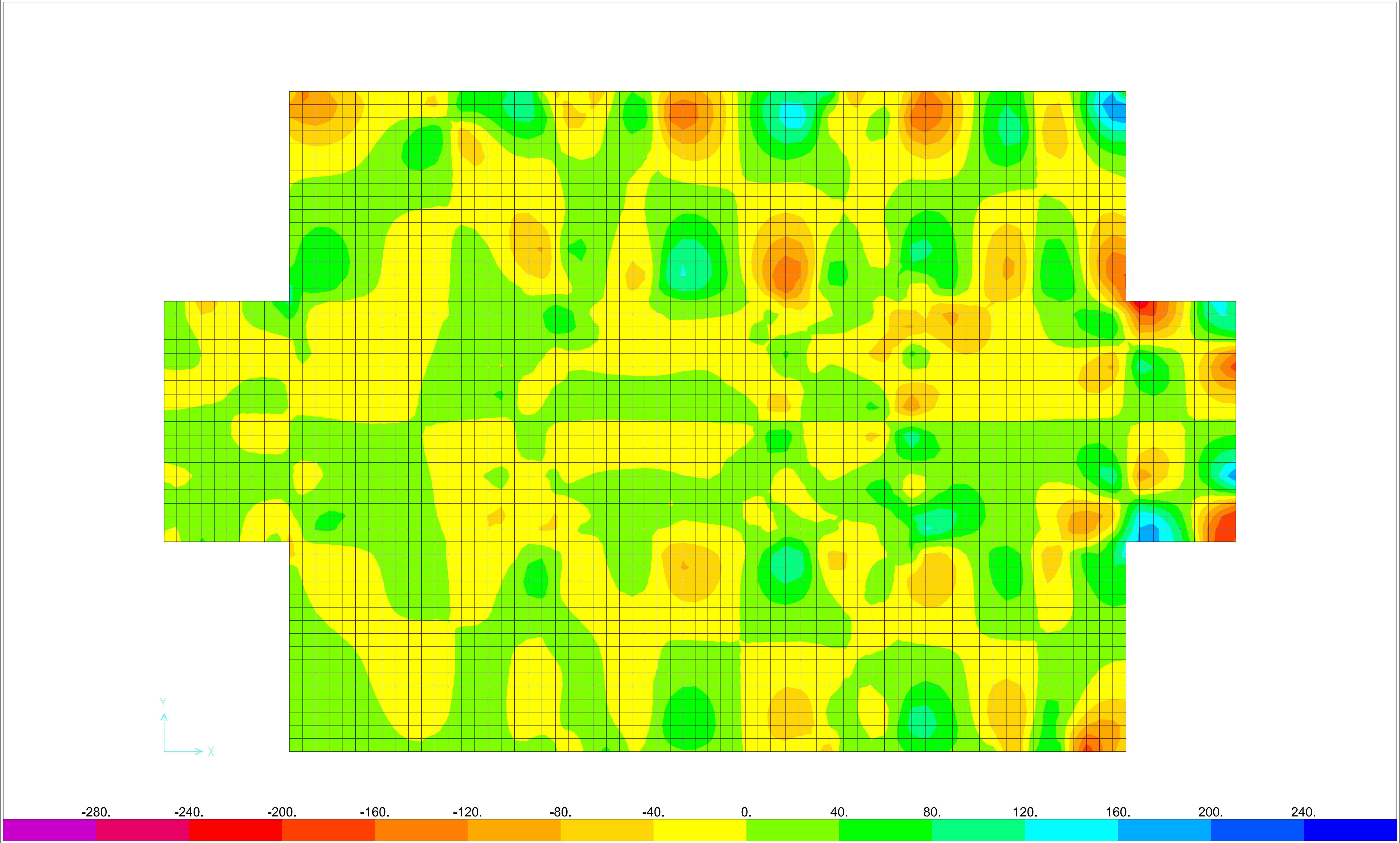
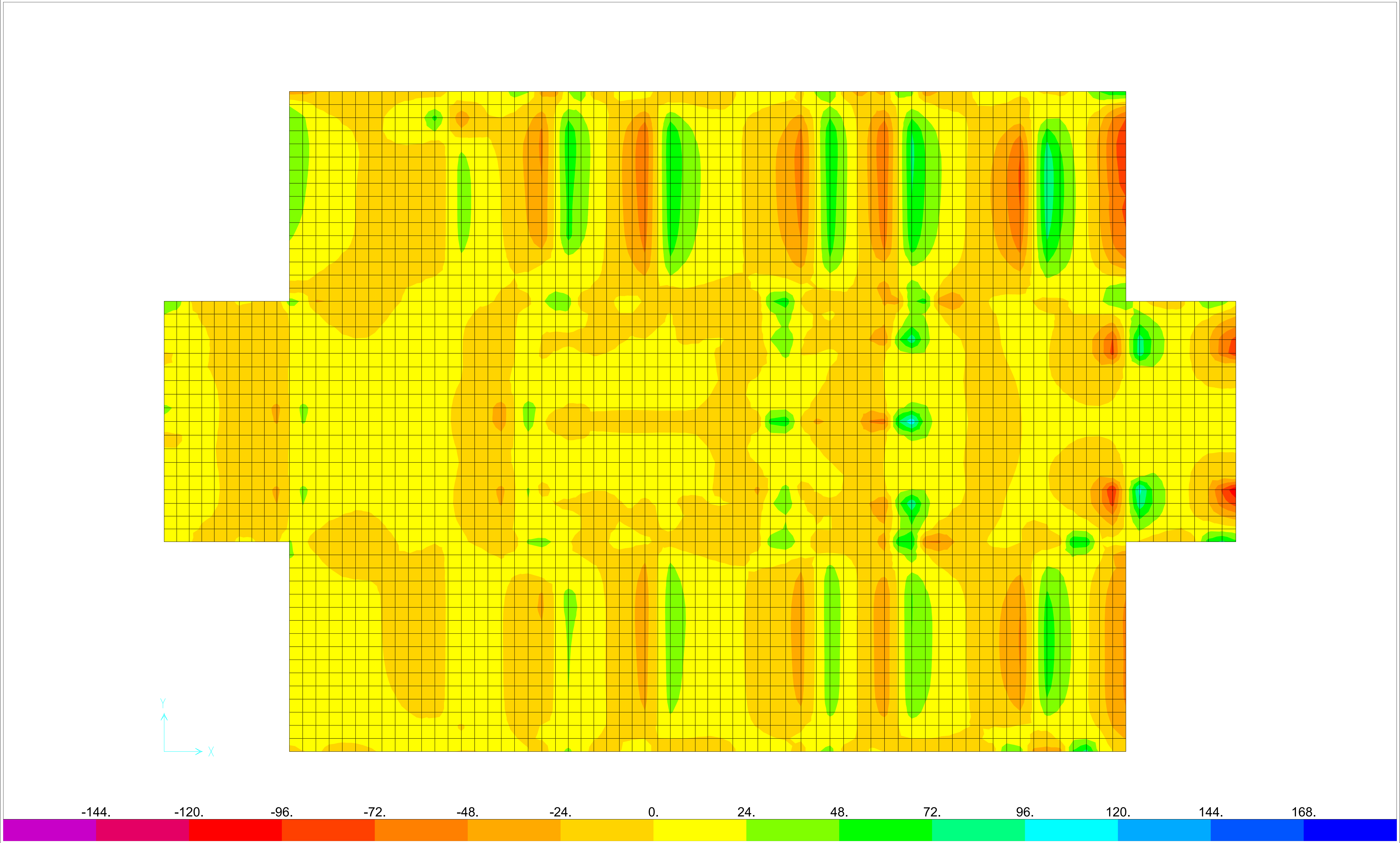


SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M12 Diagram (DL+HX+0.4HY-0.4VZ) - Kip, ft, F Units

SAP2000

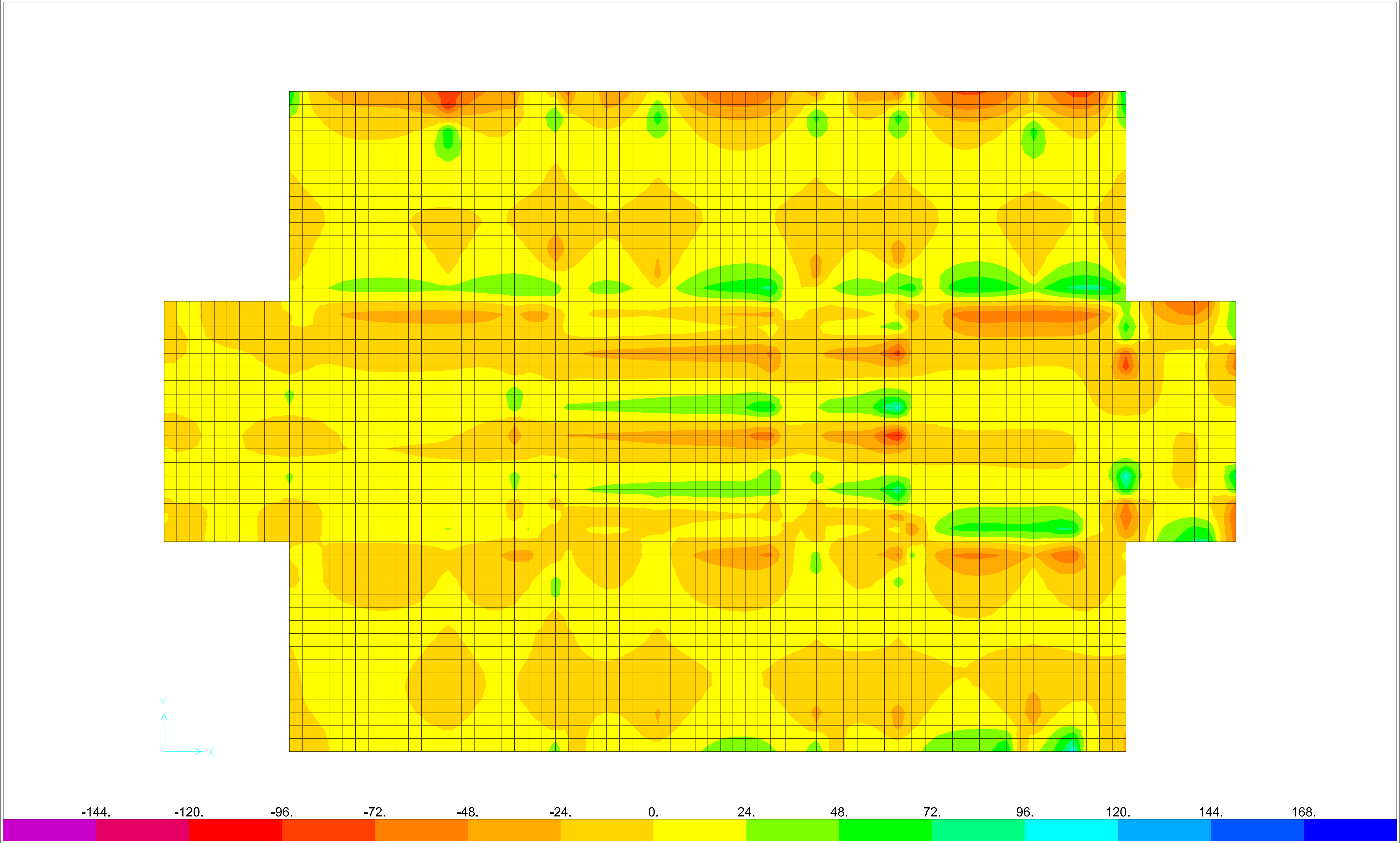
3/7/07 14:05:41



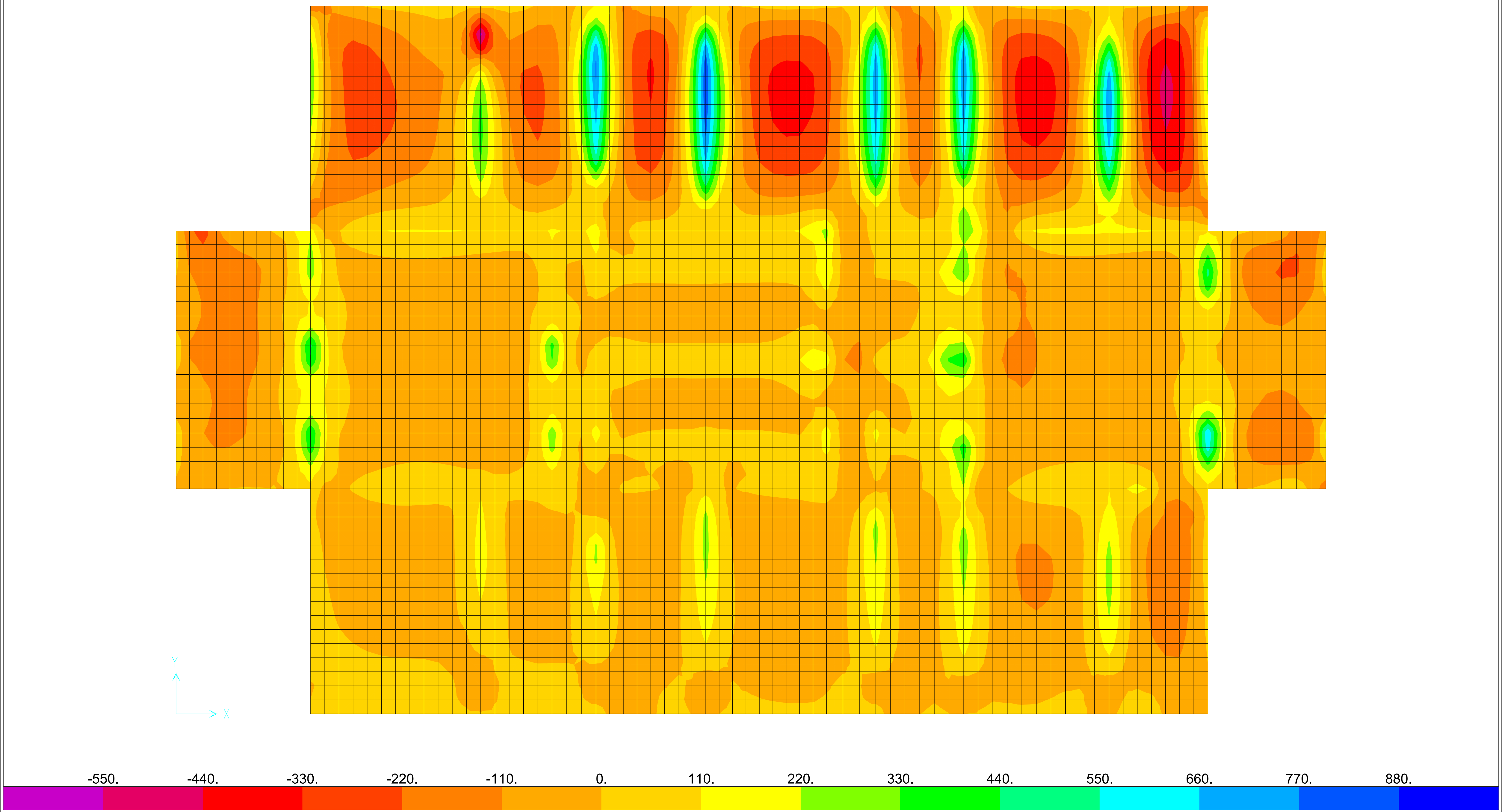
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant V23 Diagram (DL+HX+0.4HY-0.4VZ) - Kip, ft, F Units

SAP2000

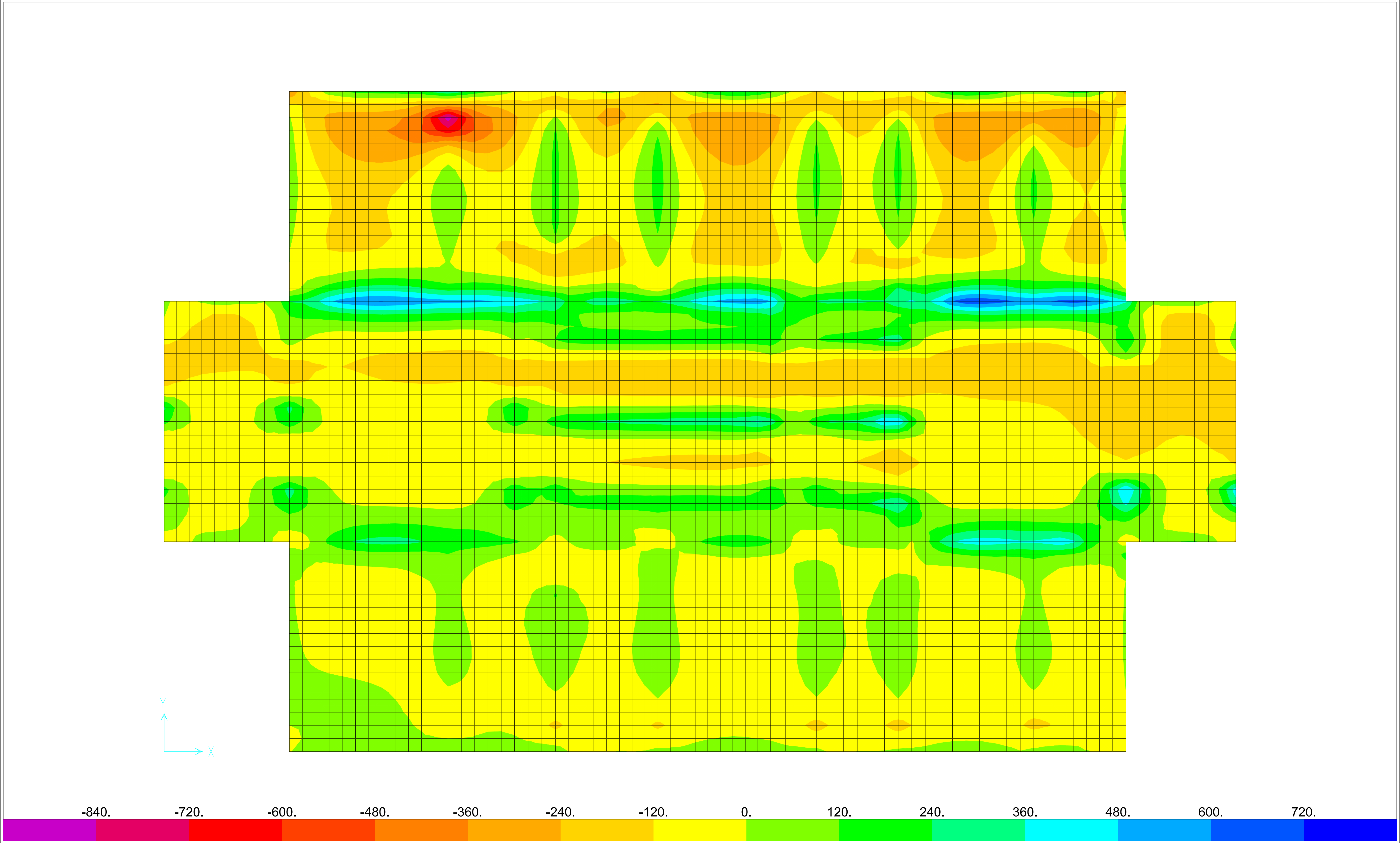
3/7/07 14:12:10



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant VMAX Diagram (DL+HX+0.4HY-0.4VZ) - Kip, ft, F Units



