TECHNICAL NOTE

The Accuracy of Beam Elements to Model Pile Foundations in SASSI
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Pile foundations are often required to support large and heavy structures by transferring the weight of the structure to more competent materials at depth and to minimize foundation settlements.

Dynamic response analysis of pile-supported structures in SASSI is relatively complex and requires proper modeling and knowledge of pile-soil-structure interaction. The original pile elements implemented in SASSI to analyze the seismic response of structures supported on piles required a large number of interaction nodes that made it unappealing for practical applications. The Spile Methodology, developed from the point load solution of an axi-symmetric pile model originally implemented in MTR/SASSI, provides accurate results for a single pile analysis but cannot be easily extended to large pile groups. As a result, the current practice in SASSI is to use beam elements to model pile group foundations.

A recent benchmark study to evaluate the adequacy of beam elements to model pile foundations in SASSI has revealed severe deficiencies in the beam elements for such applications. For example, it was found that the single pile solution obtained using beam elements in SASSI deviates significantly from Spile as well as other available solutions that use more rigorous modeling procedures.

To overcome the deficiencies of beam elements for modeling pile foundations in SASSI, a new pile element has been developed and is currently being tested in MTR/SASSI. The preliminary results for a single pile as well as small 2x2 and 3x3 pile group foundations show significant improvement compared to results using beam elements. Figures 1 and 2 show comparisons of axial and lateral dynamic stiffnesses of a single, fixed-head, floating pile in a layered soil system calculated using DYNA5 and three alternative models in MTR/SASSI (i.e., Spile, Beam, and the new Pile element). With DYNA5 providing a targeted solution for single pile, the significant improvement in the results using the new pile element is evident.

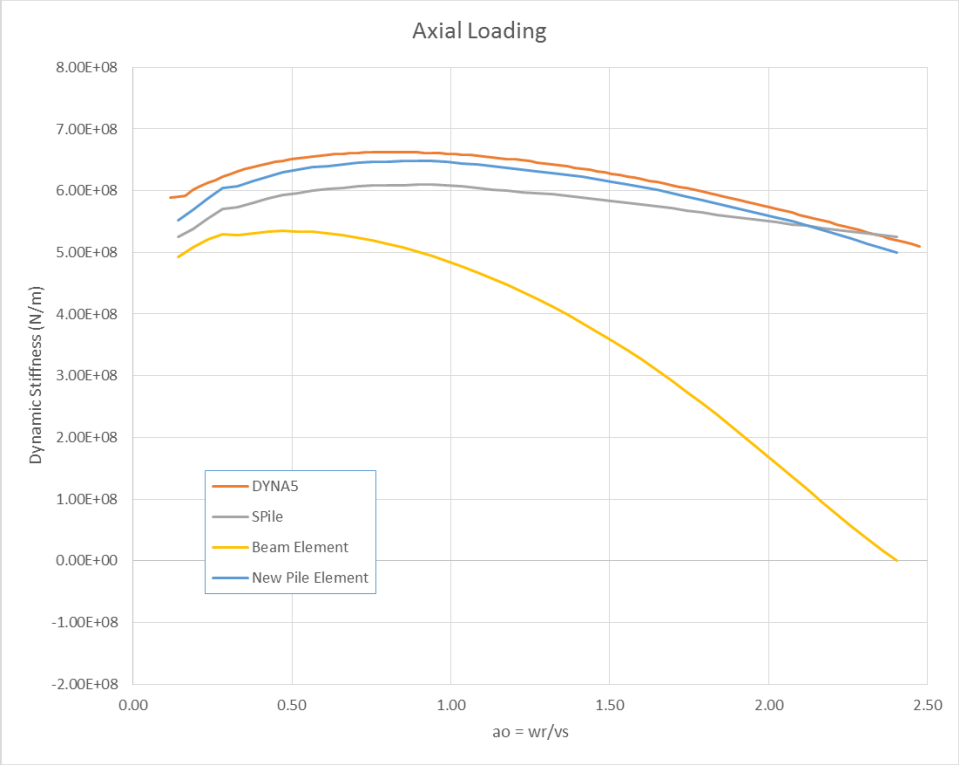

Fig 1 – Dynamic Stiffness of Fixed-Head Single Floating Pile in Layered Soil, Axial Loading

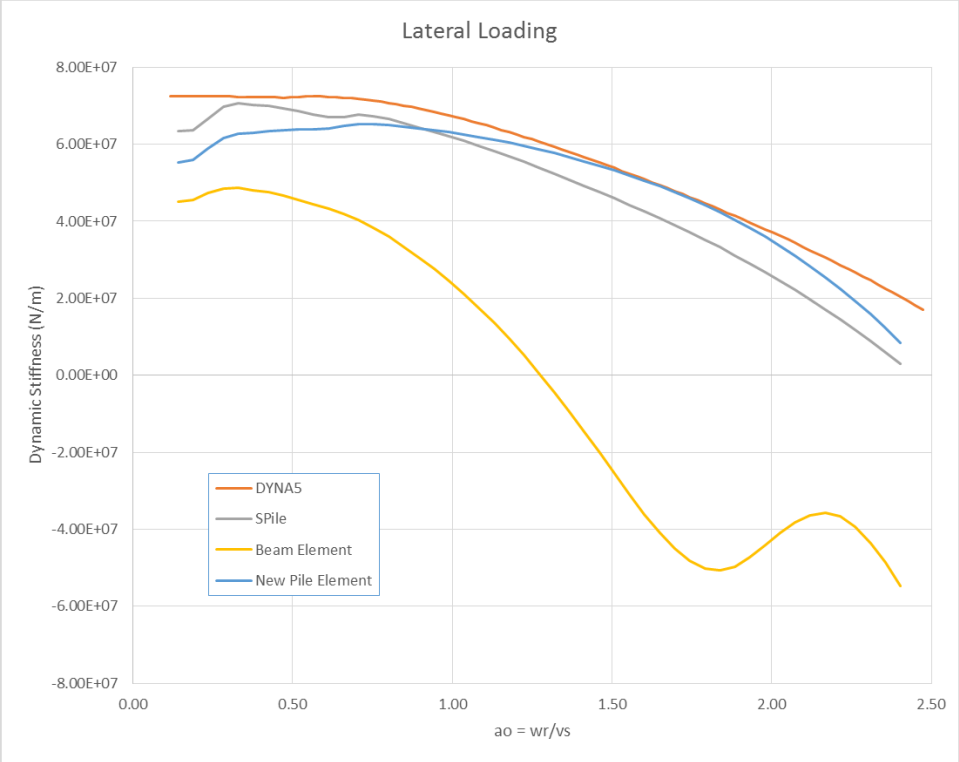

Fig 2 – Dynamic Stiffness of Fixed-Head Single Floating Pile in Layered Soil, Lateral Loading