20-10 FAULT RUPTURE

Introduction

Structures crossing faults may be subjected to ground displacement during earthquakes. Fault rupture hazard analyses shall be added to the scope of Structure Preliminary Geotechnical Reports (SPGRs), Preliminary Foundation Reports (PFRs), and Final Foundation Reports (FRs) at locations:

- where any portion of a structure falls within an Alquist-Priolo Earthquake Fault Zone.
- where any portion of a structure falls within 300 m [1,000 ft] of an unzoned fault (not in an Alquist-Priolo Earthquake Fault Zone) that is Holocene or younger in age.

Responsibilities

The Project Geologist/Geotechnical Engineer (Project G/GE), with the assistance of a geologist experienced in fault evaluations, shall be assigned lead responsibility for determining the need for further study of fault rupture and for developing recommendations, based on the above criteria. To ensure cross-functional input, the Project G/GE, a representative from the Office of Earthquake Engineering, and the Bridge Project Engineer should meet to discuss the fault rupture hazard and potential impacts to the structure, and determine the scope of any needed fault studies.

If the project is being designed for Caltrans by external entities, then the Caltrans Geologist/ Geotechnical Engineer responsible for oversight of the project (Oversight G/GE) is responsible for ensuring the recommendations and requirements of this memorandum are followed.

Methodology

If further study of the fault rupture is needed, then procedures as outlined in CGS Note 49 shall be followed. Fault investigations shall typically be conducted in coordination with the preliminary foundation investigation and as early in the design process as possible.

If a fault crosses or is very near the structure or proposed structure alignment, then a design fault offset shall be determined as the larger of the:

- deterministically derived average displacement.
- probabilistically derived displacement consistent with a 5% in 50-years probability of exceedance.

Probabilistic procedures should follow those outlined in Abrahamson, (2008) and Petersen et al, (2011). These procedures allow for site-specific offset prediction obtained from field investigation and this approach is recommended when the value of a more accurate fault offset estimate exceeds the added cost of the investigation. All recommendations, regardless of whether deterministically or probabilistically derived, must include an evaluation of the displacement potential off mapped fault traces following the procedures of Petersen et al, (2011). When the deterministically derived predicted fault offset is much larger than the probabilistically derived predicted fault offset, a risk assessment study is recommended to justify the potentially large cost associated with designing for fault offset.

Fault rupture potential including fault location and geometry, design fault offset (if any), and any need for further study, shall be addressed in the preliminary and final foundation reports.

Project Impact

Once the need to consider fault rupture has been established for a project, the impact on project scope, schedule, and cost shall be determined and appropriate action taken as established in MTD 20-8, *Analysis of Ordinary Bridges that Cross Faults*.

References

California Geological Survey (2012), Alquist Priolo Earthquake Fault Zone Maps: http://www.quake.ca.gov/gmaps/ap/ap_maps.htm

Petersen, M., and others, Fault displacement hazard for strike-slip faults: Bulletin of the Seismological Society of America, Vol. 101, No. 2, pp. 805–825. (2011)

California Geological Survey (2002), Guidelines for evaluating the hazard of surface fault rupture, CGS Note 49: http://www.conservation.ca.gov/cgs/information/publications/cgs_notes/note_49/Documents/note_49.pdf

Abrahamson, N., Appendix C, Probabilistic Fault Rupture Hazard Analysis, San Francisco PUC, General Seismic Requirements for the Design on New Facilities and Upgrade of Existing Facilities. (2008)

Caltrans, MTD 20-8, Analysis of Ordinary Bridges that Cross Faults.

Barton J. Newton
State Bridge Engineer
Deputy Division Chief, Structure Policy & Innovation
Division of Engineering Services