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# A Scale-Bridging Generalized Finite Element Method for Parallel Simulations of Spot Welds in Large Structures

**C. Armando Duarte[1]* and Haoyang Li[2]**

Department of Civil and Environmental Engineering
University of Illinois at Urbana-Champaign
2122 Newmark Civil Engineering Laboratory
205 North Mathews Avenue, MC-250
Urbana, IL USA 61801-2352
[1] caduarte@illinois.edu
[2] hli70@illinois.edu
http://gfem.cee.illinois.edu

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Spot welds are commonly used to join thin gauge metallic structural components of automotive and aerospace vehicles. The stiffness of these components is strongly dependent on the design of their sub-component connections. Multi-point constraints are commonly used to represent spot welds in finite element models. However, they lead to mesh-dependent solutions and provide no useful information about the stresses around the spot weld, which are needed for life prediction of the connection.

In this talk, we present a Generalized Finite Element Method (GFEM) [1] based on the solution of interdependent macro/global and fine/local scale problems [2]. The local problems focus on the resolution of fine-scale features of the solution near regions with singularities or localized nonlinearities, while the global problem addresses the macro-scale behaviour of the structure. Fine-scale solutions are accurately computed in parallel using the h-version of the GFEM and embedded into the global solution space using the partition of unity method. Thus, the proposed method does not rely on a-priori knowledge about the solution of the problem. Other numerical methods such as the Boundary Element Method, peridynamics, etc., can also be used to solve the local problems. This GFEM enables accurate modeling of problems involving nonlinear, multi-scale phenomena on macro-scale meshes that are orders of magnitude coarser than those required by the FEM. Numerical examples show the scalability of the method on shared memory computers and a comparison in terms of computational performance and accuracy, with a direct finite element solver. Application of the method to the simulation of a representative hypersonic aircraft panel with a large number of spot welds is presented.

## REFERENCES

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