ArevaEPRDCPEm Resource

From: BRYAN Martin (EXTERNAL AREVA) [Martin.Bryan.ext@areva.com]
Sent: Monday, November 15, 2010 4:32 PM
To: Tesfaye, Getachew
Cc: DELANO Karen (AREVA); ROMINE Judy (AREVA); BENNETT Kathy (AREVA); CORNELL Veronica (EXTERNAL AREVA); Miernicki, Michael
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 5, Part 1 of 2
Attachments: RAI 370 Supplement 5 Response US EPR DC - INTERIM_(part 1 of 2).pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38.

The schedule for Supplemental INTERIM and FINAL responses to Question 03.07.02-64 is added to provide additional information on the potential for seismic interaction between the Nuclear Auxiliary Building and Seismic Category I structures. The attached file, “RAI 370 Supplement5 Response US EPR DC-INTERIM.pdf” provides a technically correct and complete INTERIM response to Question 03.07.02-64. Because of the file size, this response is being transmitted in two parts. The schedule for the remaining question is unchanged.

Appended to"part 2 of 2" of this file (transmitted separately) is the affected page of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which supports the response to RAI 370 Supplement 5.

The following table indicates the respective pages in the response document, “RAI 370 Supplement 5 Response US EPR DC-INTERIM,” that contain the AREVA NP response to the subject question.

Question #	Start Page	End Page
RAI 370 - 03.07.02-64	2	19

The schedule for the technically correct and complete response to the remaining question is provided below.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.02-64	November 15, 2010 (Actual)	February 15, 2011
RAI 370 - 03.07.01-27	NA	May 18, 2011

Sincerely,

Martin (Marty) C. Bryan

U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Thursday, September 02, 2010 5:41 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB); Miernicki, Michael
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 4

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65.

The attached file, "RAI 370 Supplement 4 Response US EPR DC.pdf" provides a technically correct and complete response to Question 03.07.03-38, as committed. The schedule for the remaining question is unchanged.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 370 Supplement 4.

The following table indicates the respective pages in the response document, "RAI 370 Supplement 4 Response US EPR DC," that contain the AREVA NP response to the subject question.

Question #	Start Page	End Page
RAI 370 - 03.07.03-38	2	3

The schedule for the technically correct and complete response to the remaining question is provided below.

Question #	Response Date
RAI 370-03.07.01-27	May 18, 2011

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
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Martin.Bryan.ext@areva.com

From: BRYAN Martin (EXT)
Sent: Tuesday, August 10, 2010 6:44 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 3

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions.

Because the response file contains security-related sensitive information that should be withheld from public disclosure in accordance with 10 CFR 2.390, a public version is provided with the security-related sensitive information redacted. This email and attached file do not contain any security-related information. An unredacted security-related version is provided under separate email.

The attached file, "RAI 370 Supplement 3 Response US EPR DC-PUBLIC.pdf" provides technically correct and complete responses to Questions 03.07.02-64 and 03.07.02-65, as committed.

The schedule for Question 03.07.03-38 is being revised to allow additional time for AREVA NP to address NRC comments. The schedule for Question 03.07.01-27 question is unchanged.

The following table indicates the respective pages in the response document, "RAI 370 Supplement 3 Response US EPR DC -PUBLIC," that contain the AREVA NP response to the subject questions.

Question #	Start Page	End Page
RAI 370 - 03.07.02-64	2	3
RAI 370 - 03.07.02-65	4	7

The revised schedule for the technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 370-03.07.01-27	May 18, 2011
RAI 370-03.07.03-38	September 2, 2010

Sincerely,

Martin (Marty) C. Bryan
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AREVA NP Inc.
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Martin.Bryan.ext@areva.com

From: BRYAN Martin (EXT)
Sent: Thursday, June 24, 2010 12:31 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC);

CORNELL Veronica (EXT); VAN NOY Mark (EXT); RYAN Tom (AREVA NP INC); GARDNER George Darrell (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 2

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 to the response on June 8, 2010, to provide a schedule for the remaining 4 questions, which were affected by the work underway to address NRC comments from the April 26, 2010, audit.

Based upon the civil/structural re-planning activities and revised RAI response schedule presented to the NRC during the June 9, 2010, Public Meeting, and to allow time to interact with the NRC on the responses, the schedule has been changed.

The revised schedule for the technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 370-03.07.01-27	May 18, 2011
RAI 370-03.07.02-64	August 10, 2010
RAI 370-03.07.02-65	August 10, 2010
RAI 370-03.07.03-38	August 10, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
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From: BRYAN Martin (EXT)
Sent: Tuesday, June 08, 2010 3:57 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); VAN NOY Mark (EXT); CORNELL Veronica (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 1

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010.

The schedule for question 03.07.01-27 is not being changed by this supplement. The schedule for Questions 03.07.02-64, 03.07.02-65 and 03.07.03-38 has been changed. The dates for the 4 remaining questions will be evaluated and revised, as necessary, based on the information that will be presented at the June 9, 2010, public meeting and subsequent NRC feedback.

Question #	Response Date
RAI 370-03.07.01-27	August 3, 2010
RAI 370-03.07.02-64	July 8, 2010
RAI 370-03.07.02-65	July 8, 2010
RAI 370-03.07.03-38	July 8, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
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Martin.Bryan.ext@areva.com

From: BRYAN Martin (EXT)
Sent: Monday, April 26, 2010 1:18 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); RYAN Tom (AREVA NP INC); VAN NOY Mark (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 370 Response US EPR DC.pdf" provides technically correct and complete responses to 1 of the 5 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 370 Question 03.07.03-39.

