Structural and Environmental Stabilization of a Historic Wood-Framed Museum

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ABSTRACT

The Antelope Valley Indian Museum (Figure 1) is a historic one- and two-story wood-framed structure, built in the late 1920s through the 1930s near Lancaster, California. The museum houses a collection of Native American artifacts and also documents how these artifacts were interpreted by the various owners and curators, including the original owner, Howard Arden Edwards. Given that the collection was inadequately protected from temperature fluctuations, the State of California embarked on a program to insulate the building, heat and cool the museum using geothermal heat sinks, and structurally and seismically rehabilitate the building.

The existing structure was not engineered and was built in several phases with a minimum of structural framing elements, even considering standard construction practices in the 1920s and 1930s (Figure 2). Roof sheathing is composed of 1x boards that span between steeply pitched 2x4 roof rafters at up to 4-feet on center. The roof sheathing and framing are not adequate to support code-level live loads, making re-roofing as well as structural strengthening difficult. The addition of insulation and associated wood framing to the roof of the museum adds a significant amount of weight -- nearly doubling the weight of the structure. The structure resists lateral forces through straight-sheathed roof diaphragms, weak frame action of the roof trusses and exterior walls, and perpendicular walls. The structure is so flexible, it visibly moves during windstorms. As the interior finishes are actually the exposed structural elements, structural strengthening to protect the historic elements of the structure can result in the diminishment or destruction of the very historic elements one is trying to protect -- particularly if the strengthening is not performed judiciously; consequently any structural intervention must be carefully weighed against the potential impacts on the historic fabric and against cost of the work. In this case, nearly every surface is covered with painted murals and artwork, making traditional strengthening and rehabilitation measures (such as adding structural wood shear walls) difficult or impossible in most areas.

The authors selected an unusual arrangement of angled and inclined external stainless steel cables (tension guy wires) to provide increased lateral stability, and horizontal internal cables (tension collar ties) to increase the vertical load capacity of the gabled roof areas (Figure 3). The tension guy wires lend themselves fairly well to bracing this light structure; since they connect directly to the roof joists, the cables take lateral forces directly down to either stainless steel eyebolts epoxied into the surrounding rock or small concrete anchor blocks. The tension collar ties are used to create trusses out of the inclined gabled roof joists. Since the cables are relatively unobtrusive, since they clearly are not part of the original construction, and since they are almost wholly reversible, the addition of cables appeared to be a reasonable solution for the bulk of the museum.

This paper documents this historic preservation project from start to finish, including the geothermal design, the historic structural stabilization, and the seismic strengthening.

Figure 1: Antelope Valley Indian Museum

Figure 2: Historic photo of construction of the Antelope Valley Indian Museum

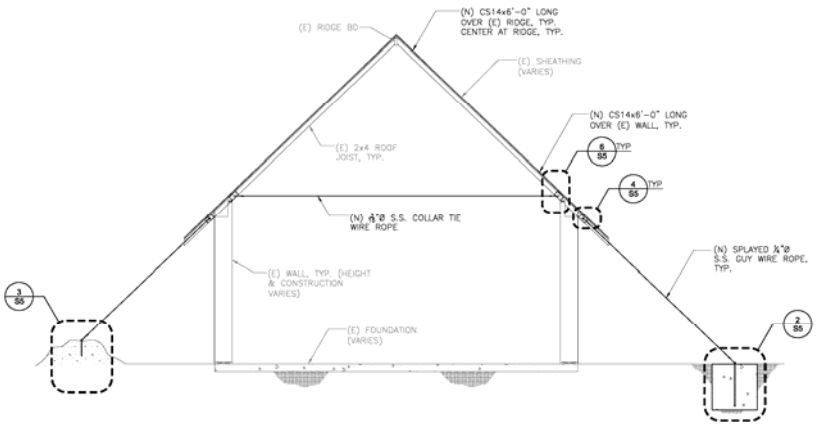

Figure 3: Schematic diagram showing strengthening measures using wire cables.