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# Influence of ISFSI Design Parameters on the Seismic Response of Dry Storage Casks

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# Origins

- While performing the seismic soil-structure interaction (SSI) analysis for the Plant Hatch ISFSI, we discovered that the flexibility of the ISFSI concrete pad was the most significant contributor to the seismic response of the free-standing storage casks (see reference below). This was the inspiration for the present parametric study.

- Moore, D.P., Bjorkman, G.S., and Kennedy, R.P., "Seismic Analysis of Plant Hatch ISFSI Pad and Stability Assessment of Dry Casks," *Proceedings, 8th International Conference on Nuclear Engineering*, Baltimore, MD, April 2-6, 2000.

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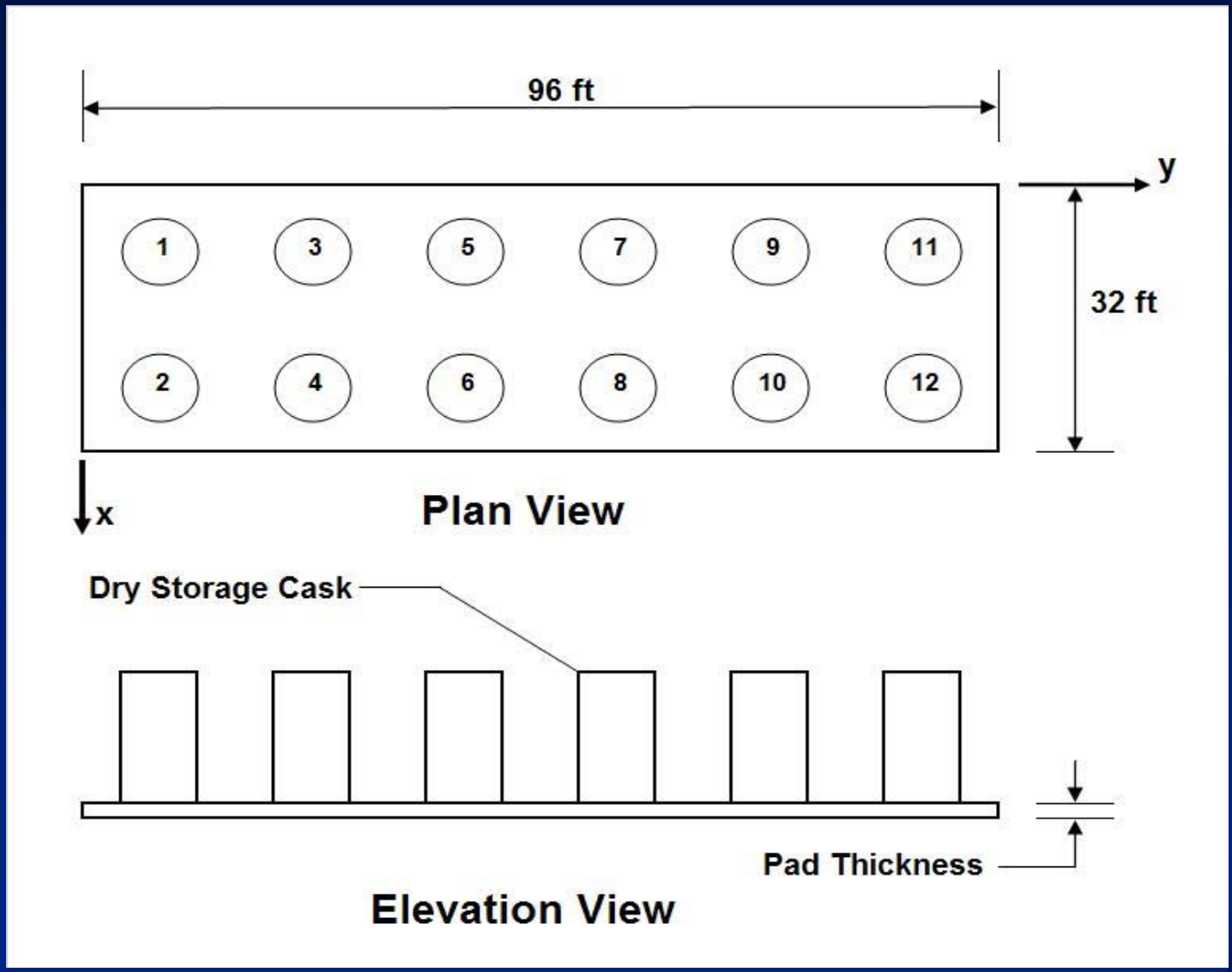
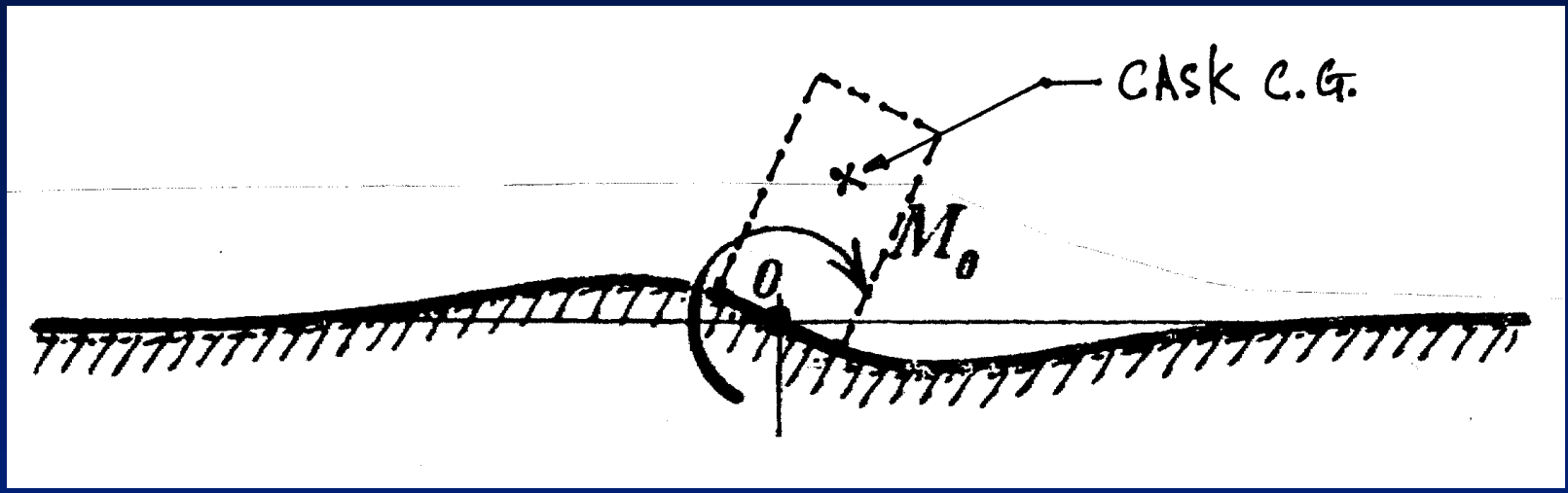
# ISFSI Pad and Cask Layout



