

Cape Mendocino, California, April 25-26, 1992

(Photographs provided by Tom Varner (EERI 1989) and Laura Varner, Dames & Moore.)

Overview. During April 25-26, three earthquakes of magnitude 6 or greater occurred in a 24-hour span in the Petrolia area of Humboldt County, California. The first, and largest, was magnitude 7.0 near Petrolia, and was the strongest earthquake in California since Loma Prieta in 1989. The second (magnitude 6.0) and third (magnitude 6.5) events were off the coast of Cape Mendocino. There was building damage to older wood frame buildings in Ferndale, Rio Dell, Fortuna, and Scotia.

Seismology and Geology. An instrument at Cape Mendocino (2.5 miles epicentral distance) recorded a peak acceleration of 2g lasting 0.1 to 0.2 seconds during the magnitude 7.0 shock. This is the highest acceleration ever recorded in California, but it may be attributable to instrument malfunction or local ground failure. Three faults meet near Mendocino; the San Andreas Fault is to the south, the Cascadia subduction zone is to the north, and the Mendocino Fault is to the west. There is a broad zone of deformation between the faults, and the resulting structure is quite complex. If the main shock was on the Cascadia subduction zone, it would be the first to rupture it. Geological evidence indicates that there have been five events of magnitude 8 or greater in the past 1700 years 250 km north of the triple junction. The magnitude 6.5 event produced an unusual amount of energy, was felt further away than the main shock, and produced additional damage around the epicenter. Preliminary observation by the USGS indicates that there were approximately six to seven miles of the Humboldt Coast that experienced a seismic uplift of one-half to one



Kitchen in the Ferndale Volunteer Fire Station



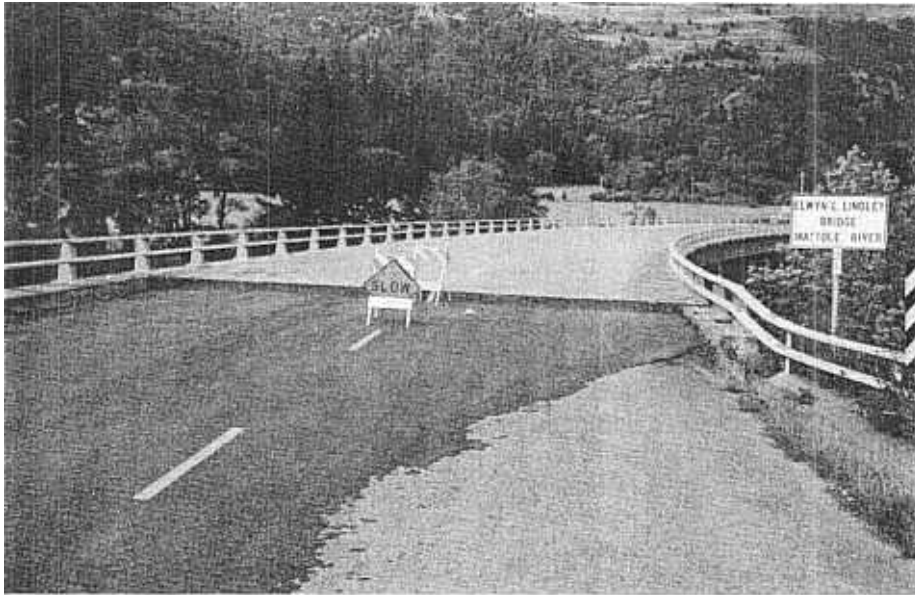
Damage to a Victorian house in Ferndale

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Strong Motion Records. A number of strong motion records were

obtained. Of particular interest was the 2g or greater peak acceleration recorded at Cape Mendocino, discussed earlier, and a 0.69g record obtained in Petrolia. Acceleration levels of 1.25g were recorded at an abutment of the Painter Street Overcrossing, while the ground acceleration was 0.55g. Details are in California Division of Mines and Geology CSMIP Report OSMS 92-04.

Building Damage. Most of the buildings that suffered damage in this earthquake were wood frame houses and 1 and 2-story wood frame commercial buildings. Homes slid off foundations. Chimneys collapsed. Stucco walls cracked and unreinforced masonry parapets failed. Buildings designed to meet seismic codes did well. Main Street in Ferndale is a three block long historic area, of wood construction and western facades. Ferndale suffered more damage than the other cities; a number of damaged historic buildings of Victorian architecture are to be



Approximately 6" of settlement occurred at the approach to the Lindley Bridge over the Mattole River



Soil movement at the Lindley Bridge abutment

restored, based on the provisions of the California State Historical Building Code. Many owners were interested in strengthening, not only repairing, their buildings. In the Historical Building Code, life safety is the minimum level required for repair and strengthening. Non-compliant materials may be used for resisting elements.

