Degenkolb

Tsunami Safety Leadership

Tsunami evacuation Tower in Tokeland, WA built by the Shoalwater Bay Indian Tribe.

Established Leadership in Earthquake and Tsunami Safety

Founded in 1940, Degenkolb Engineers' practice reflects more than eight decades of commitment to earthquake and tsunami safety. Whether it's developing new building code provisions to incorporate lessons learned from past earthquakes or leading a public workshop related to tsunami evacuation, Degenkolb strives to provide leadership in our communities.

Our Seattle office led the development of the Resilient Washington State Initiative, participated in many school earthquake safety efforts, and was a technical advisor for Project Safe Haven: Grays Harbor County. Over the past decade we have worked with many coastal communities on tsunami evacuation projects and have helped obtain over $20m in FEMA funding for our clients. We live and work in Cascadia; designing safe and resilient buildings is not just a point of pride for our engineers, it's important to us as members of the community.

Professional & Technical Staff

17 Senior Principals
30 Principals
52 Associates, Associate Principals, Senior Associates
154 Staff Engineers
19 CAD/BIM Specialists

Offices

San Francisco
Detroit
Grand Rapids
Los Angeles
Oakland
Orange County
Sacramento
San Diego
Seattle
Mexico

Ocosta Elementary School, Tsunami Vertical Evacuation Building, Westport, Washington

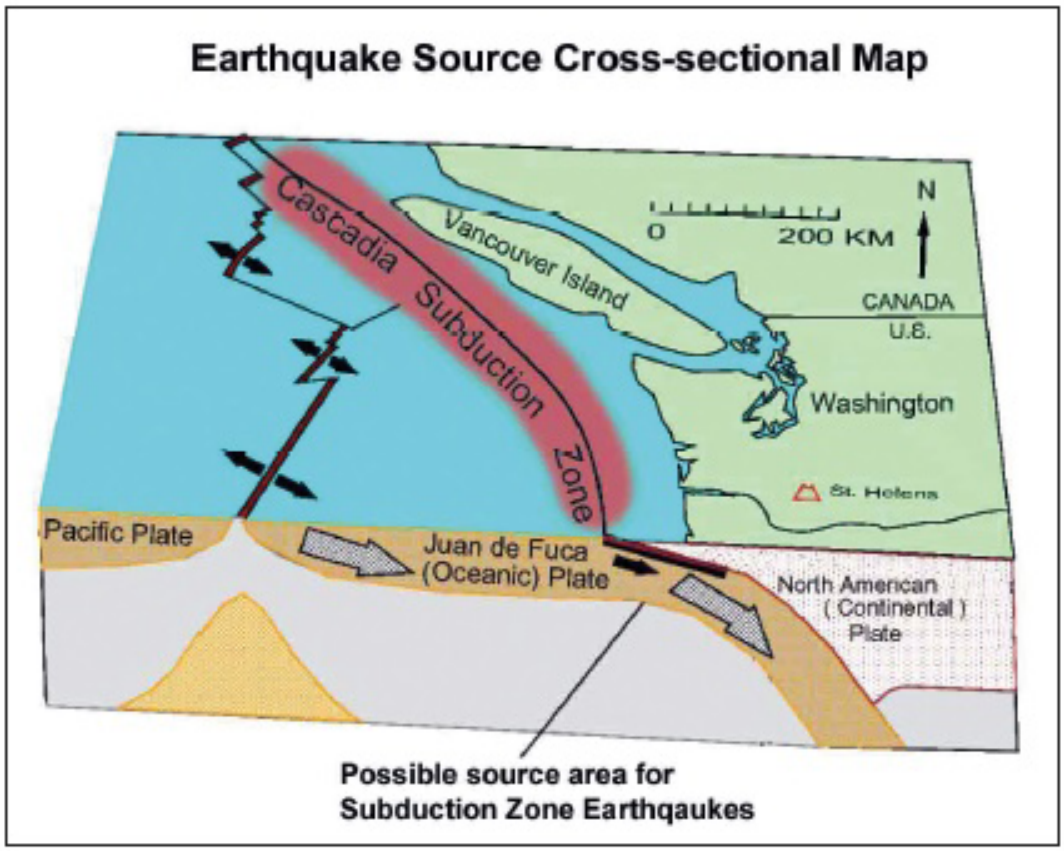
Degenkolb Engineers designed the structural system for the Ocosta Elementary School and tsunami vertical evacuation refuge. The evacuation structure is the first of it's kind in the US. The roof of the school gymnasium is a designated safe refuge and it has a capacity for over 1,000 people. Performance-based design methodologies were implemented to ensure that the structure would be able to resist a Cascadia earthquake while having sufficient capacity to resist subsequent tsunami inundation forces. Degenkolb worked closely with the University of Washington-based inundation modeling team to develop key design parameters, resulting in a safe refuge which is 55 feet above sea level and 28 feet above grade. The building features reinforced concrete stair towers and concrete-encased columns to protect against impact forces, drilled piles to resist scouring and liquefaction, and contains measures to prevent progressive collapse due to extreme impact loads.