# ISFSI Pad Flexibility




- Accelerations at the cask center of gravity (c.g.) determine the cask's stability (e.g., initiation of sliding or tipping)

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# ISFSI Pad Design Parameters Considered

| Three Parameters | Number of Cases | Range of Values |
|---|---|---|
| (1) Pad Thickness<br>(Uncracked Concrete Properties) | 4 | 1.5 to 4.0 feet |
| (2) Soil Shear Wave Velocity<br>(Uniform 100 ft. Depth) | 6 | 500 to 1700 fps |
| (3) Cask Arrangements | 2 | 3 Casks, 12 Casks |

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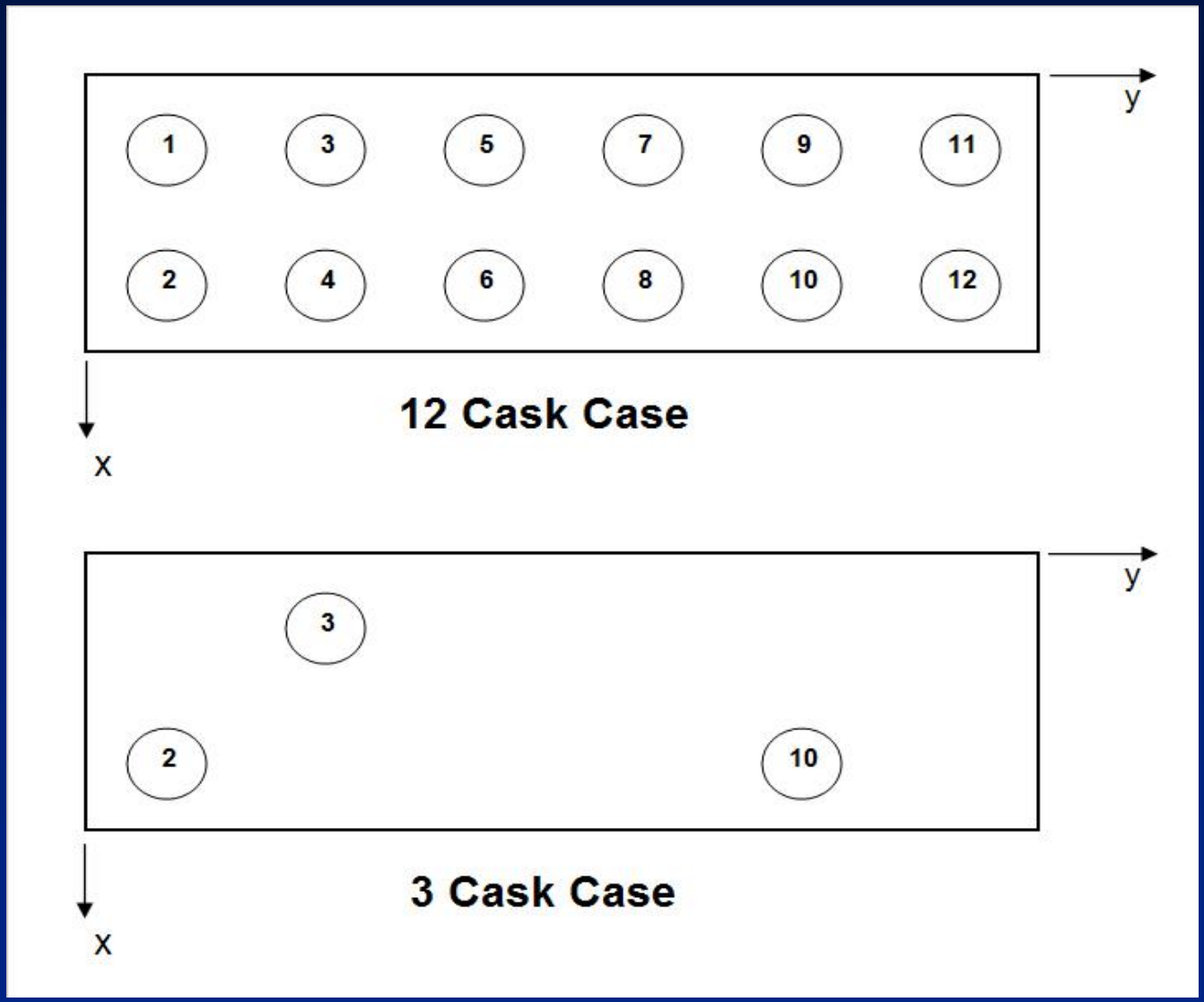
# Cask Cases Considered



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# Cases Analyzed

**3 Cask Case**

| | | Soil Shear Wave Velocity (fps) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 500 | 700 | 900 | 1100 | 1300 | 1700 |
| Concrete Pad Thickness (feet) | 1.5 | | | | | | |
| | 2 | | | | | | |
| | 3 | | | | | | |
| | 4 | | | | | | |

**12 Cask Case**

| | | Soil Shear Wave Velocity (fps) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 500 | 700 | 900 | 1100 | 1300 | 1700 |
| Concrete Pad Thickness (feet) | 1.5 | | | | | | |
| | 2 | | | | | | |
| | 3 | | | | | | |
| | 4 | | | | | | |