The following table indicates the respective pages in the response document, "RAI 370 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 370 - 03.07.01-27	2	2
RAI 370 -03.07.02-64	3	3
RAI 370 -03.07.02-65	4	5
RAI 370 -03.07.03-38	6	6
RAI 370 -03.07.03-39	7	8

A complete answer is not provided for 4 of the 5 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 370 - 03.07.01-27	August 3, 2010
RAI 370 -03.07.02-64	June 10, 2010
RAI 370 -03.07.02-65	June 10, 2010
RAI 370 -03.07.03-38	June 10, 2010

Sincerely,

Martin (Marty) C. Bryan
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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Thursday, March 25, 2010 2:00 PM
To: ZZ-DL-A-USEPR-DL
Cc: Chakravorty, Manas; Hawkins, Kimberly; Miernicki, Michael; Patel, Jay; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 370 (4292,4272,4275), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on February 18, 2010, and on March 24, 2010, you informed us that the RAI is clear and no further clarification is needed. As a result, no change is made to the draft RAI. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 2257

Mail Envelope Properties (BC417D9255991046A37DD56CF597DB710847EF51)

Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 5, Part 1 of 2
Sent Date: 11/15/2010 4:31:36 PM
Received Date: 11/15/2010 4:31:58 PM
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"CORNELL Veronica (EXTERNAL AREVA)" <Veronica.Cornell.ext@areva.com>
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Files	**Size**	**Date & Time**
MESSAGE	12112	11/15/2010 4:31:58 PM
RAI 370 Supplement 5 Response US EPR DC - INTERIM_(part 1 of 2).pdf	4415526	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Response to

Request for Additional Information No. 370, Supplement 5

3/25/2010

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.07.01 - Seismic Design Parameters
SRP Section: 03.07.02 - Seismic System Analysis
SRP Section: 03.07.03 - Seismic Subsystem Analysis

Application Section: 03.07

QUESTIONS for Structural Engineering Branch 2 (ESBWR/ABWR Projects) (SEB2)

Question 03.07.02-64:

Follow Up to RAI 248, Question 03.07.02-53:

The applicant has proposed utilizing a lateral-force resisting system (LFRS) with a controlled collapse zone as the design basis for the NAB under an SSE event. In order for the staff to evaluate the acceptability of this design feature and whether it meets Acceptance Criteria 8 of SRP 3.7.2, the staff is requesting the following additional information:

1. The design codes applicable to the LFRS and the controlled collapse zone.
2. A detailed description of the LRFS and the controlled collapse zone.
3. Figures that depict the physical dimensions of the LFRS and the collapse zone of the NAB.
4. A description of the loads and the loading combinations applicable to each portion of the building.
5. A description of the methods used to control the collapse of the non-seismic portion of the NAB in such a way that the collapse zone does not impact a Category I structure or reduce the structural integrity of the LFRS.
6. A description of the seismic analysis method including assumptions, description of the model, description and point of application of the seismic input, and a description of how the seismic loads are determined and applied to the NAB structure.
7. A description of the method used to calculate the seismic displacement of the NAB from which it is concluded that the gap between the NAB and Safeguard building (SB4) and the gap between the NAB and Fuel Building is sufficient to prevent an interaction with these adjacent Category I structures.
8. The results of an analysis that demonstrates that the NAB does not slide or overturn into adjacent Category I structures.
9. The interaction between the LFRS and the controlled collapse zone including the collapse or impact loads that are expected to be applied to the LFRS by the collapse zone.
10. The interaction between the NAB and the RWB including a detailed description of how the NAB prevents an indirect transfer of load from the RWB to Seismic Category I structures. Include in your response a description of the loads that will be transmitted to the NAB by a failure of the RWB and describe how these loads will be accounted for in the design of the LFRS.
11. Examples of a LFRS and collapse zone design concept used in the seismic design of structures that have been built especially structures at nuclear power plants.

Response to Question 03.07.02-64:

AREVA NP submitted responses to Items 1 through 6 and 9 through 11 in RAI 370 Supplement 3, dated August 10, 2010. The following provides responses to RAI 370 Items 7 and 8 regarding the methodology for Nuclear Auxiliary Building (NAB) stability analysis, including the potential for the NAB to interact with Seismic Category I structures.

The methodology for determining NAB sliding and uplift upper bounds is based on maximum energy participation/flow principles. The methodology for determining the minimum bearing area and corresponding maximum bearing pressure is based on a closed-form solution for an eccentrically loaded rectangular basemat.

The NAB-structure layout and mass parameters are as follows:

- Basemat dimensions:

  South-north: **a = 106'-2"** (32.35 m)

  West-east: **b = 120'-9"** (36.8 m).

  Total Weight = 104,010 kips (47,178 long tons) with center mass location of h ≈ 69'-3" (21.1m) above the basemat bottom.

Initial conditions to initiate sliding or uplift in quasi-static conditions for a rigid supported body are:

- Sliding initiation:

$$\frac{H_s}{(W_G - W_B) \pm V_S} \geq \mu$$

  Where:

  H_S – seismic horizontal component

  W_G – gravity weight force

  W_B – buoyancy force

  V_S – seismic vertical component

  μ – friction coefficient

- Uplift initiation:

$$\frac{H_s}{(W_G - W_B) \pm V_S} \geq f_{Uplift} = \tan(\alpha) = \left(\frac{a}{2h} = 0.77; \frac{b}{2h} = 0.87 \right)$$

  Where:

  α – instability angle

  f_{Uplift} – uplift factor

For uplift, the "uplift-factor" (***f***$_{Uplift}$) is random for the dynamic response of the deformable body supported by deformable soil because of the fluctuation in the vertical location of the resultant horizontal force. The friction-coefficient is assumed as a constant.

The NAB stability analysis is based on the following models, principles, and assumptions:

