**SURFACE FAULT RUPTURE AND XIAO YU DONG BRIDGE**
**12 May 2008 Wenchuan, China Earthquake**
**Dr. Elizabeth Hausler**
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## OVERVIEW

The $M_w$7.9 earthquake in Wenchuan, China on 12 May 2008 was catastrophic in terms of lives lost and buildings destroyed or damaged: 69,185 people killed, 374,171 injured, 18,467 still listed as missing. More than 7.79 million houses were destroyed, and 24.5 million damaged. Some villages have few to no buildings that remain standing.

*Fig 1.* Collapsed westernmost spans of four-span, reinforced concrete arch bridge at Xiao Yu Dong. IMG0047.

**USGS reports that the earthquake was the result of motion on a northeast striking reverse fault or thrust fault. The USGS centroid moment tensor solution indicates strike of 2° and dip of 47°. This short report contains observations on what is likely a surface expression of fault rupture, which passed through a bridge approach. Permanent ground displacement and strong shaking appear to have contributed to heavy damage and partial collapse of the bridge.**

Observations were made by Dr. Elizabeth Hausler during a field reconnaissance to the earthquake-affected area between 15 and 24 June 2008. Dr. Hausler's visit to Sichuan was coordinated through the 10 + 10 Strategic Partnership between the University of California system and 10 universities in China. This report is one in a series of observations on residential buildings and bridges.

Dr. Hausler is a graduate of the civil engineering program at University of California, Berkeley and the Founder and CEO of Build Change, an international non-profit engineering company that designs and trains builders and homeowners to build earthquake resistant houses in developing countries. See www.buildchange.org and contact elizabeth@buildchange.org. Comments, questions, and additional observations are welcome.

The visit was made possible by Dr. Gretchen Kalonji on the UC side and Profs. Guan Ping and Tang Ya on the Sichuan University side. Dr. Hausler was hosted by Prof. Li Bixiong, the director of the civil engineering department at Sichuan University. Kind assistance from all parties, including several students at Sichuan University, is greatly appreciated.

*Exact positions are not available. Upon learning that visitors had been detained for traveling with GPS units in China, I opted to leave my GPS unit in left luggage at Jakarta airport. More detailed location information is available upon request.*

## Surface Fault Rupture

Permanent ground displacement, which appears to be surface expression of fault rupture, is evident in farmland approximately 20 km past Pengzhou, toward Xiao Yu Dong. The north-northwest-trending rupture passes through the east approach of an E-W, four-span, reinforced concrete arch bridge. The west side appears to have moved up and away from the east side.

*Fig 2.* Permanent ground displacement, south side of bridge looking south, curved but trending NNW. West side moved up approximately 1.2m relative to east side. Possible extension to west. IMG0395

*Fig 3.* Permanent ground displacement, south side of bridge looking north-northwest, standing on the east (down block). West side moved up 1.2m relative to east side. IMG0404

*Fig 4.* Permanent ground displacement, south side of bridge looking west, standing on the east (down block). West side moved up 1.2m relative to east side. IMG0402

*Fig 5.* Continuation of surface expression of fault rupture on the north side of bridge, strike NNW. IMG0396

**Xiao Yu Dong Bridge**

The four span, reinforced concrete arch bridge was in the following condition at the time of the site visit (from East to West). East Approach:

- Heave on the west end of the approach, consistent with the permanent ground displacement in the farmland (Fig. 6)
- Collapse or cave in of the base supporting the road, near the first deck (Fig. 7 and 8)
- Displacement of the road 3-3.5m to the West on to the deck of the first span (Fig. 9).

*Fig 6.* Heave in east bridge approach, looking west. Crack is consistent with NNW-trending ground scarp. IMG0012

*Fig 7.* South side of east approach, looking ENE. IMG0015

*Fig 8.* Collapse of road fill, east approach. Looking West. IMG0065

*Fig 9.* Displacement of road deck from east approach on top of first span, offset by over 3m west and twist to the north. Looking East. IMG0414

Easternmost Span: Partially collapsed, reinforced concrete arch and spandrel elements fractured at joints. East approach moved west relative to the bridge deck, and/or the span lengthened because of arch failure and broadening.

*Fig 10.* Easternmost span, east approach and abutment have moved west and/or arch has expanded due to fracture in RC elements. IMG0014

*Fig 11.* Relative displacement of east abutment and deck of easternmost span. IMG0020

*Fig 12.* Fracture in spandrel elements. IMG0018

*Fig 13.* Fracture at connection between arch and abutment. IMG0019

*Fig 14.* Spandrel element fractures. IMG0030

*Fig 15.* Horizontal displacement of easternmost span (right) to the east. IMG0031

2nd Span (from the East): No apparent displacement (Fig. 16).
3rd Span and 4th (Westernmost) Span: Collapsed. The west approach was not accessible.

*Fig 16.* No damage to 2nd span from the east (shown at left). IMG0032

*Fig 17.* Spandrel supports, between 1st and 2nd spans from the east. IMG0033

*Fig 18.* Collapsed deck in 3rd span (shown at left). IMG0037

*Fig 19.* View from collapsed deck fo 3rd span, looking east at 2nd span. 3rd span appears to have shifted south. IMG0056

*Fig 20.* Collapsed deck and spandrel elements, 3rd span looking east. IMG0040

*Fig 21.* Fracture at spandrel connection, note lack of concrete confinement. IMG0041

*Fig 22.* Collapsed 3rd and 4th spans. IMG0039

*Fig 23.* Pier between 3rd and 4th spans, not clear if pier displacement caused the collapse, or the pier was pushed west by the collapsing deck. IMG0048

*Fig 24.* Damage at top of arch, 3rd span. IMG0053

*Fig 25.* View of collapsed 4th (westernmost) span, from 3rd span. 4th span displaced south relative to west approach. IMG0057

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