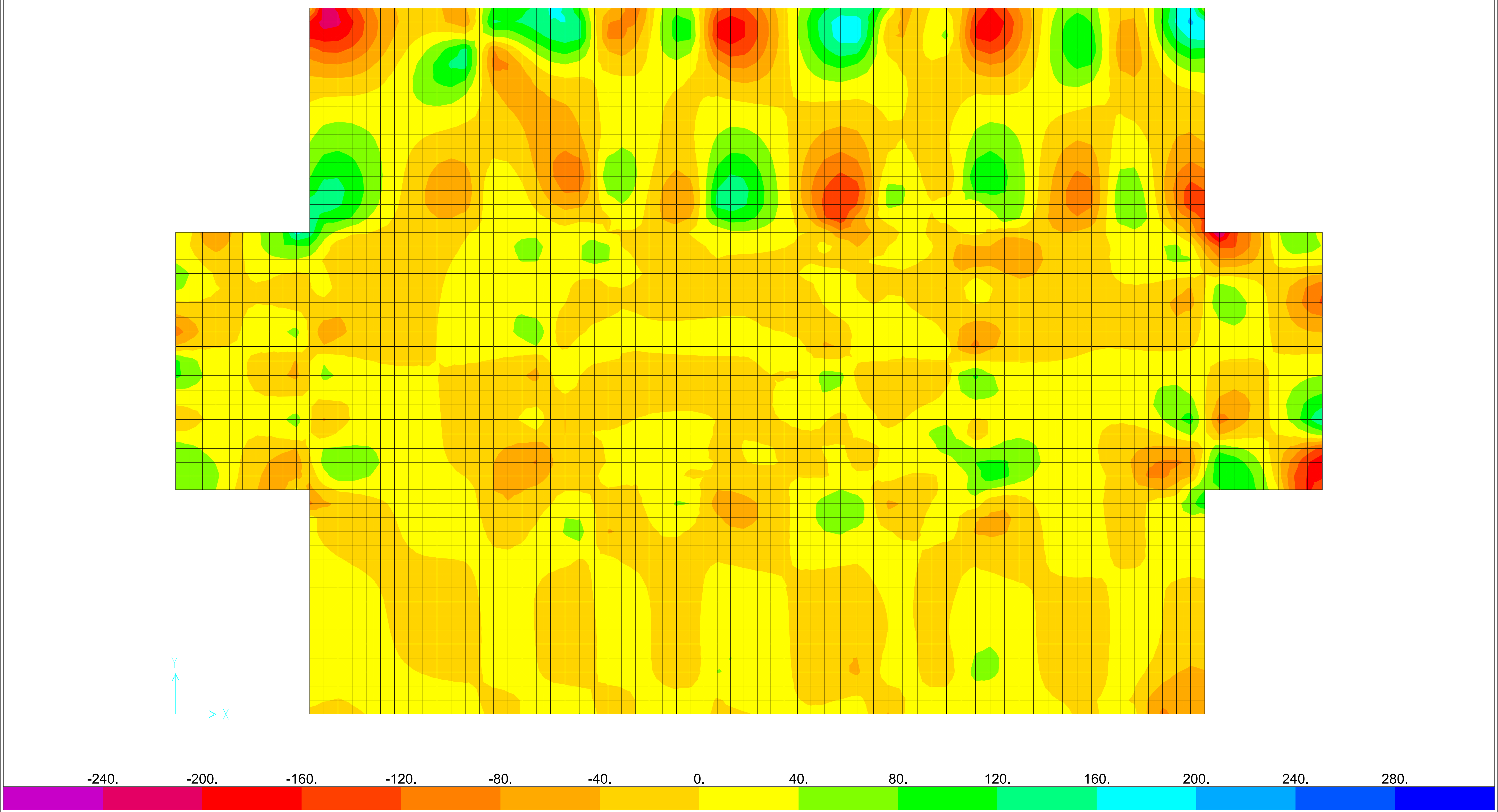
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M11 Diagram (DL+0.4HX+HY-0.4VZ) - Kip, ft, F Units



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M22 Diagram (DL+0.4HX+HY-0.4VZ) - Kip, ft, F Units

SAP2000

3/7/07 14:53:31



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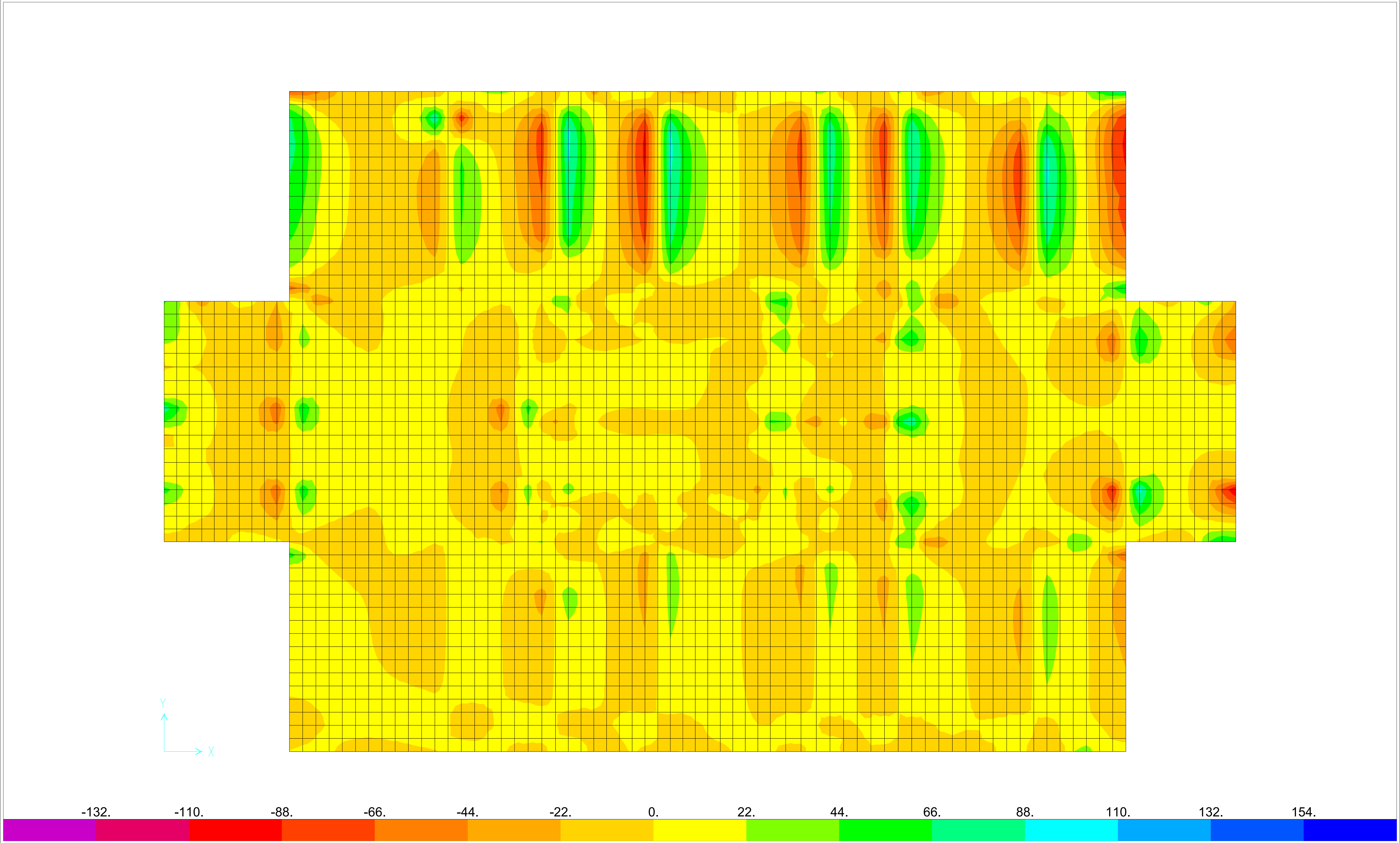
SAP2000

3/7/07 14:56:35



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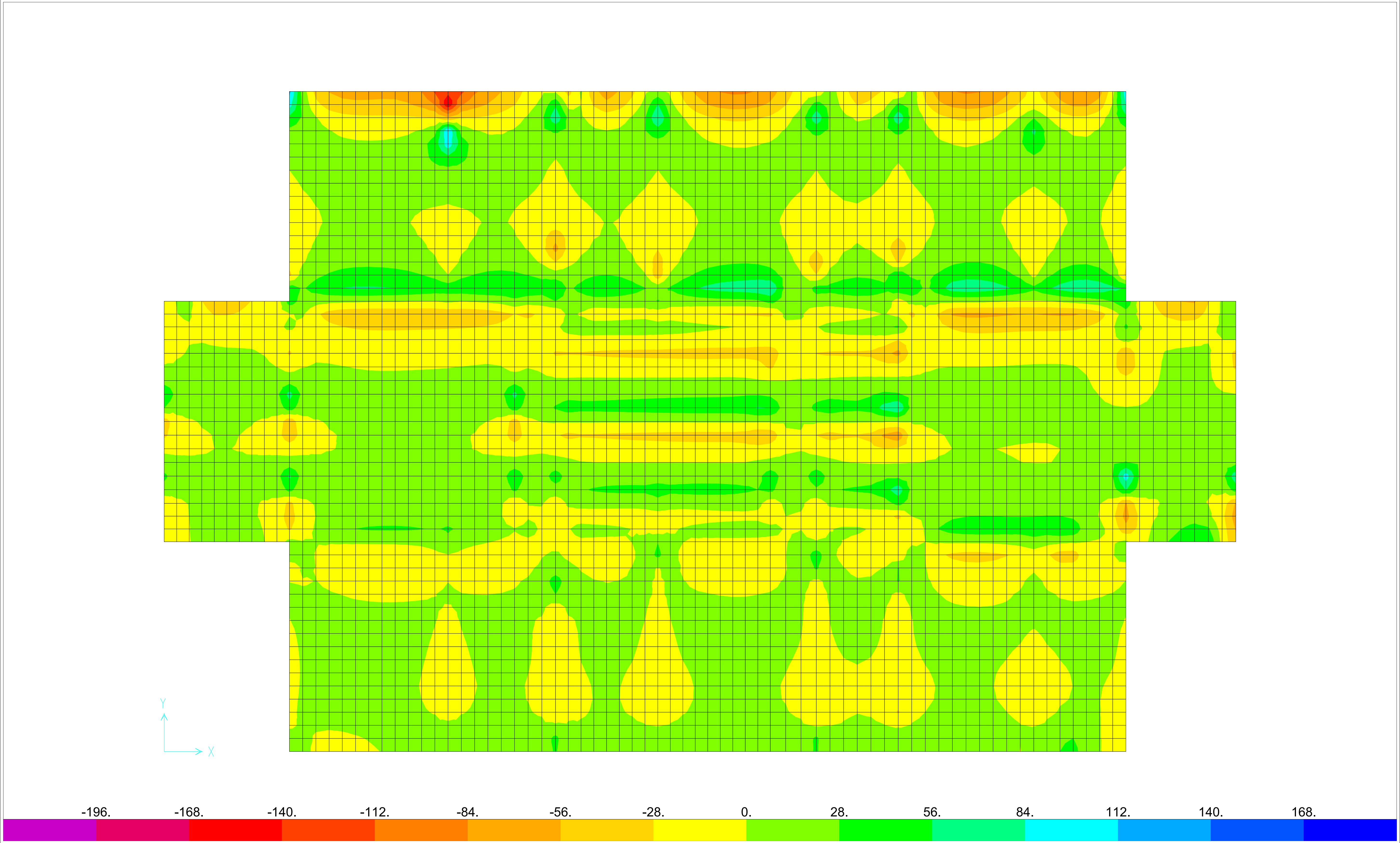

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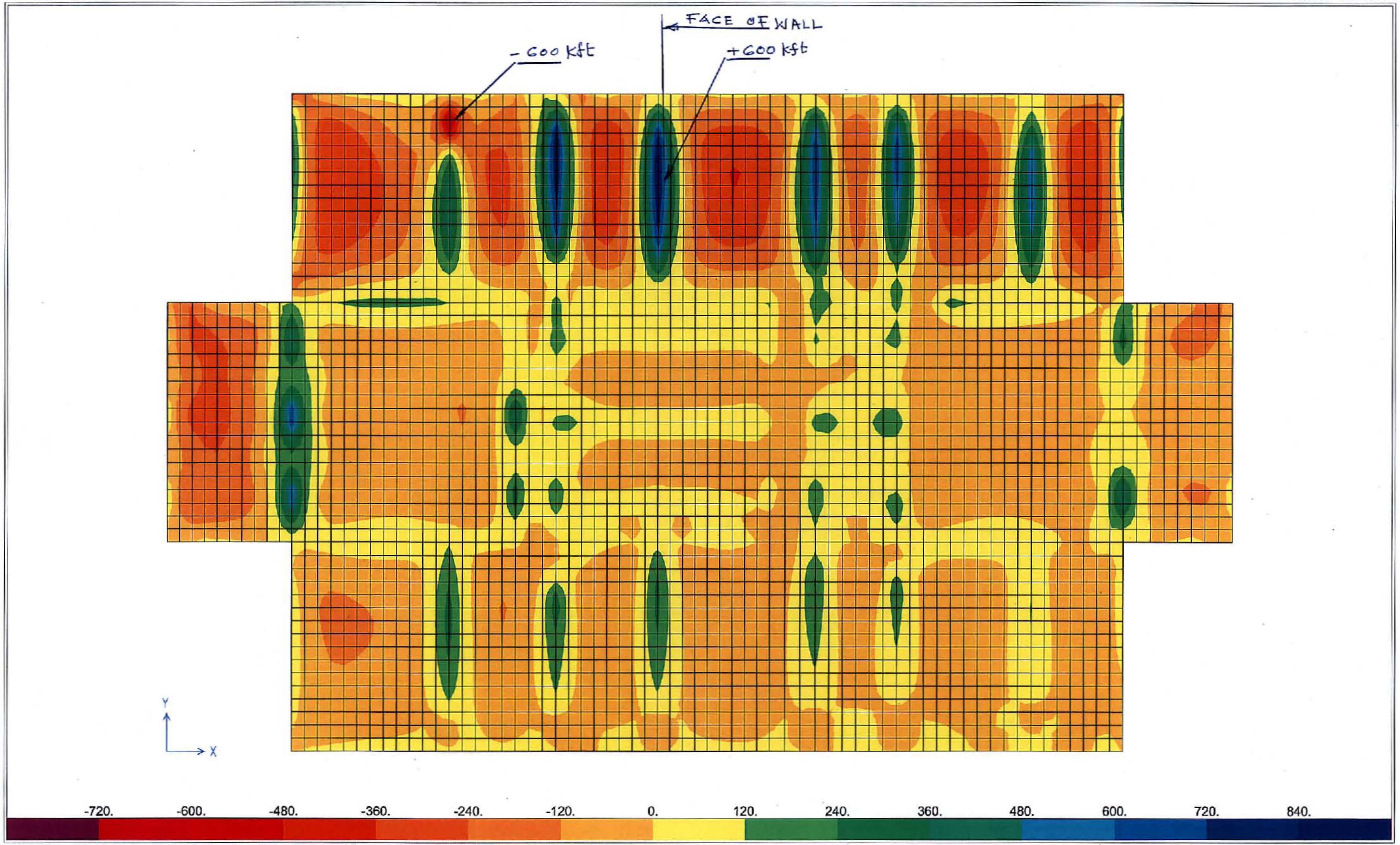
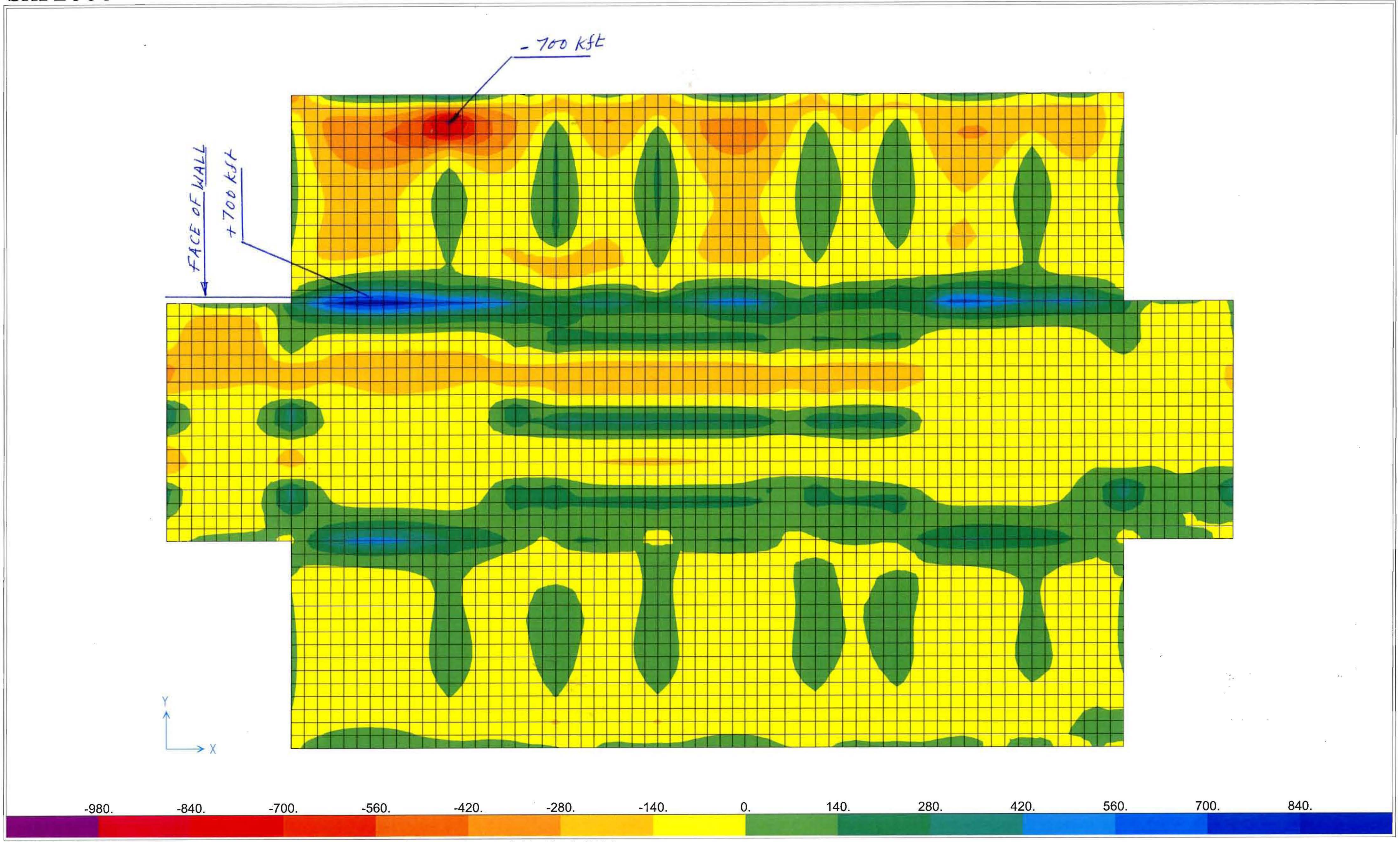


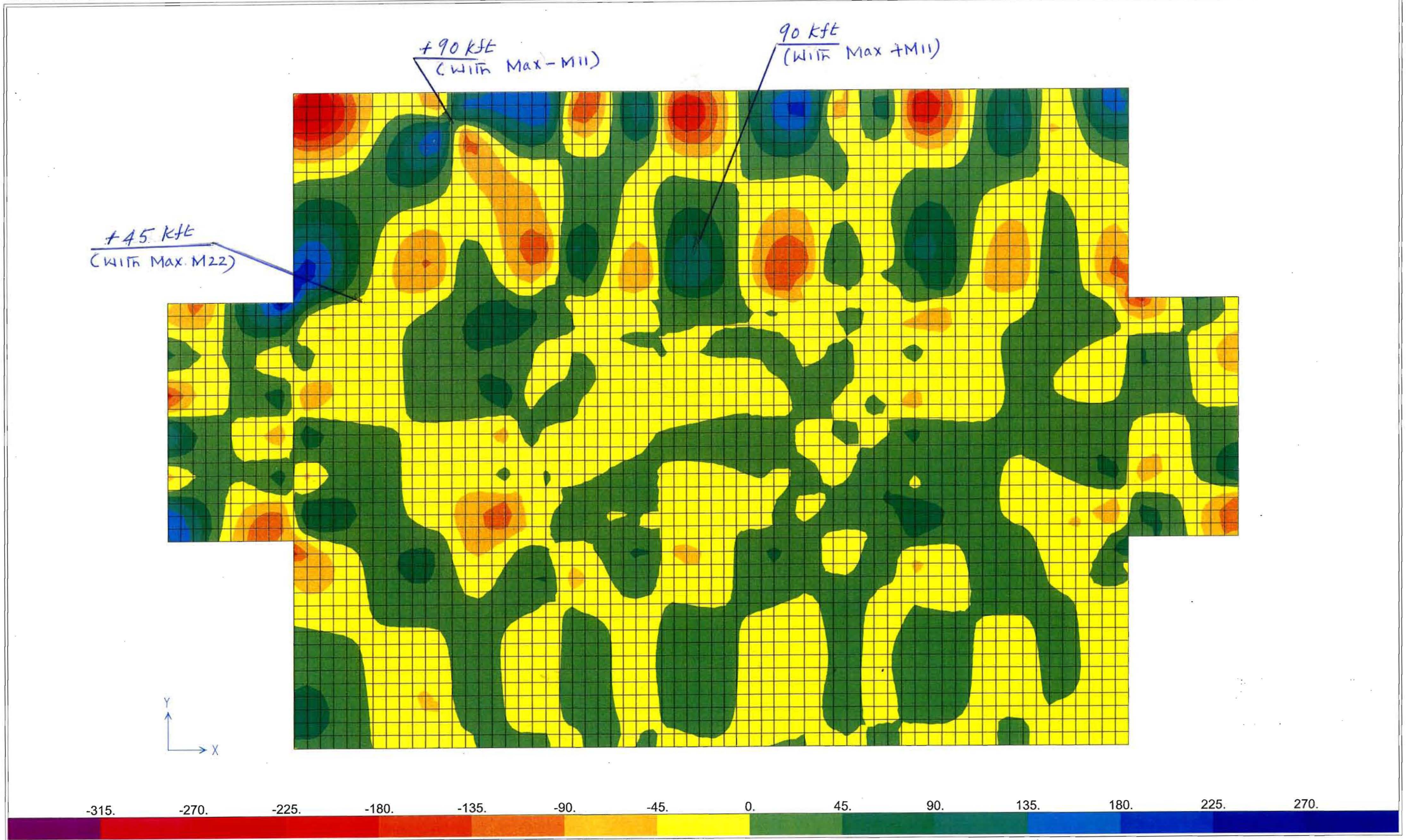
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M11 Diagram (DL-0.4HX+HY-0.4VZ) - Kip, ft, F Units

