

Creating Digital Twins of Ancient Stupa Structures in Sri Lanka: Photogrammetric Model Creation and Finite Element Analysis of Rankoth Wehera Stupa

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Sri Lanka, a land rich in cultural heritage, is adorned with numerous awe-inspiring ancient stupas, some nearly 2 millennia old. Numerous natural and human factors have caused damage to these stupas compromising their structural integrity. In this premiering work, the authors intend to introduce modern scientific techniques of Photogrammetric Digitization, Digital Twins (DT) and Finite Element Modelling (FEM) to aid with conservation efforts. By adopting said technologies, experts can gain a comprehensive and accurate understanding of these structures, allowing for detailed analysis of their geometry, structural integrity, and deterioration patterns. This information serves as a valuable resource for conservation planning and implementing targeted maintenance and restoration strategies. DJI Mini3 PRO drone was used for the survey, and a sequence of computer programs was used to import the model to FEA software. Meshroom, an open-source photogrammetry software, created the initial model, which was then repaired using Meshmixer. This model was converted into a single surface and used to create a meshed model for Finite Element Modeling (FEM). The 3D solid model was discretized using Meshroom and analyzed in ABAQUS/CEA software for structural analysis. Based on the stress analysis results, it can be observed that the stupa experiences compressive stresses under self-weight and hoop stress contours predominantly exhibit compressive stresses, both gradually increasing from top to bottom. All stress values are well below the allowable material strength properties of the stupa. The photogrammetry process employed to obtain geometric proportions of the stupa structure was successful. The methodology of obtaining the FEM numerical analysis of the Rankoth Wehera solid superstructure using ABAQUS/CEA revealed that the methodology developed in this study can be used for renovation and restoration work of the stupa.

Keywords: Photogrammetric digitization, Digital twins, FEM, Stupas, Conservation

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