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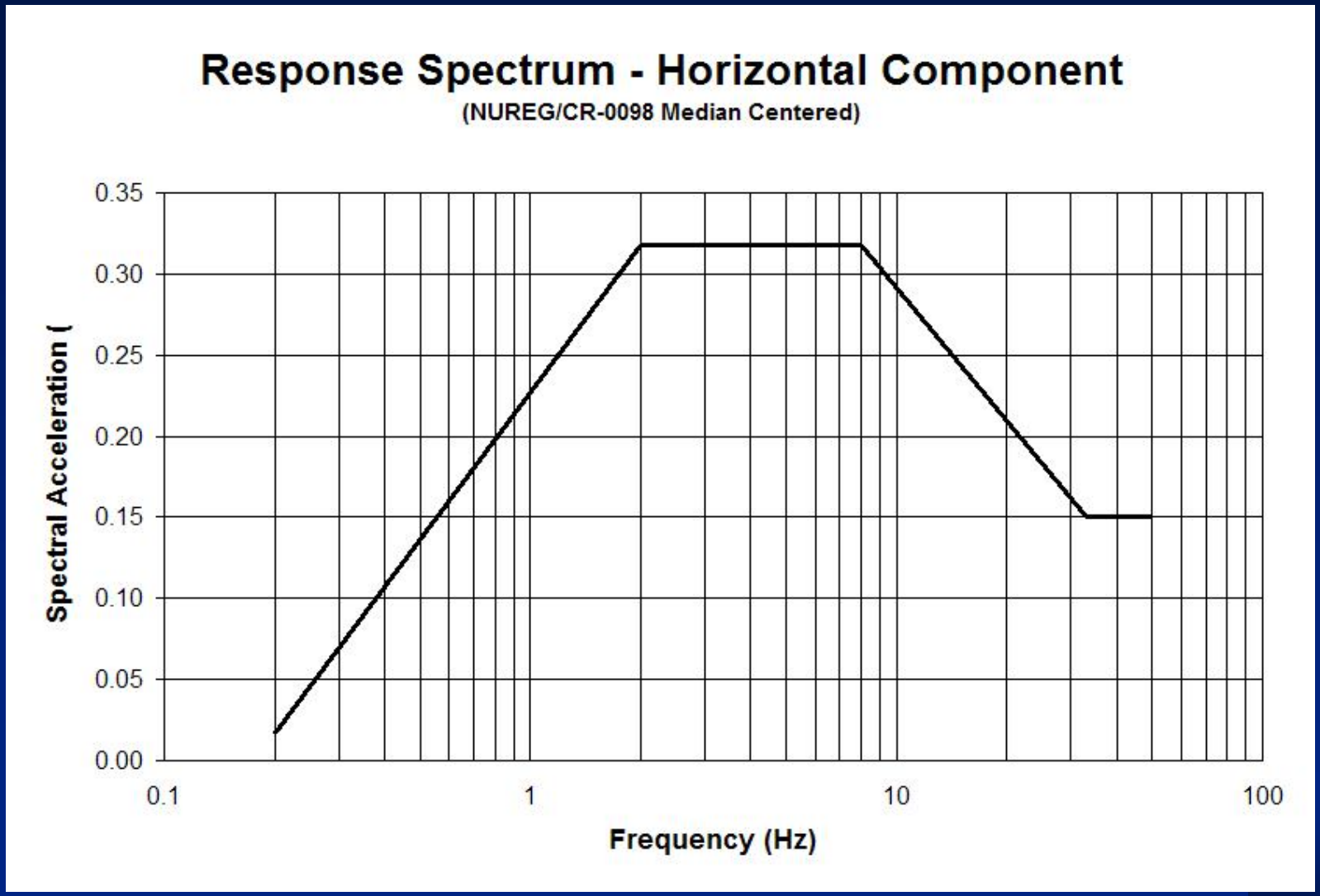
# Response Spectrum



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# SSI Analysis Program

- **SASSI**
- A System for Analysis of Soil-Structure Interaction
- Details of the SASSI Model are in the Paper

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# About the Results

- Maximum amplification at the cask base (top-of-pad) of any cask is 1.05 above the PGA and occurred for the 12 cask case.