1. Time-history analyses are performed in SAP 2000 for a new 3D Finite Element Model (FEM) of the NAB superstructure and basemat supported by compressive friction/sliding soil springs. The seismic synthetic time-history acceleration inputs are applied to the NAB model and are generated from the soil-structure interaction (SSI) analysis of the embedded Nuclear Island (NI) FEM model in MTR/SASSI. The U.S. EPR Nuclear Island embedded model includes an embedded representation of the NAB stick model. The NAB 3D FEM structural model consists of shell elements for walls/slabs and solid elements for the basemat, as shown in Figure 03.07.02-64-1.
2. Two separate time-history analyses are performed for each soil case to determine the NAB upper-bound values for both sliding and uplift. A third time-history analysis is performed to determine a best estimate of maximum bearing pressure under the NAB when combined with sliding and uplift. The analysis is based on the "Virtual Work = Energy" principle. Passive soil pressure is not considered as resistance to the building movements in the time-history analyses. Figures 03.07.02-64-2 (a), (b), and (c) show the response spectra and time-history inputs in the x, y, and z directions, respectively. The NAB stability methodology is demonstrated in Attachment A for the Hard-Soil Case 5a. Summaries of the three time-history analyses performed for the NAB can be found in the subsections titled "Upper-Bound Sliding Analysis"; "Upper-Bound Uplift Analysis"; and "Best Estimate for Bearing Pressure, Sliding, and Uplift Analysis." The preliminary results shown in Attachment A demonstrate the application of the methodology. Time-history analysis final results will be provided in the final response.
   - Upper-Bound Sliding Analysis
     - Analysis includes 0.0 percent material/modal/soil damping and the lower-bound friction coefficient of μ = 0.5. The maximum input energy flowing into sliding hysteresis results in the upper-bound sliding. Figure 03.07.02-64-3 shows that up to 90 percent of the input energy is dissipated in sliding hysteresis energy. Figure 03.07.02-64-04 shows that the calculated upper bound for sliding, based on maximum energy participation principles, is 1.6 mm. The corresponding uplift is 0.8 mm, as shown in Figure 03.07.02-64-5.
   - Upper-Bound Uplift Analysis
     - Analysis includes 0.0 percent material/modal/soil damping and the upper-bound friction coefficient of μ = 1.0. The maximum input energy flowing into uplift potential energy results in an upper-bound maximum uplift. Figure 03.07.02-64-6 shows that the input energy transfers in almost equal proportions to potential, kinetic, and sliding hysteresis energy. Figure 03.07.02-64-7 shows that the calculated upper bound for uplift, based on maximum energy participation principles, is 1.2 mm. The corresponding sliding is negligible.
   - -Best Estimate for Bearing Pressure, Sliding, and Uplift Analysis
     - Analysis includes 7.0 percent material viscosity damping with no soil radiational damping and the lower-bound friction coefficient of μ = 0.5. The input energy flowing into participating energy types is demonstrated. The best-estimate values for sliding, uplift, and bearing pressure are calculated. The calculation of the maximum bearing pressure is based on time-history tracking of the resultant vertical reaction inside the basemat footprint. These values are compared to a 50 percent uplift bound for a rectangular foundation, and the corresponding bearing area is calculated. The best-

estimate maximum values in Figure 03.07.02-64-08 show that most of the input energy dissipates in material viscosity damping energy:

Corner Uplift:	0.28 mm (Figure 03.07.02-64-9)
Corner Sliding:	0.09 mm; i.e., negligible (Figure 03.07.02-64-10)
Corner Peak Bearing Pressure:	1.79 MPa (27.4 ksf) (Figure 03.07.02-64-11)
Minimum Bearing Area by Uplift:	~ 50 percent (Figure 03.07.02-64-11)

U.S. EPR FSAR, Tier 2, Section 3.7.2.8 will be revised to include a description of the NAB stability analysis.

FSAR Impact:

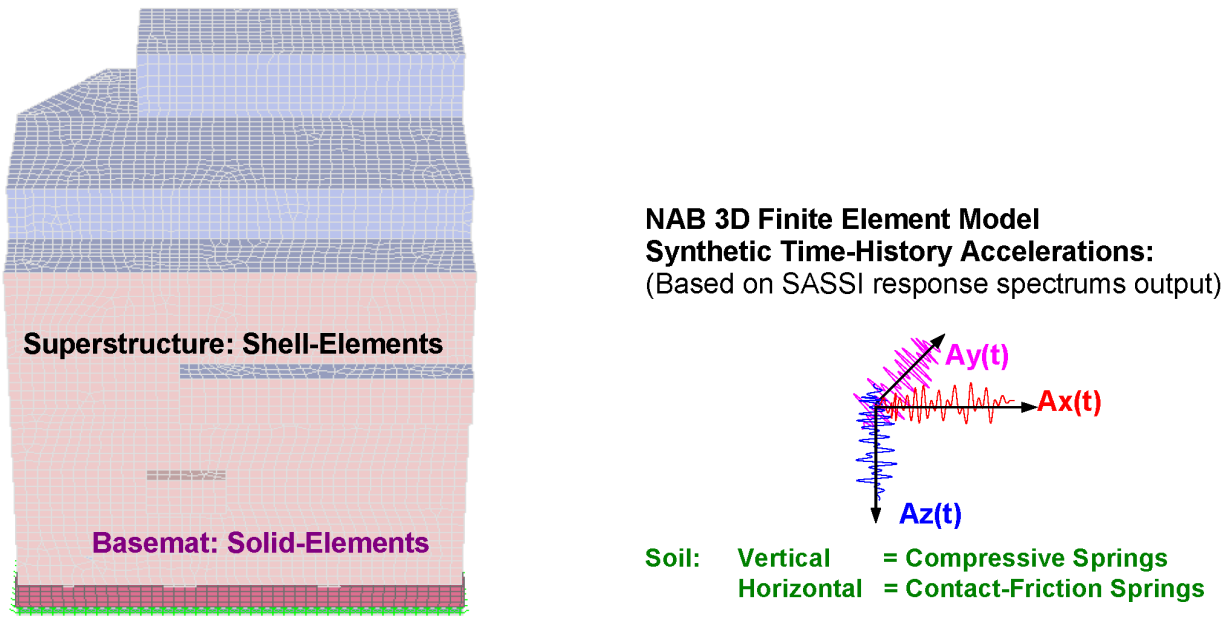
U.S. EPR FSAR, Tier 2, Section 3.7.2.8 will be revised as described in the response and indicated on the enclosed markup.

ATTACHMENT A

METHODOLOGY EXAMPLE:

NAB Hard Soil Case 5a

Figure 03.07.02-64-1—NAB-3D Finite Element Model



Note: Preliminary results are for the expressed purpose of demonstrating application of the methodology.