SAP2000

3/7/07 15:18:53



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M22 Diagram (DL-0.4HX+HY-0.4VZ) - Kip, ft, F Units



+90 kft
(With Max -M11)

90 kft
(With Max +M11)

+45 kft
(With Max. M22)

SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M12 Diagram (DL-0.4HX+HY-0.4VZ) - Kip, ft, F Units

SAP2000

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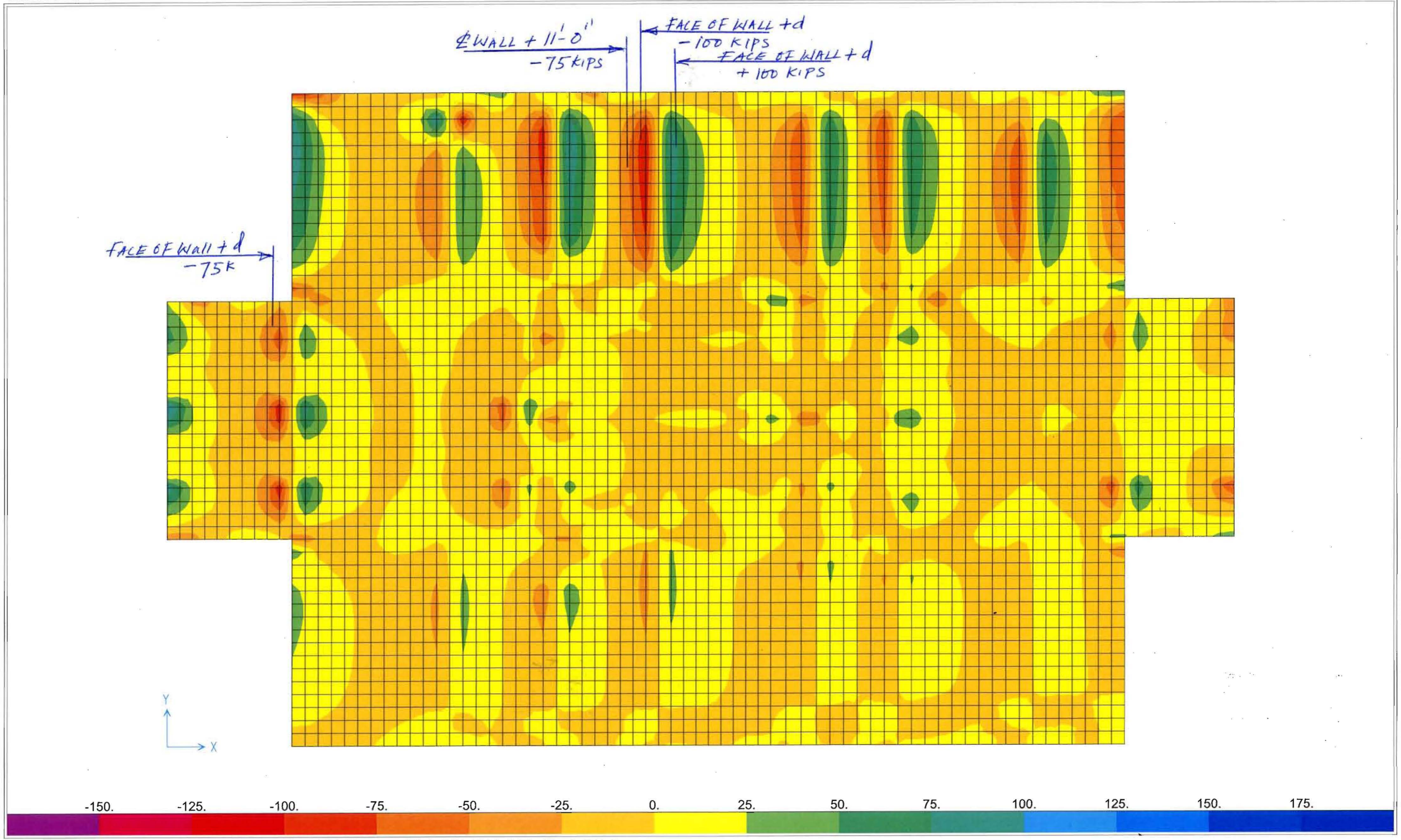


℄ WALL + 11'-0"
-75 kips

FACE OF WALL +d
-100 KIPS

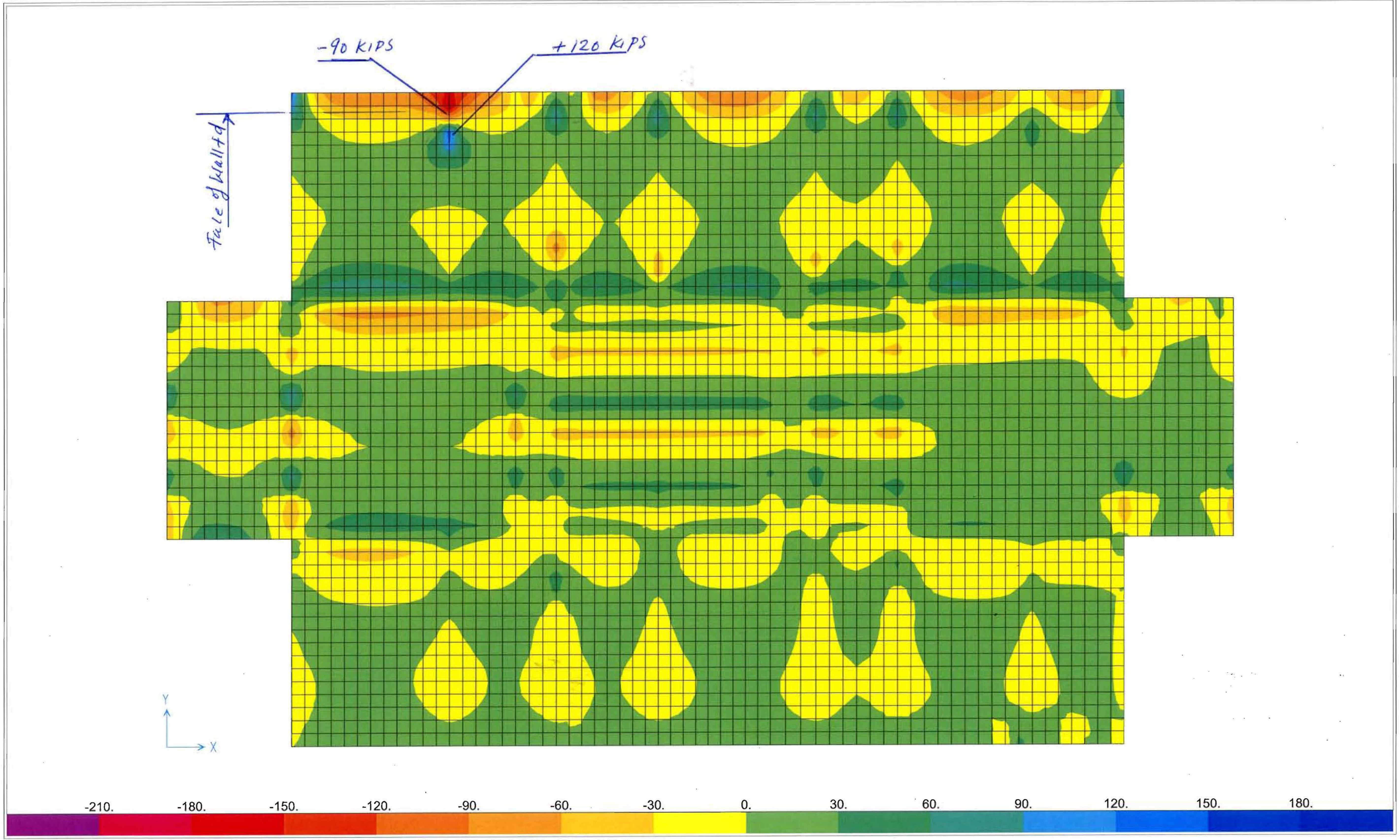
FACE OF WALL + d
+ 100 KIPS

FACE OF Wall + d
-75k

SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant V23 Diagram (DL-0.4HX+HY-0.4VZ) - Kip, ft, F Units

SAP2000

3/7/07 15:29:41

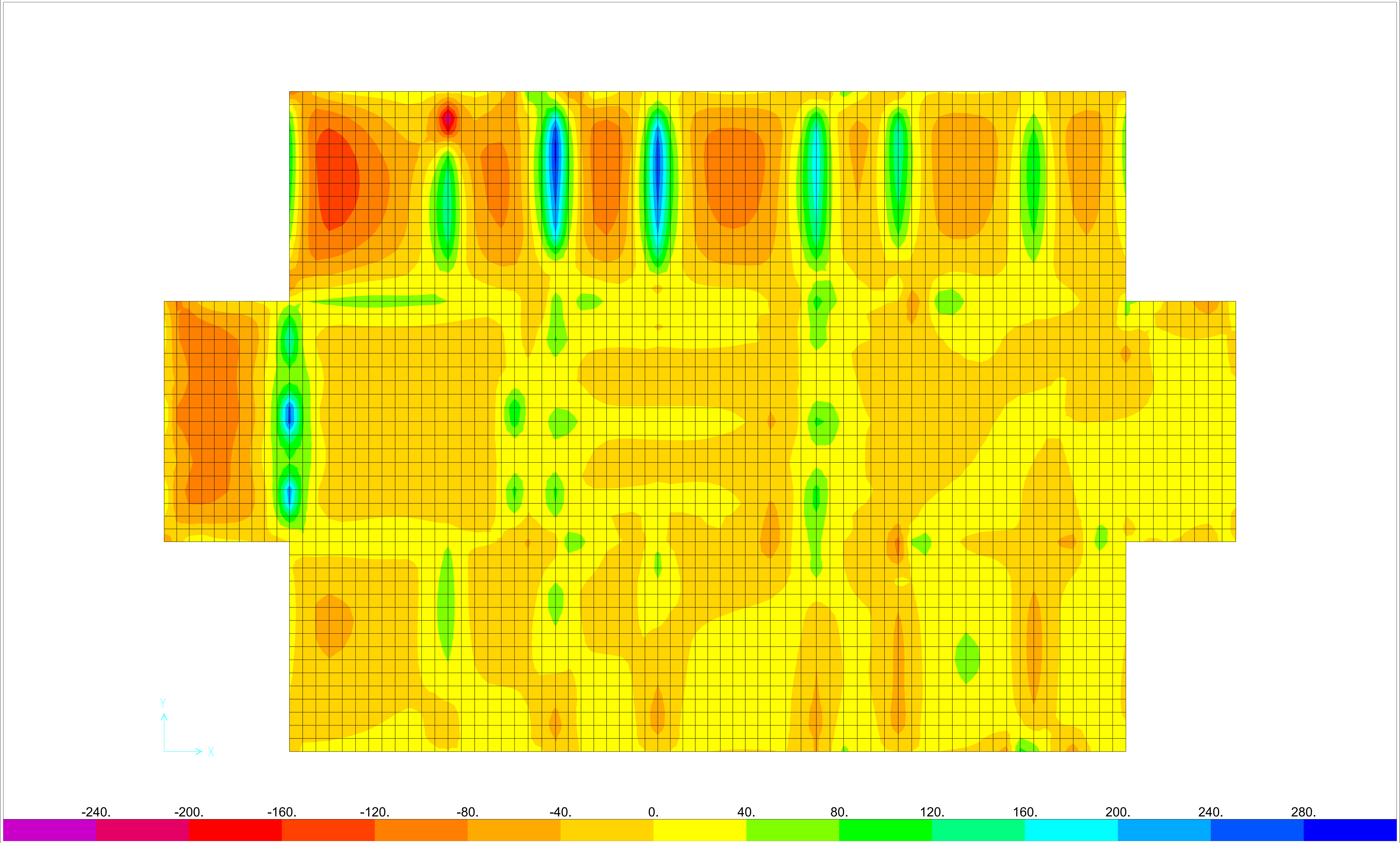


-90 KIPS

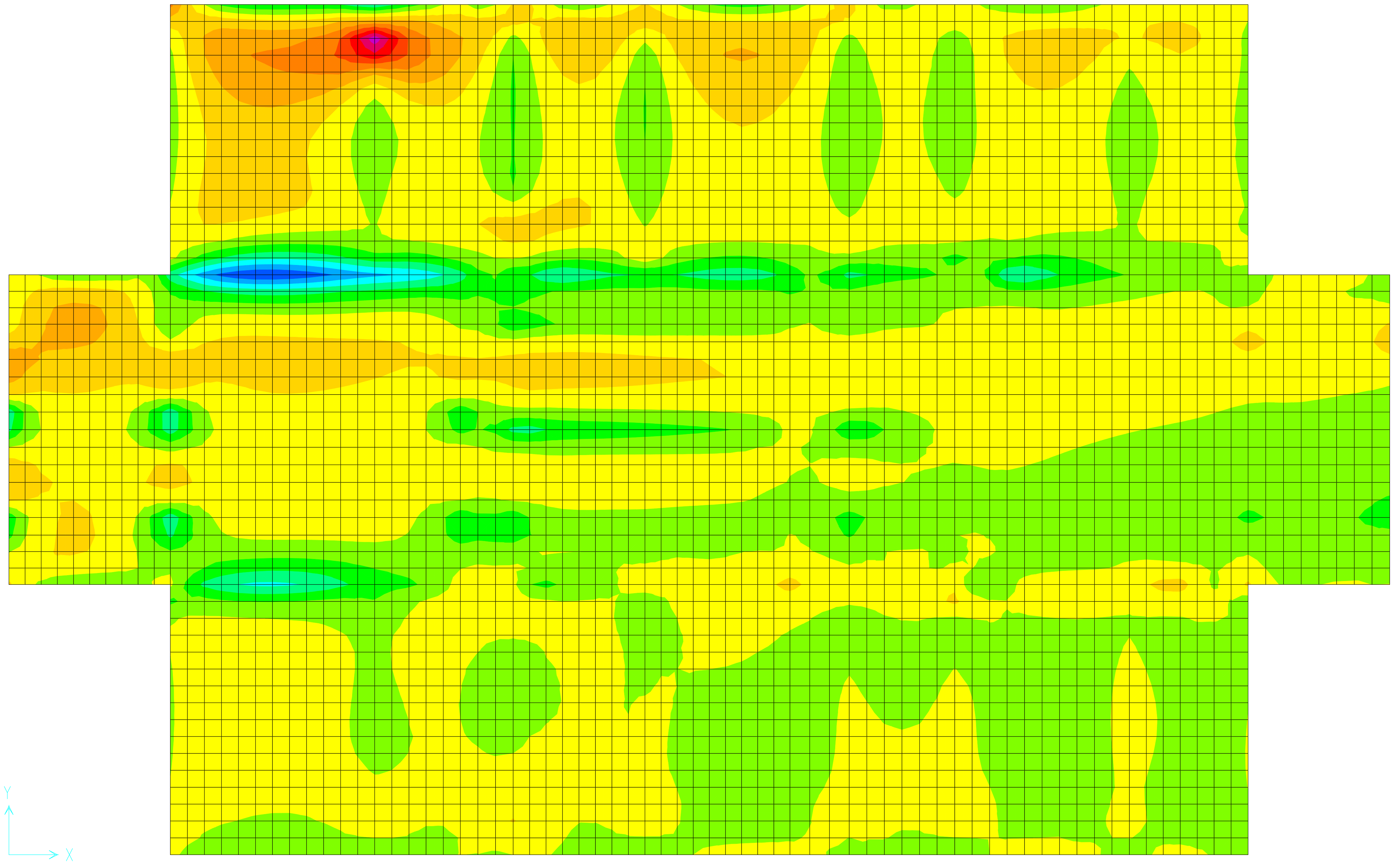
+120 KIPS

Face of wall+d

SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant VMAX Diagram (DL-0.4HX+HY-0.4VZ) - Kip, ft, F Units

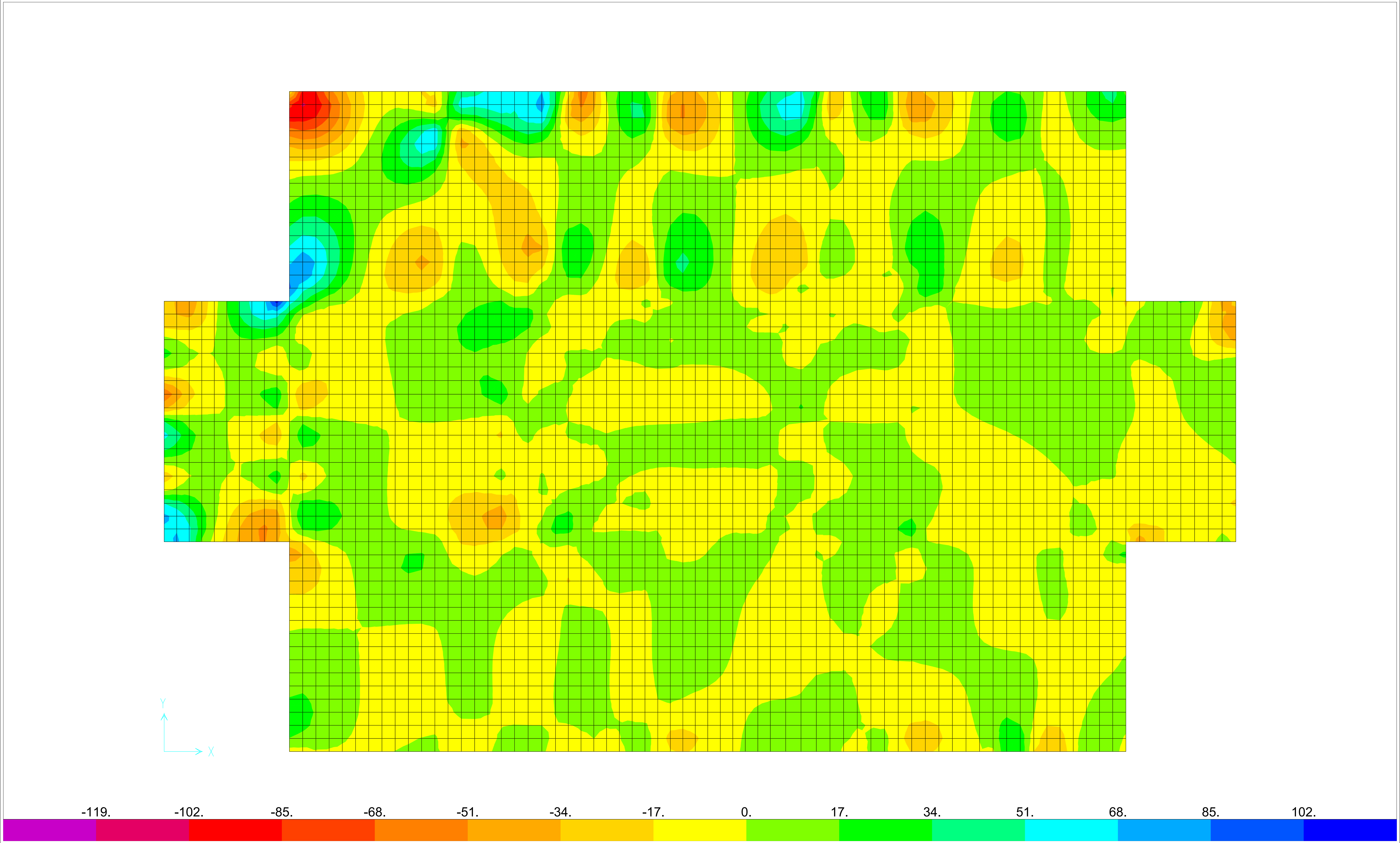


SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M11 Diagram (DL-0.4HX+0.4HY+VZ) - Kip, ft, F Units

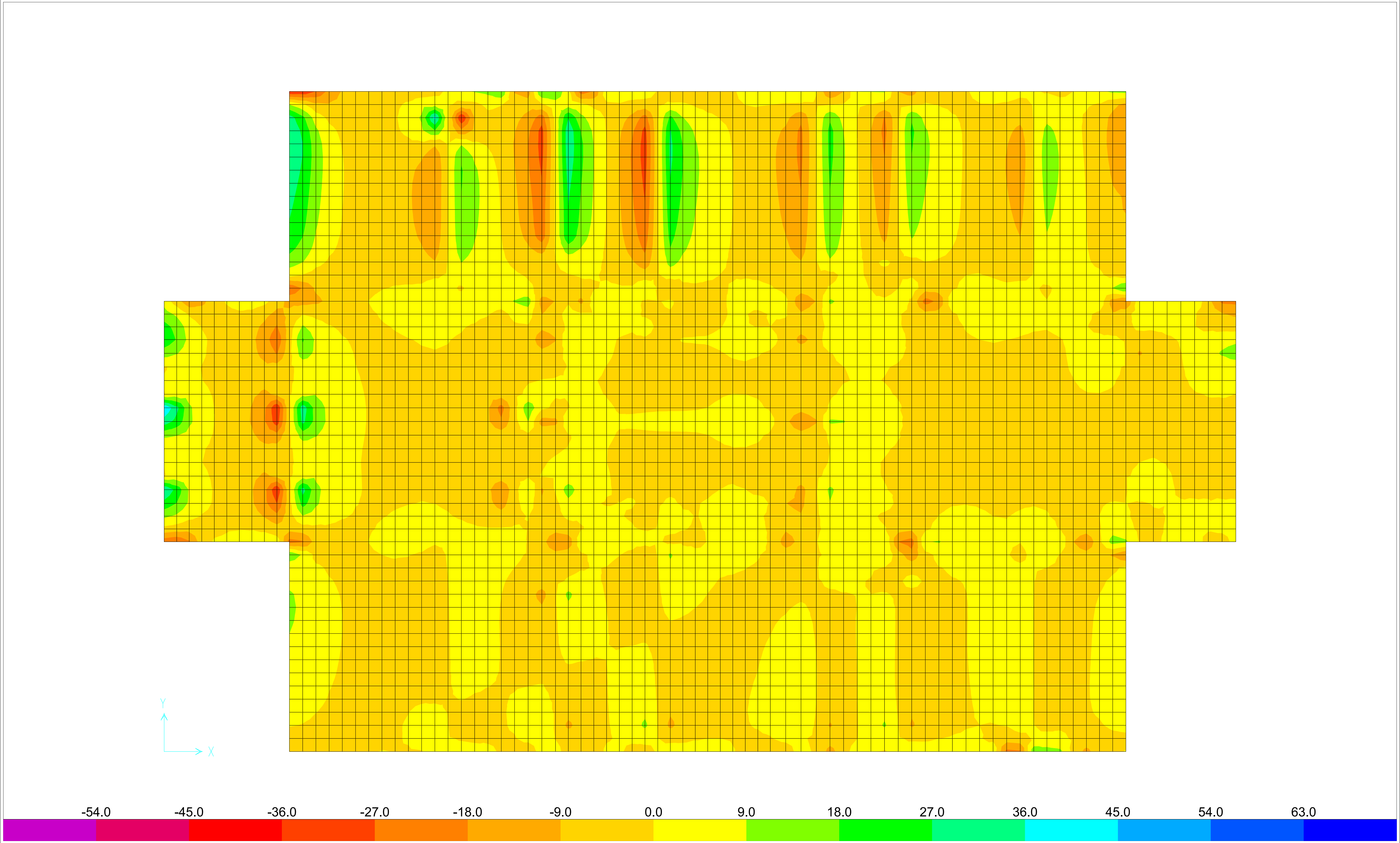


-350. -300. -250. -200. -150. -100. -50. 0. 50. 100. 150. 200. 250. 300.