- Amplification Factor is equal to the maximum acceleration at the cask c.g. divided by the PGA. [ AF = Acc. at Cask c.g. / PGA ]

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# Amplification Factor vs. Shear Wave Velocity

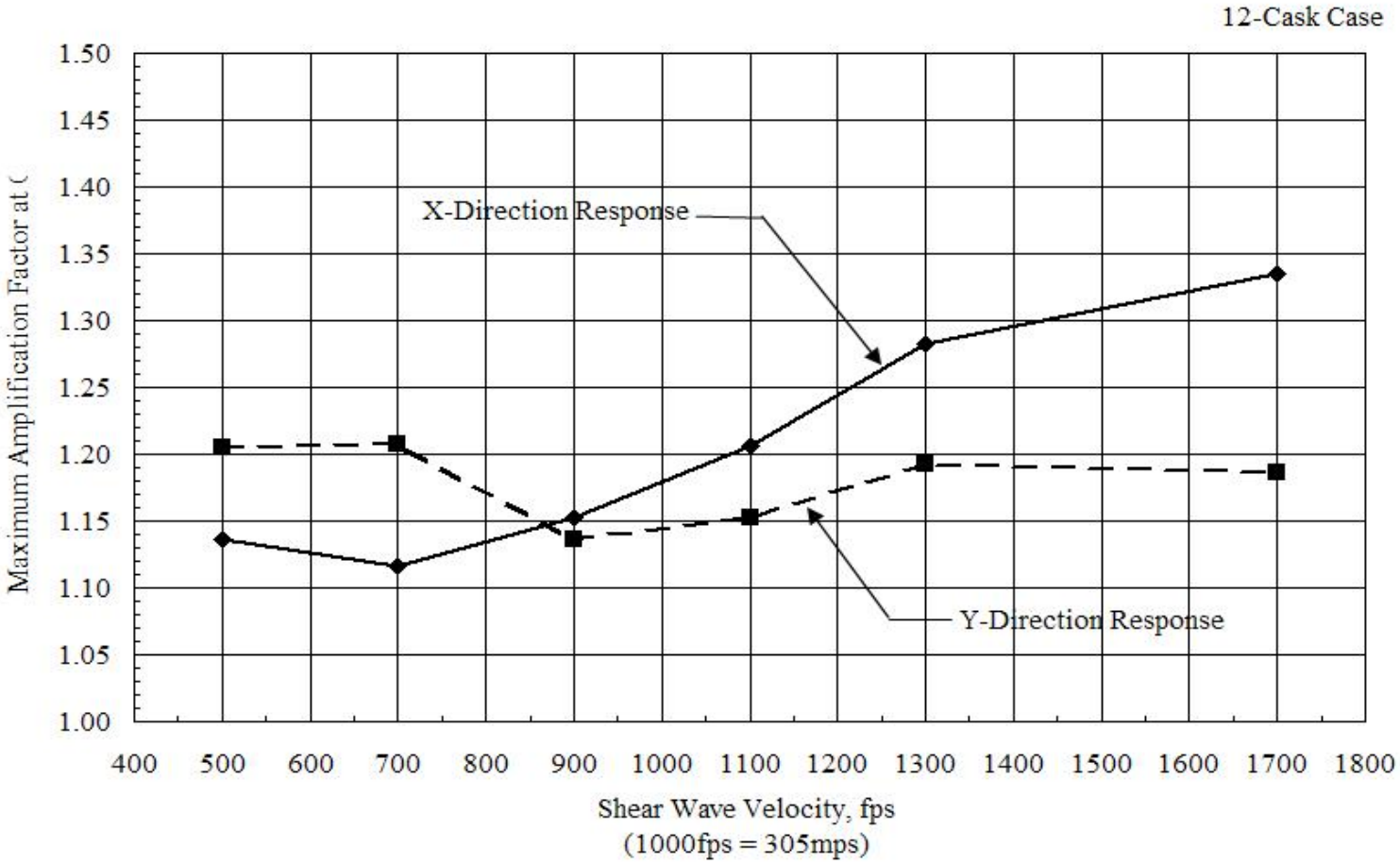


Figure 6: Amplification Factor vs Shear Wave Velocity for the 12-Cask Case for a 2 foot (0.61m) Thick Reinforced Concrete Pad

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# Amplification Factor vs. Pad Thickness

