Historic Alameda High School Retrofit

Part 1: Too Valuable to Demolish, Too Expensive to Retrofit

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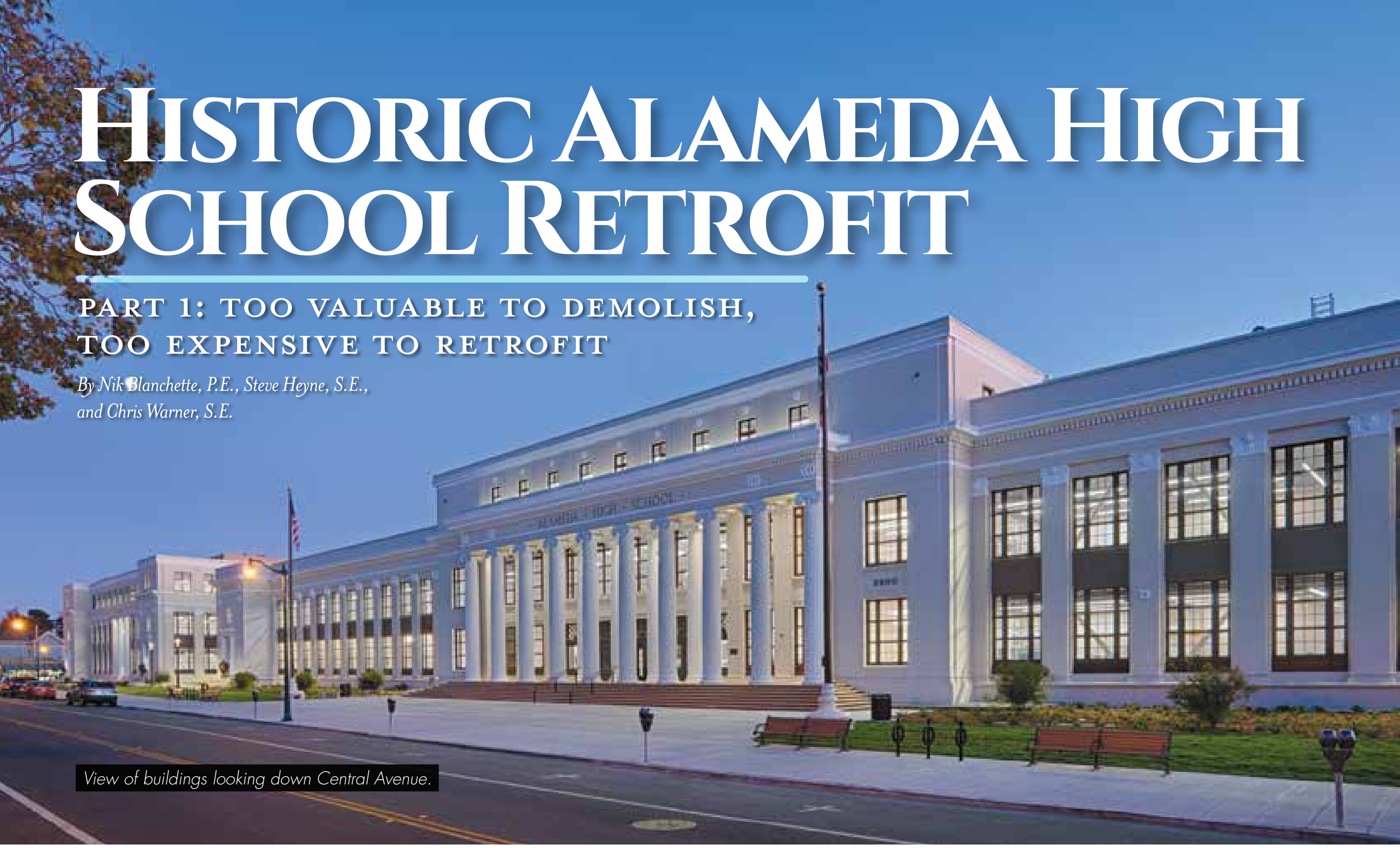


View of buildings looking down Central Avenue.

