SURE Database

A compilation of field-based datasets for PFDHA and further development

A Worldwide and Unified Database of Surface Ruptures (SURE) for Fault Displacement Hazard Analyses

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Key points

- **User-friendly format**
  - Shapefiles and tables can be easily implemented by worldwide geologists with their own datasets

- **Open access**
  - SRL Data mine paper
  - ESC Fault2SHA website

- **Long-living**
  - European Seismological Commission (ESC) guarantee
  - IRSN – french public institution- will take over

- **Content**
  - 45 earthquakes from magnitude 5–7.9
  - More than 15,000 coseismic surface deformation observations & and 56,000 of segments
  - 22 earthquake cases are from Japan, 15 from United States, 2 from Mexico, Italy, and New Zealand, 1 from Kyrgyzstan, Ecuador, Turkey, and Argentina.
  - 24 earthquakes are strike-slip faulting events, 11 are normal, and 10 are reverse faulting

→ PhD thesis of Fiia Nurminen: new historical cases, especially reverse faults (~10), will be soon implemented
Principal rupture (net slip up to 2.1 m)

Secondary and antithetic rupture (net slip <0.6 m)

Shapefile of rupture segments with related table

Observation points

Shapefile of slip measurements with related table

M6.5 Norcia earthquake (Italy)
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
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</thead>
</table>
| Basic Information | - **Id**: Segment ID  
- **IdS**: Observation of rupture ID  
- **IdO**: Date of observation  
- **Id**: Initial Reference  
- **ObS**: Source of data  
- **ObO**: ID provided by observer  
- **Long**: Longitude in decimal degrees (WGS84)  
- **Lat**: Latitude in decimal degrees (WGS84)  
- **Elev**: Elevation in meters  
- **Slp**: Strike slip (SS)  
- **Ssl**: Sense of slip (SS)  
- **Uc**: Uncertainty horizontal (+/-) (SS) in meters.  
- **Mn**: Max and min values (SS) in meters.  

| Horizontal component of fault displacement | - **Large-aperture offset (SS) and uncertainty**: Corresponds to the total strike component of fault displacement, including that on the discrete fault plane and off-fault flexure, if any.  
- **Aperture Width (SS)**: Width of the band where large-aperture offset is accommodated.  
- **Fault-normal component (heave) (FNS) and sense of relative displacement**: In meters.  
- **Scl**: Shortening (S) or lengthening (L)  
- **Opr**: Opening  
- **Vth**: Vertical throw (VT) (m)  
- **Vup**: Upside  
- **Vuc**: Uncertainty vertical (+/-) (VT) in meters.  
- **Mn**: Max and min vertical (VT) in meters.  
- **Large-aperture Offset (VT) (m) and uncertainty**: Corresponds to the total vertical component of faultsurface displacement (throw), including that on the discrete fault plane and off-fault flexure, if any.  
- **Aperture Width (VT)**: Width of the band where large-aperture offset is accommodated.  
- **Vsl**: Vertical slip (VS) (m) and uncertainties in meters. Free-face slip fail.  

+ many other variables (local geology, structural complexity, ...)

![Discrete slip](image)
Contribution of Optical Correlation data to SURE Analysis of off-fault deformation in the triple junction area of 2016 M7.8 Kaikoura earthquake rupture

1. Definition of a single Main Fault trace (Cosi-Corr, ROI)

2. 120 swath profiles, 90 m wide, defined each 500 m; length ~ 9 km


- Pléiades (post) v SPOT (pre)
- MicMac software
- Spatial resolution 1.8 m
Profile analysis

- ENVI-CosiCorr ‘Stacking profiles’ tool
  - Horizontal components of slip only
- Export profiles data to Excel
  - Adjust the far-field fit on each side of defined fault (ROI)
  - Analyze simultaneously both components
  - Estimate uncertainties

<table>
<thead>
<tr>
<th></th>
<th>Width FROM CENTER (km)</th>
<th>550 pixel</th>
<th>250 pixel</th>
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<tbody>
<tr>
<td>Left side</td>
<td>0.990 km</td>
<td></td>
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<tr>
<td>Right side</td>
<td>0.450 km</td>
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</tbody>
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Deformation Width 1.4 km

Parallel Slip 12 m
Fault slip and deformation width

- In places, total deformation is accommodated over large widths (1-3 km) according to geodesy

- Dextral motion on Kekerengu-Jordan
- Sinistral motion on Papatea
- Contraction around Kekerengu and Papatea
- Lengthening around Jordan & triple junction
• Slip distribution Jordan-Kekerengu
  – Total deformation (red curve) from geodesy exceeds field-measured values
  – Deformation zone widens north of the Papatea / Jordan intersection
SURE and its future

• Improvement
  – Complete the existing database with local geology & structural complexity information
  – New cases with field-based data

• Optical Correlation data
  – In which form?
    • Latitude, Longitude of intersection point between fault and profile
    • ‘Large aperture width’ and ‘Large aperture offset’
  – Pros
    • Complete the field measurements with a dense set of values spanning the whole rupture
    • Heave is accessible (often difficult to measure in the field)
  – Cons
    • No access to vertical component for most of the captured earthquakes
    • Depending on images’ resolution, direct access to the balance between discrete slip and warping may not be accessible without field measurement
    • Existing tool (Cosi-Corr) could be adapted for fault displacement analysis

• Collaboration
  – International community (SURE) <-> U.S. PFDHI community
    • Exchange of data and concepts
    • Common publications