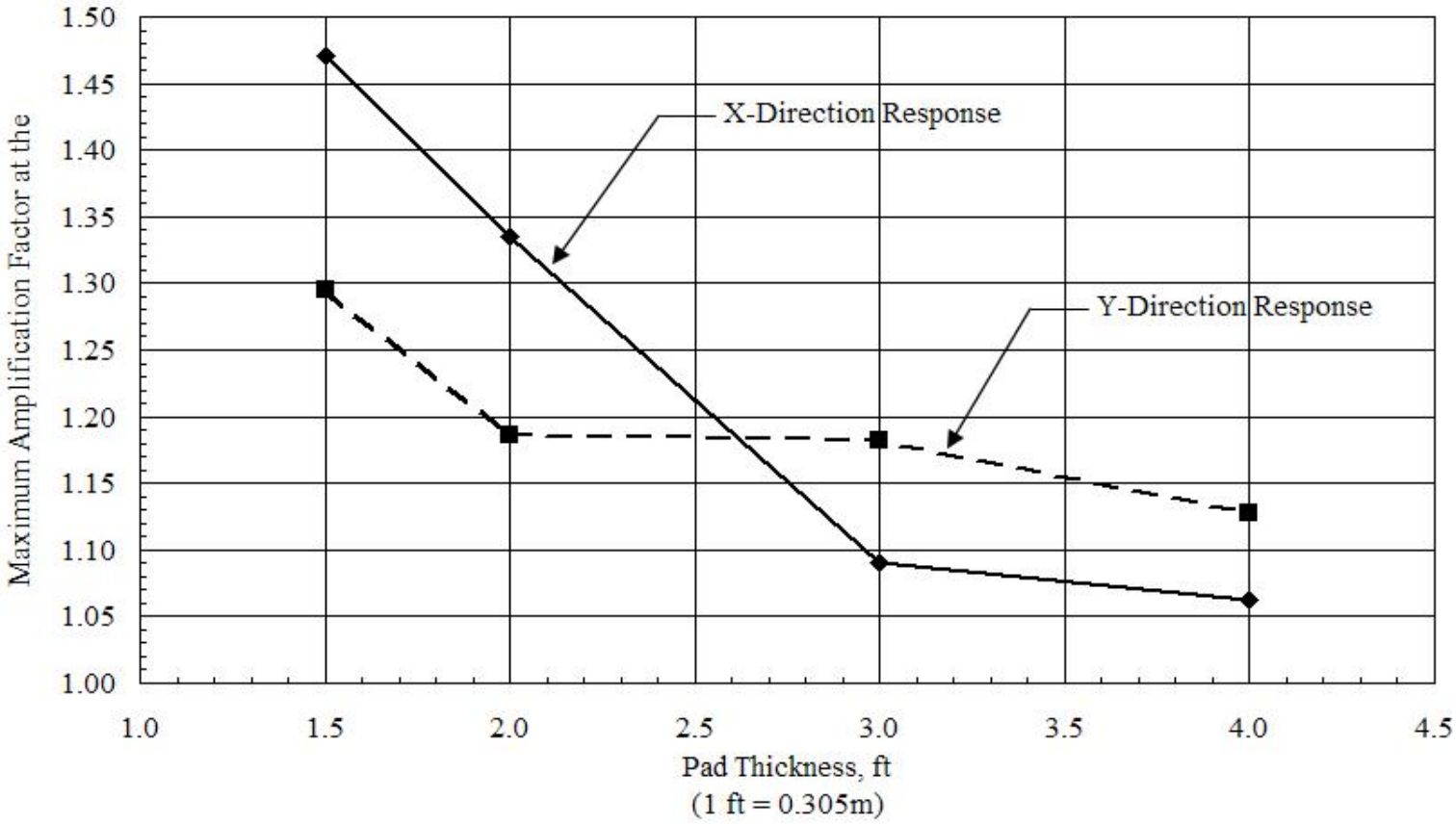


Figure 7: Amplification Factor vs Pad Thickness for the 12-Cask Case for a Shear Wave Velovity of 1700 fps (522mps)

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# Amplification Factor vs. Shear Wave Velocity