Figure 03.07.02-64-2(a)—Response Spectrum and Time-History Input in X-Direction

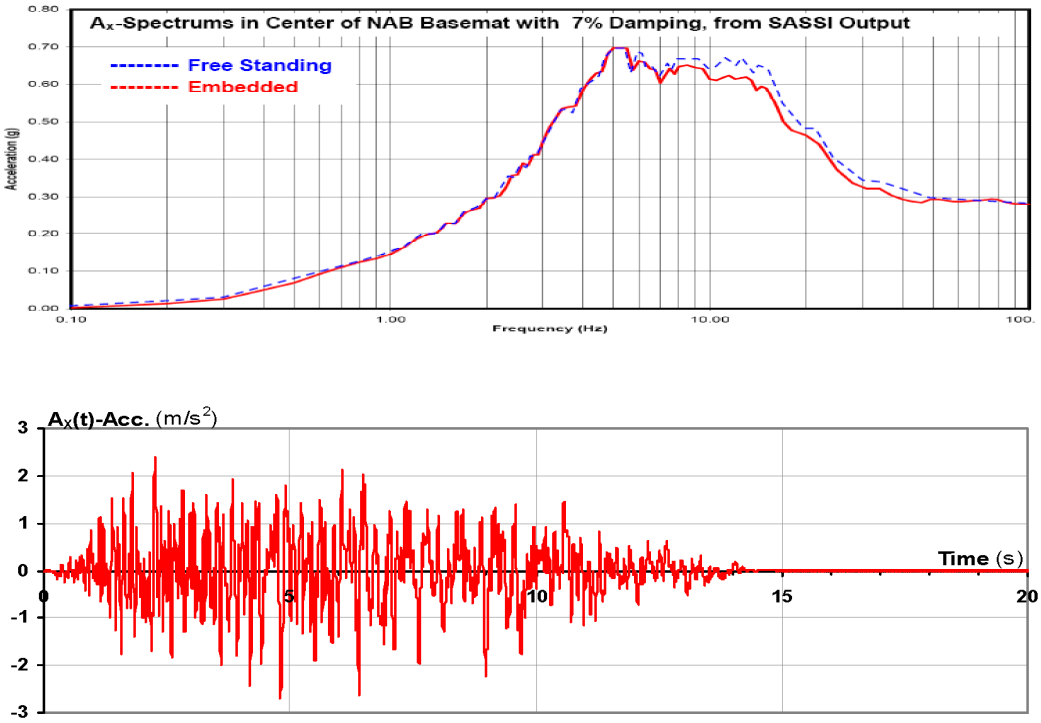
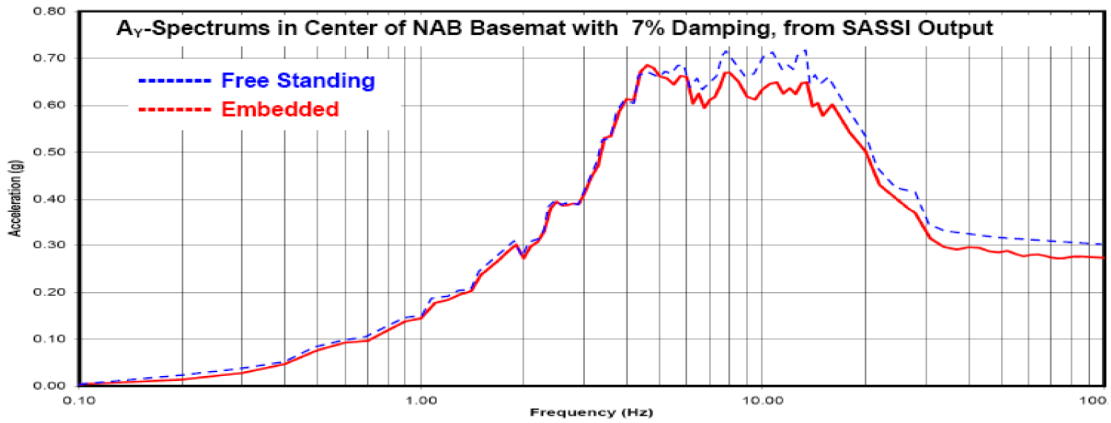


Figure 03.07.02-64-2(b)—Response Spectrum and Time-History Input in Y-Direction



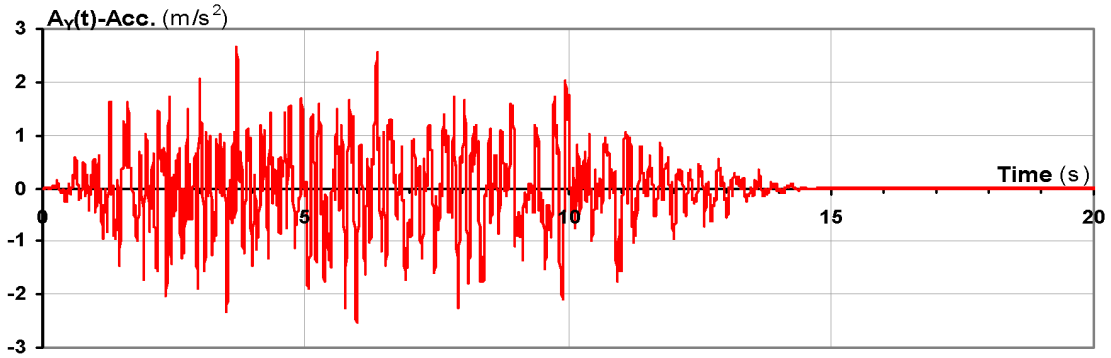
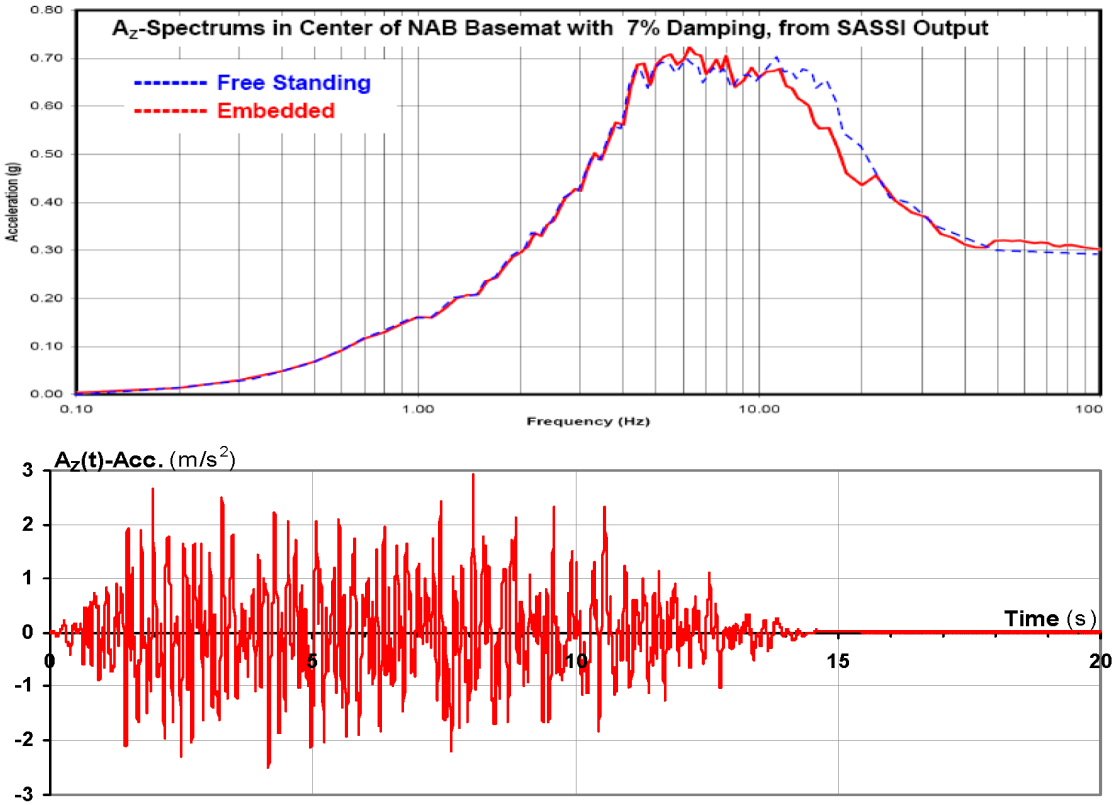