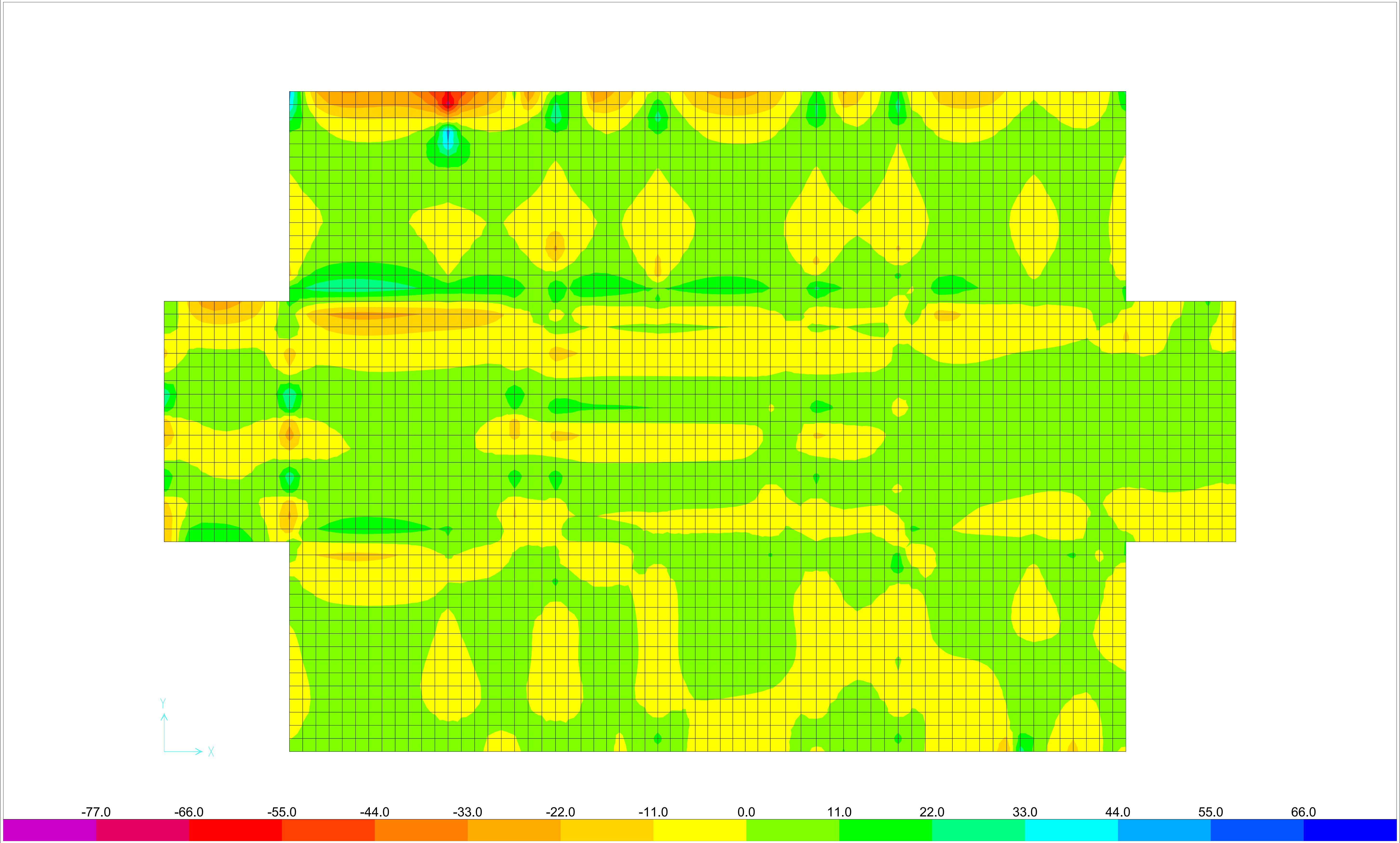
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M22 Diagram (DL-0.4HX+0.4HY+VZ) - Kip, ft, F Units



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M12 Diagram (DL-0.4HX+0.4HY+VZ) - Kip, ft, F Units



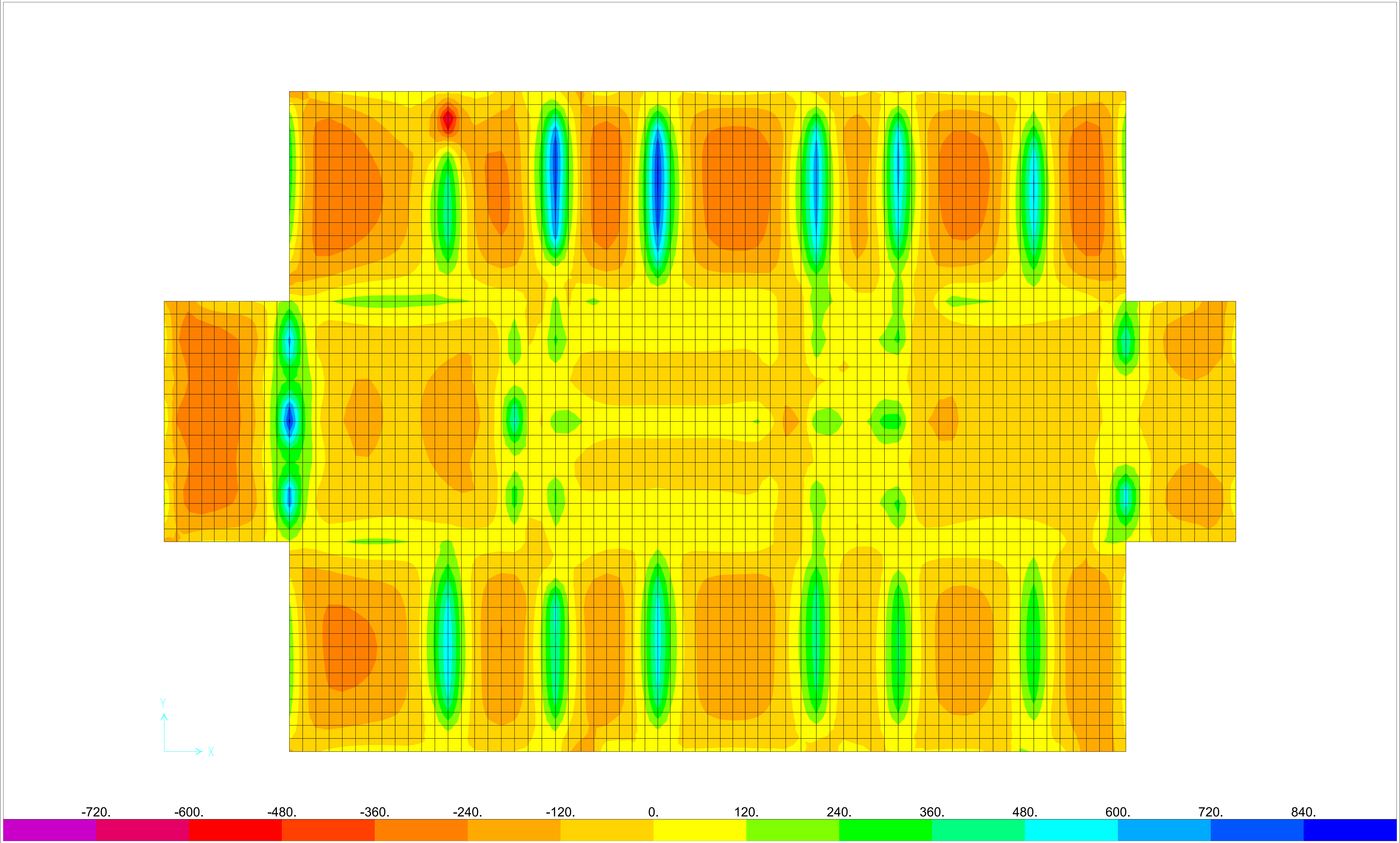
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant V23 Diagram (DL-0.4HX+0.4HY+VZ) - Kip, ft, F Units



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant VMAX Diagram (DL-0.4HX+0.4HY+VZ) - Kip, ft, F Units

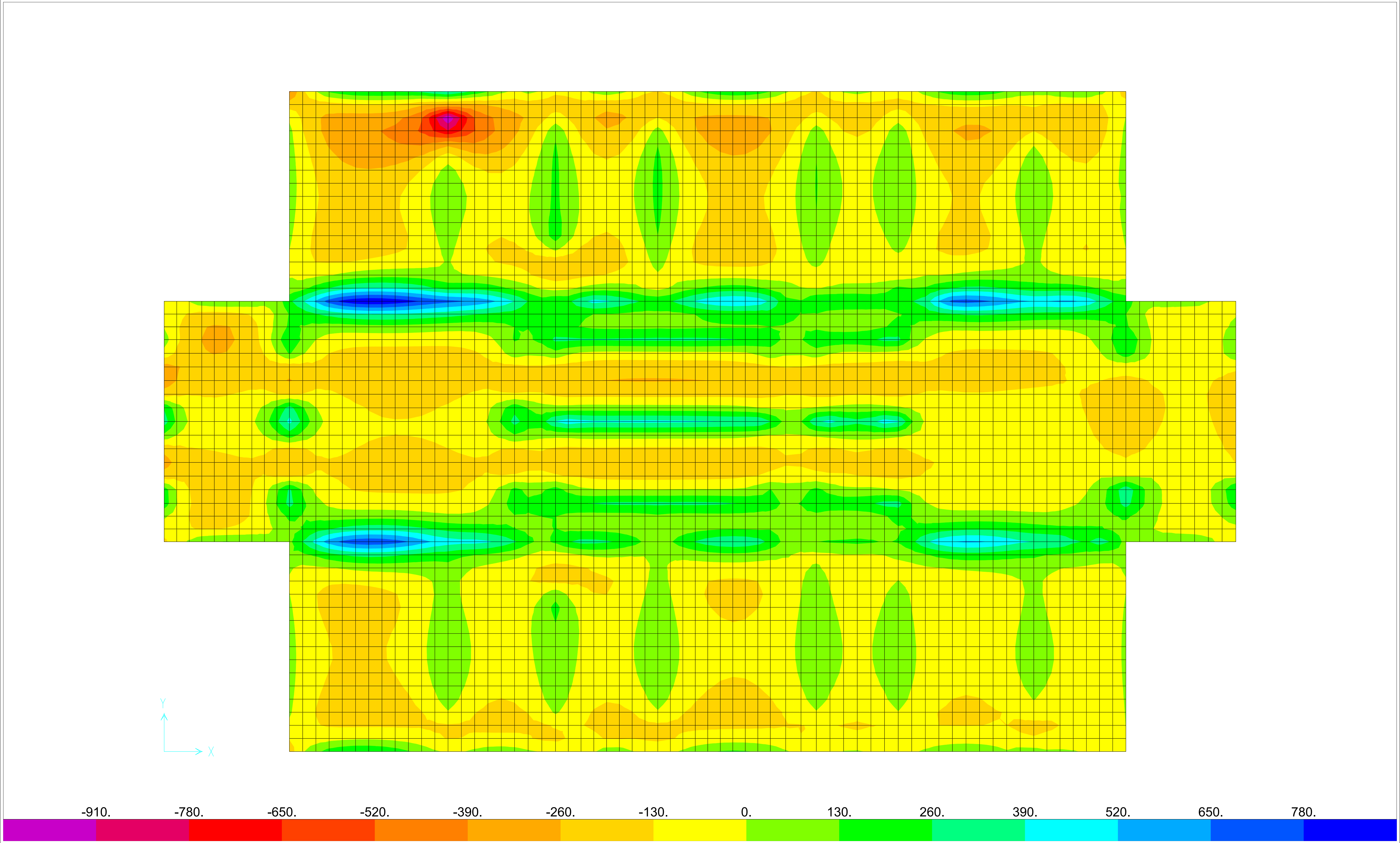
SAP2000

3/7/07 16:06:24

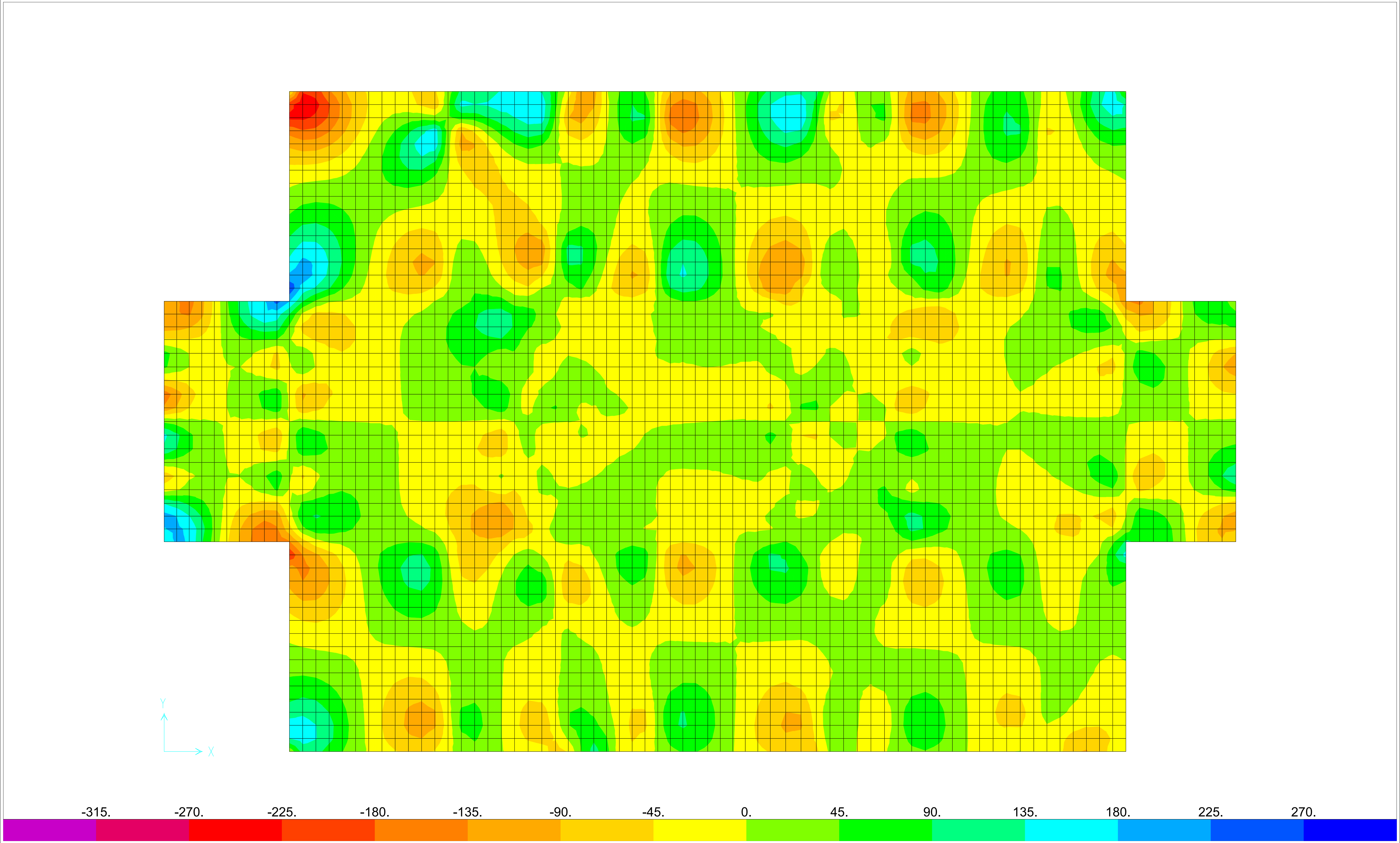


SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M11 Diagram (DL-0.4HX+0.4HY-VZ) - Kip, ft, F Units