Public Schools. Twenty-two public schools in the area were inspected.

There was no evidence of damage in 12 school buildings. Ten experienced minor non-structural damage, ranging from stucco and plaster cracks to some minor cracks in structural members.

CALTRANS Bridges. Over 50 bridges were inspected. A few were closed temporarily, but none remained closed after inspection. Many bridges showed signs of movement. The Van Duzen River Bridge, an 800 foot steel girder bridge, had minor cracks in its piers. North Van Duzen, a 750 foot concrete arch, developed cracks in a few columns connecting the arch to the superstructure. The water line to Rio Dell failed at its transition onto the southbound Eel River Bridge. The northbound Eel River Bridge was base isolated; although there were signs of substantial movement, the system performed well.

(Ron Hamburger, Sam Swan, David Cocke, Andy Michael, James Gates, and Patrick Campbell contributed material for the preceding sections of this report.)

Other Lifelines. Lifelines (transportation, water, electric power

and communications) performed well except for a few instances.

U.S. Highway 101 remained open with some temporary closures for bridge inspection and cleanup of minor landslides. Most of the highway bridges closest to the epicenters experienced settlement of the fill adjacent to the bridge abutments and concrete spalling at joints. Local roads had some closures for inspection, cleanup, and minor repairs.

The North Coast Railroad operates between Willits and Eureka transporting gravel and lumber. The two trains operating on the day of the first earthquake were stopped in accordance with company policy. Trains were cleared to proceed to their terminals after the tracks, tunnels and bridges were inspected. On the next day, Sunday, a normal non-operating day, a more detailed inspection was made. The tracks were cleared of minor loose landslide material and were rebalasted at one location of minor settlement. There was no settlement at bridge abutments. Train service returned to normal on Monday without a loss of service.

The most significant loss of water service occurred in the city of Rio Dell when their 8-inch water main broke at the riser at the abutment of the southbound Eel River Bridge. The break caused the supply tanks to drain, leaving the city without a water supply. An emergency potable supply was provided by the American Red Cross, National Guard, and Anheuser Busch, Inc. Fire protection was supplied by contractor tank trucks. Water supply to the city was restored four days later on April 29th.

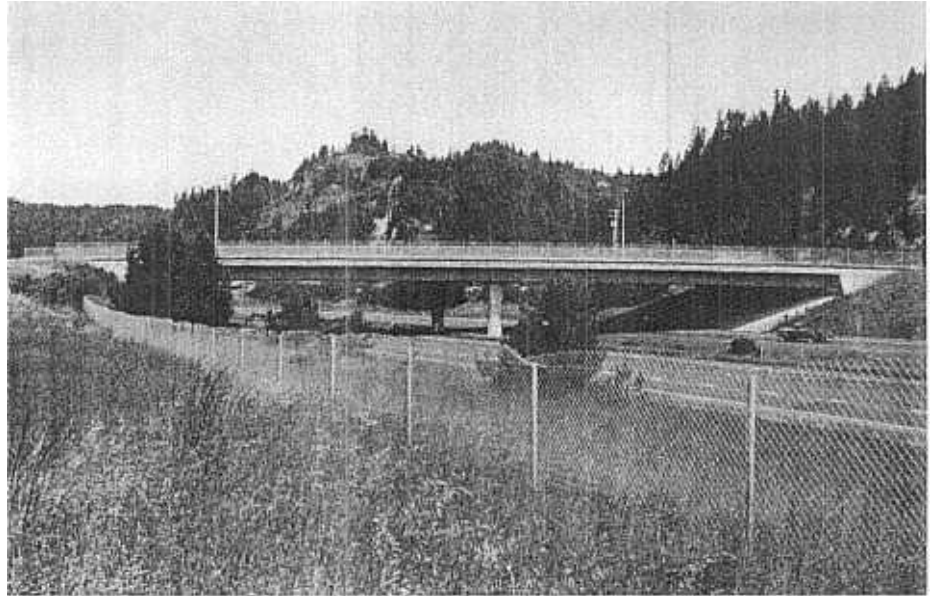
Scotia, across the Eel River from Rio Dell, has separate water supply systems for domestic and fire protection. The fire protection system was damaged and was

inoperable. A fire destroyed Scotia's four-store shopping center after the second earthquake. The California Office of Emergency Services provided the town with a portable piping system and pump which was installed by the Scotia Volunteer Fire Department. It was available for service on April 28th. There was no reported damage to the domestic water system.

The water and sewer systems in Ferndale continued to function. In Fortuna, there was a power loss to a sewer pumping plant, but there were no reported sewer spills. The communities and cities in the Eureka area are served by a regional water agency which stores runoff in Ruth Lake Reservoir on the Mad River. The dam and small hydroelectric plant (2 megawatts) continued to perform satisfactorily, as did other portions of the distribution system.