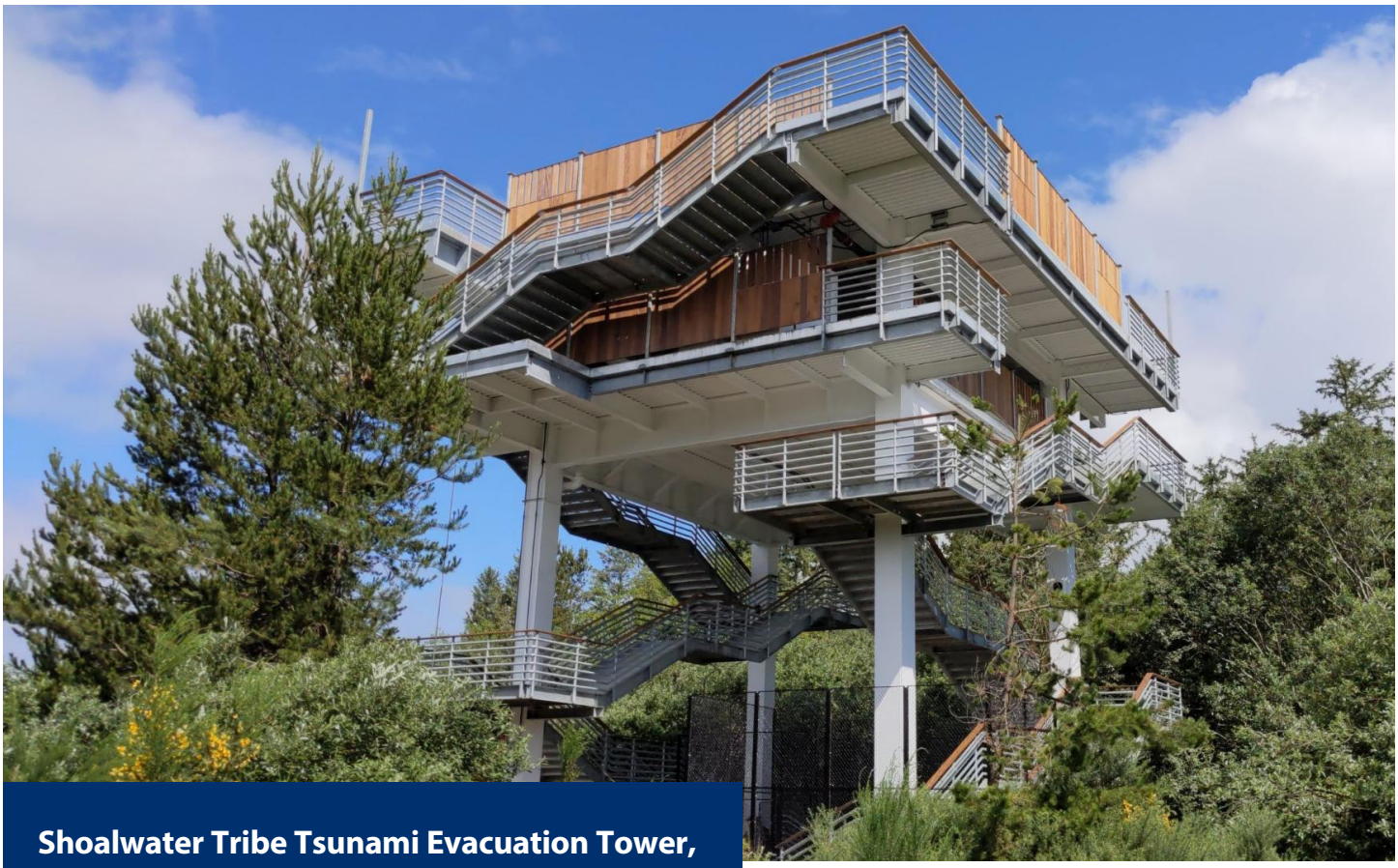
Project Safe Haven: Tsunami Vertical Evacuation, Washington Coast