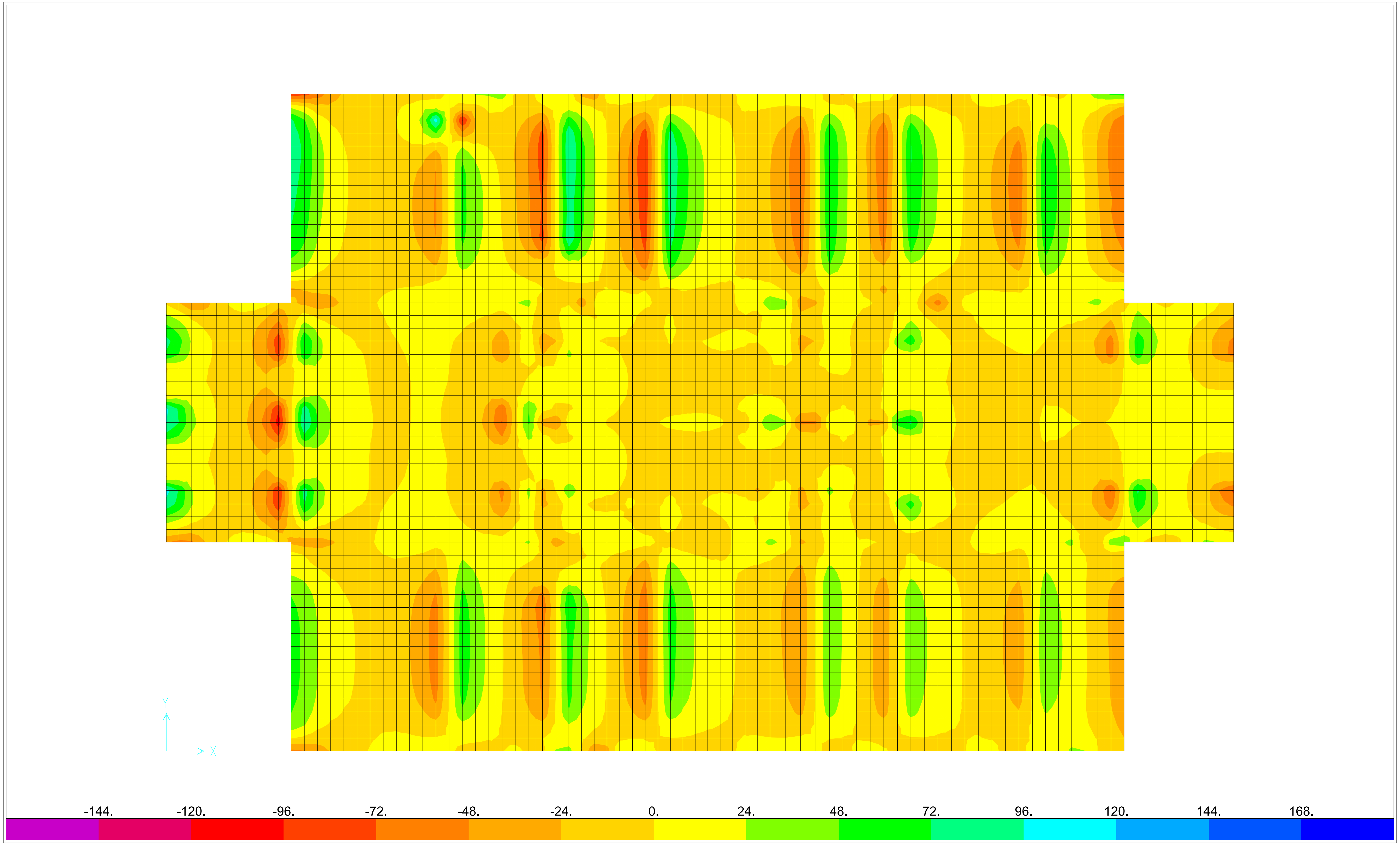
SAP2000



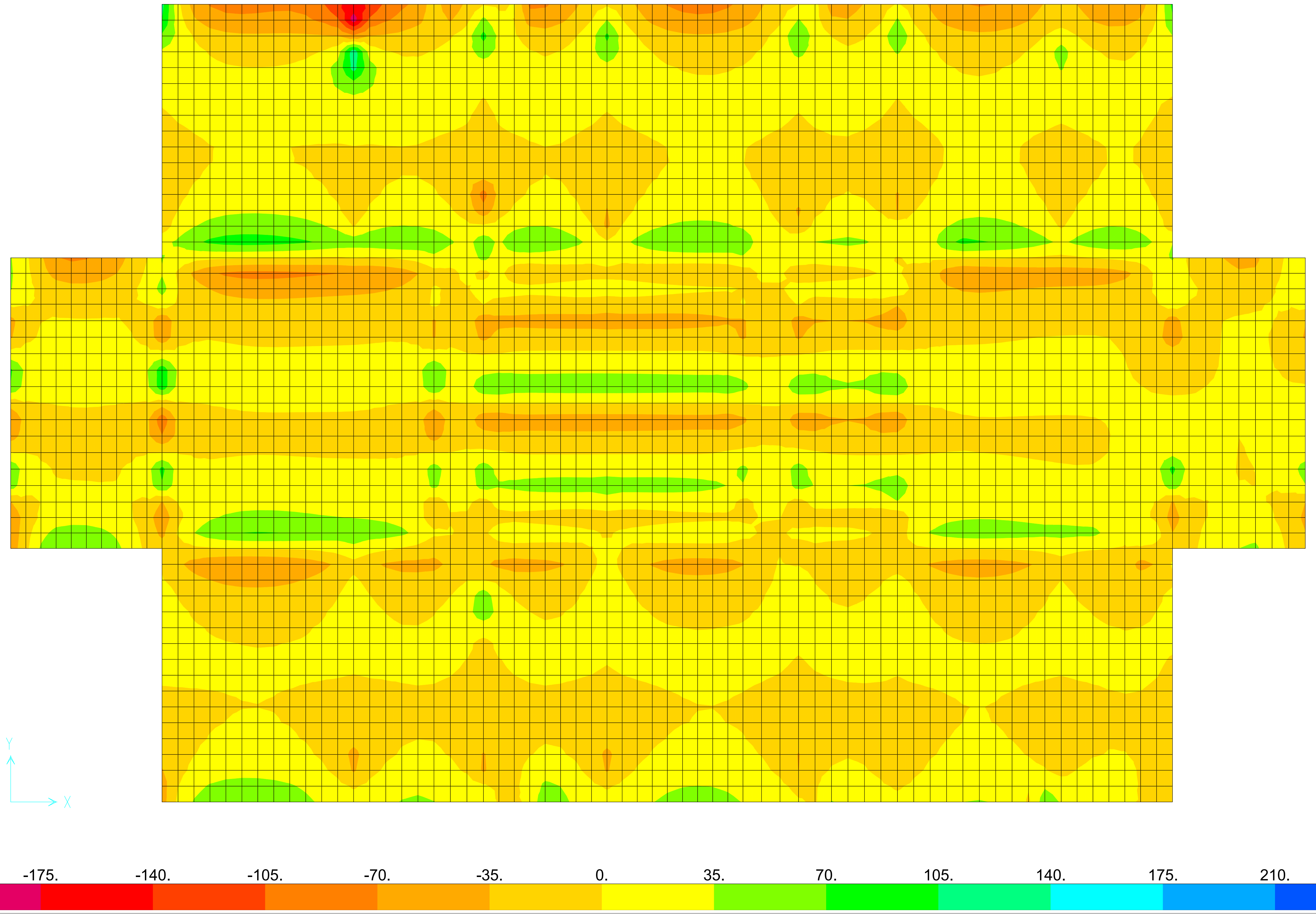
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M22 Diagram (DL-0.4HX+0.4HY-VZ) - Kip, ft, F Units



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M12 Diagram (DL-0.4HX+0.4HY-VZ) - Kip, ft, F Units



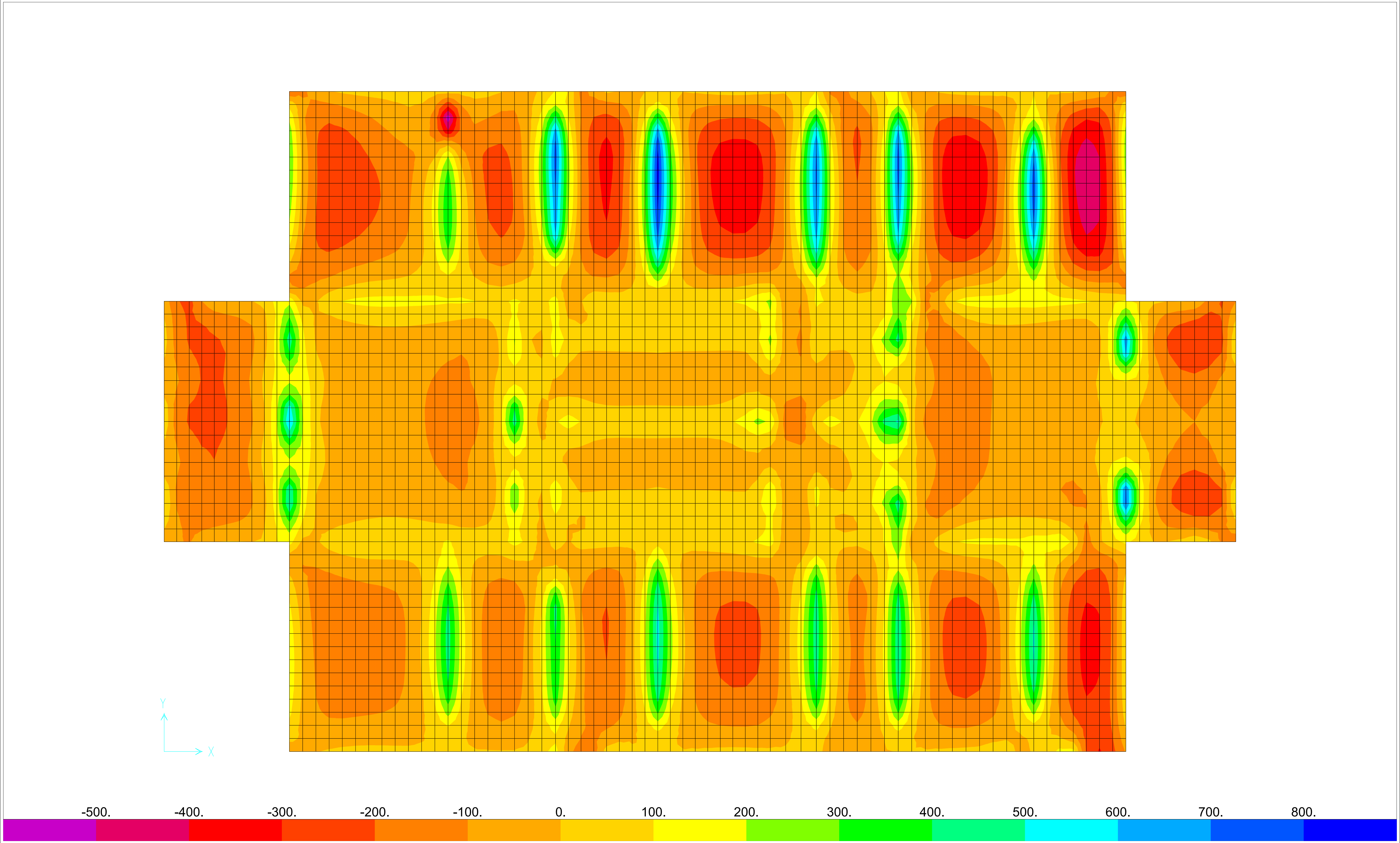
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant V23 Diagram (DL-0.4HX+0.4HY-VZ) - Kip, ft, F Units



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant VMAX Diagram (DL-0.4HX+0.4HY-VZ) - Kip, ft, F Units

SAP2000

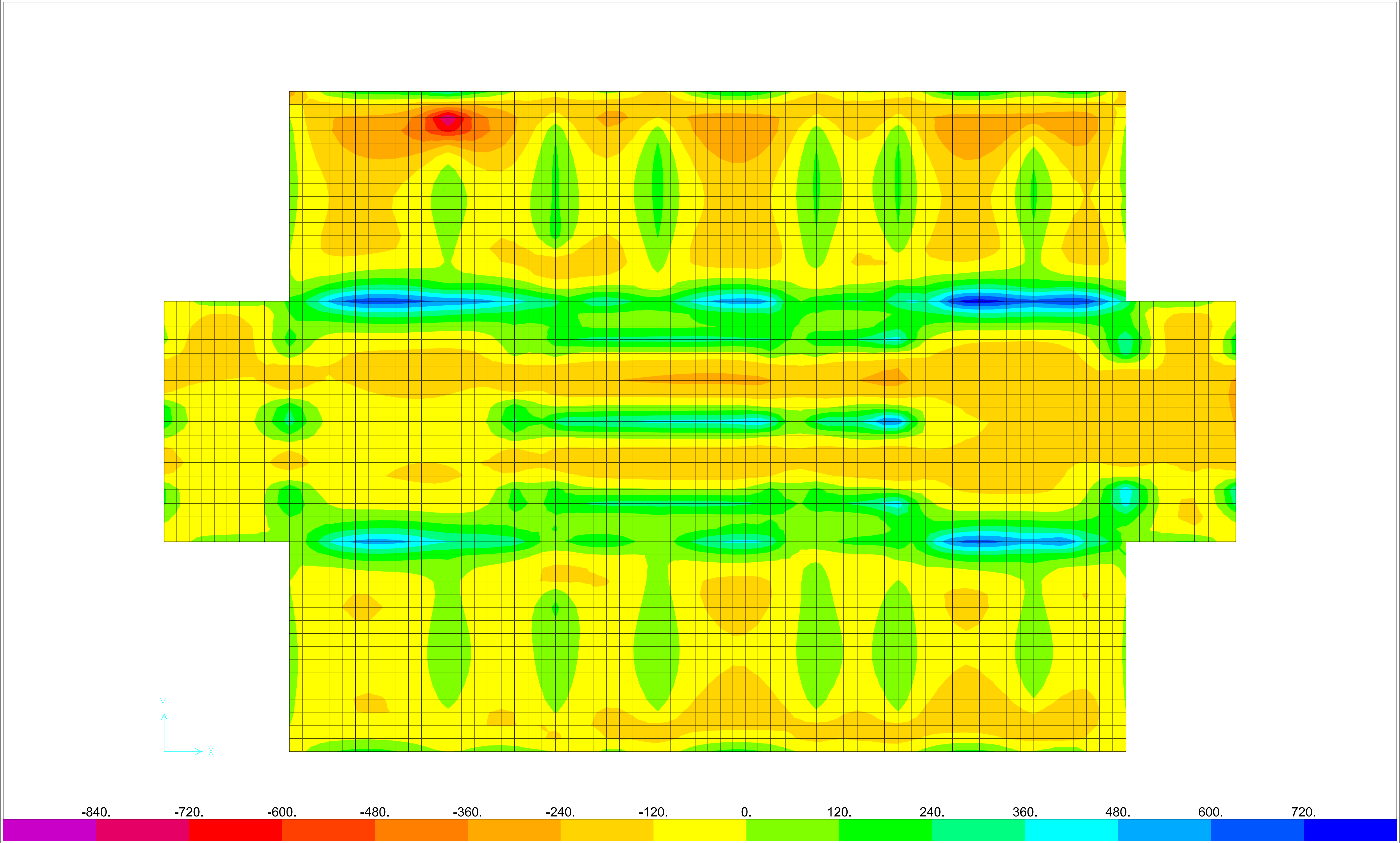
3/7/07 16:44:02



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M11 Diagram (DL+0.4HX+0.4HY-VZ) - Kip, ft, F Units

SAP2000

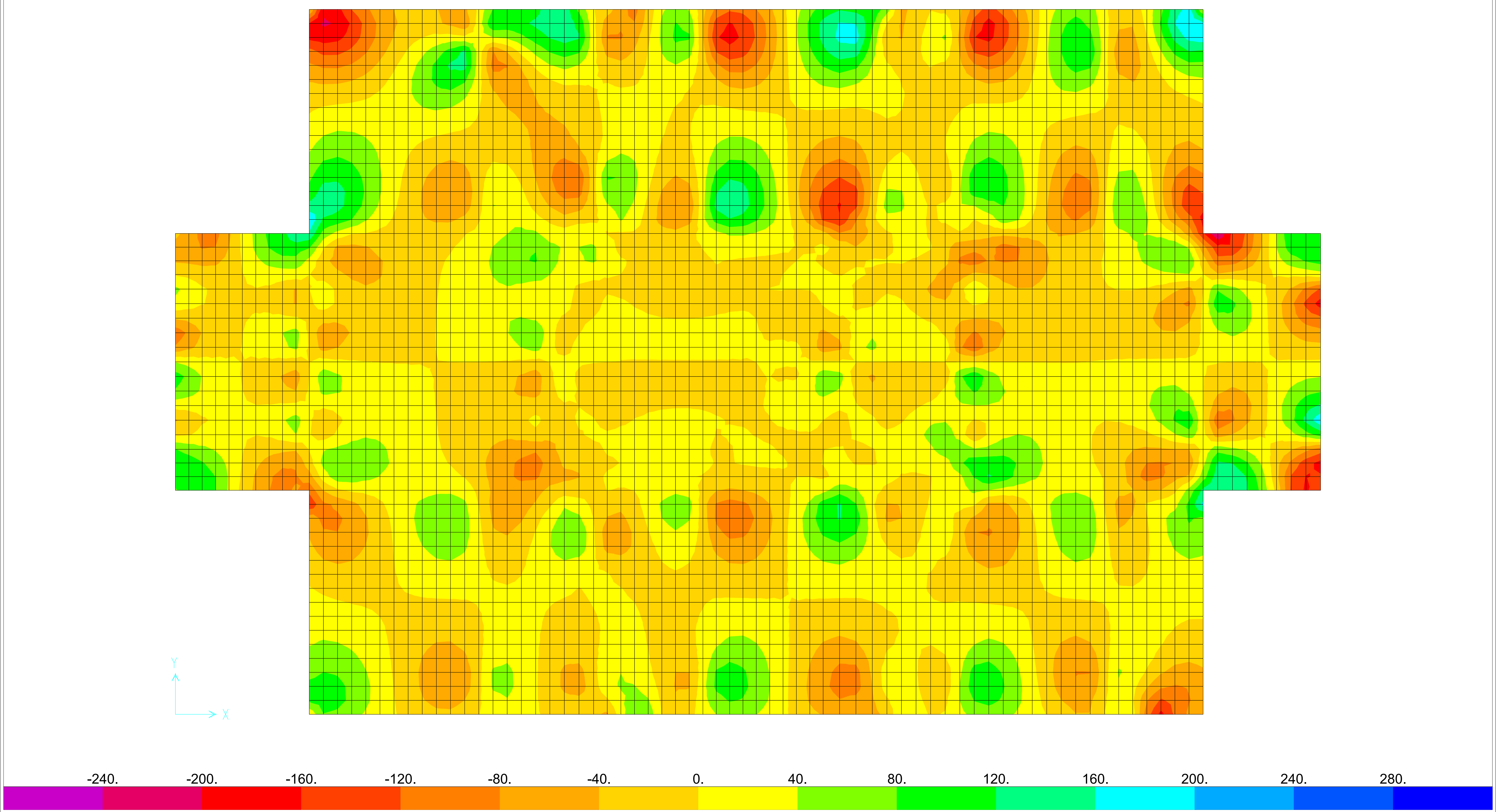
3/7/07 16:48:09



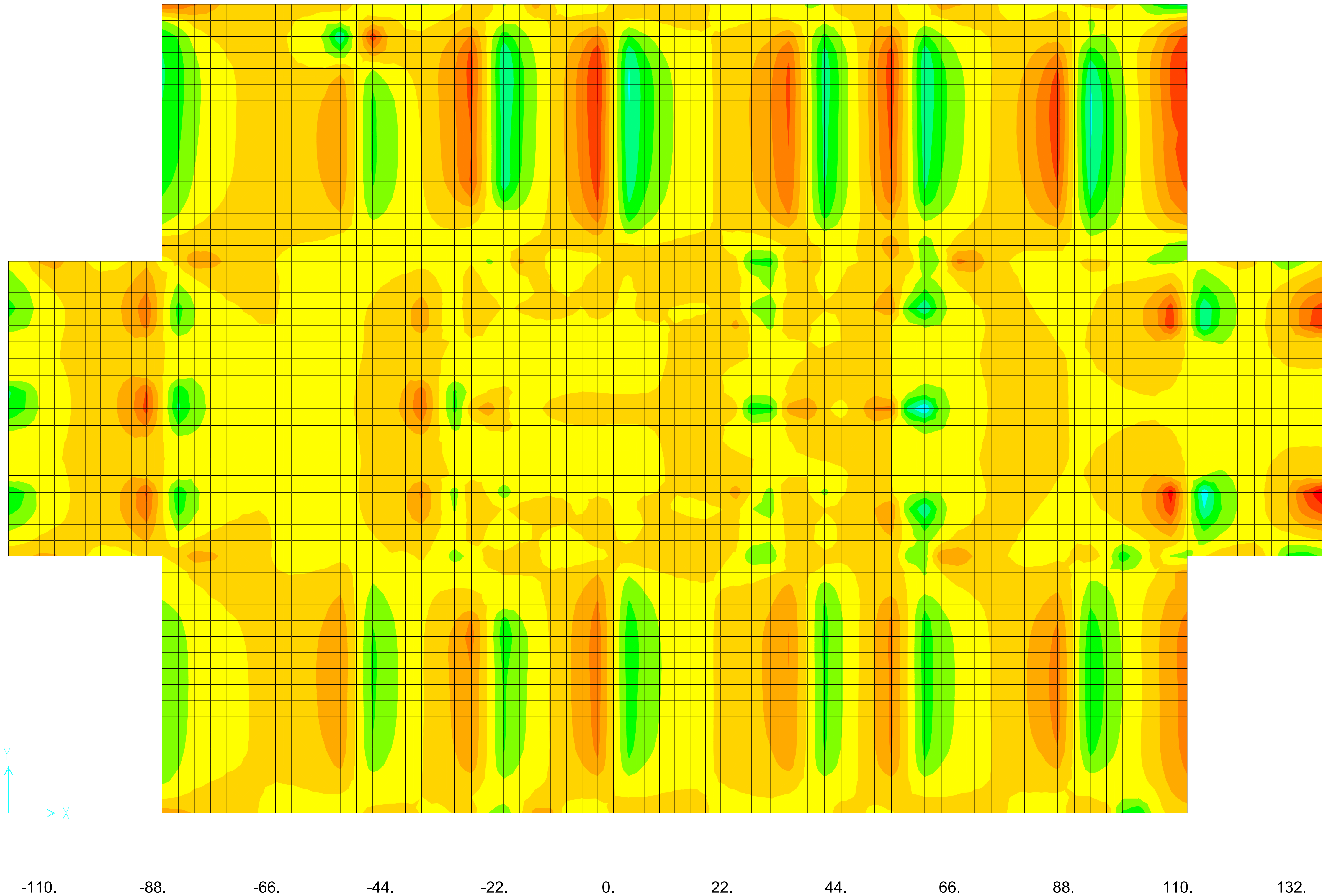
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M22 Diagram (DL+0.4HX+0.4HY-VZ) - Kip, ft, F Units