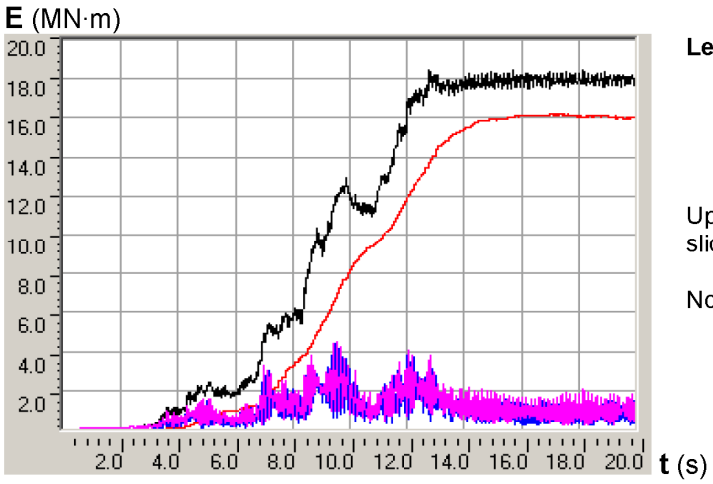
Figure 03.07.02-64-2(c)—Response Spectrum and Time-History Input in Z-Direction



Step 1: Upper-Bound Sliding Analysis

Analysis with 0.0% material/modal/soil damping and with the lower bound friction coefficient of μ = 0.5.

Figure 03.07.02-64-3—Cumulative Energies Time-History Calculated in Step 1



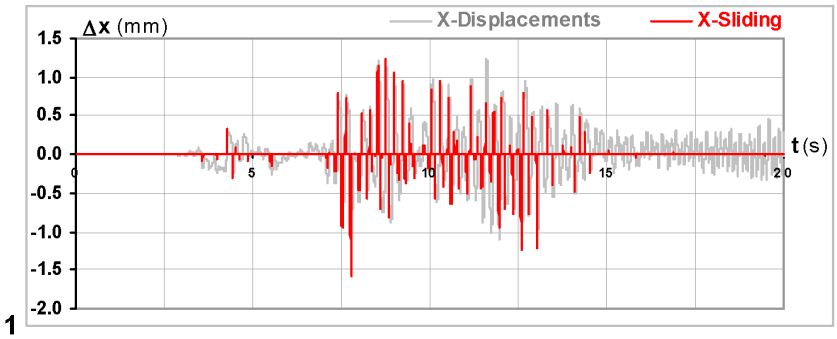
Legend:

--- Input Energy
--- Sliding Hysteresis Energy
--- Potential Energy
--- Kinetic Energy

Up-to 90% input energy is dissipated/flows into sliding hysteresis energy.

Note: The high level of oscillation results from the conservative assumption of 0% damping.

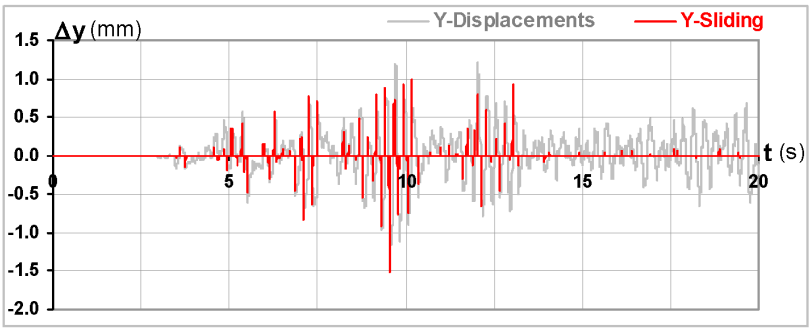
Figure 03.07.02-64-4—Basemat-Corner Sliding and Relative-Displacement Time-History calculated in Step 1

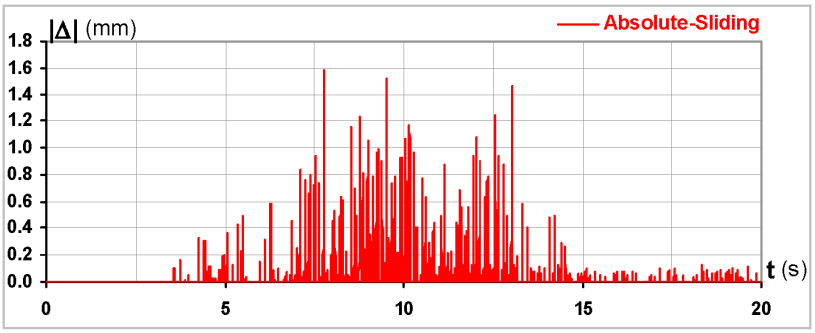


Calculated maximum Sliding in Step1 is:

- ≈ **1.53** mm in X-direction
- ≈ **1.50** mm in Y-direction
- ≈ **1.60** mm as Absolute Sliding Value