Electric power is supplied by a regional entity which had power outages ranging from seconds to several hours. Sources of power are a fossil fuel generating station, three transmission lines from outside the area, and several co-generation facilities in the area. The peaking unit operating at the time of the first event tripped off and could not be started again due to condenser tube leaks and low water levels in the steam drum. The other peaking unit was "hot" and took 6 hours to reach operating output. It then tripped during the second event. Despite these events, there was adequate power supply because of the availability of the outside sources. Local outages were caused by transformer fires, wires welded together, wires slapping together, and wires burning down. Most lifelines and essential services had emergency generator back-up power supplies for their critical facilities.

Natural gas supply is provided by a regional entity via a 12-inch high-



Painter Street Bridge - 1.25g recorded at top deck

pressure main from the Sacramento Valley and a very small supply from a local gas field. Ferndale and other smaller communities rely on bottled gas. Gas mains responded well in bridge structures even though the bridges were subject to slight displacement. There were no underground gas leaks in the distribution system; however, there were some small leaks at meter risers due to corrosion or falling debris. In Rio Dell and Fortuna approximately 50 service connections were shut off due to structural damage or leaks.

As in past earthquakes, the most significant interruption of gas service was the unnecessary turn-off of gas. There were 1190 services turned off unnecessarily in Scotia, Rio Dell, and Fortuna. The regional gas agency crews, with assistance of personnel from the San Francisco Bay area, went from house to house to relight the services.

At the regional telephone company, there was no damage to central offices or telephone equipment, except for the loss of two 25-pair cables. There was the usual telephone congestion when the number of calls exceeded the

capacity of the system. The company initiated load control, restricting incoming calls to Humboldt County for a few hours after the earthquakes.

There are six AM/FM radio stations and three television stations serving the area. Most lost their signals when they lost power supply. Some of the stations had to obtain emergency generators to restore service. The radio frequency shared by several emergency organizations became congested. The organizations involved are considering using separate frequencies in the future.

The Humboldt County Emergency Operation Center in Eureka was activated and other cities and agencies activated their EOC's. There was a separate public service answering point (PSAP), 911 service, for the county unincorporated areas and the city. Amateur radio operators were used by several agencies.

(Lifelines information excerpted from a report by Le Val Lund and Anshel Schiff, prepared for the ASCE TCLEE Earthquake Investigation Committee.)



Landslide on the Mattole Road between Petrolia and Ferndale caused tree to fall on overhead lines

Preliminary Conclusions

It is not too soon to make a few observations on lessons learned relating to earthquake resistant design and construction.

First, the California earthquakes are testimony to the advances in seismic design and construction. Buildings and bridges designed to current practice performed very well.

Second, where current standards are not followed or obvious problems, such as unreinforced masonry parapet walls, are not corrected, failures are likely to occur.

Finally, retrofit can be successfully accomplished. Especially encouraging was the observation that retrofitting using base isolation technology was successful for buildings as well as bridges. Although the methods were not severely tested in these earthquakes, these trial runs were certainly satisfactory.

The earthquake engineering professions can pause for a moment and take pride in their accomplishments to date. As the old ad went, "You've come a long way, baby!"

James Lefter, Project Manager, EERI Learning From Earthquakes



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Philippine Islands, May 18-19, 1992

Two strong earthquakes, magnitudes 7.3 and 6.8, struck just offshore of the Philippine Islands approximately 600 miles southeast of Manila on May 18 and 19. At the time of preparation of this newsletter, there were no casualty, damage, or tsunami reports. This was the strongest earthquake in the area since a magnitude 7.3 earthquake on March 15, 1934.

(Joshua Tree, cont. from page 3)
CALTRANS Bridges. Of 48 bridges examined after the earthquake, 13 showed signs of movement, with 9 suffering some minor damage. None of the bridges suffered damage significant enough to affect its capacity to carry traffic. Bridges with monolithic details performed best. Steel girder and precast concrete I-girder bridges were capable of moving and did, resulting in minor damage. The most significant damage was to the Jackson Street Overcrossing and Overhead in Indio, which lost both abutment backwalls from the steel girders banging against them during the earthquake. The Palm Springs Overhead abutments had concrete spalls. Many bridges were retrofitted after the 1968 Palm Springs earthquake and they performed well. Among them was the Colton Interchange, about 60 miles west of the earthquake, a prestressed concrete box girder. It was heavily instrumented by the California Division of Mines and Geology and a peak acceleration of 0.20g was recorded. Some soils effects were observed: settlement behind abutments, soil pushed away in front of abutments, air spaces between soil and columns.

(Condensed from a report prepared by Mark Yashinsky and submitted to EERI by James Gates.)