SAP2000

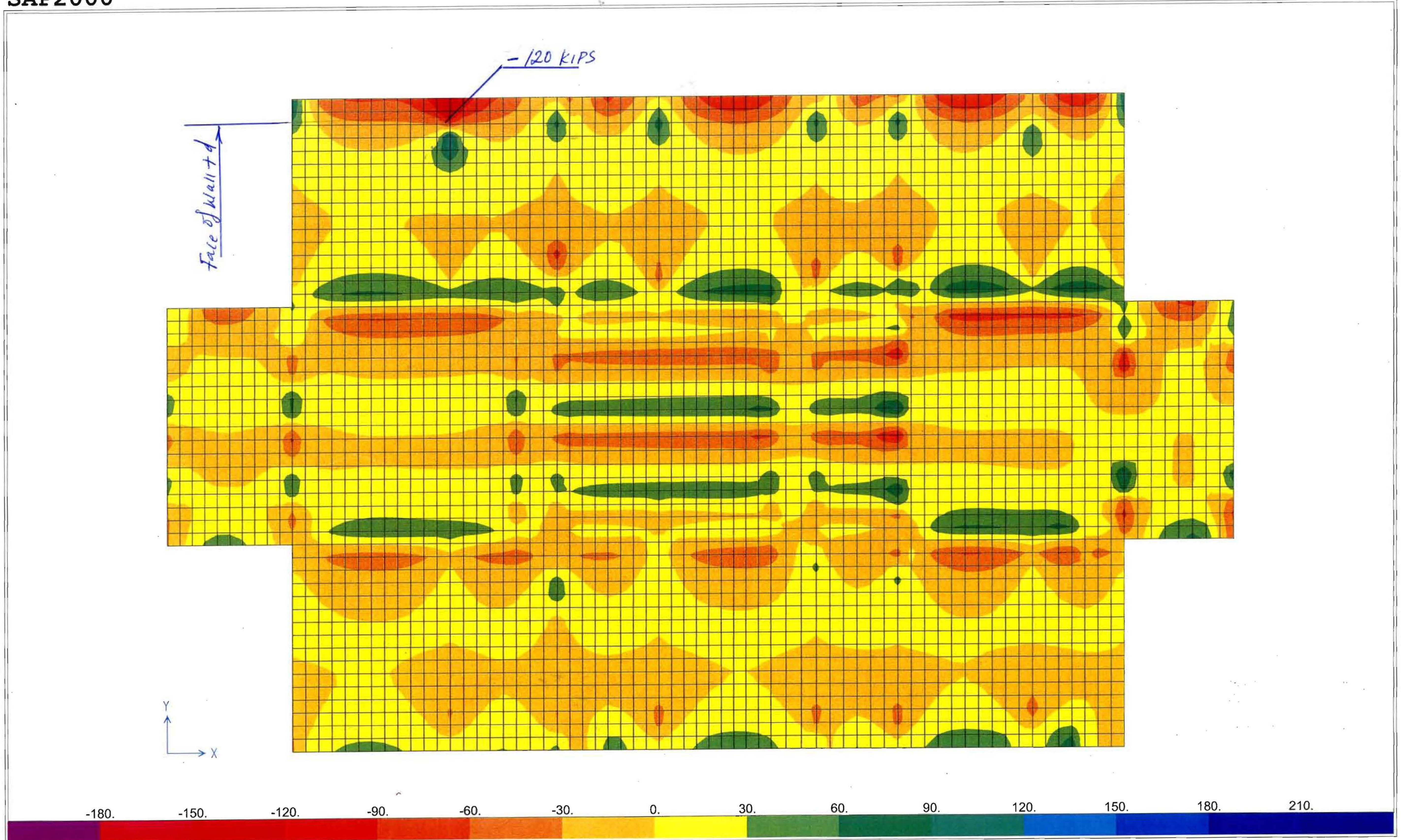
3/7/07 16:54:45



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M12 Diagram (DL+0.4HX+0.4HY-VZ) - Kip, ft, F Units



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant V23 Diagram (DL+0.4HX+0.4HY-VZ) - Kip, ft, F Units



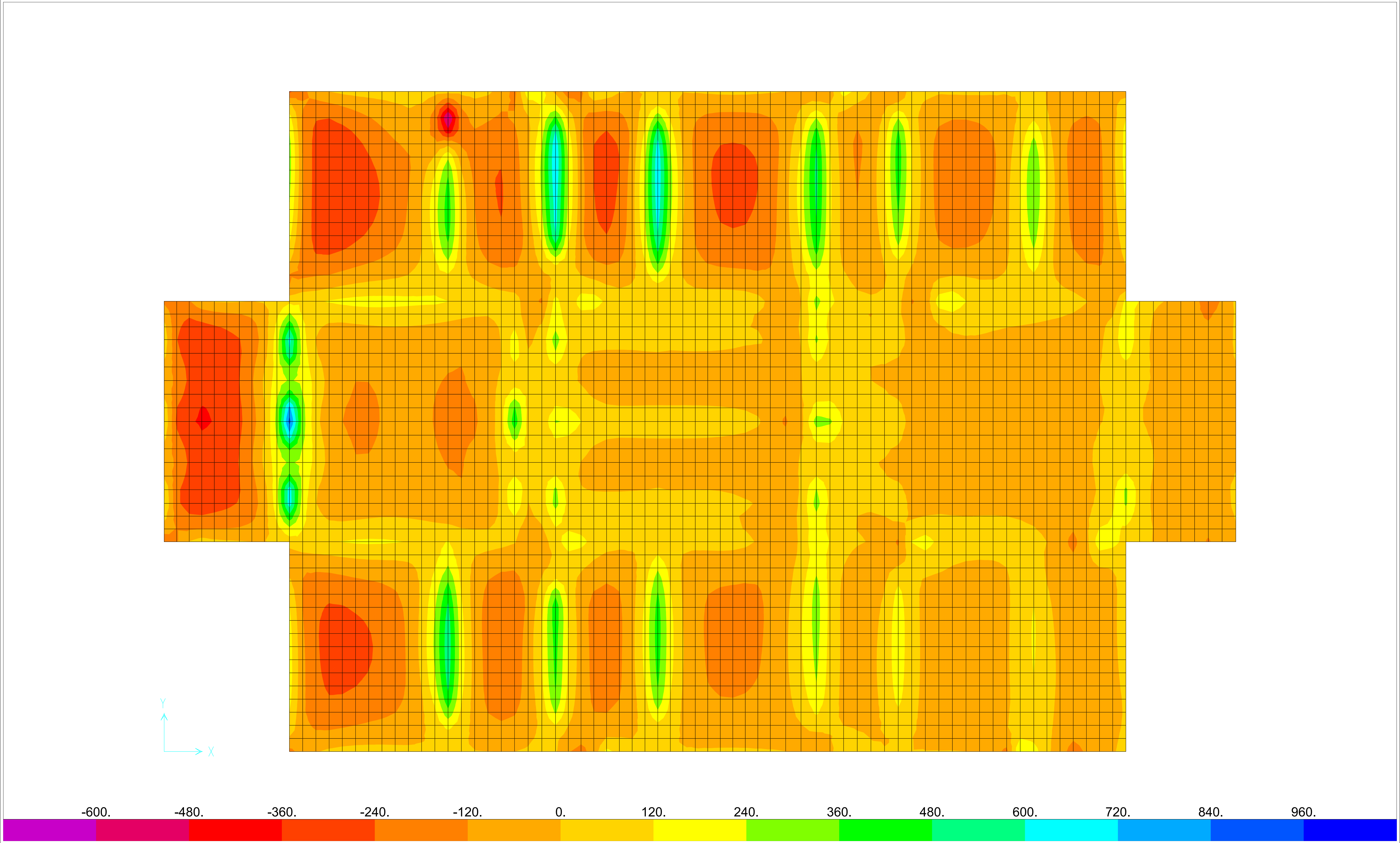
– 120 KIPS

Face of wall + d

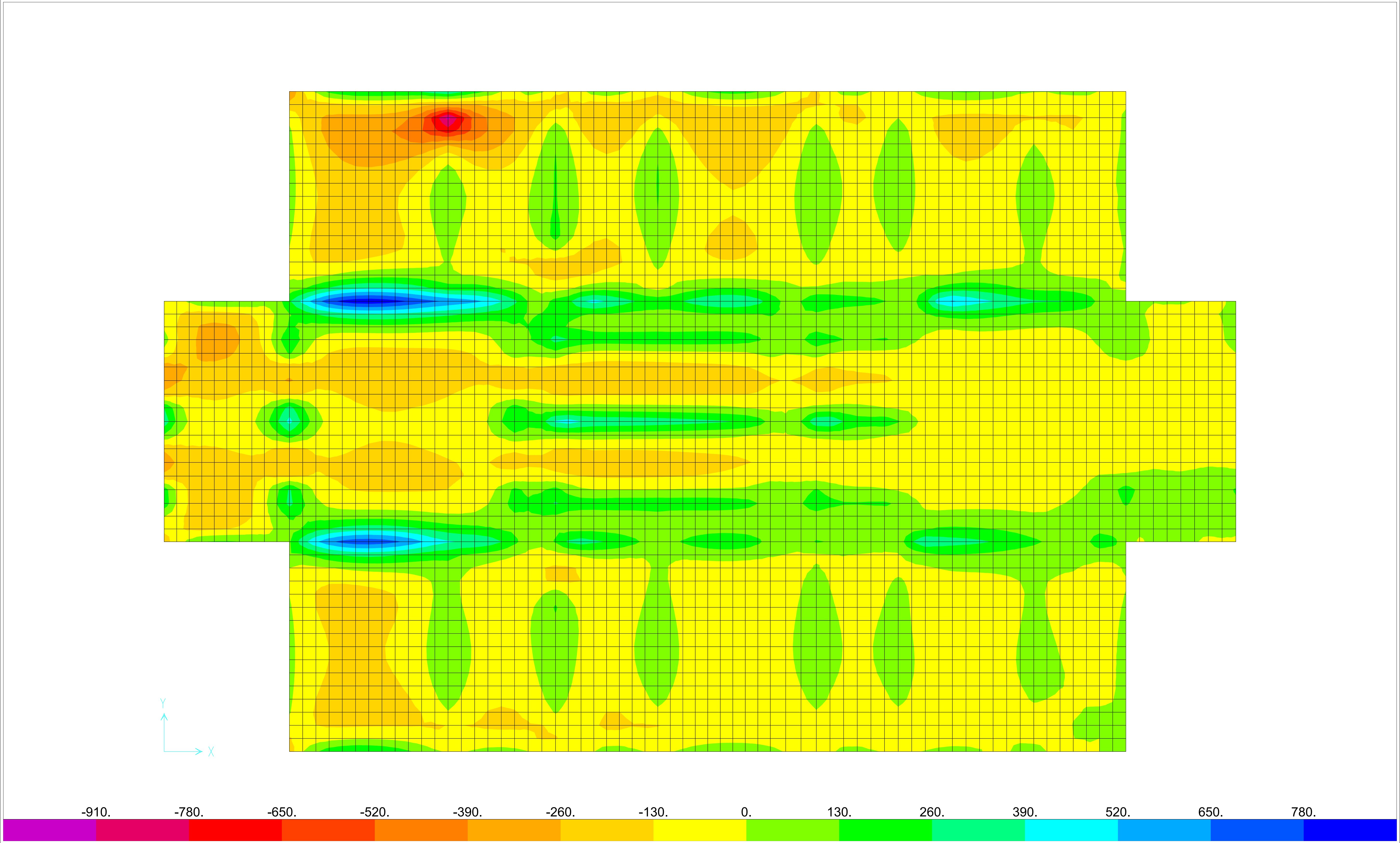
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant VMAX Diagram (DL+0.4HX+0.4HY-VZ) - Kip, ft, F Units

SAP2000

3/7/07 17:16:25



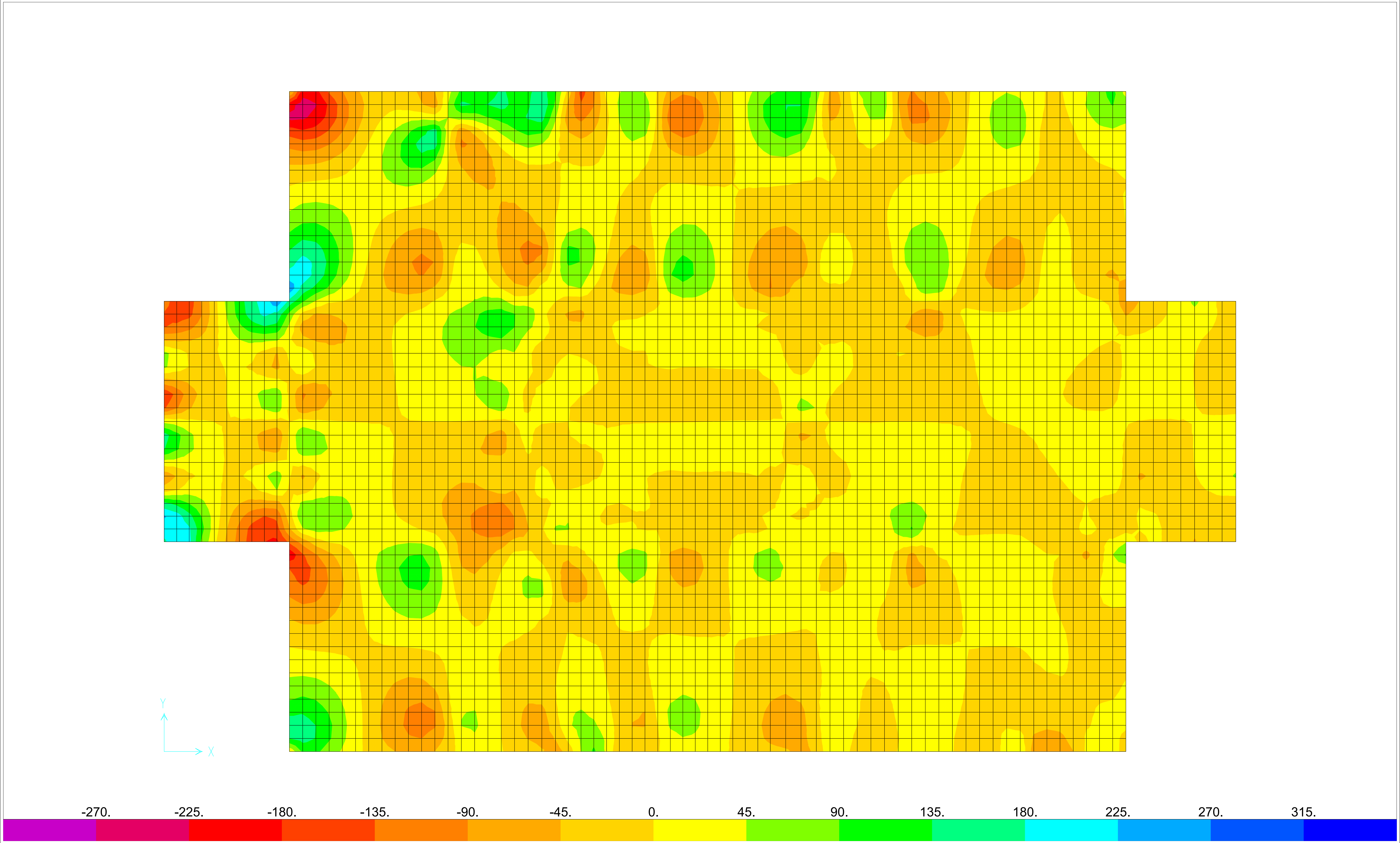
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M11 Diagram (DL-HX+0.4HY-0.4VZ) - Kip, ft, F Units



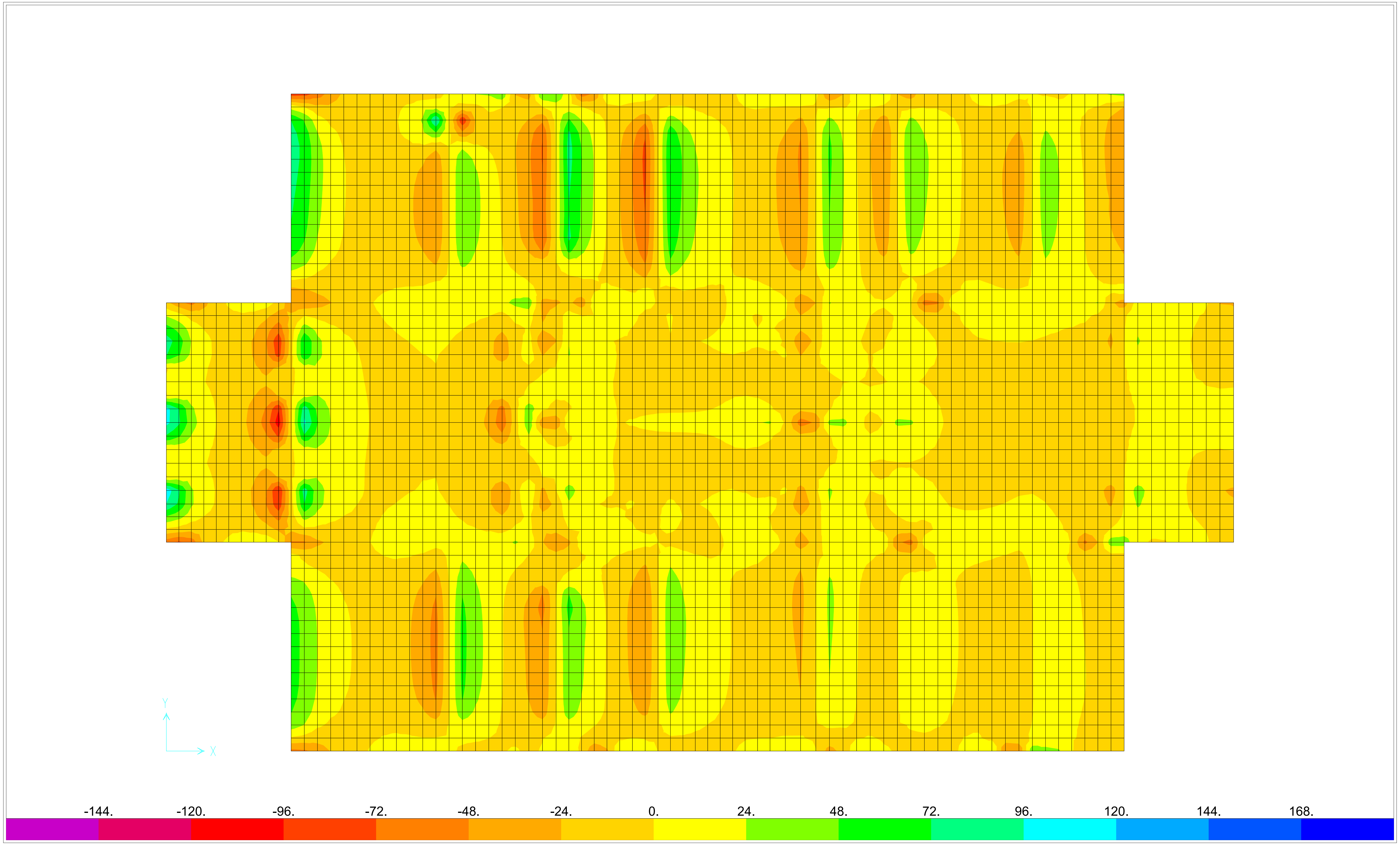
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M22 Diagram (DL-HX+0.4HY-0.4VZ) - Kip, ft, F Units