Degenkolb Engineers served as a Technical Advisor for Project Safe Haven: Tsunami Vertical Evacuation on the Washington Coast. The project utilized a grassroots process to develop vertical evacuation strategies for several communities in both Grays Harbor and Pacific counties. The Project Safe Haven process included both World Café methods and community design charrettes to allow community member consideration of evacuation options ranging from buildings and towers to raised earthen berms.

Degenkolb provided the team with structural engineering guidance for each evacuation option. These conceptual designs were used to develop cost estimates for future planning purposes. Both the Ocosta School site and Long Beach Elementary were identified as a safe haven location due to the large number of students and staff present during much of the year.

Figure 10: South Beach preferred strategy map





Shoalwater Tribe Tsunami Evacuation Tower, Tokeland, Washington

The Tokeland community and nearby communities on the Washington coast are susceptible to tsunamis induced by earthquakes along the Cascadia Subduction Zone. A vertical evacuation tower provides refuge from a tsunami in vulnerable areas. As part of the project, Degenkolb assisted the Shoalwater Bay Indian Tribe with securing more than $3M through a FEMA grant for a tsunami evacuation tower in Tokeland.

Once funding was secured, Degenkolb led the design of the freestanding tower, a first of its kind structure in the United States. To secure the tower, concrete pilings were installed 55 feet deep into the sandy soils, while the upper platform stands at 43 feet above the ground, well above the maximum wave height modeled by research partners at the University of Washington.

Construction of the tower was completed in 2023 and the tower opened to the public in August. With a 400 person capacity, the tower will serve as a refuge for the local tribe and other neighboring residents in the event of a tsunami. The Shoalwater Bay Indian Tribe specifically designed the tower as a safe refuge available to the entire community.

City of Ocean Shores Tsunami Evacuation Tower, Ocean Shores, Washington

Forming the north end of Grays Harbor, the Ocean Shores peninsula is relatively wide, has many bisecting waterways and bridges, and lacks natural high ground for tsunami evacuation. The community participated in Project Safe Haven which identified Ocean Shores Elementary School as an ideal site for an evacuation tower.

