PMSTPCOL PEmails

From: Tonacci, Mark
Sent: Wednesday, February 23, 2011 5:06 PM
To: STPCOL
Subject: FW: Paper for SSI Sensitivity Studies for Cracked Concrete and Soil Separation Cases
Attachments: SSI Sensitivity Analysis of Cracked Concrete 02222011.doc

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From: Head, Scott [mailto:smhead@STPEGS.COM]
Sent: Tuesday, February 22, 2011 2:57 PM
To: Tai, Tom; Tonacci, Mark; Wunder, George
Subject: Paper for SSI Sensitivity Studies for Cracked Concrete and Soil Separation Cases

Mark

Here is the Cracked Concrete White Paper.

We still owe you one more Beam Shear.

Thanks

Scott

Hearing Identifier: SouthTexas34Public_EX
Email Number: 2654

Mail Envelope Properties (E09C30551FD42442BA284ECF9858105F950E09AFE1)

Subject: FW: Paper for SSI Sensitivity Studies for Cracked Concrete and Soil Separation Cases
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"STPCOL" <STP.COL@nrc.gov>
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SSI Analysis Sensitivity Studies for Cracked Concrete and Soil Separation Cases

The NRC Staff has requested additional justification for not analyzing the soil separation, cracked concrete and empty fuel tank for the Lower Bound and Mean soil cases, in addition to the sensitivity studies that were done for the Upper Bound soil case. NINA believes that the sensitivity studies for the Upper Bound case are adequate to accomplish the purpose of these sensitivity studies.

Background

- The structures of STP 3&4 are designed to be of relatively crack-free concrete in continuous contact with the soil in which they are embedded. Though not anticipated, it is conceivable that there could be more cracking (and associated softening) than expected, or that separation between the subgrade walls and the upper layers of soil could develop. Either of these unexpected conditions could potentially change the structural response to earthquake shaking.

- SRP 3.7.2 Acceptance Criteria pertaining to Soil Structure Interaction states, in part:

> It is noted that there is enough confidence in the current methods used to perform the SSI analysis to capture the basic phenomenon and provide adequate design information; however, the confidence in the ability to implement these methodologies is uncertain. Therefore, in order to ensure proper implementation, the following considerations should be addressed in performing SSI analysis :
>
> A. Perform sensitivity studies to identify important parameters (e.g., potential separation and sliding of soil from sidewalls, non-symmetry of embedment, location of boundaries) and to assist in judging the adequacy of the final results. These sensitivity studies can be performed by the use of well-founded and properly substantiated simple models to give better insight;

In accordance with SRP 3.7.2, we have run sensitivity studies for cracked concrete and soil separation cases. For these sensitivity studies, SSI analyses were run with the models modified to explicitly include soil separation for one study, and the softening associated with concrete cracking for another. We also have run a sensitivity study for the diesel fuel oil tanks being empty or full. In generating the in-structure response spectra (ISRS) and seismic loads for structural design the SSI analysis results for all the above cases were enveloped.

History and Current Status

- Typically, these sensitivity analyses are performed for one soil case. For example, the ABWR DCD describes just such a process. In order to evaluate the effect of depth to water table on the seismic responses, both the Reactor Building and Control Building were analyzed using a single soil profile. An analysis was done for each of four possible water table depths, and the results were enveloped in the design. A similar approach was followed for other parameters. Sensitivity studies of cracked concrete cases and soil separation cases also used only a single soil profile.

- The sensitivity analyses for the STP 3&4 Diesel Generator Fuel Oil Storage Vault (DGFOSV) and the Diesel Generator Fuel Oil Tunnel (DGFOT) also were done for only one soil profile, i.e. the Upper Bound soil case. The NRC Staff has now asked for further justification for not also running the cracked concrete and soil separation analyses for the Lower Bound and Mean soil properties.

NINA's Position

- SRP 3.7.2 includes a requirement regarding sensitivity analyses for parameters such as the cracked concrete and the separated soil cases. However, it includes no requirement that these analyses be repeated for all soil cases. We believe, we have met the SRP requirement. The SRP requires three sets of soil properties to be used in the SSI analyses to cover the variability in soil properties. This requirement was met by performing the SSI analyses for three sets of soil properties.

- It should be noted that the SSI analyses for development of seismic design loads are highly complex analyses to generate a reasonably conservative set of loads for a seismic event. Starting from the development of ground motion response spectra (GMRS) and through the analysis and design chain, appropriate conservatisms are added by meeting the regulatory and code requirements. For example:

1. The attached figure shows that the site-specific SSE response spectrum which we are using for plant design has significant margin over the GMRS in the frequency range of interest to our design. In the figure, the horizontal GMRS that SRP 3.7.2 requires to be considered in the seismic analysis for determination of the plant design loads is represented by the lower curve. However, the site-specific Category I structures, including the Diesel Generator Fuel Oil Storage Vault and the Diesel Generator Fuel Oil Tunnel, were conservatively designed for horizontal accelerations represented by the Input Spectrum, which is the upper curve of the figure. As such, seismic loading used to design the plant is based on accelerations that are essentially double the regulatory requirements in the predominant frequency range of interest.
2. The reduction in concrete section properties for cracked concrete case is set at 50% which is overly conservative. Such a substantial cracking would require that the entire structure is very highly stressed. For the STP designs, only a small number of the structural components will be highly stressed.
3. The design of these structures for seismic loading is based on equivalent static method where the applied seismic loads are significantly higher than the seismic loads from the SSI analyses.