SAP2000

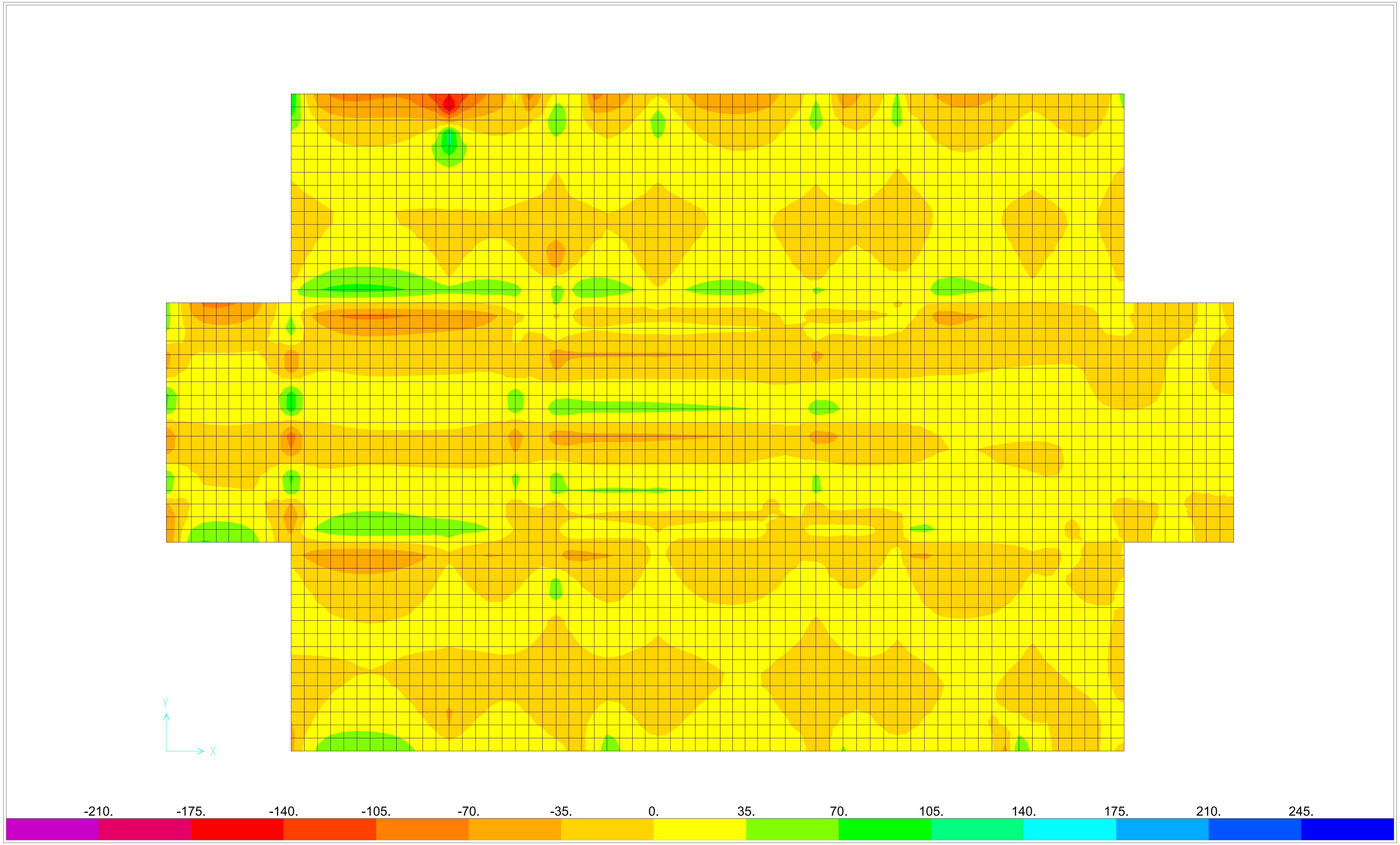
3/7/07 17:24:04



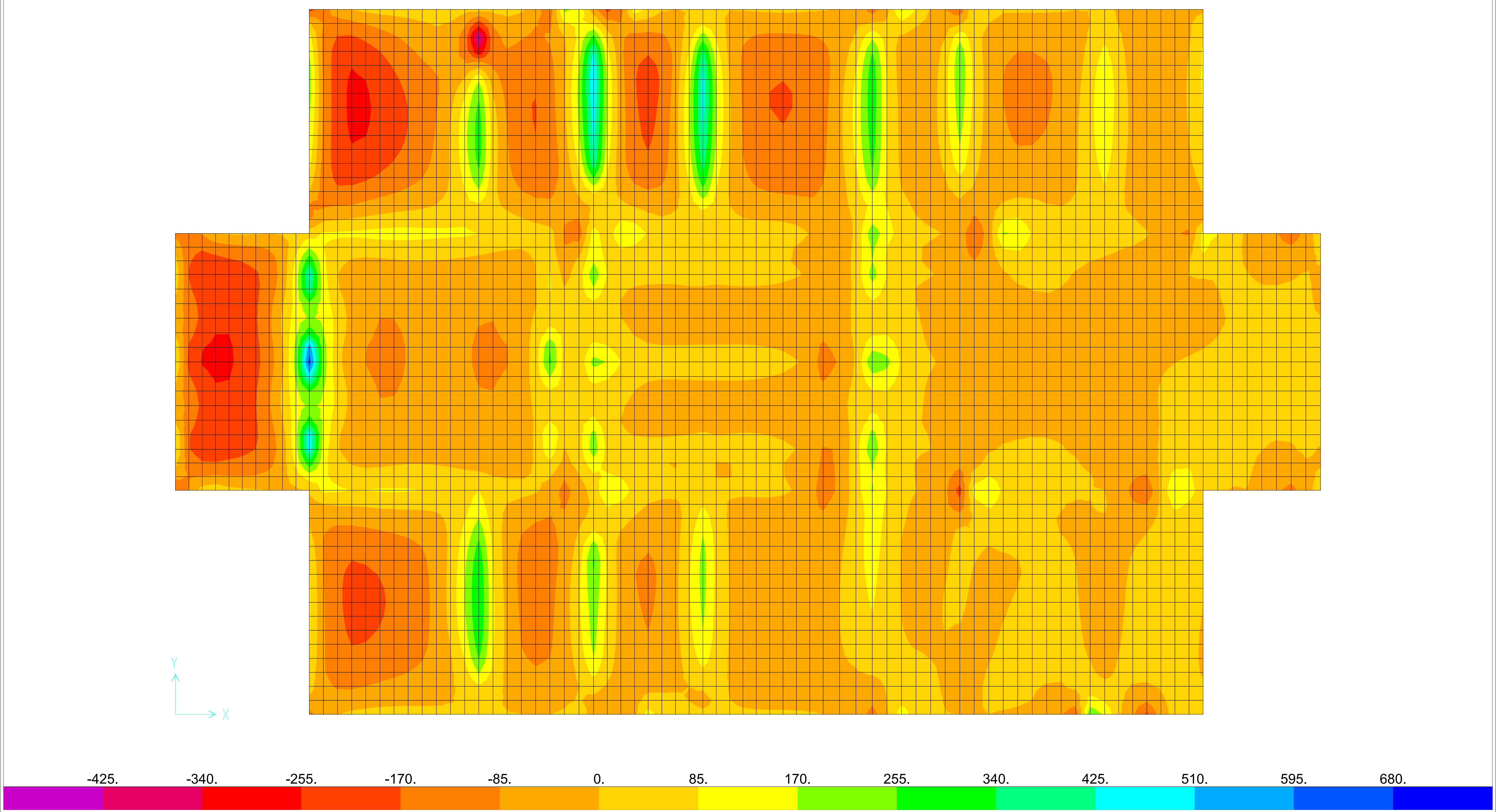
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M12 Diagram (DL-HX+0.4HY-0.4VZ) - Kip, ft, F Units



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant V23 Diagram (DL-HX+0.4HY-0.4VZ) - Kip, ft, F Units



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant VMAX Diagram (DL-HX+0.4HY-0.4VZ) - Kip, ft, F Units



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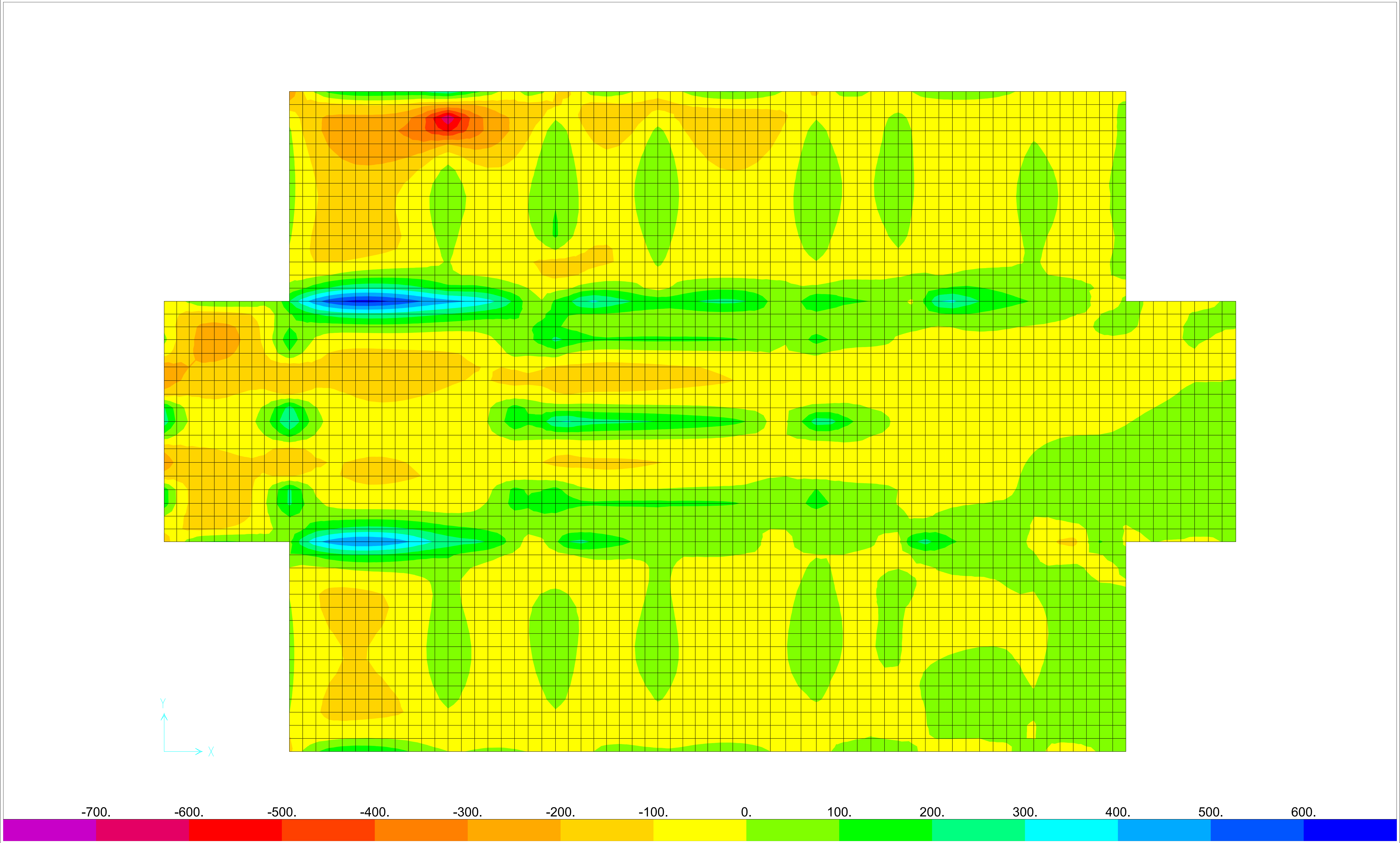
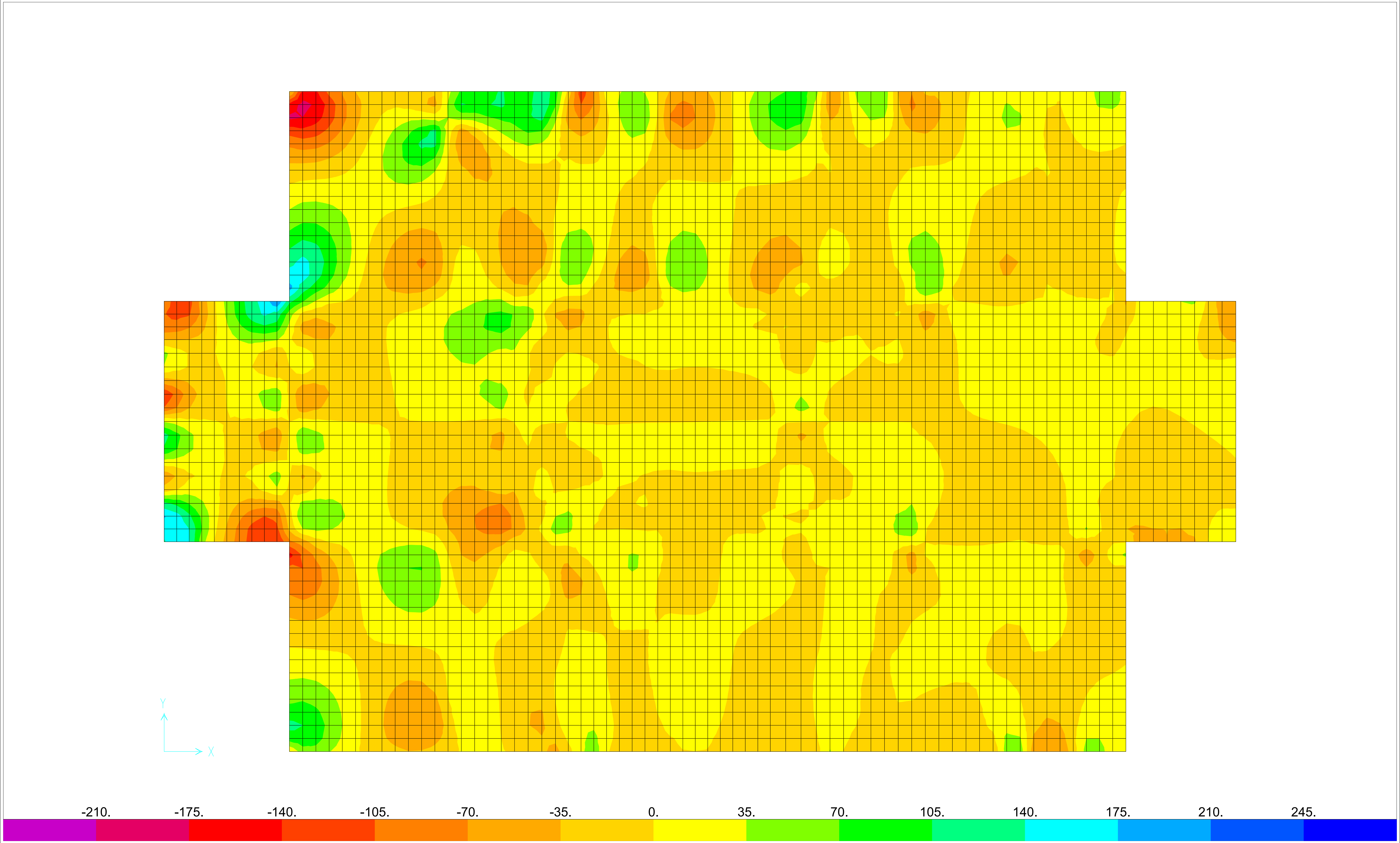
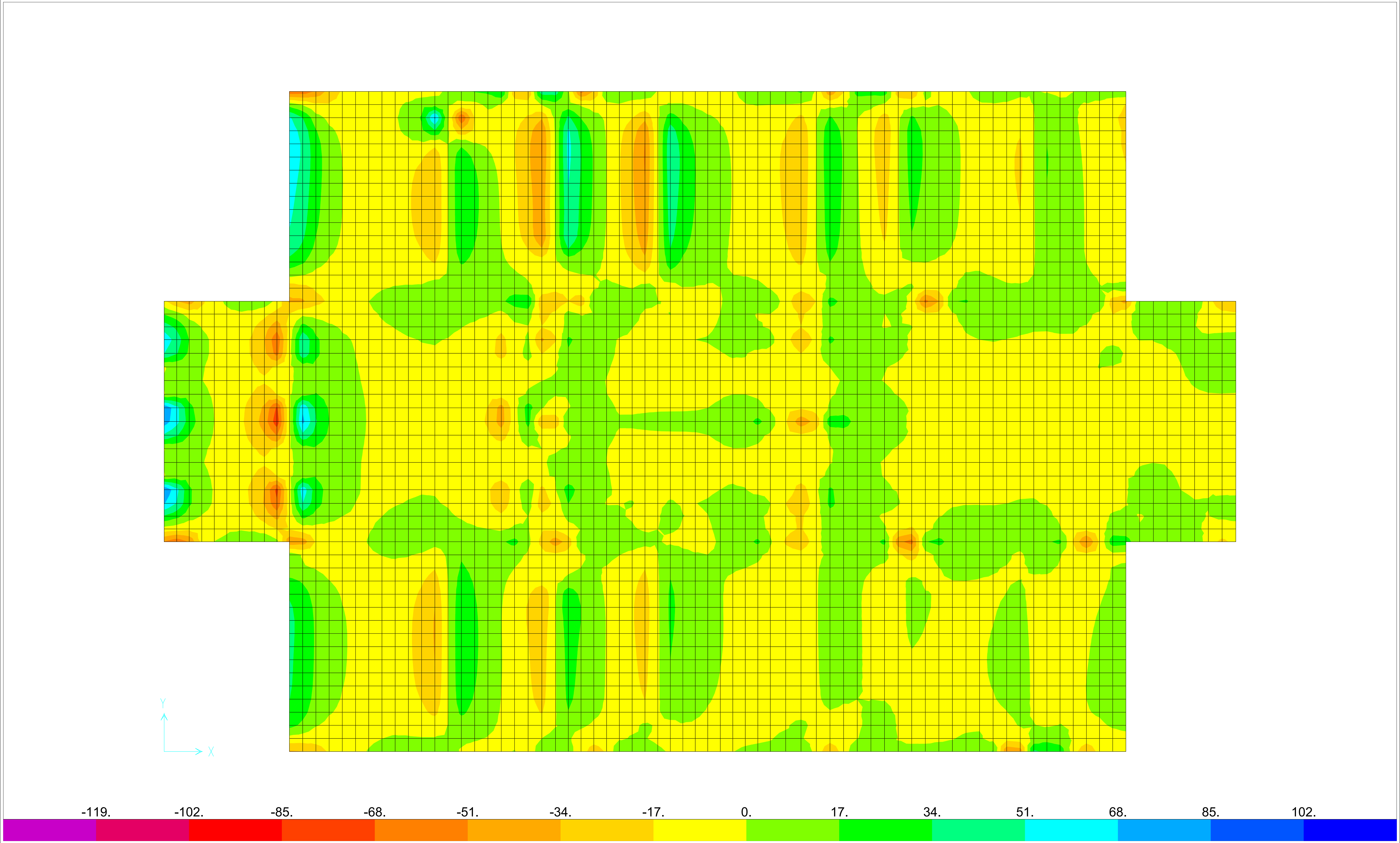


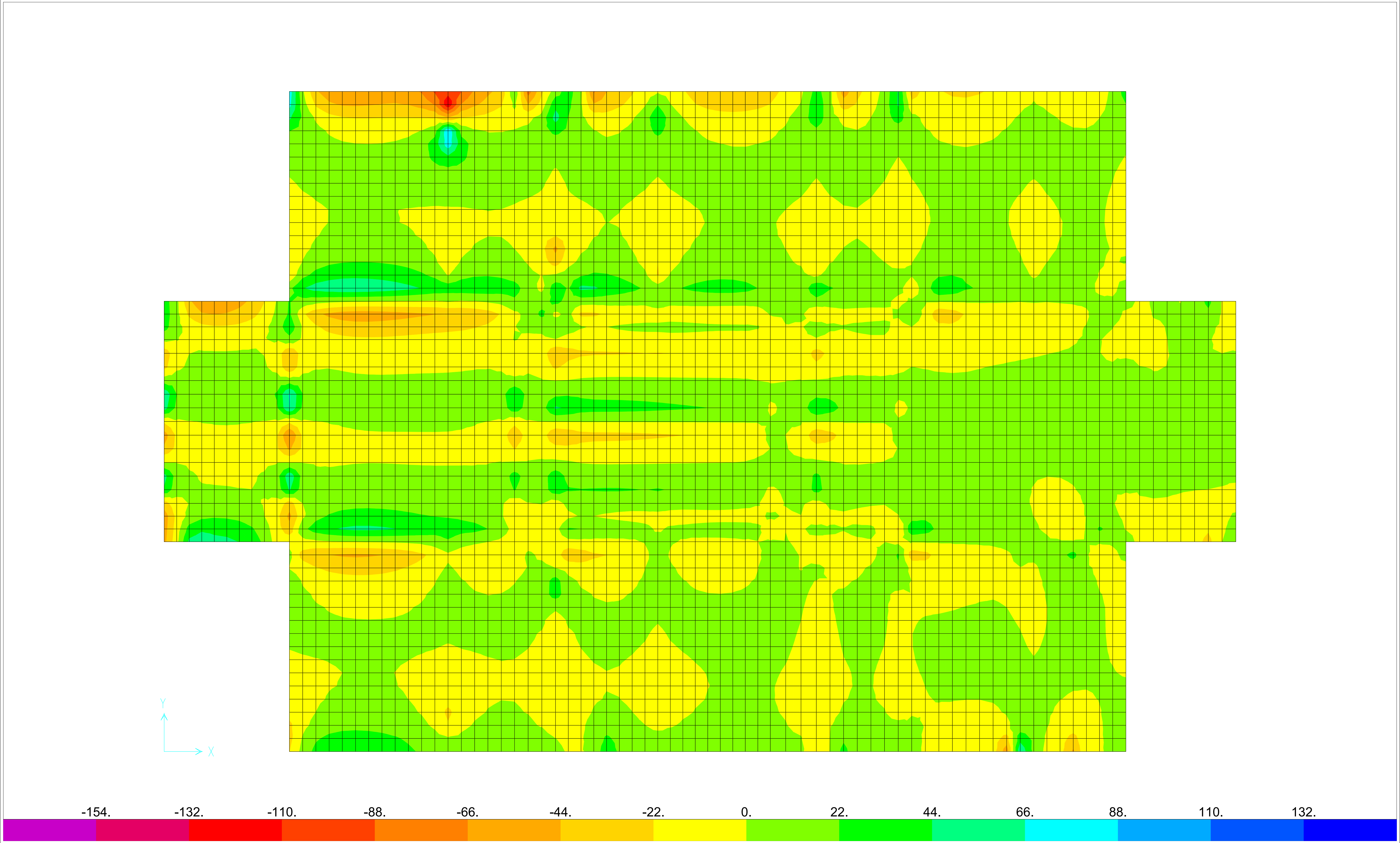
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M22 Diagram (DL-HX+.4HY+0.4VZ) - Kip, ft, F Units