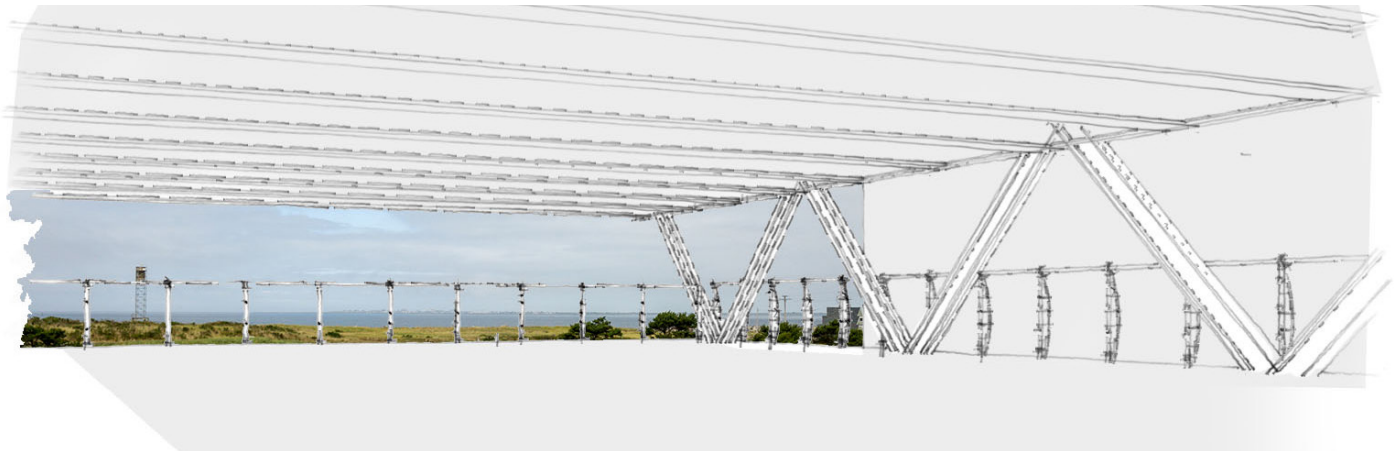
Degenkolb developed a conceptual design for a tsunami evacuation tower sited just north of the elementary school. The tower will accommodate at least 800 people on two levels with the first safe refuge level located 50 feet above grade.

Degenkolb assisted the City of Ocean Shores on a successful FEMA hazard mitigation grant application to obtain $3.59m in funding for the project and was recently selected to complete

City of Westport Tsunami Evacuation Tower, Westport, Washington

The Westport Marina District is a popular tourist destination and is home base for Washington's coastal seafood industry. Westport is also vulnerable to a Cascadia earthquake and tsunami and the Marina District represents a compelling location for an evacuation tower. Degenkolb partnered with the City in developing a conceptual design for a 1,000-person multi-purpose tsunami vertical evacuation tower.

The tower is planned to serve as a viewing platform and can accommodate a variety of grade-level events such as farmers market and performance stage. Degenkolb also assisted the City with a successful FEMA BRIC grant application that will provide over $13M in funding for the project.



City and County of Honolulu Tsunami Ready Program, Honolulu, Hawaii

Degenkolb Engineers worked with the City and County of Honolulu on improving the tsunami safety along the coast of Oahu by developing a Tsunami Ready structural evaluation program. This leverages national standard ASCE 7-16, which includes provisions for tsunami loads and effects on building structures, by developing an evaluation criteria to screen and evaluate buildings which may be viable for tsunami vertical evacuation. The evaluation procedures were developed similarly to ASCE 41-13 – Seismic Evaluation and Retrofit of Existing Buildings to take advantage of the familiarity of an existing evaluation procedure.

Degenkolb developed both a checklist-based screening and a detailed evaluation procedure to determine which existing buildings may be used for tsunami vertical evacuation purposes. Although this procedure focuses on the typical construction on Oahu, it can also be expanded to other tsunami-prone regions of the world.

Tsunami Evacuation Refuge & Fire Training Tower, Pacific County Fire District No. 1, Ocean Park, Washington

Pacific County Fire District 1 serves the northern end of the Long Beach peninsula where residents have little natural high ground for tsunami evacuation. The Fire District also does not have local access to a fire-training academy.

Degenkolb provided conceptual design for a multi-function, two-level tsunami evacuation tower. The upper level is the designated tsunami safe refuge while the lower level is primarily used for fire training purposes but also accommodates storage for emergency supplies. Access to the 400-person capacity safe refuge is provided thru both stairs and a ramp.