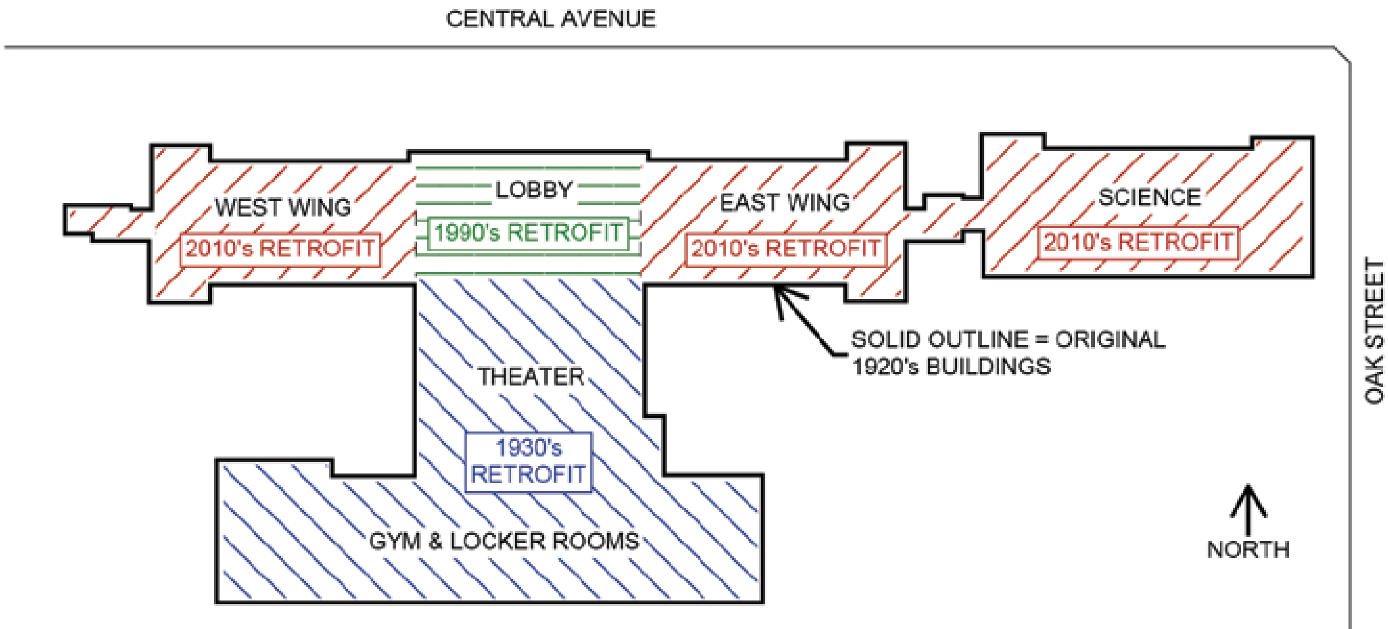
In 2012, the Alameda Unified School District in Alameda, California, made the difficult decision to fence off and vacate all three historic classroom buildings on the Historic Alameda High School (HAHS) campus due to seismic safety deficiencies. These buildings and the attached auditorium, lobby, gym, and locker room buildings had stood since 1924. However, the classroom buildings lacked approval under California's Field & Garrison Acts, putting the school district at legal risk (and any building occupants at life safety risk). The long process to rehabilitate and restore these nearly century-old buildings had entered its final chapter.

A school destroyed by the 1933 Long Beach earthquake.

The Structures

The original campus, standing three stories tall, has an impressive presence spanning an entire block of Central Avenue adjacent to the downtown district of Alameda. The buildings are of neoclassical style with grand concrete entry columns, emulating the stone columns of ancient Rome, and elaborate detail work throughout the exterior.

The buildings consist of cast-in-place reinforced concrete exterior walls supported by shallow foundations. All floors and roofs are wood-framed, except the second-story corridor floors, which were concrete (and removed during the retrofit). Reviewing the buildings against either ASCE 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, or ASCE 41, *Seismic Evaluation and Retrofit of Existing Buildings*, showed that the major elements of the lateral force-resisting system were significantly deficient, lacking strength, stiffness, and interconnection.



Key plan of building retrofit history.

The Field Act

In the early evening of March 10, 1933, less than 10 years after the construction of the HAHS campus, a magnitude 6.4 earthquake jolted Long Beach, California. Widespread damage occurred, primarily to unreinforced masonry structures. Among the wreckage were 70 destroyed schools and 120 damaged schools, totaling about 75% of the schools in the Long Beach area. Thankfully, few students and staff were present, though fatalities were not avoided.

The 1933 Long Beach earthquake resulted in creation of the Field Act for new public school construction in California, one of the early pieces of legislature incorporating seismic standards in building design. The Act prohibited unreinforced masonry construction and required consideration of a seismic design force. The Act also created the Division of the State Architect (DSA) to oversee the design and construction of public schools. DSA reviews several billions of dollars of construction every year for K-12 schools and community colleges throughout California. Since the creation of the Field Act, no public school building has collapsed, nor has loss of life occurred in a public school building due to an earthquake. The Field Act was followed by the 1939 Garrison Act, which provided criteria for analysis and rehabilitation of existing public school buildings constructed prior to the Field Act.

A Retrofit Unrealized

The 1933 Long Beach earthquake was a "wake-up call," resulting in the preparation of seismic rehabilitation drawings for the HAHS campus. Reinforced concrete shear walls were specified to supplement the overstressed diaphragms and highly fenestrated exterior concrete walls. Horizontal steel truss diaphragms were specified to augment the straight sheathed wood roof diaphragms. Concrete wall-to-diaphragm anchorage was to be improved. Unfortunately, only the locker rooms, gym, and auditorium improvements were upgraded, presumably due to limited funding. The classroom wings, auditorium lobby, and science building were not upgraded.

