DECEMBER 26, 2004 TSUNAMI IMPACTS ON COASTAL THAILAND

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On January 31, 2005, the American Society of Civil Engineers (ASCE) sent a team of engineers to the west coast of Thailand to investigate and document damage resulting from the December 26, 2004 tsunami. This tsunami was caused by a magnitude (Mw) 9.0 earthquake off the coast of Sumatra, Indonesia southwest of Thailand. The investigation covered about 150 km of the coastal region including the highly impacted areas of Phuket, Khao Lak and Phi Phi Don Island. Although 10,000 fatalities were suffered, the team focus was to document damage to coastal lifelines and other coastal facilities incurred by the tsunami generated from 500 miles to the west.

Rugged cliffs interrupted by pocket beaches characterize the Phuket coastline. These beaches are highly developed and contain most of the resorts, commercial support and resident housing for the communities. Many of these facilities are in close proximity to the beach and were subjected to the most destructive forces of the tsunami. The tsunami was generally characterized by a receding wave followed by three surging waves, depending on the location. The first wave was the smallest but still did a great deal of damage. As a result, the second and third waves contained large amounts of debris (trees, furniture, cars, glass, rocks, etc.) that caused far more casualties and damage than the saltwater waves alone.

High velocity, debris-ladened waves took their toll on many other coastal lifelines. On Phi Phi Island, the water system consists of many individual public/private well, reservoir and tank systems. Those located in the low areas were completely inundated by the saltwater waves. Some systems were temporarily restored. The lower-lying portions of the sewer system in Patong Beach were completely flooded by the tsunami waves. This included large portions of the gravity sewer system and six of their 13 pumping stations. The waves introduced salt water into the system, which entered the activated sludge type treatment plant causing it to fail. Many of the electrical power systems were disrupted along much the tsunami-affected areas. Thailand uses reinforced concrete power poles, which have been known to do very well during earthquakes. However, many of these poles were battered by debris and sheared off at the base.

Most of the bridges in the region are reinforced concrete supported on piers, abutments and deep foundations. Most of the damage was associated with abutment scouring and erosion and battering of concrete railings. Minor erosion was simply repaired using fill to restore the road surface. One bridge in Khao Lak was reported to have been swept away because of severe approach/pier erosion.

Khao Lak, a new upscale resort area north of Phuket, was completely devastated by waves that exceeded 10-m high in places. Resort infrastructure was almost total destroyed and all hotels are closed for extensive repair. Foundations were scoured, walls collapsed by wave pressure, and roof tiles removed by wave impact.

A fishing port, Ban Nam Ken, north of Khao Lak, had extensive damage to concrete piers and nearly all the fishing fleet either destroyed in place or washed a km inland. The local Navy base was severely damaged by the tsunami waves. Ships were beached and shore facilities flooded. The Navy's water treatment plant and electrical generation facility were damaged. This hindered the Navy's ability to aid in the tsunami response efforts.

Lastly, one aspect of the restoration process found during this investigation, compared to many others around the world, was that repairs/restoration is moving very rapidly. Unfortunately for documentation of damages, much of the debris has been cleared on the 100s of kilometers of inundation areas inspected. 60% of the destroyed/damaged buildings had been demolished and removed. 50% of the remaining buildings are under restoration with over 1% of them already open. A true honor to the people of Thailand.

In stark contrast to the "mainland" recovery efforts, Phi Phi Island, where approximately 3,000 people were killed, is only now beginning to recover. This island is mostly privately owned and requires boats or helicopter access. As a result, recovery has been slow. Originally, the provincial government would not allow the disposal of collected debris. This decision was reversed around February 1 and now clearing and disposal by barge is progressing.

In addition, it was indicated that Phi Phi Island would begin a planning process to limit construction in the vulnerable areas to avoid future catastrophes. Much of the formerly developed area that was wiped out will apparently be converted to a memorial park.

LESSONS LEARNED

Based on local reports and review of the various videos, it is apparent that most of the tourists and local peoples were not aware of the dangerous waves that were about to hit them. If there had been a tsunami warning system (or simply an awareness through education) thousands of lives would have been saved.

One of the greatest lessons learned from the event is that designers need to plan for tsunami inundation and the force of impact from the waves and associated debris. Structures can be designed with "flow through" first stories with limited structural areas facing the tsunami. Another aspect is that drainage control for the ebbing tide is just as critical. Adequate drainage in facilities could be an

effective means to prevent erosion and impact damage of critical infrastructure facilities.

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PHOTOS:

11Phi Phi Island Damage – 07° 44.379N; 98° 46.335E

11Damaged Fishing Pier - 08° 34.226N; 98° 13.439E

11Khao Lak - 8° 41.45N; 98° 14.49E