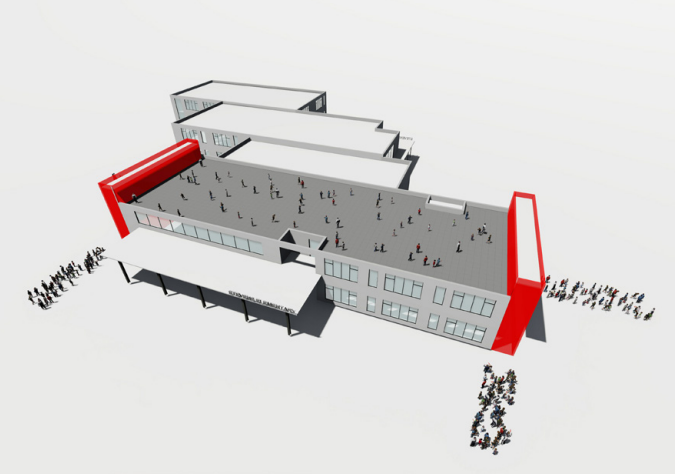
The current design phase was funded through the FEMA Advanced Assistance grant program. The Fire District is seeking local funding before proceeding with a FEMA hazard mitigation grant application for the remainder of the design and construction.

Aberdeen School District, Stevens Elementary School Tsunami Evacuation, Aberdeen, Washington

Stevens Elementary is the oldest building in the Aberdeen School District and is located within the tsunami inundation zone. Residents have to quickly evacuate the low-lying community after a Cascadia Subduction Zone earthquake.

Degenkolb provided conceptual design for a replacement 76,000 SF building with an integrated vertical evacuation refuge on the roof of the building. The 14,000 SF safe refuge, with a minimum capacity of 1,400 people using FEMA guidelines, will be accessible for students, faculty, staff, and adjacent neighboring residents. Degenkolb helped the District obtain $3m in FEMA hazard mitigation grant funding to offset the cost premium of the tsunami safe refuge.

Degenkolb participated in several outreach efforts for both the public and the school board to guide a community-based decision on the school location.



Cale Ash, PE, SE

Principal, Group Director

Education

M.S., Structural Engineering, University of Illinois at Urbana-Champaign, 2003

B.S., Civil Engineering, University of Illinois at Urbana-Champaign, 2001

Professional Registration

WA Structural Engineer, License No. 44835

WA Civil Engineer, License No. 44835

OR Professional Engineer, License No. 3342

CA Civil Engineer, License No. 68913

CA Structural Engineer, License No. 5305

HI Structural Engineer, License No. 17905

AK Structural Engineer, License No. 102591

Qualifications

Cale Ash joined Degenkolb Engineers in 2003 after earning his Masters Degree in Structural Engineering from the University of Illinois.Cale has led or participated in numerous projects and initiatives that provide safety from a tsunami and improve the resiliency of a community after an earthquake. Cale has been involved in Project Safe Haven as a technical advisor, developing tsunami strategies for coastal communities throughout Washington. He was engineer of record for the nation's first tsunami safe refuge at the Ocosta Elementary School in Westport, Washington. He has assisted several other communities along the coast, helping communities obtain over $20m in FEMA grant funding for tsunami evacuation projects. Cale is a past president of both the Cascadia Region Earthquake Workgroup (CREW) and the Structural Engineers Association of Washington (SEAW).

Relevant Experience

Ocosta School District, Ocosta Elementary School, w/Vertical Tsunami Evacuation Refuge, Westport, WA

- Nation's first tsunami vertical evacuation refuge
- Project raised awareness of tsunami mitigation options for neighboring communities

Shoalwater Bay Indian Tribe Tsunami Evacuation Tower, Tokeland, WA

- Designed two-level tsuanmi safe refuge to accomodate a minimum of 400 people
- Helped Tribe obtain about $3M in FEMA grant funding

Aberdeen School District, Stevens Elementary School Replacement & Tsunami Evacuation Refuge, Aberdeen, WA

