Post Tsunami Reconstruction in Indonesia

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Summary

The 26 December 2004 Indian Ocean tsunami, triggered by the Sumatra-Andaman earthquake, devastated the northwest coast of the Aceh Province in Indonesia. Long segments of the coastal highway and 90 bridges were destroyed. The loss of the highway crippled transportation, hampered post tsunami aid relief, and created great social and economic hardships. Under contract to the U.S. Agency for International Development (USAID), Parsons designed the roadway and replacement structures. Spliced precast I-beams, steel trusses and box culverts were selected as replacement structure types based on local construction means and methods, site accessibility and economy.

Keywords: Sumatra-Andaman earthquake; tsunami; temporary bridges; Bina Marga design code; spliced precast I-beams; steel truss bridges; box culverts.

1. Emergency Bridge Construction

A year after the tsunami we drove the 240 km coast highway between Meulaboh and Banda Aceh and observed first hand the emergency bridge constructions. At some waterways temporary panel bridges had been constructed. These were holding up well for the most part except for the timber decks that were becoming worn and had occasional missing planks. Other bridges seemed to be of local design and construction from materials that could be obtained locally. Many bridges were made of tree trunks and logs. The nicer variety of these had timber plank decks. The photo in Figure 1 shows a log bridge with planks positioned to align with vehicle wheels. In the water is the bottom side of a truss bridge that was destroyed by the tsunami.

Fig. 1: Post-tsunami Emergency Bridge January 2006

2. Structure Type Selection

A key constraint driving the structure type selection of replacement structures was site accessibility. Construction equipment and material delivery would have to be made over dirt roads and temporary bridges that proved unreliable at times. Another constraint was material availability. Precast concrete I-girders and piles were available from fabricators in Medan, Indonesia, 300 km away by road. Steel girders would have to come from Jakarta, a 1500 km trip by sea and land. Another constraint was accepted design and construction practices. For example, jointless integral abutment bridges, proposed by Parsons, were rejected by Indonesian MPW because they were not

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familiar with that construction method. Steel bridge barrier railing, recommended by Parsons, was rejected in favour of cast-in-place concrete barrier due to concerns that it would be stolen for steel scrap. Parsons proceeded with preparation of standard plans for three types of structures, these were cast-in-place box culverts, prestressed concrete I-girder bridges and steel truss bridges. These satisfied the constraints of site accessibility, material availability, and common construction practices.

2.1 Box Culverts

60 of the 90 structures were replaced by reinforced concrete box culverts. Culverts were constructed cast-in-place to eliminate the challenges associated with shipping precast boxes. Concrete was mixed at batch plants setup by the contractor at various locations along the project corridor. The standard structural plans for single cell and multi-cell box culverts accommodated cells as large and 3 m x 3 m and cover depths ranging from 0 m to 10 m.

2.2 Prestressed Concrete I-Girder Bridges

The Indonesian MPW requested that the maximum concrete I-girder length be limited to 33 m. Due to shipping constraints and to facilitate erection, precast concrete I-beams were fabricated in approximately 6 m long segments. At the bridge site, segments are assembled and post-tensioned into a continuous beam. Epoxy is applied to the keyed mating surfaces prior to post-tensioning. The preferred erection method is to launch the individual girder segments across temporary supports. They are post-tensioned after the segments are in position from one bridge pier to another.

Fig. 2: Precast Segment About to be Launched

2.3 Truss Bridges

For bridges longer than 45 m, steel truss bridges were the contractor's bridge type of choice especially if this eliminated pier work in the river. Steel truss spans ranged from 40 m to 80 m in length. Beyond 80 m, truss bridges were comprised of multiple spans. The longest truss bridges consisted of two spans of 60 meter trusses.

3. Conclusions

The Sumatra-Andaman earthquake was the largest magnitude earthquake known to ever strike Southeast Asia. The resulting tsunami claimed more lives than any other tsunami in history. The devastation instigated social and economic changes, led to the end of a 30 year civil war, afforded the U.S. an opportunity to express generosity to the largest Muslim population country in the world, and through the highway reconstruction provided economic stimulus to the impacted region.

The urgent need to reconstruct the coast highway necessitated a shortened design schedule. A programmatic design process was effective in coordinating the efforts of staffs located in multiple Parsons' offices and with USAID, USACE and the Indonesian MPW.