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A Ground Structure Method to Minimize the Total Installed Cost of Steel Frame Structures

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Abstract : This paper presents a ground structure method to optimize the topology and discrete member sizing of steel frame structures in order to minimize total installed cost, including material, fabrication and erection components. The proposed method improves upon existing cost-based ground structure methods by incorporating constructability considerations well as satisfying both strength and serviceability constraints. The architecture for the method is a bi-level Multidisciplinary Feasible (MDF) architecture in which the discrete member sizing optimization is nested within the topology optimization process. For each structural topology generated, the sizing optimization process seek to find a set of discrete member sizes that result in the lowest total installed cost while satisfying strength (member utilization) and serviceability (node deflection and story drift) criteria. To accurately assess cost, the connection details for the structure are generated automatically using accurate site-specific cost information obtained directly from fabricators and erectors. Member continuity rules are also applied to each node in the structure to improve constructability. The proposed optimization method is benchmarked against conventional weight-based ground structure optimization methods resulting in an average cost savings of up to 30% with comparable computational efficiency.

Keywords : cost-based structural optimization, cost-based topology and sizing, optimization, steel frame ground structure optimization, multidisciplinary optimization of steel structures
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