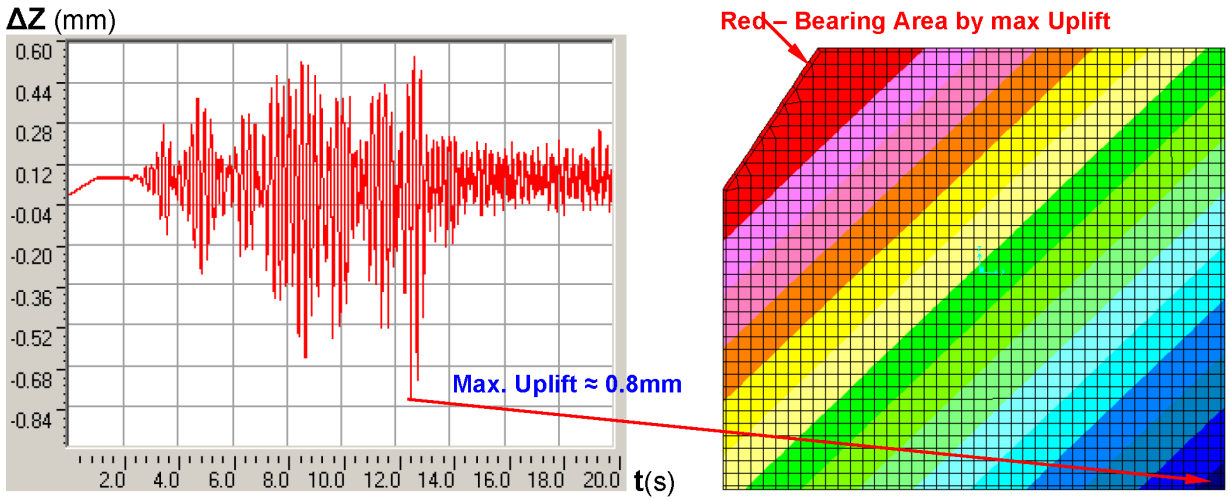
Note: The sliding development after approximately 14 seconds results from accumulated energy because of 0% damping.





The time-history plot for the absolute sliding values shows that in the case of 0% damping with μ=0.5, the structure **"wobbles"** throughout most of the seismic input duration. This confirms the Cumulative Sliding Energy plot in Figure 03.07.02-64-03.

Figure 03.07.02-64-5—Basemat South-East Corner Vertical-Displacement Time-History Calculated in Step 1



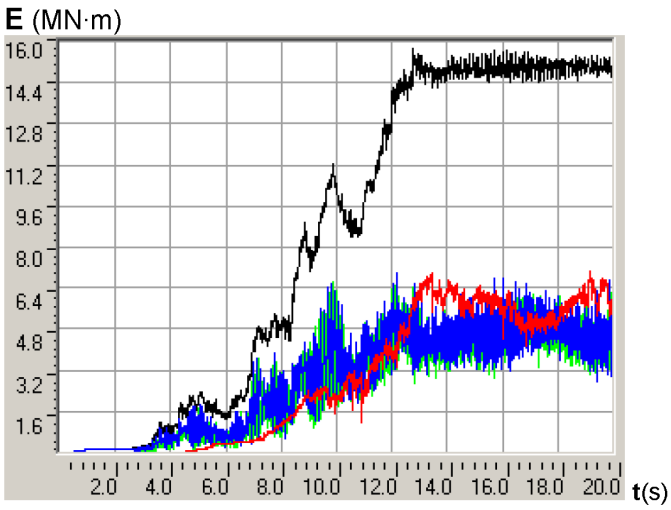
The maximum calculated uplift for the basemat-corners in Step 1 is max **Δz ≈ 0.8** mm.

Note: The major portion of the input energy is “dissipated” in sliding. The remaining energy causes the basemat area to uplift and high bearing pressure at the basemat corner. This outcome is a result of a conservative assumption of 0.0% - material/modal damping (i.e., no energy dissipation in concrete viscosity and cracking damping. This result is similar to the “approximated method for sliding and uplift of an unanchored rigid body” and therefore, too conservative for the calculation of the resulted maximum bearing pressure.

Step 2: Upper-Bound Uplift Analysis

Analysis with **0.0**% - material/modal/soil damping and with the upper-bound friction coefficient of **μ = 1.0**.

Figure 03.07.02-64-6—Cumulative Energies Time-History Calculated in Step 2



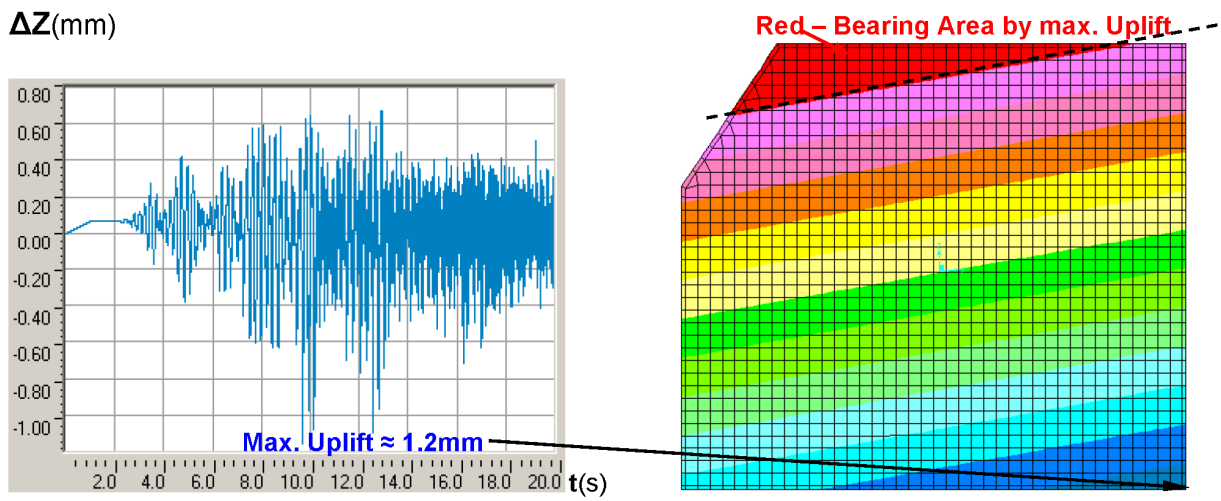
Legend:

--- Input Energy
--- Sliding Hysteresis Energy
--- Potential Energy
--- Kinetic Energy

The results demonstrate that by using μ=1.0, the input energy transfers in almost equal proportions to potential, kinetic and sliding hysteresis energy.

Note: The sliding remains in the system because of the vertical/horizontal reaction redistribution in bearing /contact area during the uplift.

