
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/31/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: NO. 854-6088 REVISION 3
SRP SECTION: 03.07.02 – Seismic System Analysis
APPLICATION SECTION: 3.7.2
DATE OF RAI ISSUE: 10/24/11

QUESTION NO. RAI 03.07.02-162:

The staff requests that the content and purpose of Section 4.2.3 of MUAP-11007 (R0) be clarified. The staff does not understand the relevance of this information to the performance of a parametric study of the effect of groundwater level on the SSI response. Specific concerns about this information are:

- Section 4.2.3 generally overstates the appropriateness of the process used to treat saturation in analyses where only one-phase constitutive approximations are used. For example, using a P-wave velocity of 5,000 fps for the soil matrix and water two-phase material is a serious approximation considering that most ground water contains entrapped air, especially near the top of the ground water table and in the perched zones above which seriously degrades the P-wave velocity. The staff considers most of this discussion to be inappropriate and the process does not follow procedures used for SSI analyses. The assumption that water movement is in fact independent of movement of the soil skeleton at the frequencies of interest to the SSI problem is a not a commonly held viewpoint in the SSI community.
- In Section 4.2.3 (2), it is stated that “Reference 7.19 concluded that the ACS SASSI assumption provides a reasonable representation for the real part of the impedance, for values of the dimensionless frequency of foundation vibration (a_0) up to approximately three (3).” It then states that $a_0 = 3.0$ is consistent with a frequency of 8.1 Hz for R/B Complex foundation, and this frequency is much higher than the natural frequencies of R/B Complex structures as well as its SSI frequency for 270-200 soil profile. However, the staff notes that the applicant did not clarify what ACS-SASSI assumption is justified by Reference 7.19. This reference was published in 1999, long before the existence of ACS-SASSI. Also, in the calculation of a_0 , the S-wave velocity of soil directly beneath the foundation should be used, not the value 200 ft below the foundation. Therefore, the calculated frequency of 8.1 Hz for R/B Complex foundation is questionable, and the actual frequency may not be higher than the fundamental frequency of R/B Complex structure and the SSI system frequency. The applicant is requested to provide the technical basis for calculated frequency of 8.1 Hz for R/B Complex foundation.

- In Section 4.2.3 (2), it is stated that “The comparison of the impedance functions indicates that the equivalent dry soil assumption is valid in the low frequency range.” It is the staff understanding that the low frequency range is estimated to be frequencies up to 8.1 Hz. This implies that the equivalent dry soil assumption is not valid for frequencies higher than 8.1 Hz. In view of this frequency limitation, the applicant is requested to justify the validity of the ground water table elevation sensitivity studies.

ANSWER:

Section 4.2.3 in MUAP-11007, Rev. 0 has been replaced by Section 2.2 in MUAP-11007, Rev. 2. This section discusses the potential that water movement is independent of movement of the soil skeleton, and explains why such phenomena can be neglected in the analyses.

The entire second subsection of MUAP-11007, Rev. 0 Section 4.2.3 “Impedance Function/Matrices for Saturated Soils” (discussed in the second and third bullets in the question, above) has been removed. This is not relevant to the SASSI analysis of unsaturated soils performed and described in MUAP-11007, Rev. 2.

Section 2.2 of MUAP-11007, Rev. 2 provides an updated discussion on the theoretical background related to the methodologies implemented to address the effect of soil pore water both in the soil-structure interaction (SSI) and the site response analyses. This section explains that the single phase continuum formulation implemented for the conventional site response and SSI analyses does not provide means for representing the soil porous media as a multi-phase system consisting of the soil skeleton, the pore water and the pore air. Instead, values for total unit weight are assigned to the saturated soil layers, which implies that the the groundwater and the soil skeleton move together.

Impact on DCD

There is no impact on the DCD.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on S-COLA

There is no impact on the S-COLA.

Impact on PRA

There is no impact on the PRA.

Impact on Technical/Topical Report

There is no impact on the Technical/Topical Report.

This completes MHI's response to the NRC's question.