The above specific analysis and design margins, in addition to the many other safety margins inherent in prudent engineering practice and requirements of the codes and standards that govern these designs, more than compensate for any uncertainty that could be resolved by analyzing additional combinations of parameters.

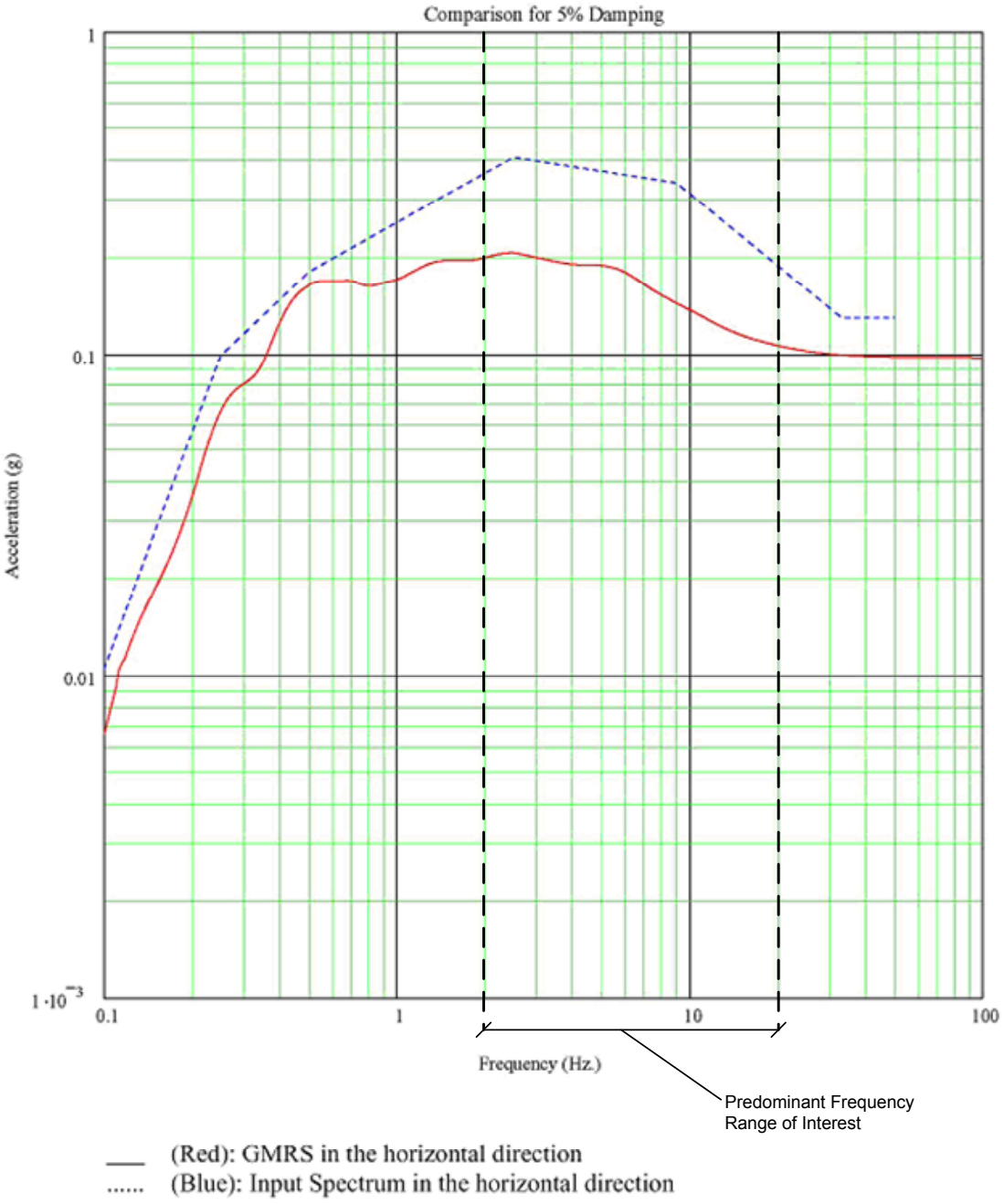
Conclusion

We have satisfied the SRP requirements, and the design incorporates substantial margin to account for any potential uncertainties. This issue should be considered resolved.

Schedule Impact

To complete the requested analyses for other soil cases for DGFOSV and DGFOT will take approximately six to eight weeks. If NRC maintains that the plant design must envelope the results of such analyses, in spite of the many design conservatisms discussed above, then some additional design changes may be required. The design calculations to make such changes would require an additional six weeks.

If similar additional analyses have to be performed for the Ultimate Heat Sink/Reactor Service Water Pump House structures, the SSI analyses will require ten to twelve weeks. To process any changes from the SSI analysis results in the design calculations will require an additional twelve to sixteen weeks.



Comparison of GMRS with the Input Spectrum (Horizontal)