- Conceptual design for replacement 76,000 SF school building with 14,000 SF integrated vertical evacuation refuge and minimum capacity of 1,400 people
- Helped District obtain $3M in FEMA grant funding

City of Westport, Marina District Tsunami Evacuation Tower, Wesport, WA

- Conceptual desing for 1,000 person evacuation tower
- Helped City obtain $13.7M in FEMA grant funding

Project Safe Haven, Washington Coast

- Technical Advisor to develop community-based vertical evacuation strategies for Grays Harbor and Pacific counties
- Raised awareness of tsunami mitigation options for neighboring communities

Pacific County Fire District No 1, Tsunami Evacuation Refuge & Fire Training Tower, Ocean Park, WA

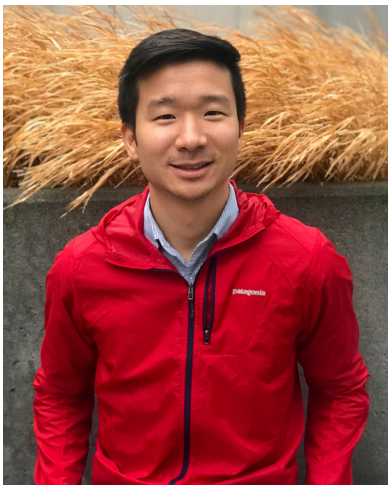
- Conceptual design for multi-function, two-level tsunami evacuation tower to accommodate more than 400 people

City of Ocean Shores Tsunami Evacuation Tower, Ocean Shores, WA

- Developed conceptual design for tsunami evacuation tower to accommodate more than 800 people on two levels
- Helped City obtain $3.59M in FEMA grant funding

City and County of Honolulu, TsunamiReady Program, Honolulu, HI

- Developed both a checklist-based screening and a detailed evaluation procedure to evaluate existing buildings for tsunami vertical evacuation purposes



Heejae Yang, PE, SE

Associate

Education

M.S., Civil Engineering,
Johns Hopkins University, 2009

B.S., Civil Engineering,
Johns Hopkins University, 2008

Professional Registrations

WA Structural Engineer,
License No. 51786

WA Civil Engineer,
License No. 51786

CA Civil Engineer,
License No. 83735

Qualifications

Heejae Yang joined Degenkolb in 2017 with more than eight years of experience after graduating from Johns Hopkins University with his Master's in Civil Engineering in 2009. Heejae brings a background in tsunami structure design, performance-based earthquake design, and nonlinear dynamic analysis. He has worked on several vertical tsunami evacuation structures along the Washington coast and in Hawaii. His experience with performance-based design and peer-reviewed design process, both as reviewer and reviewee, brings innovative solutions that are not bounded by Building Codes and existing construction and design methods. His expertise includes steel-concrete composite construction, mass timber construction, seismic base isolation system, and high-rise lateral systems.

Relevant Experience

Ocosta School District, Ocosta Elementary School, w/Vertical Tsunami Evacuation Refuge, Westport, WA

- Nation's first tsunami vertical evacuation refuge
- Project raised awareness of tsunami mitigation options for neighboring communities

City of Westport Tsunami Evacuation Tower, New Design, Westport, WA

- Conceptual desing for 1,000 person evacuation tower
- Helped City obtain $13.7M in FEMA grant funding

City of Ocean Shores Tsunami Evacuation Tower, Ocean Shores, WA

- Developed conceptual design for tsunami evacuation tower to accommodate more than 800 people on two levels
- Helped City obtain $3.59M in FEMA grant funding

Shoalwater Bay Indian Tribe Tsunami Evacuation Tower, Tokeland, WA

- Designed two-level tsuanmi safe refuge to accomodate a minimum of 400 people
- Helped Tribe obtain $2.8M in FEMA grant funding

City and County of Honolulu Tsunami Ready Program, Honolulu, HI

- Developed checklist-based screening and evaluation procedures
- Program can be expanded to other tsunami-prone areas of the world

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