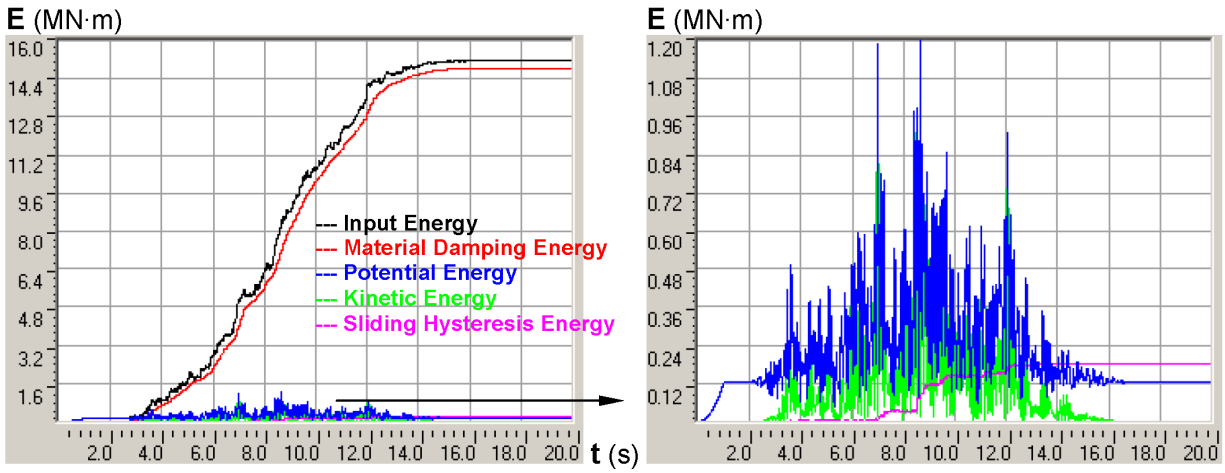
Figure 03.07.02-64-7—Basemat South-East Corner Vertical-Displacement Time-History Calculated in Step 2



Step 3: Best estimated for Bearing Pressure, Sliding, and Uplift Analysis

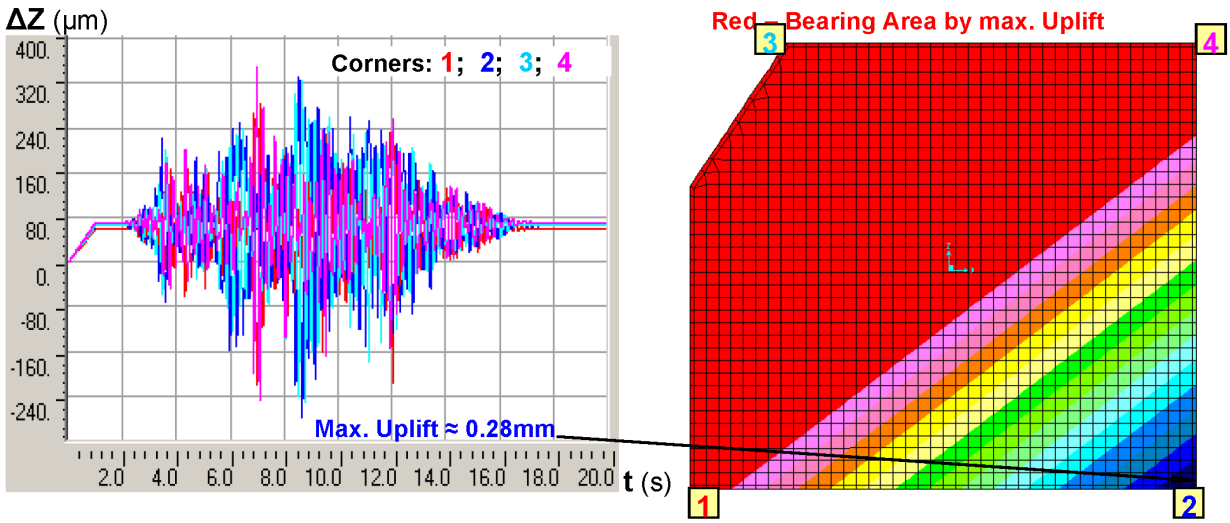
Analysis with 7.0% - material viscosity damping, 0 (zero) soil radiational damping and design base friction coefficient of μ = 0.5.

Figure 03.07.02-64-8—Cumulative Energies Time-History Calculated in Step 3



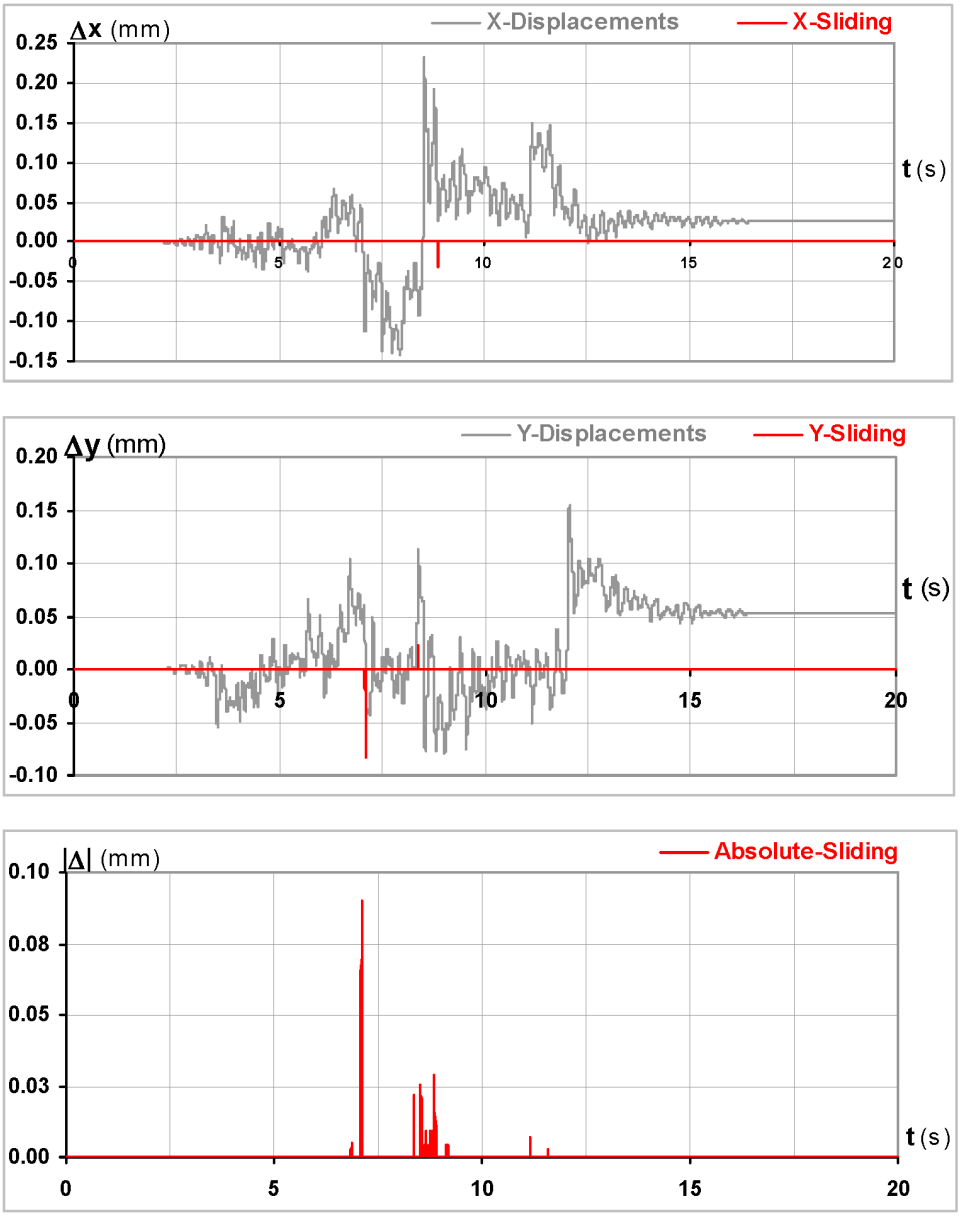
The results show that a major portion of input energy is dissipated in material viscosity damping.

