

## 2. Route 20 - Nanbu Cross-Island Highway (南部橫貫公路)

There were many failures along Route 20. Several representative sites are presented in this section.

### 2.1 Jia Xian (甲仙鎮)



#### a) Jia Xian Bridge (甲仙大橋)

Sept 5, 2009; 10:33 am (23°04'51"N 120°35'06"E elev 242 m)

The Jia Xian Bridge was severely damaged by flooding (Photo 2-1-1) and a temporary access was built, as shown in Photo 2-1-2. Part of the bridge deck and piers (with steel pipe) disappeared. The retaining walls near the bridge abutment collapsed due to scouring (Photo 2-1-3).



Photo 2-1-1. Collapsed Jia Xian Bridge.



Photo 2-1-2. Temporary access bridge near Jia Xian Bridge.



Photo 2-1-3. Collapse of retaining walls at the abutment of Jia Xian Bridge.

b) Side Bridge (四德大橋, L= 240 m)  
Sept 5, 2009; 12:58 pm (23°05'26"N 120°35'17"E elev 255 m)

Side Bridge was also damaged by flooding. Almost the entire bridge deck disappeared, and part of the span was carried a distance down the river. Several piers disappeared, though the abutments remained. Timber debris piled at the site. The retaining walls near the bridge failed by scouring.



Photo 2-1-4. Part of the superstructure and pier foundation disappeared (Side Bridge).



Photo 2-1-5. A span was washed downstream (Side Bridge)



Photo 2-1-6. Scouring of the river bank and road. Note that part of a retaining wall stayed in the riverbed (Side Bridge).

Another bridge nearby the site (marked as 3 in the map;  $23^{\circ}05'44''\text{N}$   $120^{\circ}35'39''\text{E}$  elev. 262 m) remained intact, but significant amounts of gravel and timber debris were deposited under the deck and on the road (Photo 2-1-7). Many landslides occurred in the mountains near the site (Photo 2-1-8).



Photo 2-1-7. A bridge nearby Jia Xian Bridge remained intact. The river was filled with debris.



Photo 2-1-8. Landslides in the surrounding mountains.

c) Sept 5, 2009; 1:35 pm ( $23^{\circ}04'32''$   $120^{\circ}36'44''$  elev 458 m)

Along Wenhua Road (文化路), a debris flow inundated a residence and crossed over the road. Boulders of different sizes were observed (Photo 2-1-9).



Photo 2-1-9. Debris flow that originated from the mountain buried a home.



Photo 2-1-10. Overview of debris flow at the road (after cleaning up), leading to a stream on the right.

## 2.2 Taoyuan (桃源鄉)

In the area near Gao Chung (高中) along Baojian Road (寶建路) (Sept 5, 2009; 2:46 pm, 23°07'50"N 120°42'54"E elev 535 m), significant landslides occurred.

Not far from Taoyuan Village (桃源鄉) (2:43 pm; 23°08'24"N 120°43'47"E elev 558 m), a debris flow occurred. The abutment of a bridge failed, leading to the failure of the superstructure. See also the cover photo, which was taken from the end of the bridge.



Photo 2-2-1. Failure of the abutment and superstructure of a bridge.



Photo 2-2-2. Significant slope failure on both sides of the road in Jia Xian Village.

### 2.3 Baolai (寶來)

Sept 5, 2009; 2:20 pm



Baolai is an inland resort village, well known for its hot springs. At Baolai, significant scouring occurred along the banks of the river. Buildings were buried by debris or washed away by flooding. The gate of a temple was seen hanging on the bank after significant erosion [Photo 2-3-1; 23°06'39"N 120°42'17"E elev 399 m].

Landslides occurred over an extended length of Shinbao Road (新寶路) [Photo 2-3-2; 23°06'36"N 120°42'34"E elev 436 m]. Buildings and a hotel located at the river bank were partially buried by the debris [Photos 2-3-3, 2-3-4; 23°06'36"N 120°42'29"E elev 413 m].

One of the abutments of Baolai Bridge #2 (L=174.4 m; 23°06'41"N 120°42'18"E elev 398 m) was damaged (Photo 2-3-5; ). The depth from Bridges #1 and #2 to the water was reduced from 10+ m to just a few meters due to debris deposition (Photo 2-3-6). A building located at the north end of the village, close to Bridge #2, was damaged by the debris (Photo 2-3-7; 23°06'40"N 120°42'12"E elev 399 m). Landslides were seen along the sides of the river, at the northern end of the map (Photo 2-3-8; 23°06'48"N 120°42'08"E).



Photo 2-3-1. "Hanging Gate" of a temple [Location 1]



Photo 2-3-2. Large scale landslides along Shinbao Road [Location 2]



Photo 2-3-3. First floor of a hotel buried by debris [Location 3]



Photo 2-3-4. Buildings damaged by scouring and debris flow [Location 3]



Photo 2-3-5. Damaged abutment and deck of Bridge #2 .



Photo 2-3-6. The vertical clearance of Bridge #2 was significantly reduced by debris deposition.



Photo 2-3-7. A building near Bridge #2 was damaged by the debris flow.



Photo 2-3-8. Large-scale slope failure near the river bank [Location 4]

#### **2.4 Shinkai (新開部落)**

Sept 5, 2009; 3:59 pm (23°03'36"N 120°40'48"E elev 372 m)

In the village of Shinkai, 32 persons were buried alive by a debris flow. The village was cut off for many days due to the damage of its bridge. Buildings were covered by material deposited from the debris flow. Several buildings were excavated, leaving behind ponds of water.



Photo 2-4-1. Debris flow at Shinkai Village.



Photo 2-4-2. Excavation of buried buildings.



Photo 2-4-3. Car remains found near the village.