For decades following, students and faculty still occupied all buildings. Based on a study of available documents from the school district, this issue had sporadically been discussed among hired structural engineers and the Division of the State Architect. Finally, in 1978, students were moved to a replacement campus down the street, leaving behind the large, underutilized, historic, seismically deficient buildings. During this time, one of the wings was fully vacated and remained so until the retrofit was completed in the 2010s. The other classroom wing and science building served various uses, such as adult school classrooms, a public library, and district office space.

In 1977, the community failed to pass bonds to rehabilitate the remaining non-upgraded historic buildings, so the school board voted to demolish the 50-year-old deficient buildings. However, a group of community leaders rejected the idea of losing the historic property and rallied to save the buildings. Also in 1977, perhaps not so coincidentally, the campus was recognized as a national historic monument and was placed on the National Register of Historic Places. Finally, in 1989, the group was able to pass a bond that paid for rehabilitating the auditorium lobby and seismically isolating it from the classroom wings. This allowed students to use the lobby and auditorium, sandwiched between the deficient classroom wings.

Structural debris fence surrounding an abandoned building.

A Path to Rehabilitation

In 2012, at the school district's request, ZFA Structural Engineers completed a districtwide review of DSA project certifications. During this review, it resurfaced that prior rehabilitation work to make the subject structures compliant with the Field Act was never performed. Based on this information and consultations with the DSA, the three-story science building and the two-story classroom wing that had been in use were abandoned entirely. A structural fence was erected around the buildings to prevent potential falling debris from harming the public. The 1977-78 scenario essentially replayed itself: the buildings presented a financial burden and liability to the school district, while the community, including the local historical society, saw the value of the buildings and wanted them preserved.

California voters approved Proposition 1D in 2006, which provided $199.5 million for critically seismic deficient public school buildings across the state. Under the Seismic Mitigation Program (SMP), eligible buildings receive matching funds (i.e., 50% cost reimbursement) from the state for seismic rehabilitation costs.

The DSA created Procedure 08-03 to outline the SMP process to stakeholders. The first phase is the Eligibility Evaluation Report (EER) that quickly screens and confirms the eligibility of buildings for SMP funding. Next, if the rehabilitation cost is shown to be less than half of the building replacement value, the building is eligible for rehabilitation funding; otherwise, if the cost is greater, it is eligible for replacement funding. The third phase for seismic rehabilitation is the Evaluation and Design Criteria Report (EDCR). The report characterizes the building, describes the structural analysis procedure, and outlines data collection requirements. The fourth phase is the creation of rehabilitation construction documents subject to review and approval by the DSA. The fifth and final phase is funding from the State, which occurs after the project is constructed in accordance with the DSA-approved plans.

Before involvement with the HAHS project, ZFA Structural Engineers was one of two firms hired by the State to help create the EER template as a modified version of ASCE 31, *Seismic Evaluation of Existing Buildings*, (now Tier 1 & 2 of ASCE 41) to identify which critical seismic deficiencies are most likely to trigger the collapse of the building. The EER is a uniform, straightforward approach to screen vulnerable buildings. However, some building types are excluded from eligibility due to inherent redundancy and documented performance in earthquakes, such as buildings primarily framed with wood. An example of a critical deficiency is wall anchorage; if the wall anchorage is deficient, the diaphragm could separate from the wall, and the building could collapse.

While the EER is a quick look at some aspects of the building, the EDCR represents a more significant review of the existing construction. There are numerous sources of uncertainty in the analysis of existing buildings. Construction standards in structures built long ago, including quality assurance and quality control, were typically less rigorous than current industry practice. The EDCR is the time for the DSA and the design professional to agree on an approach to analyzing the existing building. The report describes the existing construction, potential deficiencies, a methodology for calculations, and data collection.

Data collection is expected to substantiate the material properties of the existing building to be used in rehabilitation design. The main form of data collection is material testing in accordance with ASCE 41. For each building material, ASCE 41 specifies the type and quantity of testing to perform, such as concrete cores, steel coupons, or visually grading lumber. DSA reviews and approves the EDCR before the submittal of the construction documents for the rehabilitation project. Ideally, the EDCR process leads to a smoother review of the rehabilitation drawings by the DSA.

The SMP rehabilitation must follow an ASCE 41 Tier 3, Systematic Evaluation and Retrofit approach. Every component resisting seismic forces must be analyzed and shown to comply with current code requirements as if it were a new building. The retrofit is not limited to the deficiencies identified in the EER. DSA specifies the performance objective: a seismic hazard (i.e., demand) and a performance level (i.e., capacity). The performance objective for a rehabilitation of this nature is similar to what DSA specifies for new construction. Accessibility and fire life safety aspects of the building must also be made to comply with current regulations.

The SMP, along with the community discussions, convinced the school board that the retrofit of the buildings was viable, and they went forward to place and pass a bond on the ballot in 2014. This project was the largest funded in the bond.

A follow-up article will detail the technical challenges and achievements of retrofitting a nearly 100-year-old structure under DSA jurisdiction while maintaining the historic significance.▪

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