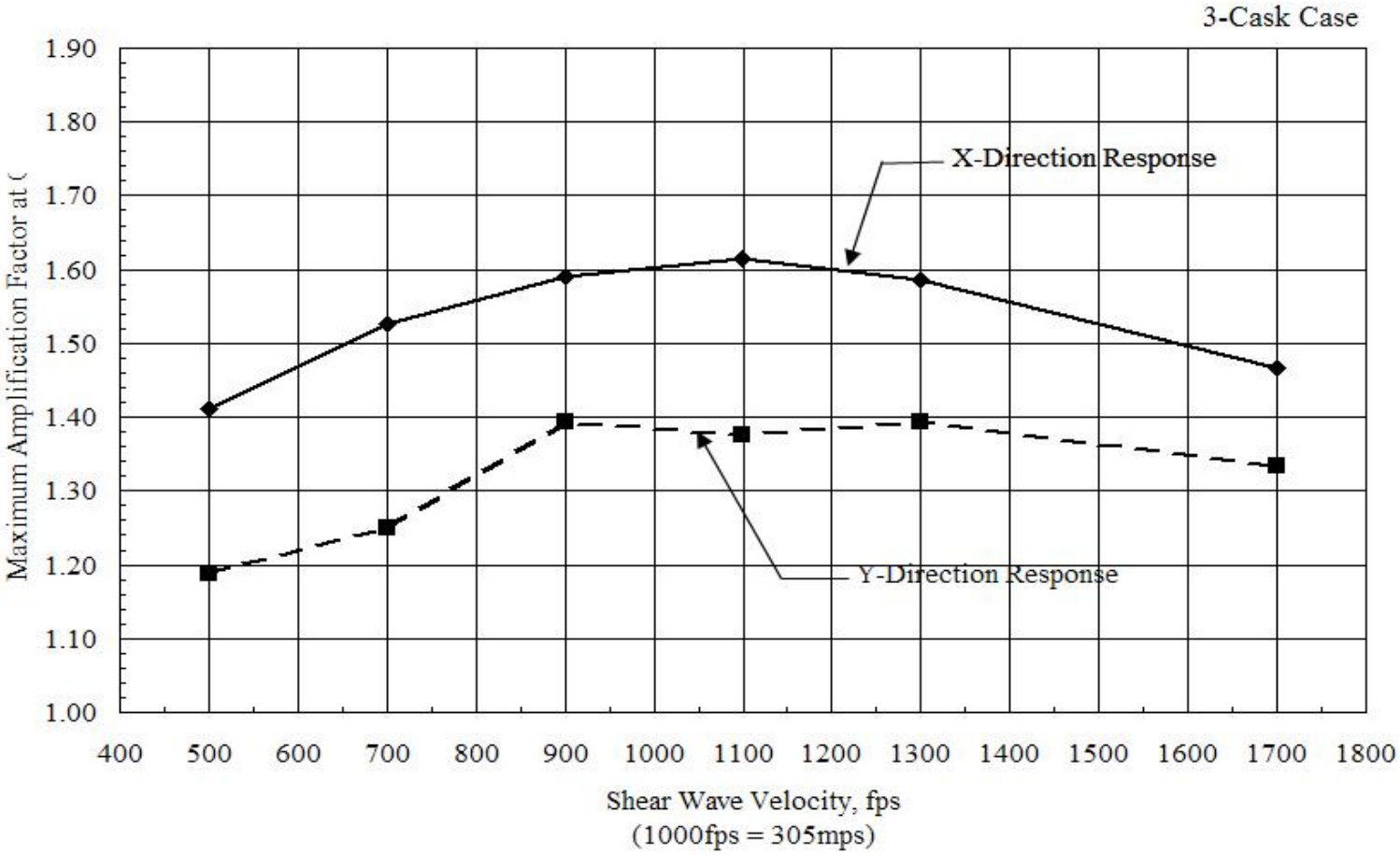


Figure 4: Amplification Factor vs Shear Wave Velocity for the 3-Cask Case for a 2 foot (0.61m) Thick Reinforced Concrete Pad

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# Amplification Factor vs. Pad Thickness