Figure 03.07.02-64-9—Basemat-Corners Vertical-Displacement Time-History Calculated in Step 3



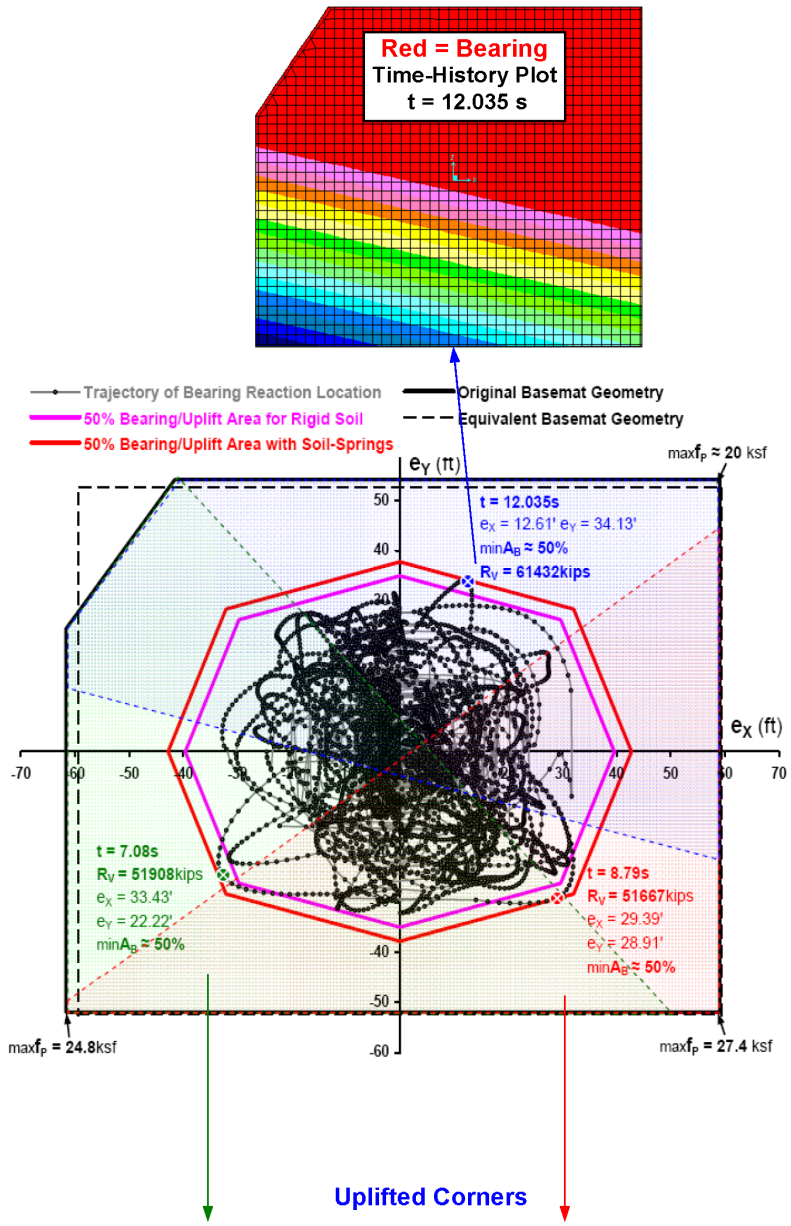
The results show that with 7 percent material damping about 60 percent of the basemat area bears on soil due to the uplift at corner No. 2.

Figure 03.07.02-64-10—Basemat-Corner Sliding and Relative-Displacement Time-History Calculated in Step 3



The results show that with 7 percent material damping the sliding is very small (Δs < 0.1 mm = negligible) and the structure may be considered as stable. This confirms the Cumulative Sliding Energy plot in Figure 03.07.02-64-08.

Figure 03.07.02-64-11—Resulted Bearing Reaction Location Time-History Orbital Plot Bearing Area and Pressure calculated in Step 3



Legend:

- Pink Octagon corresponds to closed form solution for the 50% Bearing/Uplift Area for rectangular basemat supported by "absolute" rigid soil.
- Red Octagon corresponds to closed form solution for the 50% Bearing/Uplift Area for soil springs values used for "rigid" soil case 5a analysis with the resulting bearing reaction is at least half of the gravity force.
- Bearing Reaction Location time-history "orbital" plot (each dot is a time-step).
- Shaded areas correspond to the calculated bearing area in time with maximum bearing reaction eccentricity.
- maxf_P is maximum peak bearing pressure in the basemat corner based on closed form solution for the "absolute" rigid soil bearing (minimum bearing area).

Note: The hand calculated bearing areas and maximum bearing pressures are very close to the time-history analysis results (see Bearing Area Plots).