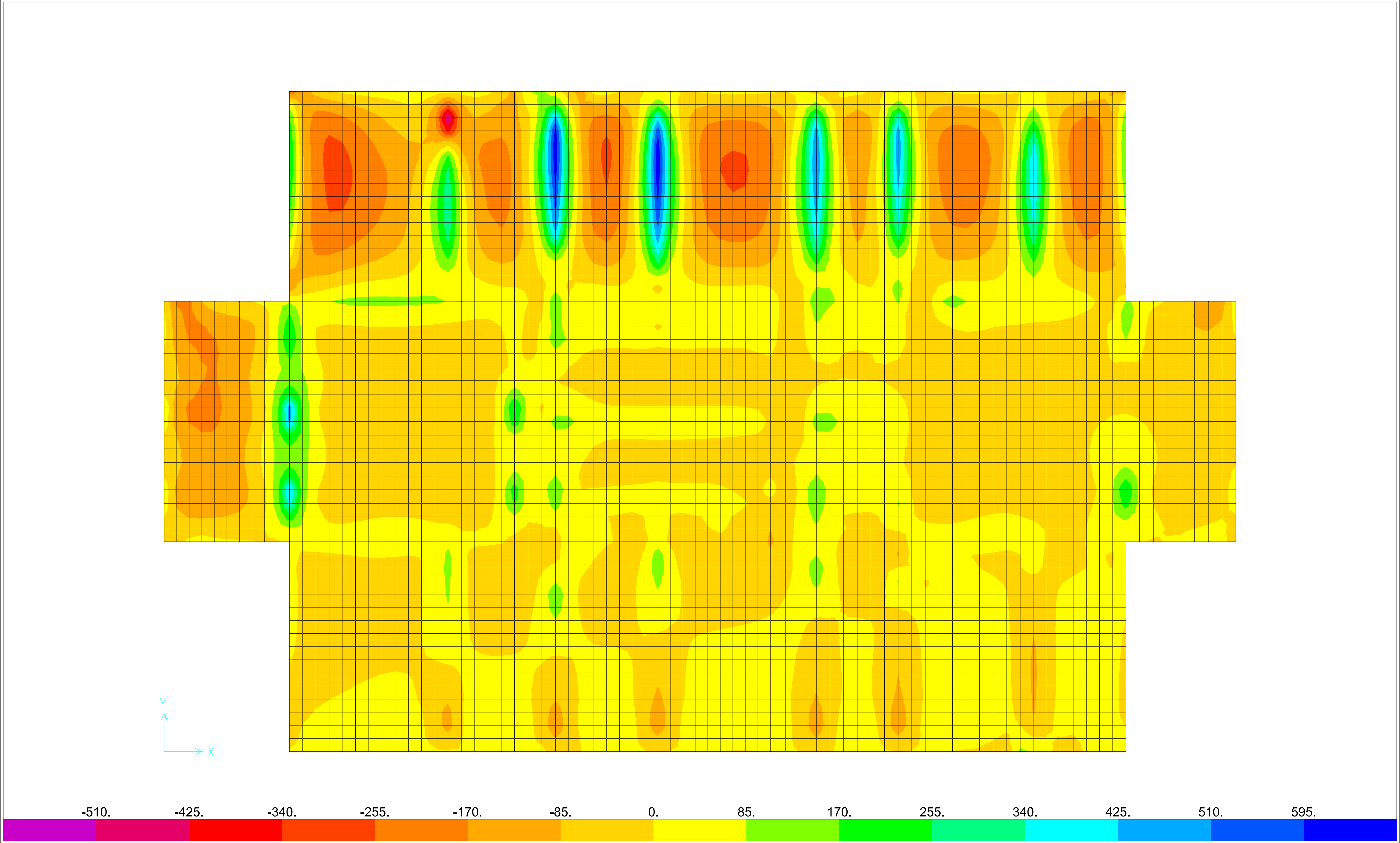
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M12 Diagram (DL-HX+.4HY+0.4VZ) - Kip, ft, F Units



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant V23 Diagram (DL-HX+.4HY+0.4VZ) - Kip, ft, F Units



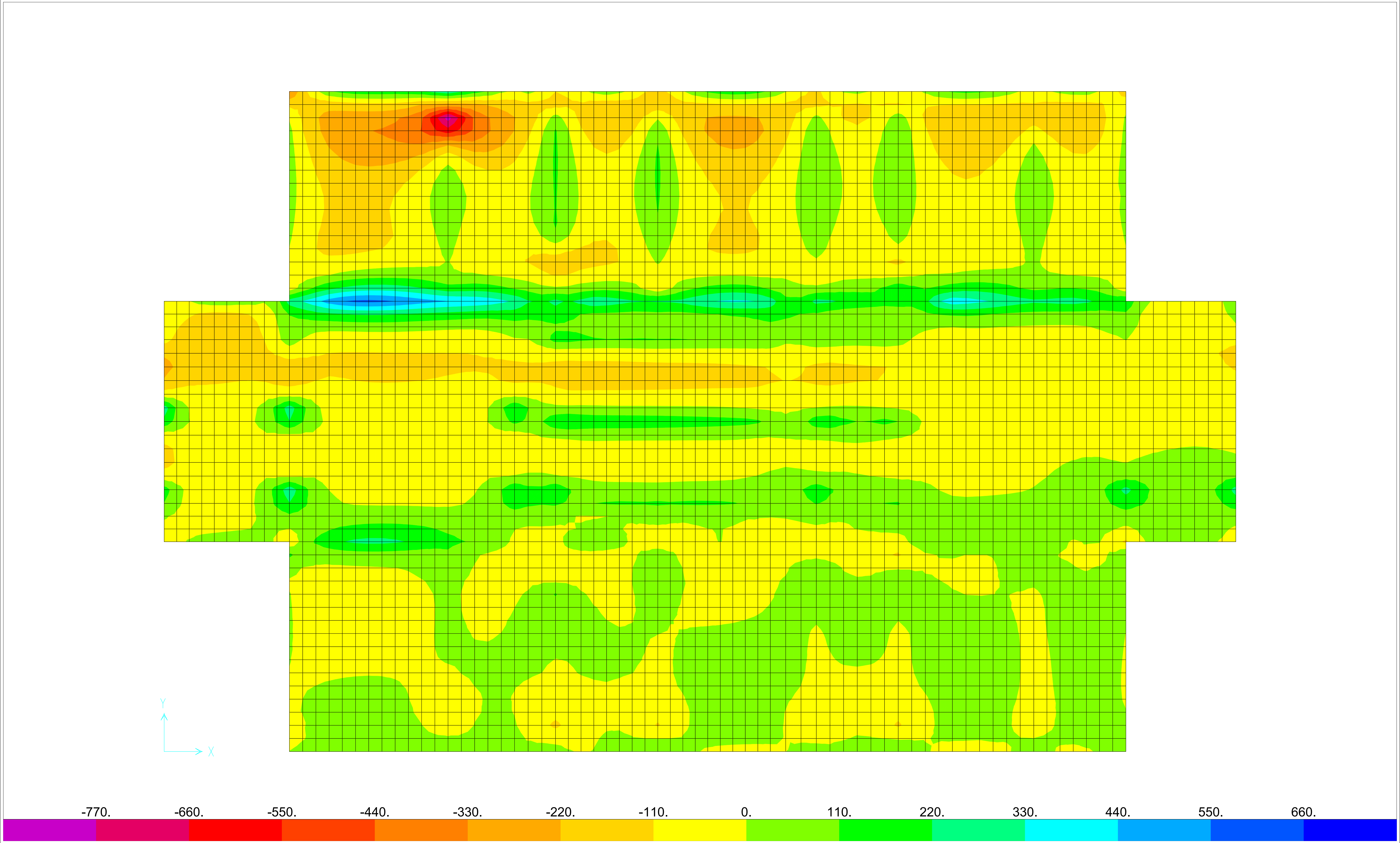
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant VMAX Diagram (DL-HX+.4HY+0.4VZ) - Kip, ft, F Units



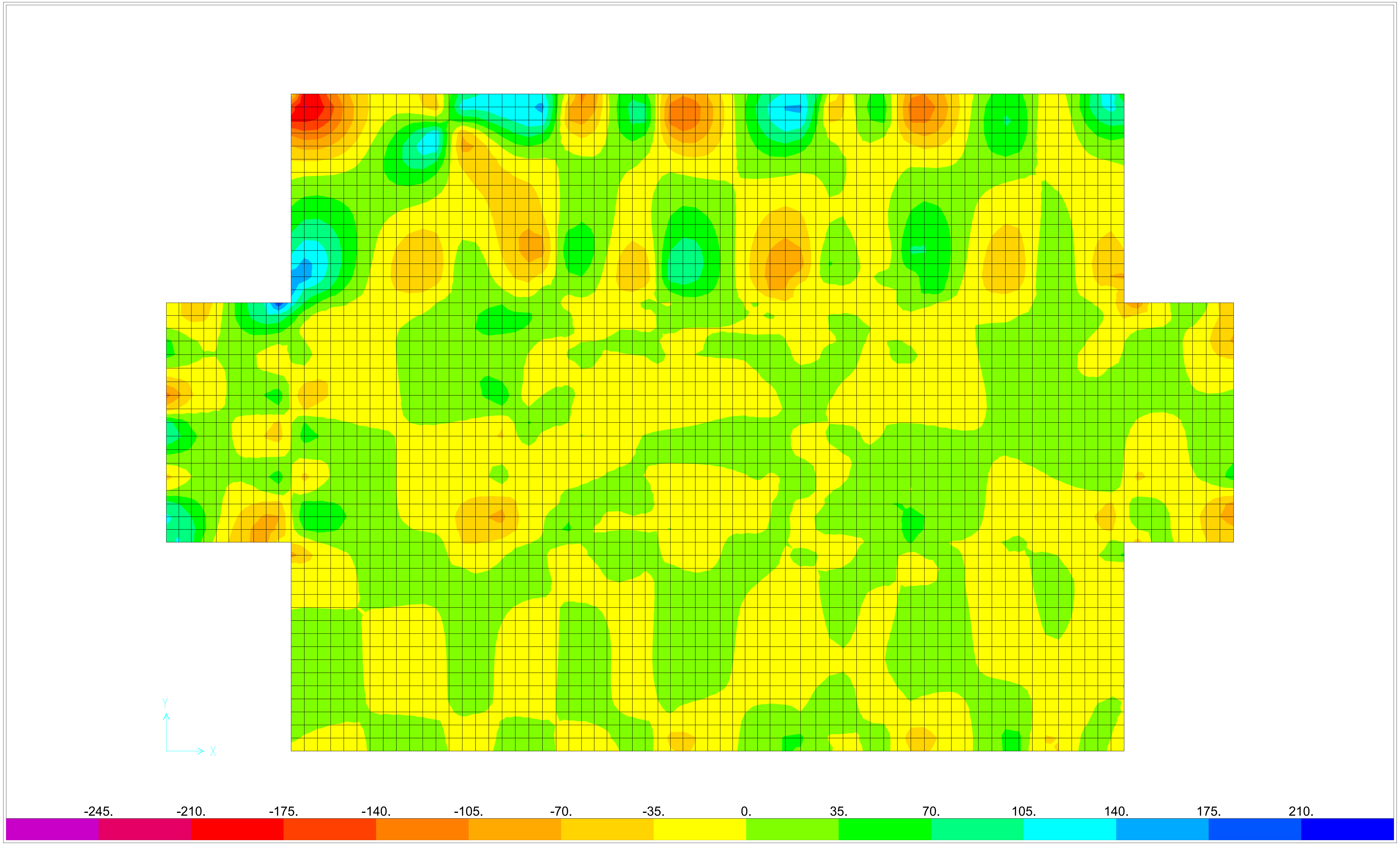
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M11 Diagram (DL-0.4HX+HY+0.4VZ) - Kip, ft, F Units

SAP2000

3/7/07 18:03:21



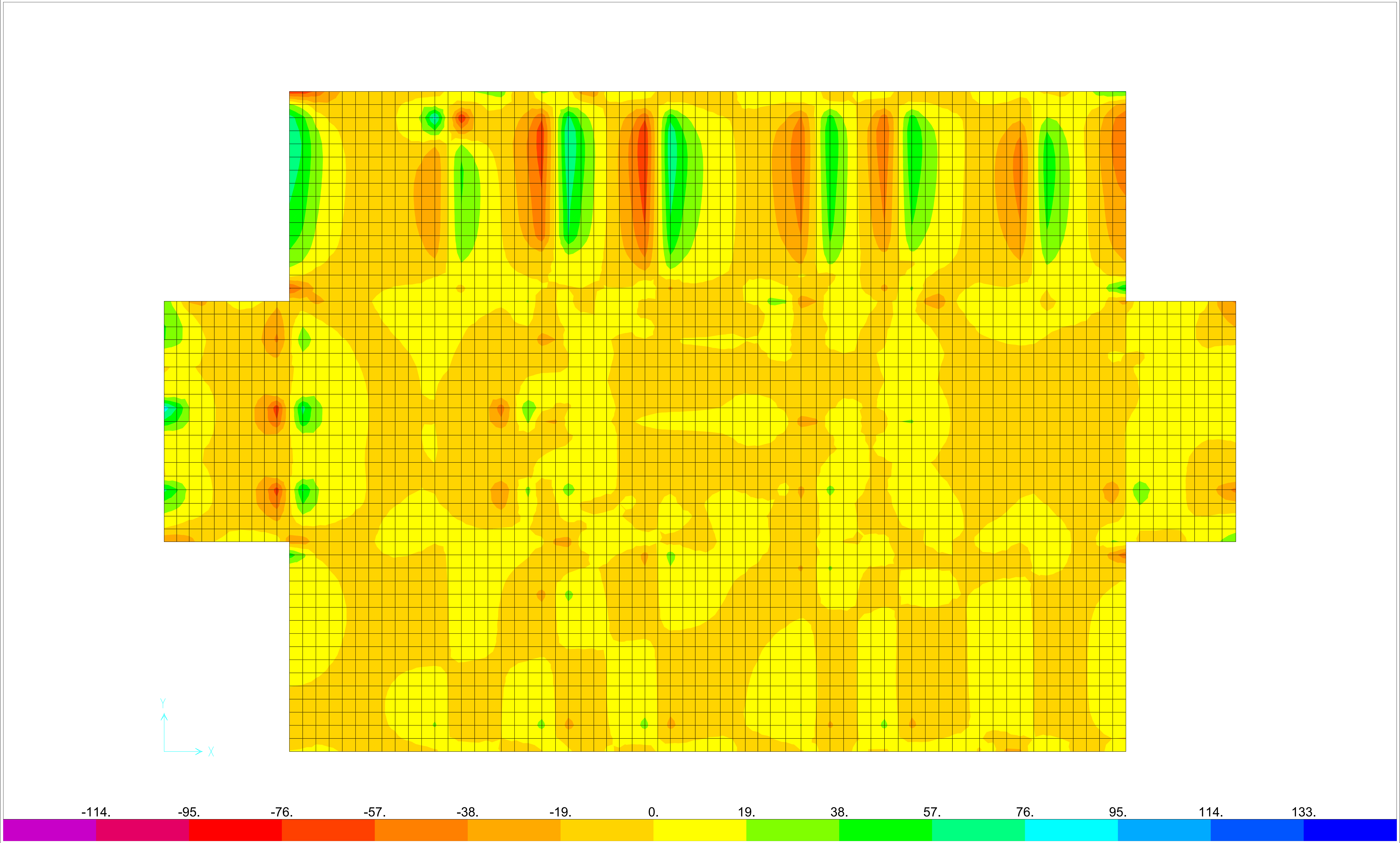
SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M22 Diagram (DL-0.4HX+HY+0.4VZ) - Kip, ft, F Units



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant M12 Diagram (DL-0.4HX+HY+0.4VZ) - Kip, ft, F Units

SAP2000

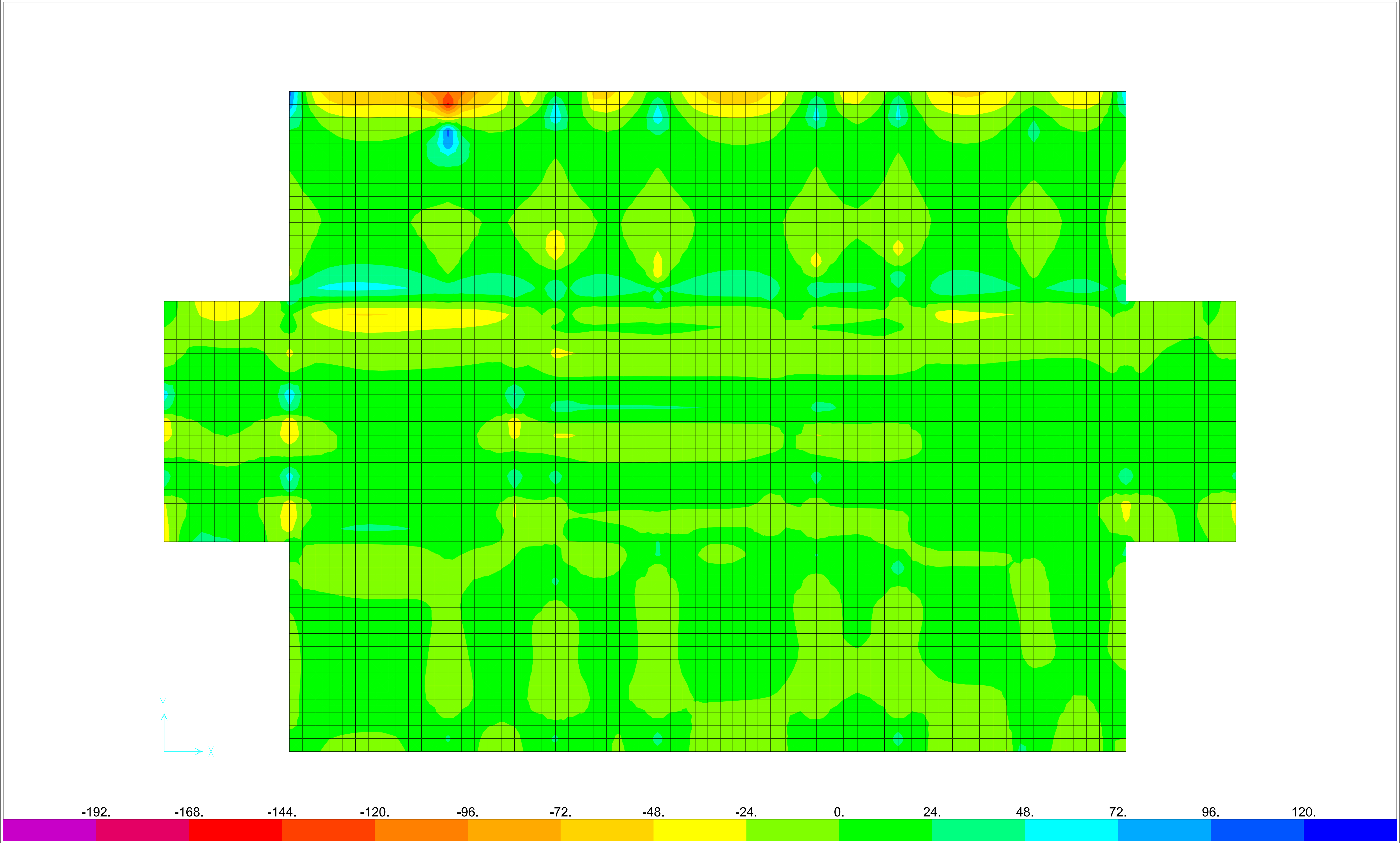
3/7/07 18:09:11



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant V23 Diagram (DL-0.4HX+HY+0.4VZ) - Kip, ft, F Units

SAP2000

3/7/07 18:11:47



SAP2000 v9.1.4 - File:baseslab spring 2jt - Resultant VMAX Diagram (DL-0.4HX+HY+0.4VZ) - Kip, ft, F Units