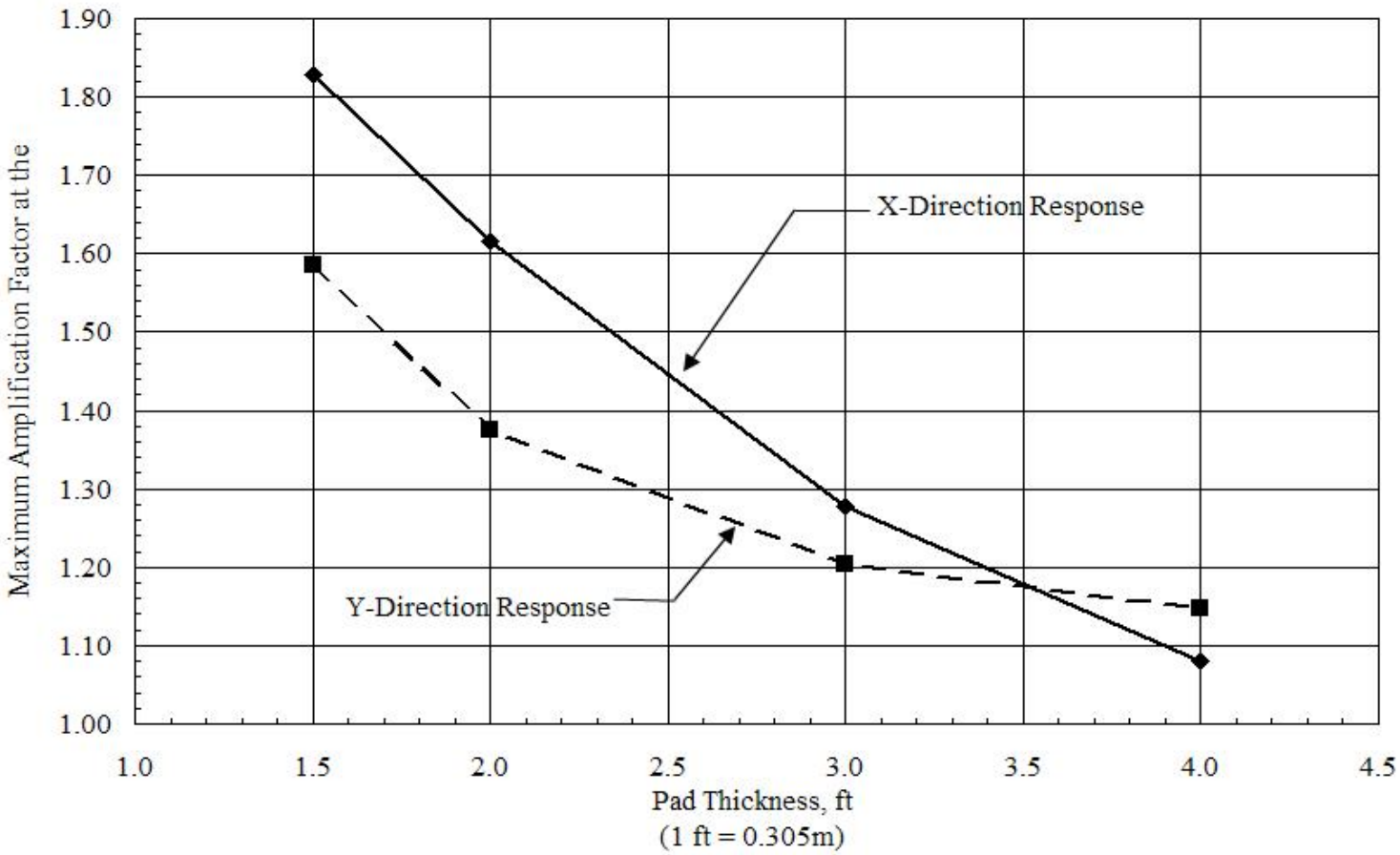


Figure 5: Amplification Factor vs Pad Thickness for the 3-Cask Case for a Shear Wave Velocity of 1100 fps (335 mps)

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# Conclusions

- ISFSI pad thickness (flexibility) is the dominant factor influencing cask response.
- The second largest contributor to cask response is the partial arrangement of casks on the pad. The more isolated a cask the higher its response.
- The maximum amplification factor at the cask base (top-of-pad) is 1.05.
- The maximum amplification factor at the C.G. of any cask is 1.83. ( Thinnest pad and most isolated cask)

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# Message

- Concrete Pad Flexibility must be considered in the SSI analysis of ISFSI Pads.

- A Rigid Pad Assumption is a BAD Assumption