

FORENSIC EVALUATION OF HISTORIC SHELL STRUCTURE: DEVELOPMENT OF IN-SITU GEOMETRY

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When completed in 1961, the roof of St. Charles Church became the largest unbalanced hyperbolic paraboloid structure in the world and the only shell structure in Spokane, WA [1]. Situated on an 8-acre site on the north side of the city, St. Charles is a modernist structure designed through partnership of Funk, Molander & Johnson and architect William C. James. This asymmetric structure spans over 27.5m (90ft) and utilizes folded edge beams that taper from 1067mm (42in) at the base to a 76.2mm (3in) thickness at the topmost edge using regular strength reinforcing steel and concrete. The novelty of the shell structure serves both architectural and structural design criteria by delivering a large, uninterrupted interior sanctuary space in materially and economically efficient manner.

Having previously completed an initial analysis of the structure [2], now, 60 years later, a complete structural forensic evaluation of the shell has been conducted using full point cloud laser scanning to generate a complete in-situ model. The geometry is analyzed and deflections are compared to original design and construction documents to facilitate repair and maintenance of this architecturally and historically significant structure. A full structural evaluation of the roof and connecting structure has been completed. The forensic survey shows minor shear cracks throughout the shell field and deterioration of the underside of the shell. However, deflection at each tip of the hyperbolic parabola is negligible compared to the design – highlighting the robust geometric stiffness and apparent resiliency of the prestressing. Results of the current in-situ geometry are compared to the design geometry of original construction documents.

Ongoing work includes detailed CFD modeling to determine accurate wind loads as well as comparison of historical and current design standards.

REFERENCES

- [1] S. Pettit, "Landmarks: St. Charles a Modernist Gem", *Inlander*, 2017.
- [2] Schultz, J. and Henriksson, V. (2021) Structural assessment of St. Charles hyperbolic paraboloid roof. *Curved and Layered Structures*, Vol. 8 (Issue 1), pp. 157-166. <https://doi.org/10.1515/cls-2021-0015>